



PROSPECTUS 2020-21

Admission Schedule Fall-2020

Application Deadline (All Programs)	(Tuesday) 4 th Aug, 2020
CBT Schedule Islamabad Multan A&AC Kamra Lahore MS/PhD CBT	(4-Stations) (Wednesday - Thursday) 22nd– 30th July & (Wednesday - Saturday) 5th- 8th Aug, 2020 (Thursday-Friday) 6th – 7th Aug, 2020 (Wednesday - Thursday) 5th – 6th Aug, 2020 (Monday- Tuesday) 10th Aug-11th Aug, 2020 (Tuesday - Wednesday) 11th – 12th Aug, 2020
Eid-UI-Azha Holidays 31 st July – 3 rd Aug, 2020	
Announcement of Merit Score (U/G Programs)	(Thursday) 13 th Aug, 2020
Portal Open for Candidates to Change Program Preference	(Thursday-Sunday) 14 th – 16 th Aug, 2020
Declaration of Final Merit List (U/G Programs)	(Monday) 17 th Aug, 2020
MS/PhD Interviews	(Tuesday- Wednesday) 18 th – 19 th Aug, 2020
Fee Deadline 1 st Merit List (U/G)	(Friday) 21 st Aug, 2020
Announcement of 2 nd Merit List (U/G Programs)	(Saturday) 22 nd Aug, 2020
MS/PhD Admission Announcement	(Friday) 21 st Aug, 2020
Fee Deadline 2 nd merit List (U/G)	(Wednesday) 26 th Aug, 2020
MS/PhD 1 st Payment Deadline	(Wednesday) 26 th Aug, 2020
Declaration of follow-up merit list as per vacant slots (U/G and P/G Programs)	Thursday 27 th Aug- Friday 4 th Sep, 2020
Orientation Day	(Monday) 14 th Sep, 2020
1 st Day of Classes	(Tuesday) 15 th Sep, 2020

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WELCOME TO AIR UNIVERSITY



Vice Chancellor's Message



It is indeed a privilege to lead Air University, a vibrant hub of academic distinction, with a strong notion of concept based learning and a culture of research and innovation. Cognizant of the dynamics of higher education, the highly qualified and dedicated faculty and staff of Air University help nurture a knowledge driven atmosphere.

In a transforming globalized environment, it will be my endeavour to foster creativity and expression to enable our graduates to contribute at the national and global level. My keen focus would remain on synergizing multidisciplinary research to accrue benefits of upcoming creative technologies. You will find the Air University campus brimming with life, offering modern facilities and opportunities to engage academically, socially and culturally. The expansion of Air University horizons to three new state of the art campuses, reflects the reputation and acclaim of the programs offered. On behalf of the Air University team, I welcome you to a challenging, inspiring and rewarding experience.

My prayers and regards for your well-being.

Air Marshal Javaid Ahmed, HI(M) (Retd)



VISION

Air University aspires to be among the leading national universities, excelling in teaching, learning, research, innovation and public service.

MISSION

The mission of Air University is to achieve excellence in teaching and research for producing graduates with sound professional knowledge, integrity of character, a keen sense of social responsibility and a passion for lifelong learning. The University shall stand committed to creating an environment conducive for attracting the best students, faculty and supporting staff for contributing to the development of a prosperous, peaceful and enlightened society.



Welcome to Air University

Air University is a federally chartered Public Sector University established in 2002. The campus is located near the Margalla foothills in the south east corner of sector E-9 (PAF Complex) of Islamabad. The main entrance is adjacent to the intersection of Agha Shahi Avenue (9th Avenue) and Khayaban-e-Iqbal (Margalla Road).

The University is a degree awarding autonomous institution and its graduates are offered good placement opportunities in the job market.

The University promotes research in all disciplines. Faculty members are encouraged to help develop the education system and curricula of the university using their experience and research. Faculty development and updating of courses are given high priority and are undertaken as a regular academic requirement.

ISLAMABAD

Islamabad, the capital of Pakistan, is located in the Potohar Plateau in the north west of the country. This city was built during the sixties to replace Karachi as Pakistan's capital. Rawalpindi is considered its sister city because of the proximity of the two cities. Islamabad is a well-organized, modern city built round a master plan of self-contained sectors, each with its own shopping areas and parks. It is home to the Federal Parliament, Supreme Court, President's Secretariat, Prime Minister's Secretariat, Federal Ministries and corporates offices of all major public, private, national and multinational organizations.

The young city of Islamabad is preceded by thousands of years of history. This is the site of one of the earliest human settlements in Asia, and is at one end of the ancient Indus Valley civilization. Stone implements made near Islamabad on a mass scale were once sent down to the lower reaches of the River Indus. This is probably where the early migrations from Central Asia of Indo-European tribes made their first settlements. The large number of languages still spoken in the Northern Areas is evidence of the different races that have left their marks on this region, races as disparate as Alexander's Macedonians and Tamurlane's Central Asians. The banks of the River Soan in Islamabad were hosts to stone-age man over seven thousand years ago, and human skulls dating back to 5,000 years B.C. have been found in and around this city.



AIR UNIVERSITY BOARD OF GOVERNORS

1.	Air Chief Marshal Mujahid Anwar Khan, NI(M) Chief of the Air Staff, PAF	Chairman
2.	Air Marshal Ahmer Shehzad, HI(M) Vice Chief of the Air Staff, PAF	Member
3.	Air Marshal Syed Noman Ali, HI(M) Chairman PAC Board Kamra	Member
4.	Air Marshal Aamir Masood, HI(M), S Bt Deputy Chief of the Air Staff (Training)	Member
5.	Senator Nauman Wazir Khattak Senate of Pakistan	Member
6.	Air Marshal Javaid Ahmed, HI(M) (Retd) Vice Chancellor, Air University, Islamabad	Member
7.	Air Vice Marshal Ahmad Hassan, HI(M) Deputy Chief of the Air Staff (Engineering)	Member
8.	Mrs. Farah Hamid Khan Secretary, Ministry of Federal Education and Professional Training	Member
9.	Captain (R) Nasim Nawaz Secretary, Ministry of Science and Technology	Member
10.	Dr. Tariq Banuri Chairman, Higher Education Commission	Member

11.	Dr. Nabeel Hayat Malik, HI, SI Chairman NESCOM	Member
12.	Air Vice Marshal Tubrez Asif, HI(M) (Retd) President, PAF-Karachi Institute of Economics & Technology	Member
13.	Prof Dr Muhammad Hafizullah Former Vice Chancellor, Khyber Medical University, Peshawar	Member
14.	Mr. Imtiaz A Rastgar Managing Director, Rastgar Engg Co (Pvt) Ltd	Member
15.	Air Commodore Muhammad Saleem (Retd), SI(M) Registrar Air University, Islamabad	Secretary

Programs Offered

Main Campus

UG PROGRAMS	
1	Bachelor of Electrical Engineering (Electronics, Power & Telecom)
2	BE in Mechanical Engineering
3	BE in Mechatronics Engineering
4	BE in Biomedical Engineering
5	Bachelor of Computer Engineering
6	BS in Computer Science
7	BS in Artificial Intelligence
8	BS in Information Technology
9	BS in Cyber Scurity
10	BS Gaming & Multimedia
11	BS Software Engineering
12	Bachelor of Business Administration (Hons)
13	BS Accounting & Finance
14	BS Aviation Management
15	BS Healthcare Management
16	BS Tourism & Hospitality Management
17	BS Mathematics
18	BS Physics
19	BS English
20	BS Psychology
MS/M.Phil Programs	
21	MBA 2-Year
22	MS Business Analytics
23	MS Aerospace Engineering
24	MS Applied Physics
25	MS Avionics Engineering
26	MS Computer Science
27	MS in Data Science
28	MS in Gaming and Multimedia

29	MS in Artificial Intelligence
30	MS in Systems Security
31	MS in Electrical Engineering
32	MS in Linguistics
34	MS in Information System
35	MS in Linguistics & Literature
36	MS in Mechanical Engineering
37	MS In Management Sciences
38	MS in Project Management
39	MS Mathematics
40	MS Mechatronics
41	M.Phil Education
42	MS Clinical Psychology
43	MS in Strategic Studies
PhD Programs	
44	PhD Aerospace Engineering
45	PhD Computer Science
46	PhD Avionics Engineering
47	PhD Electrical Engineering
48	PhD Linguistics & Literature
49	PhD Linguistics
50	PhD Mechanical Engineering
51	PhD Management Sciences
52	PhD Mathematics
53	PhD Mechatronics
54	PhD Physics
55	PhD Information Security
56	PhD Cyber Security

Note:

1. To facilitate scholars from industry and organizations, most of the graduate programs for MS and PhD degrees are available in the evening.
2. A wide range of specialized academic streams are available provided a sufficient number of scholars opt for a given stream.
3. An academic Advisor is assigned soon after enrollment to get the thesis work completed in the minimum possible time. A wide selection of research topics is available to satisfy individual professional aspirations.
4. To further the cause of higher education, a very nominal tuition fee is charged for the MS and PhD

AIR UNIVERSITY AEROSPACE AND AVIATION CAMPUS KAMRA

**AIR UNIVERSITY AEROSPACE AND AVIATION CAMPUS AUAAC
AT KAMRA, ATTOCK, PAKISTAN
(A NEW AVIATION CAMPUS OF AIR UNIVERSITY)**



Air University Aerospace & Aviation Campus Kamra (AU-A&AC)

- **Introduction:**

The Air University Aerospace & Aviation Campus Kamra has been established as a center of excellence for postgraduate studies and research & development in aviation related fields. The institute aims to support the nascent aeronautical as well as other associated high-tech industries in Pakistan through multi-disciplinary research in navigation systems, guidance and control systems, active & passive surveillance systems, digital signal processing, microwave circuit design, communication systems, integration, structures, fluid dynamics and aerospace propulsion systems etc.



AU-A&AC Vision

Air University Kamra Campus aspires to be among the leading national universities, excelling in teaching, learning, research, innovation and public service specially related to Aviation Industry.

AU-A&AC Mission

The mission of Air University Kamra Campus is to achieve excellence in teaching and research for producing graduates both in Aviation and other disciplines with sound professional knowledge, integrity of character, a keen sense of social responsibility and a passion for lifelong learning. The University shall stand committed to creating an environment conducive for attracting the best students, faculty and supporting staff for contributing to the development of a prosperous, peaceful and enlightened society.

Objectives

- To produce highly qualified trained professionals having the necessary skills to meet the needs of aviation industry.
- To identify, acquire and develop core technologies to stay abreast with the state-of-the-art R&D.
- To provide expertise and assistance for technology absorption in industry.
- To provide a forum for exchange of knowledge both within and outside Pakistan through seminars, conferences, symposia and workshops etc.
- To solve practical problems faced by public and private sector industries and organizations.
- To provide consultancy services to public as well as private sector in specialty areas.
- To collaborate with universities & research institutes and industry in the friendly countries in education, training, research and development.

- Regular induction and retention of highly qualified professionals trained within and outside Pakistan.

Campus Director Message

I appreciate your interest in Air University and assure you that you are making a right choice. As our prospective student, you will find that our campus is equipped with the state of the art laboratories and engineering facilities. Air University offers unique opportunities for academic, social, and personal growth.

Central to the University's mission is the faculty's dedication to excellence in teaching, research and the development of a fertile learning environment. The faculty and staff of Air University engage in ongoing assessment and improvement of the curriculum and other university programmes to meet the needs of students and the community. Additionally, the University strongly stresses character development that includes cultural, social and ethical values.

Dean AU-A&AC Kamra message:

I am pleased to welcome you at Air University Aerospace & Aviation Campus Kamra, which is a cornerstone of our Patron in chief's vision of promoting concept of academia industry linkage for the usability of academia towards socio- economic development of Pakistan and creating a sustainable R&D ecosystem that will enable the Pakistani aviation industry to provide indigenous solutions to PAF, sister services and civil aviation. This vision led to the induction of first cohort of graduate students in MS Programmes of Aerospace Engineering and Avionics Engineering in April 2017. Efforts are at hand to focus on multi-disciplinary research in navigation systems, guidance and control systems, active & passive surveillance systems, digital signal processing, microwave circuit design, communication systems, integration, structures, fluid dynamics and other related areas. Our aim is to establish and expand our campus with the addition of new programmes in such a way that this campus produces outstanding professionals with excellent knowledge base, professional integrity & ethical values and intellectually strong enough to undertake assignments in the fields of higher studies, innovation and development.

Inauguration of Campus





MULTAN CAMPUS

Being a federally chartered public sector university, AIR University can operate all over Pakistan. One of the major objectives of establishment of Multan Campus is to serve the nation in this particular region. Southern Punjab consists of four divisions, Multan, Sahiwal, Bahawalpur and Dera Ghazi Khan. A large numbers of students from this region desiring higher education in Management Sciences and Computer Science & Engineering move to educational institutions in Lahore, Islamabad or Karachi.

Multan is geographically well placed to serve not only these four divisions, but also the adjoining areas of Sind, Balochistan, and Khyber-Pakhtunkhwa. Considering the large number of students seeking admission to the courses of the kind offered by AIR University Islamabad, the Prime- Minister directed for the establishment of the Multan Campus of the University. The management conducted a feasibility study and decided to set up two faculties: Applied and Basic Sciences, and Administrative Sciences, in Phase I of the plan, to be followed by engineering disciplines in Phase II. The Air University Multan Campus is established in the heart of the city in a rented building named Khan Centre on Abdali Road in the Cantt. area of the city.

Now in the suburbs of Multan, the University has started constructing its purpose-build spacious Campus from April 04, 2017. It will help us offer more variety of programmes particularly Engineering along with Business Administration, Computer Science, Mathematics, etc. Thus, students opting for engineering programmes such as mechanical, civil, electrical, and aeronautical, etc. will find quality education and an environment of learning at their door steps.

The campus is closely linked with the parent departments of the main campus and has established a regular mechanism of knowledge-sharing with them. The Multan campus is linked through PERN with the main campus. The facility of teleconferencing has been provided. The class lectures of Islamabad campus and talks of world renowned scholars are also available in the campus.

In the beginning, the University started with two departments of Business Administration and Computer Sciences and offered limited programmes. However, today, by God's Grace, the University offers admission in the following areas in spite of its space constraints:

1) Business Administration

- BBA
- BS Accounting and Finance
- MBA 1.5 Year
- MBA 3.5 Years
- MS Management Sciences

2) Computer Science

- BSCS
- MSCS
- MSc in Mathematics
- Masters in Computer Science

Detailed information about these programs along with admission eligibility criteria, admission schedule and courses is provided hereafter in the prospectus.

Director AU Multan Campus

Prof. Dr. Hayat Muhammad Awan

Director Multan Campus

Former Dean Faculty of Commerce, Law and Business Administration of Bahauddin Zakariya University (BZU) Multan, Prof. Dr. Hayat Muhammad Awan has joined Air University as Director Multan Campus. Dr. Awan has also served as the Acting Vice Chancellor of BZU on various occasions. Dr. Awan has experience of over 43 years in teaching, research and leadership. After earning his PhD and MS degrees from University of Toronto, Canada, Dr. Awan joined University of Wisconsin, Madison as an Assistant Professor. He re-joined Bahauddin Zakariya University as an Assistant Professor in 1982. Over the next thirty years, besides teaching, he served BZU in various administrative posts, including Director Sub-Campus DG Khan; Chairman, Board of Faculty of Commerce, Law and Business Administration; Director Institute of Management Sciences; Chairman, Board of Studies Business Administration; and Chairman Department of Statistics.

Prof. Awan was the recipient of HEC Best Teacher Award in 2003, and won first prize for his research paper in the 1st Global Islamic Marketing Conference in Malaysia in 2007 and 4th Global Islamic Marketing Conference 2013, Istanbul Turkey.

Dr. Awan is an author of more than 70 international research publications and has attended various conferences and workshops around the world. He has also supervised research theses of over hundred students working towards PhD and MS degrees

Chair, Department of Computer Sciences & Engineering, Multan Campus



Prof. Dr. Aman Ullah Khan

**Chair, Department of
Computer Sciences and Engineering AU's Multan
Campus**

Prof. Dr. Aman Ullah Khan joined AU's Multan Campus as the Chair of Department of Computer Sciences and Engineering. After receiving an MSc degree in Applied Mathematics from a university in Multan, Dr. Khan secured Masters and PhD degrees in Computer Sciences from Wales, UK. Dr. Khan has over 33 years of teaching experience at various prestigious institutions, including

King Khalid University, Saudi Arabia. Besides teaching experience, Dr. Khan also brings with him extensive administrative and leadership experience. He has led the departments of Computer Sciences at Bahauddin Zakariya University Multan, Department of Computer Science CIITWAH, and as Dean Faculty of Information Sciences & Technology, Islamabad.

ADMISSION CRITERIA FOR ACADEMIC PROGRAM AT AIR UNIVERSITY CAMPUS MULTAN

PROGRAMS	DURATION	ELIGIBILITY CRITERIA
BBA (Honours)	4 years	FA/FSc (Pre-Engg/Pre-Med) or equivalent with 50% or more marks. Admission Test & Interview.
BS Computer Science	4 years	I.C.S (Math, Physics & Computer), F.Sc. Pre Engineering; OR equivalent (minimum 50% marks). Admission Test & Interview.
BS Accounting and Finance	4 years	FA/FSc (Pre-Engg/Pre-Med) or equivalent with 50% or more marks. Admission Test & Interview.
MBA	1- ½ years	BBA Hons.(124-136 Cr. Hrs.), Min 2.0 CGPA or 60% marks in BBA Hons. Admission Test & Interview
MBA	3- ½ years	BA/BSc./B.Com with 50% marks or equivalent Admission Test & Interview
MS Computer Science	2 years	BSCS Hons (4 years)/ MCS with minimum CGPA 2.00/4.00 or equivalent. GRE General/ GAT General Test (at least 50% score) requires for admission in MS Program. This must be passed before the date of admission in MS Program Admission Test & Interview.
MCS	2 years	Bachelor Degree with Mathematics or Computer Science from recognized university having Minimum 50 % marks. Candidates who qualify the Admission Test will appear in an interview for final selection

MS Management Sciences	18 months	Minimum 16 years of education, preferably in a business related field, (MBA/MPA/M.Com/ACMA/ACA/B.Com 4 years program) and BBA Hons. 4 years program (124-136 Cr. Hrs.) with at least 60% marks or 2.5 CGPA. For award of MS degree HEC requires GRE General / GAT-General test (at least 50% score), that must be taken before or during the first semester of the MS program. Admission Test and Interview
MSC Mathematics		Bachelor Degree with Mathematics from recognized university having Minimum 50 % marks. Candidates who qualify the Admission Test will appear in an interview for final selection.

FACULTY & RESEARCH

Highly qualified and experienced faculty comprising MPhils and mostly of PhDs are the hallmark of Air University Multan Campus. Most of them are foreign qualified with many years of teaching and research experience at both national and international levels. Since the university has the policy of promoting research and innovation in all disciplines, the faculty members are committed towards developing a competitive and progressive research culture in the campus. Its reflection is evident in their publication of a good number of research papers in the international and national journals of well repute every year. In the year 2017-18, the number of publications produced by the faculty is thirty (30).

1. Dr. Kaleem Razzaq Malik; Associate Professor

Education: PhD (Semantic Web); University of Engineering and Technology Lahore

Research Interest: Big Data, Internet of Things, Software Define Networking, Brain Informatics

Other Areas of Professional Competence: Database, Programming, Machine Language, Web Engineering

2. Dr. Muhammad Abbas; Assistant Professor

Education: PhD in Economics (Islamic Banking and Finance), Bahauddin Zakariya University, Multan

Research Interest: Economics, Islamic Finance

Other Areas of Professional Competence: Economics, Finance, Banking, Islamic Finance, Quantitative (SPSS, Eviews, Solver, DEAP)

3. Dr. Muhammad Tahir Yaqoob; Assistant Professor

Education: PhD in Linguistics, Bahauddin Zakariya University Multan;

Research Interest: Critical Discourse Analysis, Gender Politics through Semiotics, Language Ideology

Other Areas of Professional Competence: Critical Discourse Analysis, Semantics, ELT

4. Dr. Muhammad Sanaullah; Assistant Professor

Education: PhD (Computer and Control Engineering); Politecnico di Torino-Italy

Research Interest: Semantic Web, Artificial and Ambient Intelligence, Smart Environment, Ubiquitous and Perceive computing, Remote Patient Care Systems, Semantically Natural Language Processing, Formal Method, and Model Checking

Other Areas of Professional Competence: Compiler Construction

5. Dr. Zeeshan Ahmad; Assistant Professor

Education: PhD (Management Science-Agricultural Economics & Management); NORTHEAST AGRICULTURAL UNIVERSITY, Harbin, China.

Research Interest: Brand Management, Hospitality and tourism management.

Other Areas of Professional Competence: International Marketing, International Business Management, Marketing Strategy, Strategy Brand Management, Interpersonal Communication Skills and Public Speaking, Advance Research Methodology

6. Dr. Abdul Rauf; Assistant Professor

Education: PhD (Algebra, Affine Algebraic Geometry) Jacobs University Bremen, Germany JUB

Research Interest: Algebra, Affine algebraic geometry, Fluid Mechanics

Other Areas of Professional Competence: Fluid Mechanics, Algebra.

7. Dr. Adnan Ahmed Sheikh; Assistant Professor

Education: PhD (Marketing); Universiti Utara Malaysia, Sintok, Malaysia

Research Interest: Digital Marketing

Other Areas of Professional Competence: Business-to-Business Marketing, Marketing Management, Organization Performance, E-Marketing, Sales Promotion ,Branding, Strategic Marketing, Market Research, Human Resource Management (HRM, HRD, Career Management, Organization Development), e-Commerce/ e-business

8. Ayesha Afzal; Assistant Professor (on study leave for Ph. D)

Education: PhD Scholar at LUMS, MS in Computer Science; Lahore University of Management Sciences

Research Interest: Application Security

Other Areas of Professional Competence: Information Security, Computer Communications and Networks, Design and Analysis of Algorithms.

9. Ahmad Mohsin; Assistant Professor (on study leave for Ph. D)

Education: PhD Scholar, MS in Computer Science; National University of Computing &

Emerging Sciences Lahore Research Interest: Software Eng., Software Requirement Eng., Software Architecture, Nonfunctional Requirements for Web Apps.

Other Areas of Professional Competence: RE in Global SE, CBSE, NFRs for Mobile & Web based Applications, Architectural Issues in web2.0 Mobile Applications.

10. Muhammad Zubair Akbar; Assistant Professor

Education: Ph.D (Thesis submitted), MS (Mathematics); Bahauddin Zakariya University, Multan

Research Interest: Applied Mathematics and Fluid Mechanics (NANO Fluids)

Other Areas of Professional Competence: Fluid Mechanics, Numerical Analysis, Multi Variable Calculus, Differential Equation.

11. Muhammad Zia-ul-Haq; Lecturer (on study leave for Ph. D)

Education: PhD Scholar (China), Master Degree in International Business (Jonkoping International Business School Sweden)

Research Interest: Innovation & Business Creation, Entrepreneurial Growth, Management, Organizing & Leading Change.

Other Areas of Professional Competence: Creative Marketing, Advanced Supply Chain Management, (Integration and Alliance) Microfinance and new business creation, Organizational Behavior

12. Ahmad Nabeel Siddiquei; Lecturer (on study leave for Ph. D)

Education: PhD Scholar (Bond University, Australia), BBA Honors, MBA; Bahauddin Zakariya University Multan

Research Interest: Marketing (Best research paper award in the 4th Global Islamic Marketing Conference, Istanbul, Turkey)

Other Areas of Professional Competence: Services Marketing, Brand Management, Supply Chain Management

13. Muhammad Ramzan; Lecturer

Education: PhD Scholar at BZU, BBA Honors, MBA; Bahauddin Zakariya University Multan.

Research Interest: Accounting & Finance

Other Areas of Professional Competence: PEACHTREE, SPSS, EVIEWS 7

14. Nabeel Younus; Lecturer

Education: PhD Scholar at AU Islamabad, BBA Hons. MBA; Bahauddin Zakariya University Multan

Research Interest: Marketing/Sales Management

Other Areas of Professional Competence: Sales Management, Marketing Strategies, Supply Chain Management

15. Bushra Ghufuran; Lecturer (on study leave for Ph. D)

Education: PhD Scholar (Germany), BBA Honors, MBA Finance, CFA LEVEL III Candidate; Bahauddin Zakariya University, Multan.

Research Interest: Behavioral Finance

Other Areas of Professional Competence: Investment Analysis and Portfolio Management, Risk Management, Derivatives and Fixed Income Securities, Financial Reporting and Analysis, International Finance.

16. Falak Nawaz; Lecturer (on study leave for Ph. D)

Education: PhD Scholar (Australia), MS in Information Technology (Object-Oriented Software Engineering

Specialization), School of Electrical Engineering and Computer Science (SEECs), NUST, Islamabad;

Research Interest: Semantic Web, Multi-agent systems, Free and open source softwares

Other Areas of Professional Competence: Machine learning, Stream reasoning, Smart cities.

17. Usama Najam; Lecturer (on study leave for Ph. D)

Education: PhD Scholar (Malaysia), MBA/MS (HR), FAST (National University of Computer and Emerging Sciences)

Research Interest: Human Resource Management

Other Areas of Professional Competence: Training and Development, Compensation Management and Strategic HR Research, Qualitative & Quantitative Research Method (EViews, AMOS, SPSS).

18. Sadia Ishaque; Lecturer

Education: PhD Scholar at BZU, MS in Management Sciences (HRM), National University of Modern Languages, Multan

Research Interest: Employee Behavior

Other Areas of Professional Competence: Organizational Behavior

19. Nadir Munir Hassan; Lecturer

Education: PhD Scholar at BZU, MS in Management Sciences (Marketing), Bahauddin Zakriya University, Multan

Research Interest: Marketing and Supply chain Management

Other Areas of Professional Competence: Advertising and Media Planning Sales Management

20. Omer Farooq; Lecturer

Education: PhD Scholar at BZU, MS in Management Sciences (Marketing); Muhammad Ali Jinnah University-Islamabad

Research Interest: Marketing, Branding, Celebrity Endorsement

Other Areas of Professional Competence: Media and Promotion

21. Moin Ahmad Moon; Lecturer

Education: PhD Scholar (Zabist, Islamabad), MS in Management Sciences (Marketing); Muhammad Ali Jinnah University-Islamabad

Research Interest: Consumer Buying Behavior

Other Areas of Professional Competence: Impulsive Buying Behavior, Compulsive Buying Behavior, Green Consumption Behavior, Recycling Behavior, Ecological Behavior.

22. Tariq Naeem; Lecturer

Education: MS (Computer Sciences); University of Peshawar, Peshawar

Research Interest: Natural Language Processing, Machine Learning, Corpus Linguistics, Natural Language Processing/Artificial Intelligence, Computational Intelligence, Machine Learning, Industry 4.0

Other Areas of Professional Competence: Software Architecture & Design, Introduction to Artificial Intelligence, Database Systems, Research Methods and Techniques, Techniques and Methods of Software Development

23. Aatka Ali; Lecturer

Education: MS (Computer Sciences); UET, Lahore, Lahore

Research Interest: Artificial Intelligence, Software Design & Architecture, Software Engineering, Enterprise Management Information System, E-Infrastructure Development

Other Areas of Professional Competence: Visual Programming, Object Oriented Programming, Operating System

24. Umme Habibah; Lecturer

Education: PhD Scholar (IBA Sukhar), MS ((Commerce); Bahauddin Zakriya University, Multan

Research Interest: Behavioral Finance, Asset Pricing Models

Other Areas of Professional Competence: Financial Statement Analysis, Financial Management, Managerial Accounting, Managerial Accounting and Cost Control

25. Allah Ditta; Lecturer

Education: PhD Scholar (BZU), MS (Management Sciences); Air University Multan Campus

Research Interest: Accounting and Finance

Other Areas of Professional Competence: Introduction to Business Finance, Advanced Financial Management, Financial Accounting, Managerial Accounting

26. Syed Shabbar Raza Zaidi; Lecturer

Education: MS (Computer Sciences) Network Communication Principle and Practice- University of Hertfordshire, London

Research Interest: Network Security, Computer Network

Other Areas of Professional Competence: Network Security, Object Oriented Programming, Network and Information Security

AUMC Alumni:

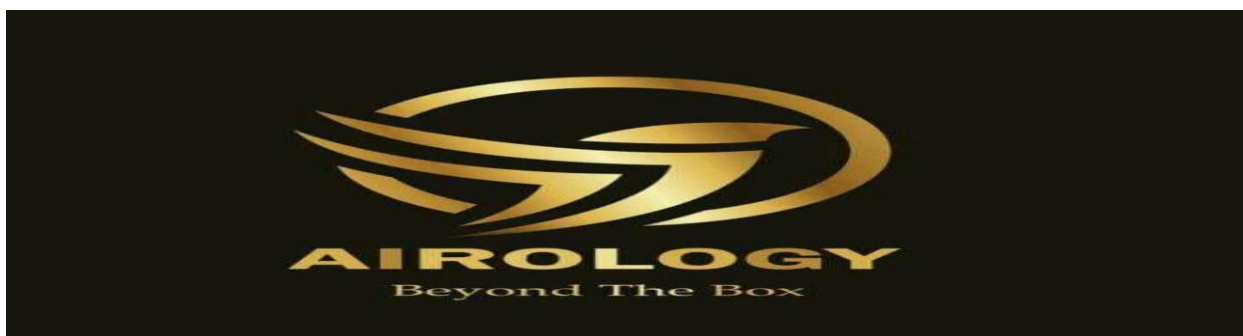


A team of dedicated students under the supervision of faculty has been formed to be in a permanent contact with Alumni of AUMC. In order to materialize it, the following activities are conducted on regular basis in the campus:

- Seminars
- Workshops
- Internship engagement.
- Job Hunt

In this regard, an AUMC Alumni social media page is existing with almost 300 Likes. This Page is regularly operated and, quite importantly, it has been found a very useful forum for availing internships and jobs etc. And an Alumni Wall has also been created on Campus in this regard.

Airology – a Platform to Boost Students Confidence:



Along with academic knowledge, it is very important to polish interpersonal skills of students to help them be better professionals. For this purpose, Airology is a unique platform to help students learn the art of conducting a seminar by themselves and to invite experts from the industry for motivational talks.

LITERARY SOCIETY

This society conducts competitions of speeches, debates, quizzes, vocabulary, cultural show etc. It also ensures students' participation in competitions organized by other universities. The objective is to equip the students with skills of communication, oratory, argumentation, etc so that they may perform distinctively in their practical lives. The society also collects information of different events for university newsletter and magazine.

SPORTS SOCIETY

Since healthy mind is not possible without healthy body, Sports Society regularly organizes indoor as well as outdoor games for the students. During the student week, a proper schedule is prepared to ensure students' active participation in games.



ISLAMIC SOCIETY

The Islamic Society is an active instrument. The objective of Islamic Society is to educate the students about Islamic teachings and motivate them to practise them in their lives. For this purpose, the Society frequently holds competitions of naat, qiraat, and quizzes and lectures/talks of prominent scholars.

DRAMATIC SOCIETY

This society arranges a number of dramas and plays not only originally written, directed and produced by the students but also enact the ones written by prominent dramatists. Particularly during the student week, it creates an entertaining and healthy environment and spirit of competition among the students. However, throughout the year it organizes drama competitions, skit competitions, movie show, documentary show and many more. The activities of the society help students identify their artistic talents and enhance them on society's platform.

BLOOD DONORS SOCIETY

The Blood Donors Society functions to organize seminars and trainings by qualified doctors and registered blood societies to raise awareness among students about blood donation. The society has compiled data and updates it on regular basis about the students' blood groups. In this way, it has indeed become a ray of hope for one who needs blood for life of near and dear ones any time.



EXCURSION & INDUSTRIAL TOUR SOCIETY

This society provides real life exposure by unfolding mysteries of professional life. It also facilitates industrial learning to mitigate the gap between academic and industrial knowledge among the students. Finally, it provides students exposure to Pakistani culture and life in various parts of the country.

SEMINARS & WORKSHOPS



Seminars and workshops are an important source of gaining knowledge since they provide students an opportunity to interact, learn and develop liaison with business professionals and companies. We frequently invite highly qualified and experienced professionals from different academic and business fields to share their expertise related to their specific fields. It greatly helps our students learn about new business ideas, policies and even issues emerging in their respective fields. Moreover, in addition to guidance for careers, seminars provide students an opportunity to share their subject-related queries and their scope and impact on the society with the resource persons. Thus keeping in view all these benefits, the university aims at conducting more and more seminars and workshops for its students.



INDUSTRIAL TRIPS

Theoretical studies need to be supplemented with practical orientation in the modern era to equip students with conceptual knowledge of their subjects. A best key to it is frequently-organized industrial trips for the students. Being aware of this fact, Air University organizes such trips for its students on regular basis. Glimpses of some recent industrial trips have been given below.

RECREATIONAL TOURS



The Adventure Club of AUMC frequently organizes various activities for its students. One of its major objectives is to supports its students not only in academics but also in arranging outdoor activities. The Club administers excursions to different areas of Pakistan not only for recreational purposes but also for the physical and mental growth of students. During a trip, participants get a chance to get acquainted with the local environment and culture of different regions in Pakistan. The organizing team of Adventure Club faces different challenges in planning, managing and preparing each trip. This helps them gain leadership qualities and decision-making in their future life. The Club has been successfully run and managed by students from different departments. It organizes different kinds of trips and in summer there are always scheduled trips to the northern areas of Pakistan. The Club envisages new sports such as caving, cliff diving, self-defense, rock climbing, archery, survival courses and many more.



Sports

Playing sports or organizing a sports event provides a wonderful opportunity of learning how to work in a team, how to compete others and how to develop a sportsman spirit. The university highly facilitates and encourages the students to take an active part in games because a sound mind is not possible without a sound body. In this regard, a generous amount is spent to organize the sports gala in an unprecedented way. Both students and faculty actively participate in cricket, football, 100 meter race, tug of war, chess, table tennis and many more.



Admission Eligibility

Bachelor Programs

- [Bachelor of Business Administration \(BBA-Honors\)](#)

The Intermediate (Part I and II) examination of any Board of Intermediate and Secondary Education in Pakistan. Applicants must have scored 50% or more marks.

OR

An examination equivalent to Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad, before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

OR

The GCE 'A' level examination with three subjects. Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad, before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

Applicants awaiting results may be given provisional admission until the declaration of their respective results. Only those scoring 50% or more marks shall be considered. Those scoring less than 50% marks shall have their provisional admissions cancelled and shall be withdrawn from their respective programs.

Applicants scoring minimum passing marks in the Intermediate or in GCE 'A' level or in any other examination equivalent to the intermediate are eligible for admission. Those getting partial pass results due to any reason, or who are required to appear in compartment/supplementary paper(s), are not eligible for admission even if their aggregate marks are 50% or more in their respective examination.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and NOT 50%.

The candidates who qualify the Admission Test will only be offered admission as per position in merit list.

- [Bachelor of Science Aviation Management \(BS AviMgt\)](#)

The Intermediate (Part I and II) examination of any Board of Intermediate and Secondary Education in Pakistan. Applicants must have scored 50% or more marks.

OR

An examination equivalent to Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad, before the

semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

OR

The GCE 'A' level examination with three subjects. Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad, before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

Applicants awaiting results may be given provisional admission until the declaration of their respective results. Only those scoring 50% or more marks shall be considered. Those scoring less than 50% marks shall have their provisional admissions cancelled and shall be withdrawn from their respective programs.

Applicants scoring minimum passing marks in the Intermediate or in GCE 'A' level or in any other examination equivalent to the intermediate are eligible for admission. Those getting partial pass results due to any reason, or who are required to appear in compartment/supplementary paper(s), are not eligible for admission even if their aggregate marks are 50% or more in their respective examination.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and NOT 50%.

The candidates who qualify the Admission Test will only be offered admission as per position in merit list.

- [Bachelor of Electrical Engineering / Bachelor of Mechatronics Engineering / Bachelor of Mechanical Engineering / Bachelor of Computer Engineering](#)

Applicants must have passed: Intermediate (Part I and II) examination with Physics, Chemistry and Mathematics from any Board of Intermediate and Secondary Education in Pakistan. Applicant must have scored 60% or more marks.

OR

An examination equivalent to Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in Intermediate.

OR

GCE 'A' level examination with three subjects (Physics, Chemistry, and Math.). The candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in Intermediate.

Applicants awaiting results shall be given provisional admission until declaration of their respective results. Applicants scoring 60% or more marks shall only be granted admission. Those scoring less than 60% marks shall have their provisional admission cancelled and they shall be withdrawn from their respective program. Upon announcement of results, only those applicants shall be granted admission, who pass ALL the subjects and score at least 60% marks. Applicants getting partial pass result, due to any reason, or required to appear in compartment /

supplementary paper(s) shall not be eligible for admission, even if their aggregate marks are 60% or more.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 59.9% is considered 59.9% and NOT 60%.

The candidates who qualify the Admission Test will only be offered admission as per position in merit list.

- **Bachelor of Science in Computer Sciences (BSCS)**

Applicants must have passed: The Intermediate (Part I and II) examination with Physics, Mathematics and Chemistry or Computer Studies from any Board of Intermediate and Secondary Education in Pakistan. Applicant must have scored 50% or more marks.

OR

An examination equivalent to the Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter-Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

OR

The GCE 'A' level examination with three subjects (Physics, Math and Chemistry or Computer Study). Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

Applicants awaiting results may be given provisional admission until declaration of their respective results. Only those scoring 50% or more marks are considered. Those scoring less than 50% marks shall have their provisional admissions cancelled and shall be withdrawn from their respective programs. Upon announcement of results, only those applicants shall be granted admission, which pass ALL the subjects and score at least 50% marks. Applicants getting partial pass result due to any reason, or who are required to appear in compartment/ supplementary paper(s), are not eligible for admission even if their aggregate marks are 50% or more.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and NOT 50%.

The candidates who qualify the Admission Test will only be offered admission as per position in merit list.

Note:

As per the revised eligibility criteria issued by HEC National Computing Education Accreditation Council (NCEAC) vide notification No. NCEAE/HEC/General/3-20 dated 20th March, 2020, students of Intermediate with Pre-Medical background are now eligible to apply for admission in all Bachelor Computer related programs however; all such students must pass deficiency courses of Mathematics of 6 credit hours within one year of their regular studies.

- **Bachelor of Science in Information Technology (BSIT)**

Applicants must have passed: The Intermediate (Part I and II) examination with Physics, Mathematics and Chemistry or Computer Studies from any Board of Intermediate and Secondary Education in Pakistan. Applicant must have scored 50% or more marks.

OR

An examination equivalent to the Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter-Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

OR

The GCE 'A' level examination with three subjects (Physics, Math and Chemistry or Computer Study). Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

Applicants awaiting results may be given provisional admission until declaration of their respective results. Only those scoring 50% or more marks are considered. Those scoring less than 50% marks shall have their provisional admissions cancelled and shall be withdrawn from their respective programs. Upon announcement of results, only those applicants shall be granted admission, which pass ALL the subjects and score at least 50% marks. Applicants getting partial pass result due to any reason, or who are required to appear in compartment/ supplementary paper(s), are not eligible for admission even if their aggregate marks are 50% or more.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and NOT 50%.

The candidates who qualify the Admission Test will only be offered admission as per position in merit list.

Note:

As per the revised eligibility criteria issued by HEC National Computing Education Accreditation Council (NCEAC) vide notification No. NCEAE/HEC/General/3-20 dated 20th March, 2020, students of Intermediate with Pre-Medical background are now eligible to apply for admission in all Bachelor Computer related programs however; all such students must pass deficiency courses of Mathematics of 6 credit hours within one year of their regular studies.

- **Bachelor of Science in Cyber Security (BSCybSec)**

Applicants must have passed: The Intermediate (Part I and II) examination with Physics, Mathematics and Chemistry or Computer Studies from any Board of Intermediate and Secondary Education in Pakistan. Applicant must have scored 50% or more marks.

OR

An examination equivalent to the Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter-Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

OR

The GCE 'A' level examination with three subjects (Physics, Math and Chemistry or Computer Study). Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

Applicants awaiting results may be given provisional admission until declaration of their respective results. Only those scoring 50% or more marks are considered. Those scoring less than 50% marks shall have their provisional admissions cancelled and shall be withdrawn from their respective programs. Upon announcement of results, only those applicants shall be granted admission, which pass ALL the subjects and score at least 50% marks. Applicants getting partial pass result due to any reason, or who are required to appear in compartment/ supplementary paper(s), are not eligible for admission even if their aggregate marks are 50% or more.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and NOT 50%.

The candidates who qualify the Admission Test will only be offered admission as per position in merit list.

Note:

As per the revised eligibility criteria issued by HEC National Computing Education Accreditation Council (NCEAC) vide notification No. NCEAE/HEC/General/3-20 dated 20th March, 2020, students of Intermediate with Pre-Medical background are now eligible to apply for admission in all Bachelor Computer related programs however; all such students must pass deficiency courses of Mathematics of 6 credit hours within one year of their regular studies.

- **[Bachelor Studies in Accounting and Finance \(BSAF\)](#)**

FA/FSc/I.Com/ICS or equivalent with minimum 50% marks

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and NOT 50%.

The candidates who qualify the Admission Test will only be offered admission as per position in merit list.

- **[Bachelor of Science in English](#)**

FA/FSc or equivalent with minimum 50% marks and at least 55% marks in the subject of English.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and NOT 50%.

The candidates who qualify the Admission Test will only be offered admission as per position in merit list.

- **Bachelor of Science in Physics**

F.Sc., Pre-Engineering OR equivalent with Physics and Mathematics as major subjects, minimum 50% marks.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and NOT 50%.

The candidates who qualify the Admission Test will only be offered admission as per position in merit list.

- **Bachelor of Science in Mathematics**

F.Sc., Pre-Engineering OR equivalent with Mathematics as major subject, minimum 50% marks.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and NOT 50%.

The candidates who qualify the Admission Test will only be offered admission as per position in merit list.

- **Bachelors of Science in Psychology (BS Psychology)**

Applicant seeking admission in BS Psychology should have qualified the Intermediate examination from any Board of Intermediate and Secondary Education in Pakistan 'OR' An examination equivalent to the Intermediate for which such candidates must submit an Equivalence Certificate issued by the Inter-Board Chairman Committee, Islamabad. Applicants must have scored 50% or more marks.

- **Bachelor of Biomedical Engineering (BE Biomedical Engineering)**

Applicants must have passed: Intermediate (Part I and II) examination with Physics, Chemistry and Mathematics/Biology from any Board of Intermediate and Secondary Education in Pakistan. Applicant must have scored 60% or more marks.

OR

An examination equivalent to Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in Intermediate.

OR

GCE 'A' level examination with three subjects (Physics, Chemistry, and Math/Biology.). The candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in Intermediate.

Applicants awaiting results shall be given provisional admission until declaration of their respective results. Applicants scoring 60% or more marks shall only be granted admission. Those scoring less than 60% marks shall have their provisional admission cancelled and they shall be withdrawn from their respective program. Upon announcement of results, only those applicants shall be granted admission, who pass ALL the subjects and score at least 60% marks. Applicants getting partial pass result, due to any reason, or required to appear in compartment / supplementary paper(s) shall not be eligible for admission, even if their aggregate marks are 60% or more. The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 59.9% is considered 59.9% and NOT 60%.

- **BS HEALTHCARE MANAGEMENT**

The Intermediate (Part I and II) examination of any Board of Intermediate and Secondary Education in Pakistan. Applicants must have scored 50% or more marks.

OR

FSC/ Pre-Medical, Pre-Engineering or equivalent (minimum 12 years) with at least 50% marks.

- **BS TOURISM AND HOSPITALITY MANAGEMENT**

The Intermediate (Part I and II) examination of any Board of Intermediate and Secondary Education in Pakistan. Applicants must have scored 50% or more marks.

OR

FSC/ Pre-Medical, Pre-Engineering or equivalent (minimum 12 years) with at least 50% marks.

- **Bachelor of Science in Gaming & Multimedia**

Applicants must have passed: The Intermediate (Part I and II) examination with Physics, Mathematics and Chemistry, or Computer Studies from any Board of Intermediate and Secondary Education in Pakistan. Applicant must have scored 50% or more marks

OR

An examination equivalent to the Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter-Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination

OR

The GCE 'A' level examination with three subjects (Physics, Math and Chemistry or Computer Study). Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

Applicants awaiting results may be given provisional admission until declaration of their respective results.

Only those scoring 50% or more marks are considered. Those scoring less than 50% marks shall have their provisional admissions cancelled and shall be withdrawn from their respective programs.

Upon announcement of results, only those applicants shall be granted admission, which pass all the subjects and score at least 50% marks.

Applicants getting partial pass result due to any reason, or who are required to appear in compartment/ supplementary paper(s), are not eligible for admission even if their aggregate marks are 50% or more.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and not 50%.

Note:

As per the revised eligibility criteria issued by HEC National Computing Education Accreditation Council (NCEAC) vide notification No. NCEAE/HEC/General/3-20 dated 20th March, 2020, students of Intermediate with Pre-Medical background are now eligible to apply for admission in all Bachelor Computer related programs however; all such students must pass deficiency courses of Mathematics of 6 credit hours within one year of their regular studies.

- **Bachelor of Science in Software Engineering**

Applicants must have passed: The Intermediate (Part I and II) examination with Physics, Mathematics and Chemistry, or Computer Studies from any Board of Intermediate and Secondary Education in Pakistan. Applicant must have scored 50% or more marks

OR

An examination equivalent to the Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter-Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination

OR

The GCE 'A' level examination with three subjects (Physics, Math and Chemistry or Computer Study). Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

Applicants awaiting results may be given provisional admission until declaration of their respective results.

Only those scoring 50% or more marks are considered. Those scoring less than 50% marks shall have their provisional admissions cancelled and shall be withdrawn from their respective programs.

Upon announcement of results, only those applicants shall be granted admission, which pass all the subjects and score at least 50% marks. Applicants getting partial pass result due to any reason, or who are required to appear in compartment/ supplementary paper(s), are not eligible for admission even if their aggregate marks are 50% or more.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and not 50%.

Note:

As per the revised eligibility criteria issued by HEC National Computing Education Accreditation Council (NCEAC) vide notification No. NCEAE/HEC/General/3-20 dated 20th March, 2020, students of Intermediate with Pre-Medical background are now eligible to apply for admission in all Bachelor Computer related programs however; all such students must pass deficiency courses of Mathematics of 6 credit hours within one year of their regular studies.

Bachelor of Science in Artificial Intelligence

Applicants must have passed: The Intermediate (Part I and II) examination with Physics, Mathematics and Chemistry, or Computer Studies from any Board of Intermediate and Secondary Education in Pakistan. Applicant must have scored 50% or more marks

OR

An examination equivalent to the Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter-Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination

OR

The GCE 'A' level examination with three subjects (Physics, Math and Chemistry or Computer Study). Such candidates are required to submit an Equivalence Certificate issued by the Inter Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in the Intermediate examination.

Applicants awaiting results may be given provisional admission until declaration of their respective results.

Only those scoring 50% or more marks are considered. Those scoring less than 50% marks shall have their provisional admissions cancelled and shall be withdrawn from their respective programs.

Upon announcement of results, only those applicants shall be granted admission, which pass all the subjects and score at least 50% marks. Applicants getting partial pass result due to any reason, or who

are required to appear in compartment/ supplementary paper(s), are not eligible for admission even if their aggregate marks are 50% or more.

The absolute value of percentage is considered as final; it is not rounded off to the next whole number, e.g., 49.9% is considered 49.9% and not 50%.

Note:

As per the revised eligibility criteria issued by HEC National Computing Education Accreditation Council (NCEAC) vide notification No. NCEAE/HEC/General/3-20 dated 20th March, 2020, students of Intermediate with Pre-Medical background are now eligible to apply for admission in all Bachelor Computer related programs however; all such students must pass deficiency courses of Mathematics of 6 credit hours within one year of their regular studies.

GRADUATE PROGRAMS

- **[MS /M.Phil in Linguistics and Literature](#)**

Master in English or Four years Bachelor Degree in English with minimum 50% marks from HEC recognized institute or equivalent.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear for an interview for the purpose of final selection.

- **[M.Phil in Education](#)**

B.Ed four years/ BS in Education /B. Ed 1.5 with MA/ B.Ed 2.00 with BA/ M.Ed/ MA Education/ MA EPM with minimum 2.0/4.0 or 50% marks from any HEC recognized University/ Institute.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidate will appear for an interview for the purpose of final selection.

- **[Master of Business Administration 1-1/2 Year](#)**

BBA Hons (124-136 Cr. Hrs), with minimum CGPA 2.00/4.00 or equivalent.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear for an interview for the purpose of final selection.

- [MBA 2 Years](#)

Minimum 16 years of education in any discipline (includes Engineering, MBBS, Computer Sciences, and Arts etc.)

Minimum 2.00/4.00 CGPA or 50% marks in annual system

University Admission Test and Interview

- [Master of Business Administration \(Executive\) 2 Years](#)

14 years of education or equivalent with minimum 50% marks.

4 Years work experience is required

Candidates who qualify the Admission Test will appear in an interview for final selection.

- [MS in Applied Physics](#)

Specialization in Renewable Energy / Nano Science & Technology / Computational Physics.

M.Sc Physics / BS Physics / BS Engineering from HEC recognized institute with minimum CGPA 2.00/4.00 or equivalent.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear for an interview for the purpose of final selection.

Master of Science in Data Science

ADMISSION CRITERIA

- 1) For Graduates having BS(CS) **OR**
- 2) Equivalent Degree BS (CS) /BS (Software) 4 Years Degree Program (min 130 credit hours), **OR**
- 3) Computer Science Conversion Course 2 Years Degree Program referred to as "MCS" or "MSc (CS)" **OR**
- 4) 16 year Science (Statistics, Mathematics), **OR**
- 5) BS Bioinformatics and Engineering (Computer Engineering, Software Engineering, Electrical Engineering) graduates are eligible but they have to cover deficiency.
- 6) The candidates who are not from CS background need to pass core deficiency courses.
- 7) **Zero Semester:** The deficient students will be filtered out at the time of admission interviews and zero semester will be assigned to them
- 8) At least 50% marks or 2.00/4.00 CGPA

- 9) AU-GAT (Gen) at least 60% score OR NTS-GAT (Gen) at least 50% score. This must be passed before the date of admission in MS Program.
- 10) Candidates will appear for an interview for the purpose of final selection.

Master of Science in Gaming and Multimedia

ADMISSION CRITERIA

- 1) The graduates are eligible to apply who fall in anyone of the following,
- 2) BS(CS), BS(IT), BE(Software), BS(Engineering) **OR**
- 3) Equivalent with 4 Years Degree Program (min 130 credit hours) are eligible but they have to cover deficiency during the degree.

Deficiency Courses:

- i. Programming Fundamentals and OOP (Core Programming Course)
- ii. Data Structures & Algorithms
- iii. Design & Analysis of Algorithms
- 4) **Zero Semester:** The deficient students will be filtered out at the time of admission interviews and zero semester will be assigned to them.
- 5) At least 50% marks or 2.00/4.00 CGPA.
- 6) AU-GAT (Gen) at least 60% score OR NTS-GAT (Gen) at least 50% score. This must be passed before the date of admission in MS Program.
- 7) Candidates will appear for an interview for the purpose of final selection.

Master of Science in Artificial Intelligence

ADMISSION CRITERIA

The graduates preferably having strong analytical skill are eligible to apply who fall in anyone of the following,

- 1) BS(CS), BS/BE(Software), BE(Computer Engineering) BE(Electrical), BE(Mechatronics) 4 years degree program or equivalent with 16 year of education preferably BS(Artificial Intelligence)

Deficient Courses:-

- i. Computer Programming
- ii. Computational Mathematics
- iii. Data Structures
- iv. Analysis of Algorithms
- v. Machine Learning
- vi. Artificial Intelligence
- vii. Probability and Statistics
- viii. Applied Mathematics
- 2) **Zero Semester:** The deficient students will be filtered out at the time of admission interviews and zero semester will be assigned to them.
- 3) At least 50% marks or 2.00/4.00 CGPA
- 4) AU-GAT (Gen) at least 60% score OR NTS-GAT (Gen) at least 50% score. This must be passed before the date of admission in MS Program.
- 5) Candidates will appear for an interview for the purpose of final selection.

Masters of Science in Systems Security

ADMISSION CRITERIA

- 1) Applicant who has done BS in engineering discipline (Telecom, Electrical, Electronics, Computer Engineering, Avionics and Mechatronics Engineering) **OR**
- 2) BS in computing disciplines (Computer Science, Cyber security, Software engineering) or equivalent degree programs are eligible to apply.
- 3) At least 50% marks or 2.00/4.00 CGPA.
- 4) AU-GAT (Gen) at least 60% score OR NTS-GAT (Gen) at least 50% score. This must be passed before the date of admission in MS Program.
- 5) Candidates will appear for an interview for the purpose of final selection.

MS Cyber Security

16 years of education in BS Cyber Security or in any computing discipline with at least 50% marks or 2.00/4.00 CGPA

AU-GAT (Gen) at least 60% score OR NTS-GAT (Gen) at least 50% score. This must be passed before the date of admission in MS Program

Candidates will appear for an interview for the purpose of final selection.

Master of Science in Computer Sciences

16 years education with minimum 130 Credit Hrs in relevant subject (Computer Science, Computer Engineering, Software Engineering or Information Technology.)

At least 50% marks or 2.00/4.00 CGPA

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear for an interview for the purpose of final selection.

- **Master of Science in Aerospace Engineering**

Specialization in Fluid Dynamics/Solid Mechanics

BE/ B.Sc. Engineering (Aerospace/ Aeronautical/ Mechatronics / Mechanical / Chemical) with minimum CGPA 2.00/4.00 or equivalent.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear for an interview for the purpose of final selection.

- [Master of Science in Avionics Engineering](#)

Specialization in Communication Systems Engineering

BE / B. Sc. Engineering (Electrical / Electronics/Avionics/ Computer/ Telecom), Minimum CGPA 2.00/4.00 or equivalent.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear in an interview for final selection.

Specialization in Signal and Image Processing Engineering

BE / B.Sc. Engineering (Electrical/ Electronics/ Avionics/ Computer/ Telecom), Minimum CGPA 2.00/4.00 or equivalent.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear in an interview for final selection.

Specialization in Microwave Engineering

BE / B.Sc. Engineering (Electrical/ Electronics /Avionics), Minimum CGPA 2.00/4.00 or equivalent

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear in an interview for final selection.

- [Master of Science in Information Security](#)

BE / B.Sc. Engineering (Electrical / Computer), BE Software Engg, B.Sc. Computer Science, BIT (4 years), Minimum CGPA 2.00/4.00 or equivalent

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear in an interview for final selection.

- [Master of Science in Electrical Engineering](#)

B.E/B.Sc Engineering (Avionics/ Computer/ Electrical /Electronics/ Mechatronics /Telecom). Fresh graduates are eligible but some relevant industrial experience will help a student gain more from the program.

Minimum CGPA 2.00/4.00 or equivalent.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear in an interview for final selection.

- **Master of Science in Mechatronics Engineering**

BE/B.Sc. Engineering or similar qualification in a relevant discipline. Fresh graduates are eligible but some relevant industrial experience will help a student gain more from the program.

Minimum CGPA 2.00/4.00 or equivalent. Students from other disciplines may be required to take prerequisite courses determined by the Department.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear in the interview for final selection.

- **Master of Science in Management Sciences (18 Months)**

Minimum 16 years of education in a business related field (MBA/MPA/M.Com /ACMA /ACA/B.Com 4 years program) and BBA Hons. 4 years program (124-136 Cr. Hrs.) with at least 2.00/4.00 CGPA or equivalent in last-earned degree from HEC Recognized University/Institute.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates who qualify the Admission Test will appear in an interview for final selection.

MS Business Analytics

HEC recognized degree in a business-related discipline e.g. MBA, BBA, BSA&F, BS Aviation Management, BS Healthcare Management, BS Tourism & Hospitality Management. A minimum CGPA of 2.0 in the semester system or 60% marks in Annual system. Candidates must possess a provable work experience of at least two years in a business related organization. Candidates will appear for an interview for the purpose of final selection.

- **Master of Science in Mathematics**

16 years of education with Major in Mathematics, Minimum CGPA 2.00/4.00 or equivalent.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear in the interview for final selection.

- **Master of Science in Mechanical Engineering**

specialization in Design Engineering/Fluid Power Engineering

BE / B.Sc. Engineering (Aerospace/ Aeronautical /Mechatronics / Mechanical / Chemical) with minimum CGPA 2.00/4.00 or equivalent.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear for an interview for the purpose of final selection.

- **Master of Science in Project Management**

Minimum 16 years of education (with 124-136 Cr. Hrs.) with at least 2.00/4.00 CGPA or equivalent.

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

Candidates will appear for an interview for the purpose of final selection.

- **MS in Strategic Studies (MSSS)**

16 years of education, preferably in (Defense & Strategic Studies, Political Science, Defense & Diplomatic Studies, Peace & Conflict Studies, Government and Public Policy Studies, Security Studies, War Studies, Pakistan Studies, Gender Studies, Energy, Environment, Climate Change Studies, and Area or Regional Studies) with at least 2.00/4.00 CGPA or 50% marks in last-earned degree from HEC Recognized University/Institute

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

MS Clinical Psychology

Applications should have 16 years of education (either BS or MSc in Psychology). A minimum CGPA of 2.0 in the semester system or 60% marks in Annual system

AU-GAT(Gen) at least 60% score OR NTS-GAT(Gen) at least 50% score. This must be passed before the date of admission in MS Program.

MS Bio-Medical Engineering

BE / B.Sc. Engineering (Bio-Medical/ Mechanical/ Electrical, Electronics, Avionics, Aerospace and Mechatronics) with minimum CGPA 2.00/4.00 or equivalent.

AU-GAT (Gen) at least 60% score OR NTS-GAT (Gen) at least 50% score. This must be passed before the date of admission in MS Program

Candidates will appear for an interview for the purpose of final selection.

- **PhD Engineering**

Master degree (18years education) in engineering (with at least 24 credit-hours course work plus 6 credit hours thesis) with a CGPA of at least 3.00/4.00 or equivalent.

AU-GAT(Sub) at least 70% score or NTS-GAT(Sub) at least 60% score or a GRE Subject Test (at least 60th percentile). This must be passed before the date of admission in PhD Program.

Candidates will appear for an interview for final selection.

- **PhD Management Sciences**

Master degree in Management Sciences (24 credit hours course work along with 6 credit hours for thesis) with a CGPA of at least 3.00/4.00 or equivalent.

AU-GAT(Sub) at least 70% score or NTS-GAT(Sub) at least 60% score or a GRE Subject Test (at least 60th percentile). This must be passed before the date of admission in PhD Program.

Candidates will appear for an interview for final selection.

- **PhD Linguistics and Literature**

M.Phil/MS in English or equivalent (24 credit hours course work along with 6 credit hours for thesis) with minimum CGPA 3.00/4.00 or equivalent from an institution recognized by the Higher Education Commission.

AU-GAT(Sub) at least 70% score or NTS-GAT(Sub) at least 60% score or a GRE Subject Test (at least 60th percentile). This must be passed before the date of admission in PhD Program.

Other requirements as stipulated by the Higher Education Commission.

Successful completion of the University's admission procedure.

- **PhD Mathematics**

M.Phil/MS in relevant field (24 credit hours course work along with 6 credit hours for thesis) with CGPA 3.00/4.00 or equivalent

AU-GAT(Sub) at least 70% score or NTS-GAT(Sub) at least 60% score or a GRE Subject Test (at least 60th percentile). This must be passed before the date of admission in PhD Program.

Candidate will appear in an interview for final selection.

- [PhD in Physics](#)

M.Phil/MS in relevant field (24 credit hours course work along with 6 credit hours for thesis) with CGPA 3.00/4.00 or equivalent

AU-GAT(Sub) at least 70% score or NTS-GAT(Sub) at least 60% score or a GRE Subject Test (at least 60th percentile). This must be passed before the date of admission in PhD Program.

Candidates will appear for an interview for final selection.

- [PhD Computer Science](#)

18 years M/Mphil degree in computer science or relevant field with minimum CGPA 3.0 At least 60% score in GRE/NTS GAT (subject) or equivalent Air University Test with at least 70 % score

- [PhD in Information Security](#)

MS / M Phil /Equivalent degree in the relevant area (CS, EE, AvE, CE, IS, Cryptology, Systems Security etc) meeting (24 Cr Hrs coursework plus 6 Cr Hrs of thesis work) with a CGPA of at least 3.00 (on the scale of 4.00) or first division in annual system. GRE/GAT Subject in Information Security, with at least 60% score. In case of non-availability of GRE/GAT Subject in Information/Cyber Security, department would conduct an equivalent test based on HEC guidelines. The applicant has to score 70% in this test for becoming eligible for admission. Candidates will appear for an interview for final selection.

[PhD Cyber Security](#)

18 years M/Mphil degree in computer science or relevant field with minimum CGPA 3.0 At least 60% score in GRE/NTS GAT (subject) or equivalent Air University Test with at least 70 % score

APPLICATION PROCEDURE:

Candidates can apply online for admission by visiting the university's website (<http://www.au.edu.pk>).

Please note that submitting incomplete, false, or misleading information is considered sufficient ground for denial of admission and dismissal at any time.

REQUIRED DOCUMENTS:

The following documents are to be submitted.

UNDER GRADUATE PROGRAMS

- Attested copy of SSC Mark Sheet or its equivalent.
- Attested copy of HSSC Mark Sheet or its equivalent.
- Equivalence certificate from Inter Board Chairman Committee for A level or equivalent qualification from other systems.
- Three fresh passport size photographs with name and admit card number on the back.
- Attested copy of CNIC or Form 'B'.
- Attested copy of domicile certificate.

The following documents are to be submitted at the time of interview:

MASTER'S PROGRAMS

- Attested copy of SSC Certificate/ Marks Sheet or its equivalent.
- Attested copy of HSSC Certificate/ Marks Sheet or its equivalent
- Attested copy of Marks Sheet of Bachelor's degree programme.
- Attested copy of Marks Sheet of Master's degree programme, if applicable.
- Three fresh passport size photographs with name and admit card number on back.
- In case of in-service students, No Objection Certificate (NOC) from the Employer is required to be attached with Application form and routed through Proper Channel or they can submit the same at the time of interview, failing which their admission shall be cancelled.
- Attested copy of NIC.
- PEC Registration Certificate is to be submitted along with the application form for MS Engineering programs.
- Attested copy of domicile certificate.

The following documents are to be submitted at the time of interview:

PHD PROGRAMS

- Attested copy of SSC Certificate/ Marks Sheet or its equivalent.
- Attested copy of HSSC Certificate/ Marks Sheet or its equivalent.
- Attested copy of Marks Sheet of Bachelor's degree programme.
- Attested copy of Marks Sheet of Master's degree programme, if applicable.
- Equivalence Certificate from HEC in case of foreign degree.
- Three fresh passport size photographs with name and admit card number on back.
- GAT Subject Test (at least 60% score cumulative) or GRE Subject Test(atleast 60th Percentile) Certificate required.
- Attested copy of NIC.
- Attested copy of domicile certificate.

- Candidates are required to provide a copy of synopsis/research proposal. Admission is subject to the availability of the Supervisor in the field of research and fulfillment of HEC's criteria.
- In case of in-service students, No Objection Certificate (NOC) from the Employer is required to be attached with Application form and routed through Proper Channel or they can submit the same at the time of interview, failing which their admission shall be cancelled.
- Every student at the time of admission to this University shall give an undertaking to the effect that he/she is not pursuing degree program in any other institution.
- Please note that submitting incomplete, false, or misleading information is considered sufficient ground for denial of admission and dismissal at any time.

ADMISSION TEST

Admission test is mandatory for candidates of all programs. Candidates who have cleared SAT/NAT (within the last one year from the date of AU Entrance Test) and GAT- General / Subject are exempted from Air University Test, provided their scores in those tests are as follows:

BBA CANDIDATES:

- At least 1100 in SAT I or
- At least 50 in NAT

Note: Qualified within last one year from the date of AU Entrance Test.

MBA/MS CANDIDATES:

- GAT-General Test (at least 50% score).

PHD CANDIDATES:

- GAT-Subject Test (at least 60% score).

INSTRUCTIONS FOR ENTRANCE TEST:

- Applicants must bring the following material for the entrance test
- Test admit card
- CNIC
- Eraser, Sharpener and Pencil.
- Applicants are NOT permitted to bring calculators, cellular phones, or other electronic devices to the examination hall. Such a device if found in possession of a candidate during examination shall be confiscated and the candidate shall not be allowed to sit for the exam.

INTERVIEWS:

Candidates on the merit list will have to appear for the selection interview as per schedule, along with their original testimonials.

ANNOUNCEMENT OF RESULTS

The results will be posted on the Air University website (www.au.edu.pk). Merit for admission will be prepared according to the following criteria:

Examination	Undergraduate Programs	Graduate Programs*		
	BE Engg/BSCS/ BBA/BSAF/BS PHYSICS/ BS MATHS/BS ENG	MBA/	Mgt Sci / MSPM	
SSC/Equivalent	15%			
HSSC/Equivalent	35%	10%		
BA/BSc/Equivalent		15%		10%
MA/MSc/MBA				15%
Admission Test	50%	75%		75%
Total	100%	100%		100%

The University Functional Committee (UFC) shall determine the number of candidates to be offered admission on the basis of available seats and the minimum acceptable score. Candidates selected by the UFC shall be notified by mail and AU website. Results will NOT be given on telephone.

LATE ADMISSION

As a matter of policy, no deviation is made from the published schedule and late admissions are not entertained. The University reserves the right to reject the application for admission of a student without assigning a reason.

TRANSFER STUDENTS

The Vice Chancellor after consultation with relevant faculty may allow transfer of students from recognized institutions and reputed universities under specific conditions. A student expelled from another institution on disciplinary grounds cannot transfer to AU.

Applications for transfer are submitted to the Director of Academics using a form available on the website.

The transfer student must complete at least 50 percent of the required credit hours at AU to earn the degree. Courses with grade less than "B minus" cannot be transferred and will need to be retaken at AU. If admitted, the student will be informed clearly what courses may be transferred and what additional courses may be needed. The student must have at least CGPA of 2.5 to be considered for transfer. The final decision is taken by the Vice Chancellor.

TRANSFER OF PROGRAM WITHIN AU

Transfer to another program is generally discouraged but under special circumstances an enrolled student may apply for transfer from one program to another, in the first two semesters of the program. The application is to be submitted to the respective Chair Department at least two weeks before the

start of the semester in which the student is seeking a program transfer. Only students with CGPA of at least 3.0 may apply.

FEE & FINANCIAL AID

FEES

AU reviews fee & other dues every year and in case of change (if any) after approval of the competent authority, revised fee would be charged to all new and existing students.

EXISTING AND NEW STUDENTS

Fee for each semester must be paid in advance and within the stipulated period. First semester's Fee is charged as per actual credit hours, for the semester. Tuition fee is to be paid only upon receipt of the online bill available at AU website. All registered students can obtain fee bill from Air University website for current semester after they have formally registered for the courses. The Fee must be settled within the deadline as mentioned in the bill.

Students who fail to pay fee within given deadline, will be charged fine within same semester @ Rs 200/day. In case of non-payment of fee till the mid-semester, student name will be struck off from the University roll. A student whose name has been thus struck off but who is otherwise eligible to continue his/her studies will be reinstated only after he/she has settled all outstanding Fee / fines.

Note:

Please note that Admission Fee, endowment fund, Sports Charges and Student Events charges are not refunded in any case. However, Tuition Fee once deposited, will only be refunded as per the following deadline:

- i. 100% Tuition Fee Refund Up to 7th day of convene of classes
- ii. 50% Tuition Fee Refund From 8th -15th day of convene of classes
- iii. 0% Tuition Fee Refund From 16th day of convene of classes

Admission of candidates who are waiting for results will be cancelled if they fail to meet the minimum eligibility criteria after declaration of the awaited result. Tuition Fee, if submitted, will be refunded as per the timeline mentioned above. Students are not allowed to drop courses during their first two semesters. Refunds for dropped courses from third semester onwards are issued as per policy outlined in AU Academic Regulation.

LEGAL ISSUES

FOR ISLAMABAD CAMPUS:

Only the Courts at Islamabad shall have the jurisdiction to adjudicate any legal matters/ issues pertaining to University versus student(s).

FOR MULTAN CAMPUS:

Only the Courts at Multan shall have the jurisdiction to adjudicate any legal matters/ issues pertaining to University versus student(s)

The fee for Academic Year 2019-20 is shown in the table below:

Fee & Financial Aid

Tuition Fee @ AU

S.No	Program	Total Credit Hours	Tuition Fee Rate(Per Cr. Hr.) RS	Estimated Total Cost of Degree Program(RS)	Credit Hours 1st Semester*	Tuition Fee as Per Cr. Hr. for 1st Semester(RS)
1	BE Computer Engineering	136	4510	613360	18	81180
2	BE Electrical Engineering (E-P-T)	136	4510	613360	18	81180
3	BE Mechanical Engineering	130	4510	586300	18	81180
4	BE Mechatronic Engineering	138	4510	622380	17	76670
5	Bachelor of Engineering in Biomedical Engineering	138	4510	622380	18	81180
6	Bachelor of Business Administration (BBA-Honors)	135	4622	623970	18	83196
7	Bachelor Studies in Accounting and Finance (BSAF)	136	4160	565760	17	70720
8	Bachelor of Science in Aviation Management	138	4622	637836	18	83196
9	BS Tourism And Hospitality Management	136	4622	628590	18	83196
10	BS Healthcare Management	136	4622	628590	18	83196

S.No	Program	Total Credit Hours	Tution Fee Rate(P er Cr. Hr.) RS	Estimate d Total Cost of Degree Program(RS)	Credit Hours 1st Semest er*	Tution Fee as Per Cr. Hr. for 1st Semester(RS)
11	Bachelor of Science in Computer Science	133	4160	553280	16	66560
12	Bachelor of Science in Cyber Security	130	4510	586300	17	76670
13	Bachelor of Science in Information Technology	132	4160	549120	15	62400
14	Bachelor of Science in Software Engineering as (HEC Approved-Non PEC Program)	131	4510	590810	18	81180
15	Bachelor of Science in Gaming Multimedia	132	4510	595320	17	76670
16	Bachelor of Science in Artificial Intelligence	-	7000	-	18	126000
17	Bachelor of Science in English (BS English)	136	3025	411400	17	51425
18	Bachelor of Science in Psychology	134	3025	405350	17	51425
19	Bachelor of Science in Mathematics	130	3102	403260	16	49632
20	Bachelor of Science in Physics	131	3102	406362	16	49632
21	Executive Masters of Business Administration(MBA Executive) 2 Years	66	3570	235620	15	53550
22	Masters of Business Administration (MBA) 2 Year	66	5058	333828	18	91044
23	MS in Management Sciences	30	5963	178890	12	71556

S.No	Program	Total Credit Hours	Tution Fee Rate(Per Cr. Hr.) RS	Estimate d Total Cost of Degree Program(RS)	Credit Hours 1st Semest er*	Tution Fee as Per Cr. Hr. for 1st Semester(RS)
24	MS Business Analytics	33	7000	231000	12	84000
25	MS in Project Management	30	5324	159720	12	63888
26	MS in Computer Science	30	5963	178890	10	59630
27	Master of Science in Cyber Security	32	7000	224000	10	70000
28	Master of Science in Gaming and Multimedia	31	5963	184853	10	59630
29	Master of Science in Artificial Intelligence	31	5963	184853	9	53667
30	Master of Science in Data Science	31	5963	184853	10	59630
31	Masters of Science in Systems Security	31	5963	184853	10	59630
32	MS in Applied Physics	30	5963	178890	9	53667
33	MS in Mathematics	30	5963	178890	12	71556
34	MS in Information Security	30	5963	178890	9	53667
35	MS/M.Phil Linguistics & Literature	30	4066	121980	12	48792
36	M.Phil in Education	30	4066	121980	12	48792
37	MS Linguistics	30	4066	121980	12	48792
38	MS in Strategic Studies	30	4066	121980	12	48792
39	Master of Science in Clinical Psychology	39	7000	273000	12	84000

S.No	Program	Total Credit Hours	Tuition Fee Rate(Per Cr. Hr.) RS	Estimated Total Cost of Degree Program(RS)	Credit Hours 1st Semester*	Tuition Fee as Per Cr. Hr. for 1st Semester(RS)
MS Engineering Programmes						
40	Aerospace/Avionics/Electrical/Mechatronics/Mechanical	24+6	4066	121980	9	36594
41	MS Bio-Medical Engineering	31	7000	217000	9	63000
Ph.D Programs						
42	Electrical /Aerospace /Avionics /Mechanical /Computer Sciences /Cyber Security / Management Sciences /Linguistics /Linguistics and Literature/Mechatronics/Mathematics/Physics	18+30	3696	177408	9	33264
* No. of credit Hrs may vary as per program requirement.						
Other Charges						
43	Allied Charges	Amount	Payable			
44	Admission Fee	20,000	At the time of Admission (Once)			
45	Security Refundable	10,000	At the time of Admission (Once)			
46	Endowment Fund	5,000	At the time of Admission (Once)			
47	Convocation Charges	5,000	In last semester of Program			
48	Thesis Evaluation Fee	20,000	In last semester of Program			
49	Students' Event	1,000	Per Semester			

S.No	Program	Total Credit Hours	Tuition Fee Rate(Per Cr. Hr.) RS	Estimated Total Cost of Degree Program(RS)	Credit Hours 1st Semester*	Tuition Fee as Per Cr. Hr. for 1st Semester(RS)
50	Sports Fee	1,000	Per Semester			
51	Library Fee	500	Per Semester			
52	Exam Fee	2,000	Per Semester (Not applicable to PG student's when only registered in Thesis during semester studies)			
53	Re-Joining Fee	3,000	After Semester leave			

The university reserves the right to review tuition fee or any of the above charges at any time, if deemed necessary.

PAYMENT OF FEE

The fee is to be paid before the start of the semester. Fee bills are enclosed in the admission letters sent to successful candidates. Candidates failing to submit the fee by the due date shall lose their seats, which will be offered to the next candidate on the merit list.

FINANCIAL AID

SCHOLARSHIPS

Air University provide number of scholarship to support the student in pursuit of their studies. These scholarships are available from undergraduate level to post graduate level.

TYPES OF SCHOLARSHIPS

- **AIR UNIVERSITY NEED BASED FINANCIAL GRANT (AUNBFG)**

Need Based Financial Grants (NBFG) are offered to Undergraduate students of fresh entry on annual basis after assessment of their financial need through a Grant Award System (GAS). NBFG for continuing students are awarded on the basis of their financial need and their educational performance in the previous semester. Fresh entrants may submit their request for scholarship when they deposit their fee after becoming bonafide students of University. However, already enrolled students are also eligible to apply.

Eligibility Criteria

- (a) Students securing admission on open merit only are eligible for the NBFG award.
- (b) Continuation of NBFG is subject to good conduct of the student and educational performance (minimum CGPA of 2.0) in the preceding semester. Financial Grant of the student having less than CGPA of 2.0 will be frozen and would be resumed only when CGPA ≥ 2.0 .
- (c) Only one NBFG to a student is permissible i.e. student availing any other need based grant or departmental grant or employee concession will not be eligible for second NBFG award.

In a repeat case of penalty due to use of Unfair Mean Case or act of indiscipline, a student would be ineligible for any Need Base Financial Grant/Scholarship in next semesters.

AIR UNIVERSITY INCENTIVE SCHOLARSHIP (AUIS)

Air University Incentive Scholarship (AUIS) intends to encourage students with outstanding performance in F.Sc to join all programmes of AU. Under AUIS twenty students in each programme with F.Sc marks greater than 85% will be offered Full Tuition Fee waiver in first Semester. The continuation of scholarship is subject to good performance in the next semesters.

HEC NEED BASED SCHOLARSHIP

Air University in collaboration of Higher Education Commission aims to provide an opportunity for talented students who are financially disadvantaged and are incapable of meeting higher education costs at partner institutions /universities in all disciplines.

In this regard, funding opportunities are provided for academically qualified, yet financially needy, Pakistani students to continue university studies in selected partner universities of Pakistan, especially from remote and rural areas of Pakistan (FATA, Khyber Pakhtunkhwa, Southern Punjab, Balochistan, and Northern Sindh). So far, 400 students have availed HEC Need Based Scholarship with total amount disbursed to them is 94 Million approximately.

The scholarship covers full tuition fee along with monthly stipend.

Eligibility Criteria

- (a) Students securing admission on open merit only are eligible for the NBFG award.
- (d) Continuation of NBFG is subject to good conduct of the student and educational performance (minimum CGPA of 2.0) in the preceding semester. Financial Grant of the student having less than CGPA of 2.0 will be frozen and would be resumed only when CGPA ≥ 2.0 .

(e) Only one NBFG to a student is permissible i.e. student availing any other need based grant or departmental grant or employee concession will not be eligible for second NBFG award.

(f) In a repeat case of penalty due to use of Unfair Mean Case or act of indiscipline, a student would be ineligible for any Need Base Financial Grant/Scholarship in next semesters.

PUNJAB EDUCATION ENDOWMENT FUND SCHOLARSHIP

Punjab Education Endowment Fund has signed an MOU with Air University in 2014 to provide scholarships opportunities in Undergraduate programs to talented and needy students of Punjab Province for pursuing quality education.

ELIGIBILITY CRITERIA

In order to qualify to apply for the scholarship, the student must have:

- Punjab domicile
- Secured at least 60% marks in last degree final exams
- Passed the examination as a regular student from:
- Government Institution, or Continuing scholar of the respective institution
- As a Private Candidate or
- Private Institution (low fee private institutions)
- Monthly household income of families of the selected student is not more than Rs.30,000.
- Not availing any other educational scholarship during the respective academic year.

MERIT BASED SCHOLARSHIP

Air University awards Merit Scholarship to Students who demonstrate academic excellence by achieving outstanding positions at the end of a semester. These scholarships are awarded to **TOP THREE** position holders of each class (section) in the shape of fee waiver as given below:

Undergraduate Programs

- 1st Position Holder 50% Tuition Fee wavier
- 2nd Position Holder 40% Tuition Fee wavier
- 3rd Position Holder 30% Tuition Fee wavier
- Student attaining SGPA of 4.0 will get 100% Tuition Fee waiver, however they would be included in first three position holders of the class

Postgraduate Programs

- 1st Position Holder 35% Tuition Fee wavier
- 2nd Position Holder 30% Tuition Fee wavier
- 3rd Position Holder 25% Tuition Fee wavier

Students attaining SGPA of 4.0 will get 50% Tuition Fee Waiver, however they would be included in first three positions of the class

PRIME MINISTER TUITION FEE REIMBURSEMENT SCHEME FOR LESS DEVELOPED AREAS

Students with valid domicile/local certificates of Less Developed areas of South Punjab, FATA, Khyber Pakhtunkhwa, Interior Sindh and Baluchistan enrolled in PhD program in Air University are eligible under the scheme. The scheme covers Full Tuition Fee along with other mandatory charges. For details click the following link:

(<http://www.hec.gov.pk/INSIDEHEC/DIVISIONS/HRD/TFP/Pages/Introduction.aspx>)

How to Apply

For Fall Session, students can apply through online scholarship portal on University website while entering their information regarding family Financial Resources and Expenses along with other important information. New students securing admission after depositing the Tuition Fee would be eligible to apply. After online application, the students will submit the required documents to the AU Financial Aid Office, within ten days after the final date of online submission.

Grant Award System

(a) Applications for all Need Base Grants are submitted online at the moment of admission and required documents are submitted within Ten (10) days of final admission date at AU Financial Aid Office (FAO).

AU Financial Aid Office will scrutinize student's documents and prepare a composite list of all the students whose documents are verified.

Departmental Award Committee (DAC) constituted in each academic department will allocate need assessment points to individual candidates on the basis of the eligibility criteria given at para 8 below in an interview of each student.

Central Award Committee (CAC) will, based on inputs available from FAO and DAC, interview applicants and finalize the composite order of financial need.

STUDENT SERVICES

Air University Central Library (AUCL)

The library aims to enrich learning, teaching and research programs of the University by providing timely access to high quality scholarly information and learning material in a variety of formats.”

Computing Facilities at Air University

Air University provides high-quality IT services to University students, faculty and staff members.

University has a high speed network of more than 1200 nodes. All university blocks are interconnected with high speed optical fiber network.

University has nine (09) computer labs and one (1) language lab. These Labs are equipped with more than 425 high specs desktop computers. University upgrades these computers frequently to meet the latest I.T and engineering software requirements. All computers are centrally connected with domain based network. These

labs provide the facilities of high speed internet, intranet, individuals email address, individual secure profiles and separate storage areas for students.

Students have access to computer labs from 8:00am till 9:00pm six days a week (Monday – Saturday). Our highly qualified lab staff is always available there to assist students in their daily work.

Campus Medical Officer

—An on-campus medical officer is available for students, faculty and staff from 8:30am till 4:30pm from Monday to Friday. The doctor provides medical consulting, emergency clinical treatment, referral service and first aid. The doctor is also responsible for providing health and hygiene related information to students, faculty and staff. This office also organizes blood donation drives in coordination with various public and private sector organizations.

Hostels

Air University offer hostel facility to female students only. This is available at first come first serve basis.

Advisors

Each student is assigned an advisor from the faculty. The advisor helps the student to identify and achieve high academic goals and take advantage of learning opportunities. The advisors also guide students at the time of course registration every semester.

Transport Facility

Air University transport is available on payment for most students. This facility is available on designated routes between Rawalpindi and Islamabad.

Engineering Laboratories

Students are provided an opportunity to augment their learning through practical work in the modern laboratories of all engineering departments. These labs are adaptable, reconfigurable and modular, making them ideally suited for undergraduate teaching in a wide range of fields. Lab experiments are designed in coherence with theory. Students get confirmation of theoretical concepts by performing experimental work in the laboratories.

1. Avionics Integration Lab (AIL)

The aim of this lab is to provide the-state-of-the-art hybrid avionics equipment integration and systems development platform supporting multiple busses, multiple platforms and unified operations. Demonstration of implementing multiple gateways will be possible through most modern reconfigurable and programmable Hard Ware. This complete instrumentation ready lab is the key strength of avionics integration research facilities at IAA. It is bifurcated into two parts. The avionics Integration test-bed which aims at the integration of one specific aircraft and the research test-bed which aims at providing a toolset for simulating the environment for any research purpose in the area of avionics integration and aerospace sensors & systems simulation.

The instrumentation platform chosen for these test beds is PXI for seamless integration of signal conditioning, data acquisition and switching mechanisms. AIL's main strength is that the addition of cards can help the instrumentation equipment to morph into the desired research test bed for avionics integration. AIL is equipped to support research in the following areas:

- Real-time fault tolerant Protocols design, implementation and analysis
- Aerospace Sensor and Systems Research
- Distributed Controls Systems Design and Evaluation Platforms
- Embedded Systems Design and Implementation
- Reconfigurable Hardware Applications
- ASIC Design Testing and Validation
- FPGA Algorithms Optimization and Basic Support Facility for ASIC Design
- Instrumentation and Measurement
- Design Validations Facilities
- Automated Test Equipment
- Production Validation and Quality Assurance



2. Electro Optics Lab (EOL)

This lab aims at providing the-state-of-the-art thermal imaging, optical and image processing and tracking , multiple sensors fusion FLIR/CCD, robust image registration techniques, optical measurement and testing using spectrometry, fiber optic sensors calibration, linearization and testing facility. Also included in the scope of this lab are fault diagnostics using multiple vision sensors, laser applications, light source, monochrome and color LEDs testing. EOL will be equipped to support research in the following areas:

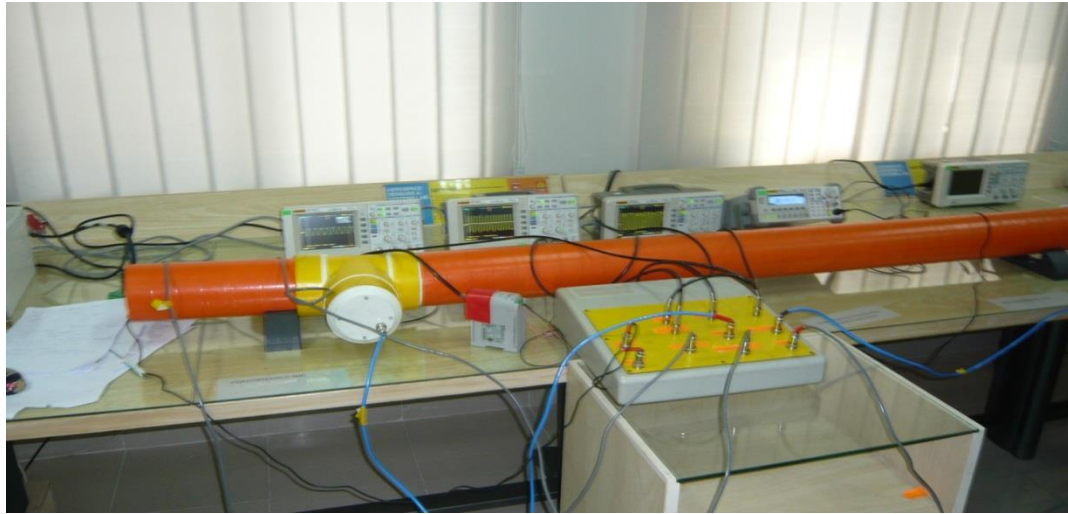
- Image Processing and Image Based Tracking Control
- Multiple Sensors Fusion FLIR/CCD
- Robust Image Restoration Techniques
- Optical Measurement and Testing Using Spectrometry
- Fiber Optic Sensors Calibration, Linearization and Testing Facility
- Fault Diagnostics Using Multiple Vision Sensors
- Lasers Target Designation and Ranging and Precise Motion Measurement



3. Aerospace Sensors & Systems Lab (ASSL)

Aerospace sensors and systems lab aims at providing the research facility for advanced topics in aerospace sensors such as sensors modeling, linearization, sensor failure detection, complimentary filtering, and multiple sensor fusion. This lab uses a modular test and measurement system platform extended in SCXI signal conditioning interfaces that allow programmable filtering and signal conditioning of sensors signal as well as sensor activation. This lab when used in conjunction with avionics system integration will become a unique aircraft instrumentation and avionics integration test-bed for research purposes. ASSL will be equipped to support research in the following areas:

- Aerospace Sensors and Systems Research
- Vibrations
- Adaptive Control
- Aerospace Vehicle Autopilot Design
- Fault Tolerant and Robust Controls
- Optimization and H-infinity Controls
- Fault Detection and Isolation
- Sensors and System Identification
- Data Fusion
- Neuro-Fuzzy Techniques in Instrumentation and Measurement



4. Communication Security & Embedded Systems Lab

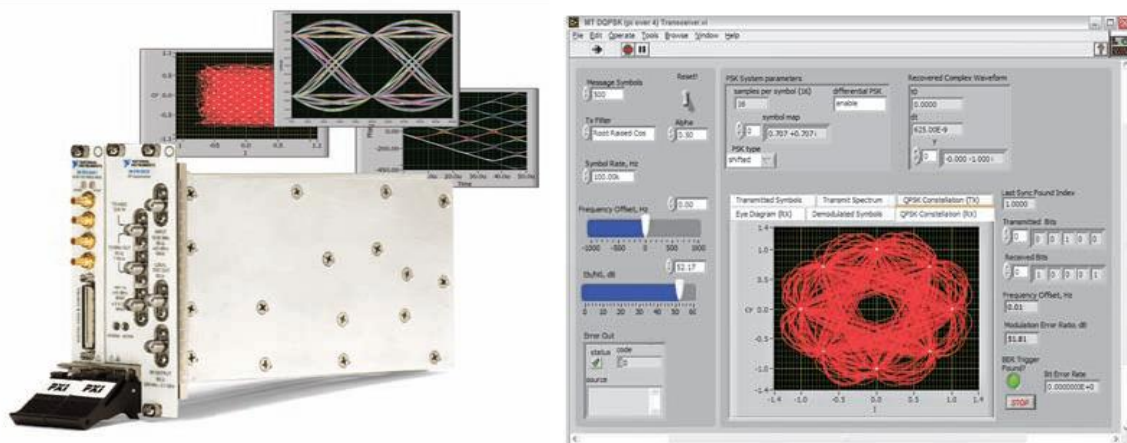
This state-of-the-art lab can support research and development in Voice Encryption / Decryption, IP Exchanges, E1 / T1 Interfaces, E1 Analysis, VPN Implementations, IP Terminal Development, FPGA and DSP implementation of algorithms



5. ECM & Radar Lab

The aim of this lab is to provide complete test facility in the range of the software defined radios, frequency hopping radios and systems, wireless adhoc networks, HF, UHF, VHF spectrum monitoring and selective jamming including the concepts of OFDM implementation and testing services. This Lab is equipped to support research in the following areas:

- Software Defined Radios
- Hopping Radios Analysis and Testing
- Jammer Design, Self-Protection Jammer, Friend Aware Jamming
- Wireless Adhoc Networks
- WiMAX and Emerging Standards Analysis in Commercial Range
- HF/UHF/VHF Spectrum Monitoring and Selective Jamming
- Orthogonal Frequency Division Multiplexing (OFDM)



6. Micro Electro-Mechanical Systems Lab

Micro-Electro-Mechanical-Systems (MEMS) is an emerging technology that has found abundant use in aerospace systems. Miniaturized sensors on silicon chips have replaced bulky sensors saving volume, weight and power all of which are at a premium in aerospace vehicles. The lab adds a highly sought-after dimension to the in-country indigenous capabilities in the area of MEMS. At present it has facilities for characterization of MEMS devices but work is in hand to expand the available facilities to fabrication of micro and nano sensors and devices for aerospace as well as electronics, automotive and medical applications etc.

7. Mechanical Vibrations Lab:

The aim of this lab is to provide experimental insight regarding mechanical vibration systems. The apparatus includes Single degree of freedom, multi degree of freedom systems, plate vibration system, whirling of shafts, bifilar pendulum, Kater's Pendulum, torsional vibration apparatus, linear vibration test stands and universal vibration system.

8. Heat & Mass Transfer Lab:

The purpose of this lab is to introduce the undergraduate students with the advanced equipments in the industry, and provide a hands-on training of the proper operation of units i.e., linear and radial conduction apparatus, free and forced convection and radiation apparatus. It also includes condensation and vaporization units. This helps in not only understanding the theoretical fundamentals of the subject but also helps to visualize its real-world applications in the industry.

9. Mechanical Project Lab:

This lab acts as a repository for students' final year projects. Final year projects are kept for future working and demonstration of the sheer brilliance and capabilities of graduating students.

10. Fluid Mechanics Lab:

Fluid Mechanics laboratory provides a "hands on" environment that is crucial for developing student's understanding of theoretical concepts of fluid mechanics. The lab is equipped with different flow measuring set-ups such as Venturi meter, orifice-plate, pitot tube, rotameter etc. Osborne Reynolds's setup provides visualization of laminar and turbulent flows. Subsonic wind tunnel provides research opportunities to investigate flow and resulting lift and drag forces on scaled models of various geometries. Losses in bends and valves can also be measured using respective apparatus. Furthermore the lab has demonstration units of pelton turbine, experimental reaction turbine module,

series/parallel pumps, pipe surge and water hammer apparatus, centrifugal pump, compressible flow & pipe friction module, free-forced vortices setup, flow over open channel and impact of jet set-up.

11. Ic Engines Lab:

This laboratory is equipped with sectioned models of engines, Demonstration unit of Actual cut section working Model of Four Stroke Four Cylinder Petrol Engine. Furthermore the test bed for simulation of practical engine cycles (Otto and Diesel) is under procurement.

12. Cae Lab:

Computer aided engineering lab introduces the students to state of the art computer tools being used in the industry. This laboratory provides training facility for modeling and simulation of mechanical systems and processes. Software library includes PRO-E, ANSYS and MATLAB. They allow development of 3-D models, mechanical design, linear and non-linear analysis of structures. It also caters for thermal, fluid, acoustic and other field problems. This facility has been used for conducting training workshops on computer integrated design, development and manufacturing of engineering components

13. Instrumentation And Control Lab:

In this lab, a number of test benches are available. It is used to teach the students how to check the serviceability of various instruments for measurements of pressure and temperature. In addition to these equipment, it also includes process trainer for controlling temperature, pressure, flow, level, speed and motion.

14. Engineering Drawing Lab:

State of the art drawing laboratory. Activities include Use of drawing instruments, Standard Drawing office practice, Principles of orthographic projection in relation to simple solids. Students also study **Descriptive Geometry, Plane curves and Machine drawing in this lab.**

15. Cnc Lab:

Students gain knowledge and experience in CNC programming, understand basic machining processes, learn to set up and adjust the tools and fixtures and follow safety procedures. The hands-on machining experiences in this mechanical lab benefit our engineering students in their current academic course learning as well as future career plan/job searching. CNC milling and CNC turning machine is currently being used to support academic and engineering education.

16. Embedded Systems Lab (Mechatronics Engineering)

Embedded systems Lab is newly established in Department of Mechatronics Engineering. Undergraduate students are used to perform their hardware based experiments on latest equipment i.e Oscilloscopes, Function Generators, Power Supplies, FPGA Kits (Field Programmable Gate Array), Programmers, Digital Multimeters.

This Lab is also equipped with Multimedia and updated computer systems with latest software's for students to perform their software based experiments/tasks.

17. Analog and Digital Communication Laboratory

For electrical engineering students especially, for telecommunication engineering students a state of the art laboratory has been established to give practical knowledge of the modern communication systems. All present-day analog and digital communication systems can be modeled practically in this laboratory.

Experiments for the curricula of communication systems, digital communication-I, and digital communication-II are conducted in this laboratory. Spectrum analyzers, RF signal generators, network analyzers and latest telecommunication trainers are a part of this lab.

18. Communication Security and Embedded Systems Laboratory

Embedded System and System on Chip (SoC) are the most advanced fields of engineering discipline. Most of the Electrical and Computer Engineering projects of students are accomplished by utilizing the technologies of our Embedded Systems Laboratory. We emphasis on modern tools usage like Mikro-C programming, Arduino and Raspberry Pi and the modern microcontrollers PIC 18F452 and AVR. This laboratory has full support of training tools and equipment.

This revolutionary lab can support research and development as well in Voice Encryption/Decryption, IP Exchanges., E1/T1 Interfaces, E1 Analysis, VPN Implementations, IP Terminal Development, FPGA and DSP implementation of algorithms.

19. Control & Instrumentation Engineering Laboratory

The Control Engineering Laboratory is equipped with the latest training modules. Concepts in control engineering are experimentally verified on computer based training systems. The trainers assist in enhancing the concepts starting from simulating a simple transfer function, sensing and measuring various quantities, and PID control to complex coupled multivariable nonlinear systems, and such as this Magnetic Levitation System, the Twin-Rotor MIMO System, the Gyro-stable platform and the 3-degree-of-freedom Helicopter Model. The trainers offer maneuverings to both analog and digital systems. Moreover, industrial control is introduced using the Siemens Programmable Logic Controllers. Recently, the laboratory is equipped with K&H ACS 1000 Analog Control System Trainers.

20. Digital Electronics Laboratory

The Digital electronics lab is designed to provide practical knowledge about the fundamental courses of electronics. The laboratory has the latest equipment to fulfill the requirements of lab work for the courses, such as electron circuit analysis, digital logic design, digital and analog electronics and network analysis etc. The laboratory is equipped with function generators, oscilloscopes, computers and many type of different trainers.

21. Digital Signal Processing Laboratory

The Digital signal laboratory contains latest DSP kits of Texas Instruments, USA as TMS320C6713, TMS320C6424 and the TMS320C6714. A code composer studio is used to code the Digital Signal Processors. These DSPs are used for a wide range of image and signal processing applications. The

general-purpose digital signal processor is dominated by applications in communications like cellular phones and PDA. Embedded digital signal processors are dominated by consumer products. They are found in cellular phones, fax/modems, disk drives, radio, printers, hearing aids, MP3 players, high-definition television (HDTV), digital cameras, and so on. These processors have become the products of choice for a number of consumer applications, since they have become very cost-effective solutions.

22. Electronic Systems Laboratory

The Electronics System Lab is the Advanced Analog and Digital Electronics Lab. It is equipped with high frequency oscilloscopes, function generators, curve tracers and digital electronics trainers. Function Generators are stable with low distortion, and can generate signal, in the frequency range up to 10 MHz. The Curve Tracer is high performance test equipment. When it is combined with a general purpose scope, characteristic curves of all type of semiconductor can be accurately displayed. The Digital Electronics Trainers are used as a teaching and development tools.

23. Embedded Systems Laboratory

The Embedded Systems Lab is equipped with 27 sets of *i-7* PC based Microprocessor and Microcontroller Interfacing stations, a variety of Micro Controllers Kits, FPGA Training Kits of Xilinx Spartan-II and Spartan-3E FPGAs, all types of tools and accessories e.g. Digital Multi Meters, Universal Programmers SmartPro and ALL-11, Digital Storage Oscilloscope etc. components, consumables, on bench illumination lights, *i-7* PCs, Multimedia, simulation softwares. The Embedded Systems Lab offers practical facilities for Intel Microprocessor and PIC, Atmel 89c51 and AVR Micro-controllers interfacing, programming, controlling and monitoring. Modern single board computers like Raspberry Pi and Arduino are also a distinguished part of this laboratory.

24. Electrical Engineering Project Laboratory

The Project laboratory is equipped with equipment of a multidimensional nature. The purpose of this laboratory is to facilitate students of all semesters from all electrical and computer engineering streams in their respective semester projects as well as in final year design projects.

General project related to design and testing equipment including personal computers, oscilloscopes, function generators and high wattage power supplies have been made available in ample quantity. It also has latest ALL-11 and SmartPro Universal Programmers, which are capable of programming microcontroller ICs like AVR, PIC, EEPROM and UVROM, which makes it the best current programming option in the world

25. Industrial Automation Laboratory

The lab is equipped with Programmable Logic Controllers PLC and all the requisite equipment. This enables students to perform various experiments concerning Industrial automation processes and methods. We have Allen-Bradley and FATEK PLCs and trainers to demonstrate the sensors feedback and actuator working.

26. Power Electronics and Electrical Machines Laboratory

The Electrical Machines and Power Electronics laboratory is used to carry out practical work for Electrical Machines, Power Electronics and Electromagnetic Waves. It is equipped with software controlled LabVolt (Canada) equipment, which is useful to perform experiments related to Single Phase/Three Phase Transformers, A/C Generators/Motors, and D/C Generators/Motors, etc.

In order to perform Power Electronics related experiments it has Software Controlled Lab-Volt (Canada), Terco (Sweden), and K&H (Taiwan) equipment to perform experiments related to Power Thyristors, MOSFET, A/C Motor Drives, D/C Motor Drives, and Speed Regulation etc. This Laboratory is also equipped with Oscilloscopes, Function Generators, Multimeters, and D/C Power Supplies.

27. Power Systems Laboratory

Power Systems laboratory is equipped to provide laboratory support for Power Generation Systems, Power Transmission Systems, Power Distribution and Utilization Systems and Power System Analysis.

It is equipped with LabVolt trainers on which a large number of experiments related to these courses can be performed.

28. RF and Optical Communication Laboratory

The RF and optical communication lab is designed with versatile training systems to familiarize students with the practical aspect of microwave and optical phenomenon. Comprehensive lab handouts are designed for all the systems and are provided to the students to facilitate them in the practical work. Students also benefit from planar array antennas constructed using microstrip technology. The digital telephony system including digital switching system, telephony training system, and trunk networks is used to practically demonstrate the concepts of telephone networks. The lab is equipped with Rohde & Schwarz and LabVolt equipment like Vector Network Analyzers, Spectrum Analyzer and RF signal generators as well.

29. Telecommunication Network Laboratory

Telecommunication Networks Lab is designed to provide practical knowledge for the courses of Telecommunication Networks and Computer Networks. The laboratory has Feedback Instruments modern equipment to fulfill the requirements of lab work for these courses. Complete hardware trainers for telephony are provided on which all the signaling and call processing can be monitored by computer integration. Experiments on complex Data Networks are performed on emulation software. However advanced hardware equipment of industrial routers and switches are in procurement phase.

SOCIETIES & CLUBS

At Air University we do not believe in producing single dimensional personalities we rather believe that curricular and co-curricular activities complement each other to develop well-rounded, socially skilled, healthier individuals. Air University promotes variety of activities under different clubs/societies from which a student can choose that which appeals to him/her personally. These activities range from athletics, debates, music, Qirat, dramas, poetry to cultural activities. Out of these some students choose more than one. Each society has a faculty member incharge to facilitate

while the entire management of these activities is done by the students themselves. The University encourages students to self-manage these societies and clubs and provides the required resources while the guidance is given by Patron-in-chief of the societies.

We are very pleased to report that students who have been involved in co-curricular activities tend to do well in academic areas as well. This may be due to increased self esteem, motivation, team spirit and better time management that they learn while organizing such events. Many can get "athletics" or "sports" scholarship abroad as modern universities everywhere are more interested in recruiting students who have something more to offer besides academic qualification.

AU Adventure Club

Shaoor Society

Air University Alumni Association

AU Cultural Society

AU Literary Society

AU Music Society

Air University Sports Club

Air Media Club

Air University Society of Mechanical Engineering (AUSME)

ACTIVITIES

AU Signs MoU with FFC

Air University (AU) Islamabad signed a Memorandum of Understanding (MoU) with Fauji Fertilizer Company limited (FFC). As per this MoU, FFC will provide jobs opportunities, scholarships and internships to Air University students and graduates. Registrar Air University Air Commodore Ghulam Mujaddid (Retd.) and FFC Company Secretary Brig. Sher Shah (Retd.) signed this MoU on behalf of their respective organizations.

Air University wins first prize

A team of two members, Junaid Bin Aamir (BEME) and Ahsan Mustafa accompanied by the FM Incharge Naveed Ehsan and Proctor Capt. Nadeem Sheikh represented Air University in the Inter-University Urdu Declamation contest. The event was organized by National Accountability Bureau (NAB). Thirty participants from twenty four universities participated in this contest. By the grace of Almighty Allah, Ahsan Mustafa of the department of Mechatronics Engineering (BEMTS 3), Air University won First position in the contest. The second position was bagged by Foundation University and the third position went to NUML. Congratulations to Air University.

Air University in HEC collaboration starts indigenous training workshop

Islamabad: A 5-day Higher Education Commission (HEC) funded indigenous training workshop has started in Air University Islamabad campus. In the inaugural speech chief guest Director General Institute of Avionics, Air Commodore (Retd) Khalid M Tahir said that this was a great opportunity for the participants to learn the required management skills through interactive sessions with professionally sound experts. He stresses on the importance of workshop and appreciated the HEC role to train mid-level managers to perform in the light of designated rules and policies in Higher Education Institutions (HEIs). In the opening ceremony Workshop Coordinator Ms. Tayyaba Razzaq stated the goals and objective of on-campus training workshop. Director Quality Enhancement Cell

Air Commodore Abdul Wahab Motala added that HEC has started plenty of schemes to train to academia and management for provision of quality education across the country. He admired the role of Learning Innovation Division in HEC for planning such useful training workshops in HEIs. In his statement he added "I always emphasis on trainers and participants to make the session useful with their proactive involvement."

Director ORIC Air Commodore (Retd) Afzaal A Khan said that this was the tremendous effort of HEC to train the education managers for management skills and this workshop will provide an ample boost to all participants in their management skills. He added that this focused and well-planned workshop will surely add the valuable information to all participants who are performing their roles in education management at Air University.

Air University Team Wins First Prize in AIAA's Design Build & Fly Contest 2014 in Solar Category

Air University was happy to announce that a team of its final year students has won first prize in Design Build & Fly Contest (DBFC) arranged by Ghulam Ishaq Khan Institute (GIKI) American Institute of Aeronautics & Astronautics (AIAA) chapter in Solar Powered UAV category (see the pictures attached).

Trip to Skardu Area

Air University Adventure Club arranged a six day trip to the city of Skardu and its surrounding areas in Gilgit-Baltistan area of Northern Pakistan.

MOL-FRESHHH-2014 International Competition

FRESHHH competition was being held by MOL Group Hungary from last 7 years among 70 countries. This year there were record 1570 teams. Each team comprised of 3 members. Syed Ammar Haider Zaidi, Mateen Irshad and Naeem Shahzad from BEME FALL-10 participated in this competition through placement office.

The competition comprised of 3 rounds. At the end of first round top 40 teams were selected for the second round and Air University team secured 34th position. At the end of second round top 5 teams were selected for final round and Air University team secured 2nd position in the second round and got the honor of representing Pakistan for the first time in the final of this international competition held at Budapest Hungary.

In the final round Air University students secured 4th position and best team dynamics award. MOL Group's top executives were present in jury to judge their abilities. Air University tea, were highly appreciated by them because they were the most unexpected team among others, as Air University students secured 4th position among 1570 teams from 70 countries of the World.

Best Research Paper- An Honor for Air University

Professor Dr. Faqir Muhammad, Faculty of Administrative Sciences, participated and presented a research paper in the International Conference on Computation and Social Sciences (ICCSS). The topic of the paper was "Importance of socializers and motivational factors in career choice". The paper presented was declared the Best among all the papers presented in the stream of social sciences and a shied was awarded.

PTV English World Channel recording

PTV English World Channel recorded an episode on Positivity, Think Positive, Be Positive. Placement Office makes the necessary arrangements to help the production team of PTV World for recording. Students from all discipline participated in this show.

Nestle on Campus Recruitment Drive Session

Nestle Pakistan Limited conducted On Campus Recruitment Drive session in Air University for all Graduating Batches. The HR Manager gave briefing on nestle brands and also in detail told about Management Training Programs and other vacancies in Engineering fields. Students were benefited by this brief lecture and in end question answer session was conducted and give aways were distributed.

Nayatel on Campus Recruitment Drive

Nayatel strongly believes in building Academia-Industry Relationships in order to provide maximum exposure and employment opportunities to the young Graduates. Nayatel conducted On Campus Recruitment Drive for telecom, electronics and computer science students. Almost 100 students participated in test.

Multan and Bahawalpur trip by AUAC

Around 18 member team from Islamabad Campus joined a 30 member team of Multan Campus for a five day visit to Derawar Fort, Cholishtan Desert, Lal Suhanra National Park, Noor Mahal Place in Bahawalpur city, and visit of historical places and shrines in Multan city.

Give & Get Initiative” Training Session on Employability Skills by Yunus Textile Mills

Placement and Alumni Office of Air University and Yunus Textile Mills Karachi organized a “Give & Get Initiative” Training Session on Employability Skills at the main campus of Air University in Islamabad. Registered students from all the departments attended the session. The main speaker was Mr. Shaikh Zubair, GM HR of Yunus Textile Mills. The objective of presentation was to know about employability skills, to understand difference between manager and student, how to market yourself, how to create a focus plan, how to sell yourself through your own questions at the interview, how to be an effective professional? Whole session was interactive and followed by question and answer. In the end souvenirs were distributed by Business Administration Dean Dr Moeen A Zafar to speakers and certificates were handed over by Yunus Textile to Placement Office for students.

HEC Workshop with Cambridge University Press

HEC had arranged a very useful workshop in collaboration with Cambridge University Press (CUP).

The Workshop had the sessions on

- Cambridge Journals Training on how to access and utilize them in research Work.
- Open Access.
- Preparing papers for academic publishing.

The workshop had led by Ms Caroline Kerbyson and was very beneficial to all MS/PhD students and young faculty members as it prepared better for accessing online resources and good practice for academic publishing.

International Conference on Energy Systems and Policies (ICESP-2014)

The Conference was organized by Air University. The International Conference on Energy Systems and Policies (ICESP-2014) aimed to bring together leading scientists, engineers, researchers, scholars, academics, planners, policy makers, industry experts, consultants, and, governmental and non-governmental entities to exchange and share their experiences and research results about all aspects of energy systems and policies, and discussed the practical challenges encountered and the solutions adopted.

The ICESP-2014 included a series of tutorials/lectures by domain experts enabling participants to learn about the latest trends in various aspects of energy technologies. An industrial exhibition was an important additional feature of ICESP-2014.

OFFICE OF RESEARCH, INNOVATION AND COMMERCIALIZATION (ORIC)

Besides teaching the prescribed syllabus for its undergraduate, graduate and post graduate level students as per approved curricula, the University is mandated to conduct research & development and provide consultancy services in each specialized discipline. Air University, promotes research in all disciplines and is continuously building its research potential including qualified faculty, staff, facilities and facilitation to ensure its continuous growth; an essential element of its overall academic activities. AU ORIC having a comprehensive operational set up, is available to all faculty members and students for enhancing the Research efforts through guided facilitation.

ORIC started functioning in year 2012 as per the guidelines of Higher Education Commission (HEC). Despite limited infrastructure and available resources, it helped in enhancing Research culture at the University. ORIC has now grown to a fully functional organization dully recognized by HEC. The areas covered by ORIC are summarized below:

Activities

The research activities cover the following spectrum:

- (a) Academic Research and Publishing of work in periodicals/Journals of repute.
- (b) Specialized and Multidisciplinary Research Projects with industry.
- (c) Designs and Provision of Solutions to Industry.
- (d) Prototyping and Commercialization of Students/ Faculty Projects.
- (e) Focused and gradual expansion of infra-structure.
- (f) Up gradation and Development of laboratories.
- (g) Undertaking any other challenging work.

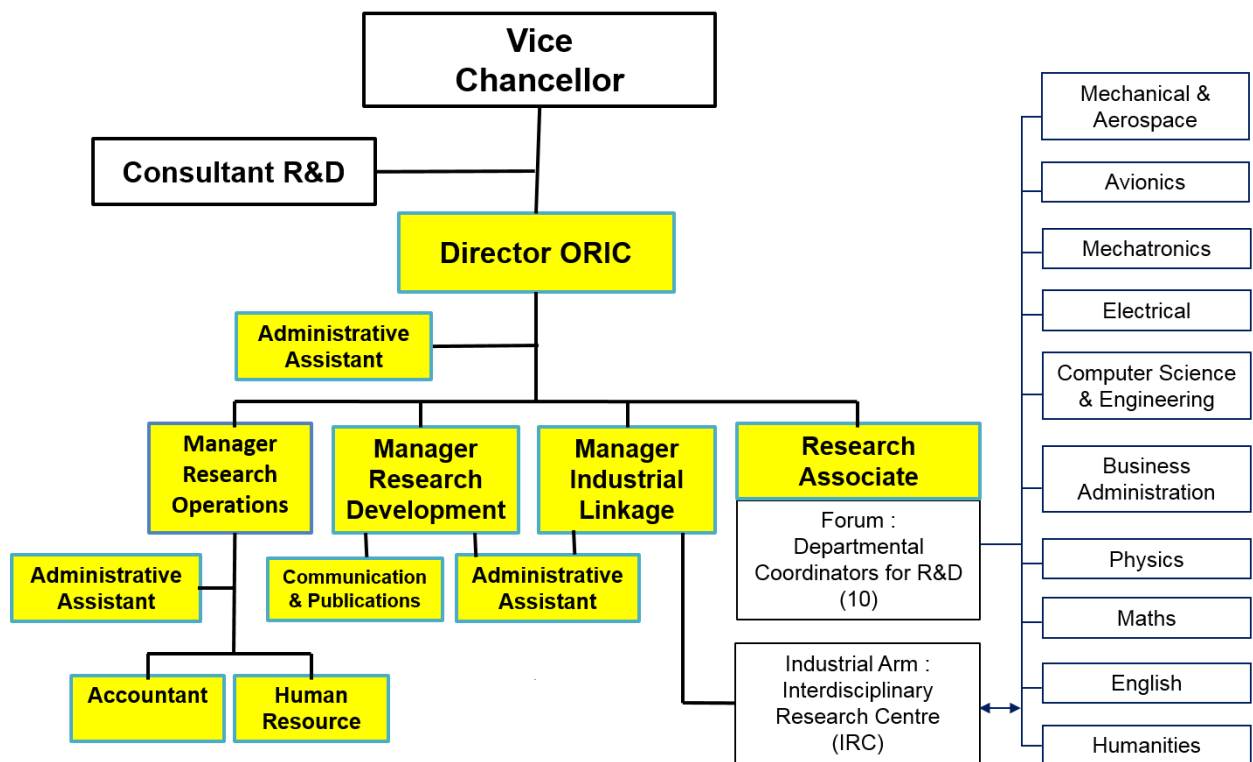
Research Facilitation

To facilitate multi-disciplinary research work for focused strength areas and specialties, ORIC acts as a central forum. The departmental research efforts are linked with ORIC through ten R&D Departmental Coordinators. Other than Departmental research activities, all members of the University are dedicated to excel and individually contribute in research work as per their expertise and vision. Further facilitation especially for multidiscipline research, industrial linkages and commercialization work is facilitated by ORIC through the following two committees:

- R&D Policy Committee

- R&D Executive Committee

The functions of ORIC in Research Operation, Research Development, Industrial Linkages and Commercialization are supported through the three managers and AU Industrial Arm (IRC; Inter-disciplinary Research Centre). The AU ORIC organogram is appended below:



LINKAGES:

Universities Research Collaborations

- **Slovenia**
University of Nova Gorica, Slovenia
Research projects/ Exchange of technical, Scientific & Academic Staff etc.
- **SINGAPORE**
National University of Singapore
Research projects/ Exchange of technical, Scientific & Academic Staff etc
- **USA**
Michigan State University, USA
Research collaboration in field of Maple-seed Robotics Flyers
- **Germany**
University of Applied Sciences Merseburg
MoU for Academic / Research Collaboration
- **Sweden**
Blekinge Institute of Technology

MoU for Academic / Research Collaboration

- **China**

Northwestern Polytechnical University, Xi'an, China

Beijing University of Aeronautics and Astronautics (BUAA), China

Nanjing University of Aeronautics and Astronautics (NUAA), China

Nanjing University of Sciences and Technology (NJUST), China

Signed MoU for Academic / Research Collaboration

- **UK**

University of Cambridge, UK

Formal research collaboration under the auspices of British Council / HEC INSPIRE grant for research in Micro-sensors / MEMS

Southampton University

Greenwich University

University of Nottingham

Kingston University

Industrial Collaborations

- Pakistan Air Force
- Pakistan Navy
- Army Aviation
- Directorate General of Military Procurement (DGMP)
- National Engineering and Scientific Commission (NESCOM)
- Pakistan Space and Upper Atmosphere Research Commission (SUPARCO)
- National Electronics Complex of Pakistan (NECOP)
- Defence Science and Technology Organization (DESTO)
- Pakistan Atomic Energy Commission (PAEC)
- National Instruments (NI) USA
- Queens Medical Centre, Nottingham UK
- Micropak (pvt) Ltd, Islamabad

INTER-DISCIPLINARY RESEARCH CENTRE (IRC)

The aim of the IRC is to bridge the gulf between academia and industry by providing, within a legal framework, a solid and reputable platform to the academic community for delivering projects within time, cost and quality. The IRC is registered as a private limited company. It is thus able to pick up projects from the industry. The successful completion of projects results in training of faculty and students as well as to accrue some financial benefits for the University. The students get an opportunity to experience the real world and resultantly are able to upgrade their knowledge and skills. A registered, private and limited company is able to sign MoUs and bid for projects with the sponsoring organizations, may they be private or public.

Inter-disciplinary Research Centre is a unique university industry linkage that is different from existing models of such linkages such as research/science parks or technology incubation centers. These models require investment and government funding for sustained and uninterrupted support for a substantial amount of time.

Technology/Science parks are dependent on the flow of either outsourced work or the industry especially high tech industry which is almost absent. On the other side the absence of pure research due to financial constraints of universities and government funding further makes it impossible to

enjoy the luxury of pure research making the possibility of high tech spin off companies almost impossible.

The best high tech technologies that can be sustained here is system integration of the existing technology from established high technology companies and provide technology mediation services. This gives the opportunity to faculty, staff and the regional end users of that technology to directly benefit and open doors for healthy and economically mutual viable interaction between industry (end users), university (academia) and the technology companies (industry).

The Human Resource Development Centre (HRDC) and Collaborative Project Support Program at Air University has the potential to substantially help end users to reduce their development time and save budget through sustainable Human Resource Development while building more confidence of technology companies in investing in the country.

As an additional benefit using the existing brand of the world class company, the university has the opportunity to sell its know-how and research through the worldwide sales channels and platform of the collaborating technology company.

The Air University team provides a complete automation solution with seamless integration of the hardware and software. The projects complete in a short period while satisfying the end-user with its performance, reliability and accuracy.

Knowledge exchange is of paramount importance for any University's research and outreach program. A technology outreach programme launched by IRC has accrued substantial benefits for Air University.

Aim of Technology outreach programme at Air University is to bring university research to less privileged communities world-wide through exchange of ideas, evidence and expertise. To fulfill the same objective IRC has ventured into projects related to alternate energy and tele-health.

Air University got an opportunity to work with Aeronautics Research Centre (ARC) Kamra for Data Logger. Data Logger was deployed on F-7 aircraft and flew for one year in all-weather profiles. The huge correlated datasets captured were analyzed using state-of-the-art data-mining tools at Air University. The analysis report of Air University was accepted and trials for the recommended modification to control the avionics bay temperature, are underway at ARC.

Technology with Mediation Services at IRC

Technology Mediation includes trainers who prepare instructional materials and teach classes on technology use, technical support personnel who configure the technology, experts who resolve thorny technical problems, administrators who issue policy and practice guidelines for use, sales people who persuade users to adopt specific technical innovations, and even lead users who have acquired adequate technical proficiency that they can advise or improve other users on technology interactions. These actors all play a role in customizing the technology to its context of use, in shaping users' understanding of the technology, and in establishing users' work habits around the technology.

Internships

IRC provides internship opportunity for students during the summer break with opportunities to work directly under the supervision of IRC engineers. IRC, in the field of instrumentation and measurement, is committed to enhance engineering and science education nationwide by providing flexible software and modular hardware that work with mainstream computing technologies to help integrate theoretical concepts with real-world applications.

Training & Certifications Exam

Short Courses, Hands-on Training, and Skill Development Services. With a view to overcoming the theory practice gap between academia and industry IAA has established a purpose built Human Resource Development Centre (HRDC). This centre identifies high-tech domains and enabling technologies, the know-how of which can provide a competitive edge to the local industry. The

HRDC runs specialist short courses to enhance the skill set of an engineer in the field of instrumentation and measurement.

INTERNATIONAL COOPERATION OFFICE (ICO)

International cooperation takes on added significance and importance in the light of ongoing globalization. It has diversified in terms of formats, including personnel exchange, data exchange and sharing, bilateral workshops, international conferences, joint research centers, project-based joint research groups, joint laboratories, or partnership institutes. It has been extended from bottom-level scientist cooperation to high-level strategic communication, from bilateral agreements between scientific institutions to multilateral research programs, and from pure science research to partnership with industries for transnational research and technology transfer.

The Air University ICO manages and furthers the internationalization process at the University. This includes:

- Students exchange for summer courses and 1-2 semester
- Staff and faculty exchange
- Split MS and split PhD programs
- Joint research publications (conference and journal papers)
- Joint supervision of MS and PhD students.
- Joint seminars and conferences
- Exchange of scholarly and technical information
- Other mutually beneficial collaborative activities

AU has also signed MoUs, Letters of Collaboration and Letters of Agreements with well reputed universities in UK, USA, China, Turkey, Malaysia, Saudi Arabia, Slovenia and Morocco etc. for effective collaborations in diverse fields. A very active research collaboration exists with University of Cambridge, UK, one of the top universities of the world, under the auspices of the prestigious British Council / HEC's INSPIRE and KEP grants for last six years.

In this context, Director ICO visited four UK universities (Cambridge University, Southampton University, University of Birmingham and University of Bedfordshire) in 2017 to revitalize the existing relationship with partner universities and to discuss further collaboration opportunities available for students and faculty. In response, delegates from different UK universities like Cambridge University, Kingston University, University of Bedfordshire and City University of London visited AU. Some of the visitors also delivered guest lecture to AU faculty and students.



Top ranked universities from Italy (La Sapienza University, Tor Vergata University), Australia (Macquarie University, Deakin University), Oman (German University of Technology - GUTech), Malaysia (University Technology Malaysia, University of Technology Petronas) and Thailand (Asian Institute of Technology) also visited AU during 2017-18. Similarly, Vice Presidents, Deans and renowned professors of reputed Chinese Universities like Tsinghua University, Shanghai University, Fudan University, Shanghai Jiao Tong University, Zhejiang University, Beihang University of Aeronautics and Astronautics (BUAA), Northwestern Polytechnical University (NWPU), Yunnan University and Dalian University of Technology also visited AU to enhance mutual collaborations.



ICO, Air University under patronship of HEC, China's Professional Engineering Postgraduate Education Steering Committee (PEPESC) and China's Professional Engineering Management Postgraduate Education Steering Committee (PEMPESC) also organized **"1st Pakistan-China Engineering Postgraduate Education Forum"** on 26th-28th April, 2018 at Air University. Seven senior Professors from six top Chinese Universities (Tsinghua University, University of Science & Technology, Tongji University, Beijing Institute of Technology, Sichuan University and Tianjin University) and Pakistani professors from 13 different universities attended the conference. The said conference intended to provide a discussion platform to the officials of Chinese and Pakistani institutions to deliberate on the prospects of starting new Joint PG (MS / PhD) Degree Programs.

QUALITY ENHANCEMENT CELL AT AIR UNIVERSITY

OVER VIEW OF QA SYSTEM AT UNIVERSITY

Quality Enhancement Cell (QEC) was established at Air University in 2010 to assess, assure, monitor and manage quality of educational programs in the light of HEC defined criteria and standards. QEC strives hard to achieve its vision and Mission with all out support from Vice Chancellor. We at Air University are devoted to bring excellence in teaching and research by implementing process control effectively and develop faculty through continuous training and interacting with industry. QEC is making all its efforts to implement quality criteria and Institutional Performance Evaluation Standards (IPEs) defined by HEC. University management is not just aiming to implement these standards but also trying to create quality culture within the institution, where all stakeholders can communicate through top-down and bottom-up interaction and enjoy the combination of cultural elements, structural dimensions and shared values.

Vision Statement of QEC

The vision of Quality Enhancement Cell is to bring excellence in all programs offered at Air University in the next five years.

Mission Statement of QEC

Quality Enhancement Cell of Air University is committed to enhance the quality of education at each department by implementing effective and efficient quality assurance system to fulfill requirements of all stake holders.

Milestones Achieved by QEC 2017-18

- Acquired Highest **'W'** category in 2016 during quantitative assessment for ranking by HEC
- Self-Assessment Reports of all 35 Programs have been developed and internal assessment of all 35 programs have been conducted.
- Developed a quarter-wise activity calendar, trainings and awareness sessions for faculty and staff on different areas of Quality Assurance.

- QEC conducted student's feedback on teachers and curriculum evaluation for spring and fall semesters in 2016-17 and developed trend to identify areas for improvement by using advance data management techniques.
- QEC has organized training workshop for accreditation on OBE format at engineering departments
- QEC managed the data of Pakistan Qualification Register(PQR) and fed it on e-portal of HEC
- QEC conducted academic audits at each department to review the curriculum and identify the gaps for improvements.

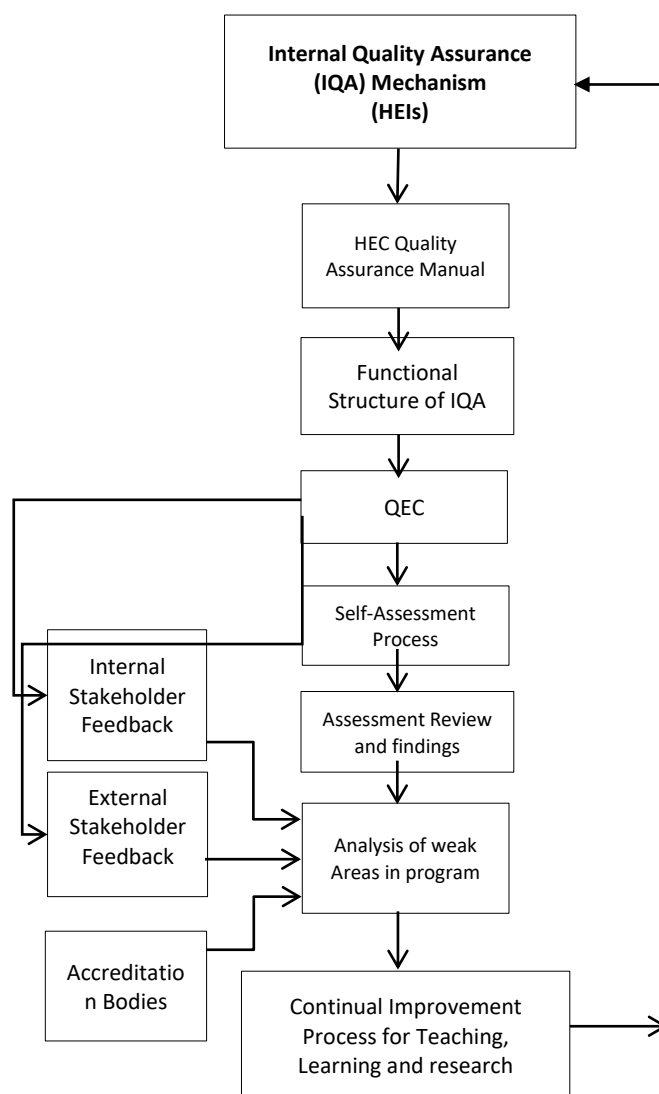
QEC ACTIVITIES DOMAIN

Quality Enhancement Cell at Air University has two domains of working: Internal Quality Assurance (IQA) domain and External Quality Assurance (EQA) domain.

Internal Quality Assurance (IQA)

The IQA focuses on Self-Assessment by implementing quality criteria's defined by HEC and includes following:

- Accreditation Self-study for all accredited programs.
- Trainings and awareness sessions for faculty and staff at university
- Development and conduct of Academic Training Program
- Collection, compilation and provisioning of data to HEC for QEC and University ranking.
- Development of Self-Assessment reports of all programs and assessment reviews
- Implement anti-plagiarism policy in university.
- Self-Assessment of academic programs and internal/external specialists.



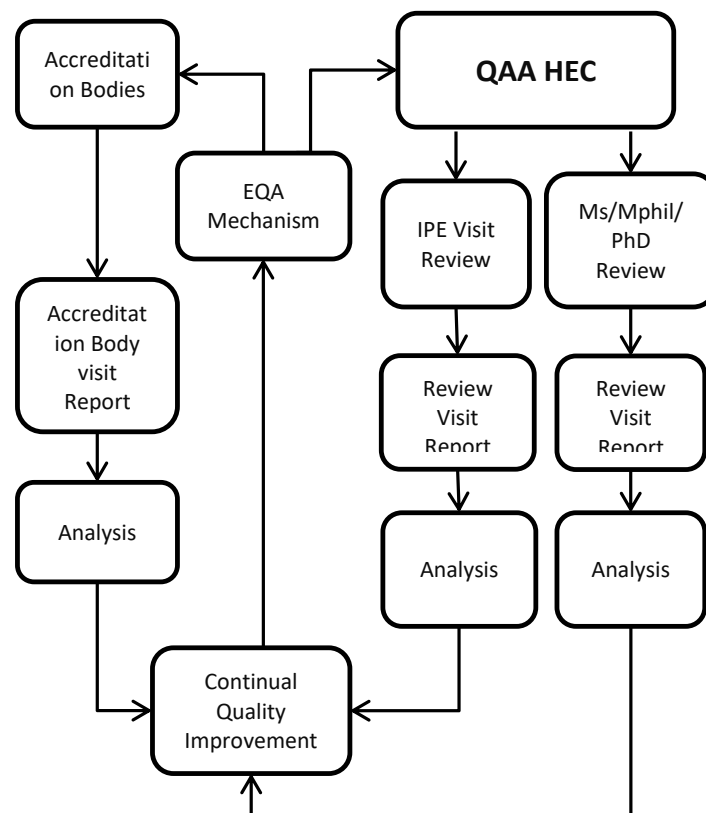
External Quality Assurance (EQA)

The EQA will include assessment by external agencies like accreditation bodies and HEC. QEC has managed external assessments through following bodies.

- IPE visits by HEC teams.
- Third Party Audit.
- MS/M.Phil./ PhD program review by HEC.
- Accreditation of programs.

CONTINUAL QUALITY IMPROVEMENT (CQI) PROCESS

Teacher Evaluation by students at the end of each semester is an important feedback to improve upon quality of teaching methodologies and plan faculty development. Higher Education Commission (HEC) designed attributes and instruments for teacher evaluation in 2003 and included in eleven feedback proformas.



Teacher Evaluation Proforma (P-10) Improvement

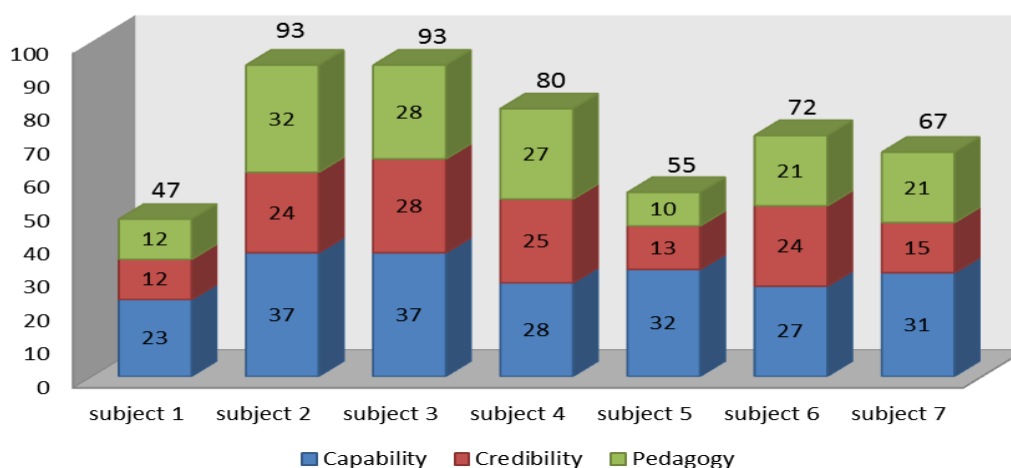


Figure 1 Teacher Evaluation Proforma (P-10) Improvement

Air University has reviewed predesigned attributes and made teacher evaluation more realistic by giving weightages to each response and grouping attributes in three main domains as Capability, Credibility and Pedagogy. Likert Scale weighted averages method is used for analyzing the positive and negative responses of students against teachers' performance. Specific weight is assigned to each survey response option i.e. weight 4 is used for Strongly Agree, weight 3 is used for Agree.

PHOTO GALLERY OF QEC ACTIVITIES DURING YEAR 2017-18



Group Photo of Participants of OBE workshop with Vice Chancellor



OEC aTraining workshop on Professional Development for



Group Photo with the participants of National Seminar where Director Quality AU conducted an awareness session on Quality Assurance



Vice Chancellor AU with the participants of closing Ceremony of PCEPT

QEC Linkages



Convocation 2018

The eighth convocation of the Air University was held at main campus Air University, Islamabad on 24th March, 2018. The honorable Air Chief Marshal Mujahid Anwar was the chief guest of the ceremony. Air Chief Marshal Mujahid Anwar, NI(M), S Bt, Chief of the Air staff and chairman Air University Board of Governors, Professor Dr. Mukhtar Ahmed, Chair Person Higher Education Commission and Chancellor Air University, heads of the various institutions, senior civil and military officers, parents of the graduating students and prominent citizens attended the function. Bachelors and masters degrees were conferred on over 1000 students in engineering, basic and applied sciences, social sciences and business administration programs.

The Prime Minister awarded the first Ph.D. degree of Air University to Ms Kiran Sultan (Electrical Engineering), and 18 Gold medals to position holders in various masters programs for their outstanding academic achievements.

In his speech, the Prime Minister stressed on the government's commitment to education for providing access to all citizens and for achieving knowledge based economy to realize the socio-economic development of the country. He highly appreciated the Air University's achievements in higher education in a very short span of time. He reiterated his government's resolve to give due importance to women education and their empowerment for a better future of the country. He appreciated the graduating students comprised a significant number of female award winners and graduates. The Prime Minister showed an appreciation for the concern and efforts of Chief of Air staff for the acquisition of land required to achieve due expansion in Air University dynamic educational programs. He announced that he has already directed the relevant authorities for giving possession of the 70 Acre of land that CDA has already allotted to Air University, without any further delay.

Dr Ijaz Ahmad Malik, Vice Chancellor of the University, in his welcome address informed the audience that the university now has over 3000 students and 170 highly qualified faculty with programs in engineering, basic sciences, business and management sciences and social sciences. The University, he said, has been continuously upgrading the infrastructure, laboratories and other facilities to meet the growing requirement of the qualified professionals in the country. He further elaborated that the University laid emphasis on quality enhancement in education, research and development, and character building of students who actively participated in all the curricular and co-curricular activities. Towards the end of his address, he thanked the Higher Education Commission and the Pakistan Air Force for their continues support towards the University.

It was encouraging to note that a substantial number of graduating students were females. The ceremony resumed after the first session for the award of Silver Medals and degrees by the Vice Chancellor.

DISTINCTIVE FEATURES

Since its establishment Air University Multan has shown a commendable growth in its infrastructure, academics and facilities. As expected, it has indeed proved to be a blessing for the people of southern Punjab who had too limited options for higher education in the recent past. An ever-increasing intake of students in the disciplines of Business Administration and Computer Sciences at the campus every year is enough to prove the point. The University is distinct in many ways and could be assessed by the snapshot being presented here.

Opportunity of Higher Education at the Door Step

One of the major objectives of the establishment of Air University Multan Campus was to serve the region from where students having an urge for higher education had to apply to the universities located in more developed cities like Lahore and Islamabad. The University, by God's Grace, is appreciably successful in fulfilling this noble cause since ample admission to University programmes reflect people's trust and satisfaction towards us.

Establishment of a Purpose-Built Spacious Campus

The University has acquired fifteen acres of land in the surroundings of Multan and intends to start a purpose-built spacious campus soon. One of the major benefits of this campus along with quality education with modern standards will be offering of a wide range of programmes particularly engineering programmes.

Listed for Prime Minister's Fee Reimbursement & Laptop Scheme

For our students financial constraints are no more hurdles in a way to higher education and advanced research for they are entitled to benefit from Prime Minister's fee reimbursement and laptop scheme.

Strong Linkage with the Main Campus

The university is closely linked with the main campus and has established a regular mechanism of knowledge-sharing to fully benefit our students. In this regard, the facility of teleconferencing and recordings of class lectures of the main campus and seminars by world renowned scholars are also available in the campus.

Financial Aid

The University awards various scholarships to outstanding candidates admitted to the programmes offered by the University. For instance,

- Scholarships for Merit List Toppers

- AU Need Based Scholarships
- HEC Need Based Scholarships
- Punjab Education Endowment Scholarships

STUDENT SERVICES

Computer Laboratories

In order to help our students get acquainted with latest research studies and specific subject matters, two general purpose and open-access computer labs and a digital logic design lab with a high speed internet facility have been established in the campus. These labs are connected with HEC digital library. Moreover, the students have an unlimited access to the computer and professional software tools and other facilities of the main campus. In addition to these labs, the university has also developed a Project/Research lab and an HPC cluster of 09 nodes for the students of MSCS.

Alumni Affairs Office

Alumni Affairs Office has been established in the University to cater for the needs of University's Alumni. This office serves as a bridge between the University and the growing community of its alumni. It helps and assists the alumni to strengthen the friendships formed in the university, build strong and mutually beneficial ties between the University and its alumni, create a dynamic alumni programme that will stimulate interest, assist and advance the alumni in the pursuit of excellence, promote goodwill in the community and build loyalty, increase involvement and generate support for the University. The primary task of this office is to help the alumni in their quest to find new and better career opportunities.

Language Laboratory

We are committed to improving the communication skills of students. For this purpose, a sophisticated language laboratory has been established equipped with language desks through computers. The state-of-the-art equipment with forty booths helps in the development of language skills. The laboratory is well equipped with the latest software to enable independent learning at various levels.

University Library

The campus library aims at enriching learning, teaching and research programs of the University by providing timely access to highly quality scholarly information and learning material in a variety of formats. Currently, the library contains a wide range of books, magazines and journals related to all areas particularly Management Sciences and Computer Sciences. Since libraries speak of universities' standings we

keep on upgrading it to have maximum reading material about the existing subjects and the ones we plan to introduce in the next semester.



Advisors

Each student is assigned an advisor from the faculty. The advisor helps the student to identify and achieve high academic goals and take advantage of learning opportunities. The advisors also guide students at the time of course registration every semester.

Transport Facility

Air University transport is available on payment for the students. The facility is available on designated routes within Multan city.

SOCIETIES & CLUBS

Perfect learning cannot be expected only from course books. Students need to have social, curricular, sports and many more experiences to cope with the challenges of the modern life. For this very purpose Air University Multan has formed different committees so that our students may not only have respite from their robust studies but also learn how to act as organizers, administrators, accountants etc by conducting different activities inside and outside the campus. This is necessary to reinvigorate their potential and energy and for overall personality development of the participants. The university Student Club manages a wide range of clubs and societies catering for both co-/extracurricular activities. Here is an overview of all the societies working in the university.

AIR UNIVERSITY SCHOOL OF MANAGEMENT (AUSOM)

The Faculty of Administrative Sciences has a tradition of doing things differently. From developing unique and robust business programs to building lasting relations with the corporate world, it has earned a strong reputation of 'academic excellence at par'. Within a few years of its inception, the Faculty of Administrative Sciences has been successful in offering business programs at distinct levels with a strong qualitative edge attracting a large number of applicants every year. With these enterprising footprints, the Faculty of Administrative Sciences also launched PhD program in Fall 2011.

Faculty Members

01. **Dr. Idrees Khawaja Dean, Faculty of Administrative Sciences**

Dr. Idrees Khawaja has a MBA in Finance, PhD in Economics from Pakistan Institute of Development Economics (PIDE) and Post Docs from University of Oxford and University of California Los Angeles (UCLA). He has also gone through training at Harvard University, USA in evidence based decision making. With 11 years of experience in Development Banking and 20 years of teaching experience, Dr. Khawaja brings rich expertise to AUSOM. Prior to joining AUSOM he has been associated with the Pakistan Institute of Development Economics (PIDE) and a number of Business Schools. He started his career as a Development Banker at the National Development Finance Corporation (NDFC) a premier financial institution of the country then. At NDFC he was involved in preparing the feasibility reports for the setting up large industrial projects which came to the bank to for financing. A crucial aspect of his task was undertaking projected financial analysis using advance techniques studied learned while doing MBA. Later he adopted teaching as a profession and while teaching at Business schools he did PhD in Economics. On completion of the PhD he joined PIDE, a premier research think tank cum University, as Senior Research Economist cum Associate professor. He had been teaching finance based courses in Business schools. At PIDE he used to teach Institutional Economics and Public Policy to graduate students. At PIDE he also launched the School of Public Policy in 2014 and headed it for two years. The School offers MPhil in Public Policy. On the research front, besides publishing research papers in refereed journals he led a team responsible for publishing the 'PIDE Economy Watch'. The Watch includes an overview of the state of economy and notes on major developments of economic interest. The issues are available at: <http://www.pide.org.pk/index.php/research/economy-watch>. Earlier he had also been publishing (from May 2009-October 2011- Issue: 5-9) a biannual feature called 'PIDE Business Barometer'. The Business Barometer prepared using responses of the firms listed on Karachi Stock Exchange dilated upon the present state of the economy. It also made an attempt to forecast the country's economic outlook in near future. The issues are available at: <http://www.pide.org.pk/index.php/research/business-barometer> Besides academic publications for refereed journals, Dr. Khawaja has offered consulting services to a number of national and international agencies, including; World Bank, Pakistan Poverty Alleviation Fund (PPAF), UNDP, Forum of Federations (Canada), GIZ and the Ministry of Commerce. He also won three research projects in competitive process from the South Asia Network of Regional Economic Institutes (SANEI), the Pakistan Strategy Support Program (PSSP) and the Higher Education Commission of Pakistan. Dr. Khawaja occasionally writes opinion articles in leading English Newspapers like Dawn and The News. So far he has written 30 such articles in newspapers. These are available at: <https://www.dawn.com/authors/3868/idrees-khawaja> Dr. Khawaja has travelled widely, in Pakistan and abroad, for studies and to undertake professional assignment

02. **Muhammad Mohsin Butt Professor**

He has more than 19 years of work experience in industry, teaching and research. He completed his PhD in marketing from University Malaysia Sarawak on a full scholarship in 2010. He has extensive experience of teaching at different universities such as International Islamic University, The University of Nottingham Malaysia Campus and Curtin University of Technology Malaysia Campus.

He has extensively published in world class journals in business, such as International Marketing Review, European Journal of Marketing, Journal of Business Ethics, Business Strategy and the Environment and Studies in Higher Education. His areas of research include halal branding, brand equity, ethnic marketing and service quality/financial service marketing.

03. Dr Ghulam Dastgeer is an Assistant Professor of Human Resource Management at the Air University School of Management. He received his PhD in Human Resource Development from the National University of Modern Languages and Sciences in 2012. He has contributed several research articles to regional and international journals. His research interests include Positive Organizational Behavior and Human Behavior.

04. Dr. S. K. Shahzad is currently associated with the Air University School of Management, Islamabad, Pakistan as an Assistant Professor of Management. Before his joining Air University, he worked as a visiting faculty member at the University of Paris Saclay, France.

Dr. Shahzad received a Doctorate in management studies from University of Paris Saclay, France for his thesis on Institutional transformation and stakeholder salience. He has an MBA from IAE Lyon France where he graduated with distinction (top of the university). In addition to it, Dr. Shahzad also has a first class Master degree in Economics from University of Peshawar Pakistan and Economic Analyst certificate from National Institute of Banking & Finance Islamabad Pakistan.

In his research, he concentrates on multifaceted links between strategic management, International business management and sustainability etc. His research work has won place in world's elite research outlets e.g., Journal of Business ethics, Academy of International Business, European Academy of Management etc.

His previous appointments include State (Central) Bank of Pakistan and Sungi Development Foundation. As a Deputy Director at SBP, Dr. Shahzad contributed in refining and strengthening the regulatory framework relating Commercial Banks and Development Finance Institutions in Pakistan. In recognition of his significant contributions in the development of World Bank's Financial Performance and soundness Indicators (FPSIs III), he was conferred Departmental Commitment Award by the State Bank of Pakistan. In addition to managerial and surveillance roles, Dr. Shahzad has also been a part of Economic policy and Research Departments at SBP where he conducted research and analysis on variety of subjects.

As a Program Head at Sungi Foundation, he conceptualized, formulated and implemented a major plan of restructuring the Sustainable livelihood and microfinance program at Sungi Development foundation Pakistan, transforming it into a strong and viable department. In recognition of the favorable socio-economic impacts of this program, it was conferred Silver Award by Social Performance Task force, USA. Dr. Shahzad's active relationship management also helped this organization win a central place on a network of important stakeholders including World Bank, DFID, Oxfam Novib, Government of Pakistan and PPAF etc. Moreover, Dr. Shahzad also led a

major effort in shaping the organization's policy processes and strategies on the issues of poverty reduction, gender, human rights, governance etc. and also facilitated the systematic evaluation of organization's overall socio-economic initiatives. Occasionally, he has also worked as a management and leadership trainer with organizations such as Prudence consulting and technology management USA and Omar Asghar Khan Centre for development Pakistan.

05. **Dr. Muhammad Umar** is an Assistant Professor of Finance at AIR University School of Management (AUSOM). He obtained his PhD in Finance from Dongbei University of Finance and Economics (DUFE), Dalian, China on Cultural Exchange Scholarship offered by Interprovincial Coordination Ministry of Pakistan (IPCM). He has published eight research papers regarding bank liquidity and non-performing loans in reputable international peer-reviewed journals so far. Many of his research papers are under review and some are in pipeline. He did his M.S. in Financial Management from TIAS School for Business and Society, Utrecht campus, The Netherlands on partial scholarship and got his MBA (Finance) degree from Pakistan Institute of Development Economics Islamabad (PIDE) on merit Scholarship. He is enthusiastic about research and teaching in the field of Finance.

06. **Dr. Mohsin Ali** is serving as an Assistant Professor of Finance at Air University Islamabad. He has more than 6 years of work experience in industry, teaching and research. He completed his PhD in Islamic Finance from INCEIF, Malaysia on a full scholarship in 2017. He has contributed several research articles to accredited journals and books. His research interests include Islamic Finance, Behavioral Finance and Religious Economics.

07. Dr. Shabbar Hussain

8. **Imran Hameed** is Assistant Professor at AUSOM. He holds Bachelors in Journalism and Fine Arts from University of Punjab; a Masters in Design from the National College of Arts, Lahore; and a Masters in Business Administration from San Francisco State University, U.S.A. His Ph.D. in Management, from SZABIST, Islamabad.

His key academic strengths include strategic management, entrepreneurship, innovation, ethics and corporate social responsibility. Imran has a work experience of over 20 years in advertising, sales and marketing, business development, and management consulting.

Imran has served at number of universities during the last fifteen years. Before joining Air University, he spent two years with University of Punjab (2002-4) as visiting faculty, and four years at G.C. University (2004-8) as Assistant Professor. At AUSOM, he currently serves as Associate Editor, Journal of Business & Economics. The students at AUSOM undertake the MBA Capstone Project and the BBA Final year projects under Mr. Hameed's overall supervision.

Imran Hameed holds a strong background in consultancy and training to the public enterprise and the SMEs with experience spanning many years. His consulting skills include strategic analysis, business development, business model, and ethical audit of corporations. As a trainer, he has conducted a variety of workshops for small-and-medium enterprise and specialized training sessions for public organizations. His subjects of interest in corporate training include; ethics in business, developing strategy for competitiveness, creating mindset for corporate entrepreneurship, developing a competitive business plan, bringing creativity and innovation to organization, analytical and critical thinking, and decision making for effectiveness.

Imran was among the pioneer group to establish the Executive MBA Program at G.C. University, Lahore in 2004 where he served as Program Manager during its first three years. He was honoured to be the official instructor for GCU- Cranfield University, U.K. Joint Higher Education Link Program in 2005. In addition, Imran has served as Member, Board of Studies at Department of Economics, G.C. University, Lahore (2004-8), and Member, External Academic Assessment Team, Quality Enhancement Cell (QEC) at Fatima Jinnah Women University, Rawalpindi in 2009-10

9. **Mr Farooq Rasheed** is associated with Air University since February 2008. Before joining Air University he served at Institute of Business Management Karachi and PAF-Karachi Institute of Economics & Technology. He received his M Phil in Economics from Quaid-i-Azam University, MS and M.Sc in Economics from University of Karachi. He won funding for a research project from South Asia Network of Economic Research Institutes (SANEI) in a competitive process. The project was successfully completed and presented in SANEI Conference Dhaka. He contributed to launch of three research journals in different universities Including “Journal of Business & Economics”, “Pakistan Business Review” and “Market Forces”.

10. **Qaiser Janjua** is PhD (Mktg) Candidate, MBA (SFU Canada and QAU), with more than thirteen years of experience in marketing, having a solid record and ability to work in teams and produce results. After his first MBA from Quaid-i-Azam University Islamabad in early 2000, Mr. Janjua spent quite a while in marketing related to aerospace and defense industry. He participated in the first ever defense exhibition of Pakistan, IDEAS 2000 held in Karachi and Sonmiani. He also successfully led his marketing team to Defendory 2000 (Athens), SLAF Aviation Display 2001 (Colombo), and IDEF 2001 (Ankara). He also had a brief stint in the sales and marketing of earthmoving equipment and was involved in EU rehabilitative projects in Pakistan.

After his MBA from SFU, where he also had a great teaching experience as a TA, he moved to the academia in 2009 by joining Air University as Assistant Professor of Marketing. Mr. Janjua uses case method of teaching and has to his credit several triumphs from highly acclaimed business contests in the country including; Discover NUST Business Plan Competition 2012 (Finalist), LUMS Marketing Colloquium and Synergies 2012-2015 (Winner Entopia 2013, Runner-up Business Case Competition 2013), IBA INVENT Entrepreneurial Challenge 2013 (1st Runner-up; 1 lac prize), NASCON 2014-2015 (1st Runner-up 2015), Case Business School (Runner-up 2015).

He also offered an entirely new pedagogical orientation to the faculty of administrative sciences and laid the foundation of a new business school, branded it with a new name of Air University School of Management-AUSOM which was officially approved by the Chairman BOG in June 2015.

Mr. Janjua also acts as an active member of Faculty Board of Studies and CAC in designing the BBA and MBA curriculum, teaching methodologies and addressing academic issues. He is also involved in developing the original curriculum and contents for the first ever MS/PhD programs launched in 2011 at AUSOM. His course ‘Analyses and Strategies in Emerging Markets’ was selected among the top six courses to be considered in the NBEAC Conference 2017 under ‘Stories of Indigenization’ category.

Apart from teaching and pedagogy, Mr. Janjua has been actively involved in research. He is one of the founding editors of Journal of Business and Economics (JBE) being published by the Air University since 2009 – which is an X category journal in the HEC classification. He along with his team have been awarded with crest and cash reward in the 6th Convocation Ceremony for their contribution in making the JBE a journal of repute.

He has published on some key areas of marketing and his thesis is also about academia. He also reviews research articles from prestigious AMA journals and has frequent invites from local journals as well.

11. Monal Ramzan is an Assistant Professor of Finance at Air University School of Management Sciences (AUSOM). She has taught undergrad and graduate courses at AUSOM. She got her Masters in Finance from Brandeis University, Boston. Her undergrad is from Kinnaird College, Lahore. She has worked as a portfolio analyst with asset management companies in Boston and Bethesda, Maryland, USA. Her research interests include Behavioral Finance and Investments and Portfolio Management. 14.

12. Muhammad Faisal Siddiqui is Assistant Professor at the Air University School of Management (AUSOM). He holds MBA and MS in Finance and currently perusing PhD in Finance. He has served the industry for more than eight years as General Manager and Business Development Manager. He has been actively involved in managing the BBA Program. Currently he is Program Manager of the BSAF program at AUSOM. He has been awarded commendation certificated by the Vice Chancellor for his contributions to AUSOM. He is also the Cluster Head of Accounting for all programs at AUSOM. Mr. Faisal Siddiqui has also conducted in house Corporate trainings at AUSOM.

13. Mr. Shakeel, is a Lecturer have done his MBA from LUMS Lahore and Electrical Engineering from UET Lahore. He has served corporate world for over 12 years and joined teaching from 2016 onwards. While working with corporate world he gained vast experience of Marketing Management, International Marketing, Brand Management, Digital Marketing, B2B & B2C Marketing & Selling. His corporate career enabled him to travel some World Destinations and interact with diverse cultures & different ethnicities coming from Europe, Australia, Middle East & Asia. Starting his first corporate assignment with Kohinoor Maple Leaf Group Pakistan, he progressed to work for some of the World's Top Notch organizations like Alcatel-Lucent (now Nokia), Perkins UK, IF Marketing (now IF Business Solutions), etc. While these assignments, he interacted with over 50 Nationalities of the World in different parts of Globe. He found out that Business & Management Studies pave way for a successful career of a person. Currently, he is serving as a Lecturer Marketing at Air University School of Management, Islamabad.

14. Mr. Umer Ghauri is a Lecturer Air University School of Management, Islamabad (AUSOM), Pakistan. He did his Bachelors of Computer Sciences and MBA from SZABIST. He worked in IT/Telecom industry in Pakistan before pursuing his Masters of Science in Project Management from KTH, The Royal Institute of Technology, Stockholm, Sweden. Currently he is a Program Manager of Project Management at AUSOM. Before joining Air University, he has worked in the corporate sector for 6 years in IT and Telecom industries as Project Manager and Business Analyst. He is a project management enthusiast and his research interests are in program/project management, leadership and organizational excellence.

15. Ms. Fakhra Malik is Lecturer of Accounting and Finance at Air University School of Management, Islamabad, Pakistan. She did her BBA (Hons) and MBA from Hamdard University Karachi. She did her MS Finance from Air University, Islamabad. She has served as Research Associate at PMAS Arid Agriculture University Rawalpindi and as Lecturer at University Institute of Information Technology (UIIT). She especially contributed for the development of industry-academia linkages. In 2015, she won the one year DAAD Scholarship for Research Fellowship in Germany. She has published four research papers in international and local journals. Her research interests include Dividend Policy, Corporate Finance, Corporate Governance, Financial Markets, CAPM, Behavioral Finance, China-Pakistan Economic Corridor and Human Resource

Development. She has supervised student's thesis at Graduate and undergraduate level, Industrial Project (BBA) and Capstone Project (MBA).

16. **Ms. Bushra Karim Mirza** is MS in Finance, MBA with Top position, having fifteen years of total experience. After her MBA she worked at reputable commerce and business institutions as visiting faculty for 2 years. She also worked with a leading textile company, Sapphire Fibre Ltd as Manager Merchandising and consultant for plant automation. In 2005 she joined Air University. She worked with the Dean Faculty of Administrative Sciences for establishment and development of Air University School of Management. She had been involved in developing the original curriculum and contents for MBA 2.5 years' program launched in 2009 at AUSOM. She played a key role in establishment of Business Department for Multan Campus of Air University that was successfully launched in 2011.

She is regular Faculty for Accounting with 11 years in higher education with focus in accounting research. Her research interests include Accounting disclosure and stock market efficiency, financial distress measure and remedies, Islamic Finance. Apart from teaching she is also a member of Faculty board of studies for bachelor programs. She is also a member of productivity association of Pakistan since 2012. She has been involved in Designing courses for BSAF program. She is a trained case study faculty and has incorporated and conducted multiple cases in Accounting courses. She has been supervising students' Research and Industrial projects since 8 years.

17. **Mr. Shoaib Ali** is Lecturer of Finance at Air University School of Management. He is currently perusing his PhD Finance from International Islamic university, Islamabad. He did his M. Phil Economics and Finance from Pakistan Institute of Development Economics (PIDE), Islamabad. He did his BBA (Hons) Finance from Bahauddin Zakariya University (BZU). His research work is published in well reputed journals.

18. **Mr. Imran Yousaf** is Lecturer of Finance at the Air University School of Management Sciences, Islamabad, Pakistan. He is currently pursuing his PhD in Finance. He has completed his M.Phil Economics and Finance from Pakistan Institute of Development Economics (PIDE), Islamabad. He spent some time in the Health service industry and State Bank of Pakistan before joining as Lecturer. His research interests include; Corporate Governance, Corporate Finance, Capital Markets and Behavioral Finance. Currently, Mr. Imran is enjoying his teaching activities.

19. **Ms. Sara Farhan** is a Lecturer of Economics at Air University School of Management; Islamabad She has MSc. International Economics from University of Nottingham, UK. She also has MBA in Finance and Risk Management and BS (JH) in Economics and Finance from Institute of Business Management, Karachi. Before joining Air University, she served as Associate Director in a think tank for three years. Sara specializes in trade policy, competition and private sector development. She has authored 'Unilateral Liberalization: Pakistan's Path to Trade Revival', 'GSP Plus: UNCAC Compliance', 'Low Cost Private Schools in Khyber Pakhtunkhwa', and Export Development Fund: A Critical Analysis and Roadmap for Restructuring.

20. **Ms. Anoosha Mazhar** is a Lecturer of Management at Air University School of Management, Islamabad, Pakistan. She received her BBA (Hons) from FAST School of Management and then joined NUST Business for a 2 years MBA program. Ms. Anoosha Mazhar has also delivered several training sessions in Roots Millennium Schools on the "Diversity in learning styles of students" and in OGDCL at the "Art of Negotiation".

21. **Hina Munir** is a lecturer of Marketing at AUSOM. She has done her MBA and BSC (Hons) from LUMS. She is teaching since last year at various universities and has successfully employed Case-based methodology and interactive learning. She also has rich experience spanning over 3 years

at banks. As a Product manager for Credit cards at Bank Alfalah, she developed Cash back and No Interest campaigns to increase sales. She was awarded employee of the month at MCB for her contributions at Internal Control department. She specializes in teaching Marketing strategy, Consumer behavior and New Product Development.

22. **Mr. Nayar Rafique** received MS International Development from Northumbria University, UK. He also has Masters in Applied Sciences (Economics) from Applied Economics Research Center University of Karachi. Nayar obtained his MBA-Finance degree from GC University Faisalabad and BCS from M.I.U, AJK. He has diverse academic as well as non-academic professional experience as he has been serving in public as well as private sector. Currently, he is pursuing Ph.D. Economics from Pakistan Institute of Development Economics, Islamabad.

23. **Mr. Abdul Rafay Sheikh** is an Associate member of ACCA, ACPA and CIPFA. He has also done Master in Commerce and BSc (Hons). He carries diverse experience relating Audit Assurance and Financial Consultancy. In this connection he has exposure of NGO, Govt. and Commercial Organizations environments.

24. **Ms. Ifrah Munir** is a lecturer at Air University School of Management, Islamabad, Pakistan. She completed her MBA and BBA (hons) from AUSOM. Her majors are in Human Resource Management. Ifrah possesses a strong understanding of Human Resource Management, Human Resource Development, Training and Development and Leadership and Motivation. She has open SAP certification in Run Simple HR with Success Factors Employee Central.

VISITING FACULTY MEMBERS:

S#	Name	Qualification
1	Mr. Muhammad Arshad	MS (Finance)(University of Arid Agriculture RWP)
2	Ms. Ayesha Sohaib Malik	MCS(Software Engineering) SZabist Karachi.
3	Col(R) Manzoor Iqbal Awan	MS; University of Kansas, USA MSc; Quaid-e-Azam University, Islamabad
4	Ali Haider	PhD Scholar (Management Sciences), MS (Management Sciences)
5	Muhammad Atif Khalil	ACCA QUALIFIED
6	Sajjad Ahmad	FCMA, MBA, ACIS, FPA, CIMA/CGMA (FINAL), DTM (USA),
7	Sobia Rashid	PhD Scholar (HR) Air University, MS (HR) Gold Medalist AU

Bachelor of Business Administration (BBA-Hons)

The four-year BBA (Honours) program is designed for candidates who aspire a comprehensive business education as well as an opportunity to develop strong business and management skills after their higher-secondary education. This 8-semester (4 year) program consists of 142 credit-hours. The first two years of study emphasize broad-based education related to social sciences, mathematics, economics, business, finance, management, marketing and law while the final two years of the program focus on advanced courses and specializations in three major areas including Human Resource Management, Marketing and Finance.

A summer internship as well as an applied project is also an integral part of the program so that candidates are equipped with first-hand experience in dealing with real-time business issues.

Program Details

Semester I

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	HU113	Introduction to Psychology		3-0-3
2	BA 111	Financial Accounting I	-	3-0-3
3	BA 151	Principles of Management	-	3-0-3
4	HU 101	Communication Skills	-	3-0-3
5	HU 106	Islamic Studies	-	3-0-3
6	HU 110	Pakistan Studies	-	3-0-3
		Total		18

Number of Courses = 6 Credit Hours = 18

Semester II

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 112	Financial Accounting II	BA 111	3-0-3
2	BA 131	Microeconomics	-	3-0-3
3	BA 160	Self Development	-	3-0-3
4	HU 102	Skillful Reading and Writing	HU 101	3-0-3
5	HU 214	Introduction to Sociology	-	3-0-3
6	MA 104	Business Mathematics	-	3-0-3
		Total		18

Number of Courses = 6 Credit Hours = 18

Semester III

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 101	Business Ethics	-	3-0-3
2	BA 232	Macroeconomics	-	3-0-3
3	BA 241	Principles of Marketing	-	3-0-3
4	BA 157	Management Information Systems	-	3-0-3
5	HU 201	Business Communication I	-	3-0-3
6	MA 205	Business Statistics	-	3-0-3
		Total		18

Number of Courses = 6 Credit Hours = 18

Semester IV

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 202	Logic & Critical Thinking	-	3-0-3
2	BA 233	Pakistan Economy	BA 232	3-0-3
3	BA 242	Marketing Management	BA 241	3-0-3
4	BA 252	Organizational Behavior	BA 151	3-0-3
5	HU 202	Business Communication II	HU 201	3-0-3
6	BA 121	Introduction to Business Finance	BA 111	3-0-3
		Total		18

Number of Courses = 6 Credit Hours = 18

Semester V

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 315	Managerial Accounting & Cost Control		3-0-3
2	BA 322	Financial Management	BA 121	3-0-3
3	BA 354	Human Resource Management	BA 151	3-0-3
4	BA 356	Entrepreneurship	BA 151	3-0-3
5	BA 357	E-Commerce	BA157	3-0-3
6	MA 207	Calculus	MA 104	3-0-3
		Total		18

Number of Courses = 6 Credit Hours = 18

Semester VI

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 303	Decision Making & Negotiation	-	3-0-3
2	BA 424	Financial Institutions and Markets		3-0-3
3	BA 343	Strategic Marketing	BA 241	3-0-3
4	BA464	Project Management	BA 121 & BA 151	3-0-3
5	BA 368	Business Law	-	2-0-2
6	MA 206	Statistical Inference	MA 205	3-0-3
		Total		17

Number of Courses = 6 Credit Hours = 17

Semester-Summer

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 466	Internship	-	3-0-3

Number of Courses = 1 Credit Hours = 3

Semester VII

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 404	Analysis and Strategies for Emerging Markets	-	3-0-3
2	BA 355	Operations Management	-	3-0-3
3	BA 363	Business Research Methods	MA 205	3-0-3
4	BA 469	Tax Management	-	2-0-2
5	BA ---	Elective I	-	3-0-3
6	BA ---	Elective II	-	3-0-3
		Total		17

Number of Courses = 6 Credit Hours = 17

Semester VIII

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 457	Business Policy and Strategic Management	BA 151	3-0-3
2	BA 458	International Business Management	BA 151 & BA 121	3-0-3
3	BA ---	Elective III	-	3-0-3
4	BA ---	Elective IV	-	3-0-3
5	BA 499	Final Year Project	-	3-0-3
		Total		15

Number of Courses = 5 Credit Hours = 15

Program Summary

Number of Courses	Credit Hrs. Labs
Core: 42	124
Specialization: 04	12
Internship:	03
Project:	03
Total	142

Course Description

BA 101 Business Ethics

PreReq: None

Credit Hours:

3-0-3

It is sometimes said that the phrase “business ethics” is an oxymoron. This course will attempt to dispel the popular conception. By working our way through many of the moral issues to which the practice of business gives rise, we will show that the interests of business people and moral philosophers converge.

BA 111 Financial Accounting I

Pre-Req: None,

Credit

Hours 3-0-3

Students are introduced to the basic structure of accounting and accounting cycle for service and merchandising concerns. Concepts include deferrals and accruals along with standards and principles associated with recordings, compilation, and preparation of financial statements. Fundamentals of corporate accounting are also discussed.

BA 112 Financial Accounting II

Pre-Req: BA 111

Credit

Hours 3-0-3

This course moves further from the accounting cycle and covers detailed merchandise accounting, classified balance sheet, and multiple income statements. Other topics include cash management, accounts receivable management, inventory management, long-term assets, depreciation, liabilities

and loss contingencies. The course concludes with stockholder's equity statement, corporate income measurement, issuance of stocks, distribution of dividends and stock splits. Students also learn to prepare the cash flow statement at a later stage of the course.

BA 131 Microeconomics
Hours 3-0-3

Pre-Req: None

Credit

This course examines supply and demand analysis, elasticity concepts with applications. Theories of cost are also included. In addition to these topics, the behavior of product and factor markets such as pure competition, monopoly, monopolistic competition, oligopoly, and monopsony is also included. This course also covers equilibrium (firm and consumer equilibrium) with emphasizes on indifference curves and budget line approach.

BA 151 Principles of Management
Hours 3-0-3

Pre-Req: None

Credit

The prime focus of the course is on the functions such as planning, organizing, staffing, leading and controlling. This course is oriented to modern management practices that are integral for organizations especially for those with diverse workforce and for functioning under the changing global, economic, social and technological conditions.

BA 160 Self Development
Hours 3-0-3

Pre-Req: None

Credit

The course gives an overview of socio-psychological skills applied in interpersonal relationship management. It teaches students to organize personal life and reduce physical and mental stress in the corporate setting. Explicit concepts in speed reading, time management, positive thinking, transactional analysis, personal conduct and attitude are stressed upon.

BA 202 Logic and Critical Thinking
Credit Hours 3-0-3

Pre-Req: None

This course is an introduction both to logic and to critical thinking, assuming no previous work in logic or philosophy on the part of the student. The critical thinking portion of the course covers the distinction between logic and rhetoric, the distinction between deductive and inductive arguments, the analysis of ambiguities and the nature of common fallacies in reasoning. In the logic portion of the course, the basic topics include the symbolization and evaluation of deductive arguments using truth tables and the construction of proofs to assess validity. We will also look at extensions of classical logic (such as modal logics, multi-valued logics), apart from discussing some fundamental issues pertaining to the nature of reasoning and logic. The objectives of the course, then, are both to become familiar with and competent with basic techniques of formal logic and to acquire skill in using these and related formal techniques to assess reasoning in a wide variety of applications.

BA 121 Introduction to Business Finance
Hours 3-0-3

Pre-Req: BA 111

Credit

This course aims at introducing the fundamental tools of business finance. The main concepts include financial analysis, financial decision-making, time value of money, cash flow estimation, analysis of investment, and financing decisions of the firms.

BA 232 Macroeconomics
Hours 3-0-3

Pre-Req: None

Credit

The focus of this course is upon building concepts in macroeconomics such as total output of a country and its growth, GDP multiplier, foreign trade, recession, unemployment and inflation. It also examines how monetary and fiscal policies can be used to achieve the objectives of output growth and price stability. To gain better understanding of macroeconomics, the course begins with a discussion about the problems of scarcity and opportunity costs.

BA 233 Pakistan Economy
Hours 3-0-3

Pre-Req: BA 232

Credit

The primary aim is to provide theoretical knowledge backed up by country experiences. To achieve this, the course introduces students the major theoretic paradigms and debates on growth and development. It then introduces Pakistan's perspective on policy issues and experience relating to agriculture, trade, industrialization, human development and international financial flows.

BA 241 Principles of Marketing
Hours 3-0-3

Pre-Req: None

Credit

This course introduces students to the fundamentals of marketing. Areas of study include determining how to identify consumer needs and satisfy them by making appropriate products, how to make products available through suitable distribution channels at the right price. It also creates appreciation of the role of marketing in complex business environments and provides basic concepts for further specialization in this field.

BA 242 Marketing Management
Hours 3-0-3

Pre-Req: BA 241

Credit

The prime objective of this course is to build an analytical approach towards marketing facing various industry contexts. Topics include influence of the market place and the marketing environment on marketing decisions, determination of the organization's products, prices, channels and communication strategies, and the organization's system for planning and controlling its marketing effort.

BA 252 Organizational Behavior
Hours 3-0-3

Pre-Req: BA 151

Credit

This course analyzes behavior of firms and individuals in large groups and complex work settings. It analyzes mutual relationship between different individuals, teams/groups, departments, and businesses. This helps student appreciate peculiarities of particular business situations and approaches towards a performance-driven mindset and behavior.

BA 157 Management Information Systems
Credit Hours 3-0-3

Pre-Req: None

This course covers the history of computing, relevance of information systems, and computing as a problem-solving system. Focus is directed towards information use and strategies in implementing global information systems. Topics include database management system, data communication, network system, and ethical issues relating to the modern information age.

HU 201 Business Communication I
Credit Hours 3-0-3

Pre-Req: None

Communicating with colleagues and customers effectively, writing letters, memos, preparing meeting agendas and minutes and preparing professional presentations are routine activities in any business environment. The focus of this course is to develop strong foundations of business communication right from an early stage of the program. At this level the students work in different groups in order to sharpen their interpersonal skills. Students are taught the basics of reading and writing as well as the art of non-verbal communication. At the same time they are trained to make formal presentations as well.

HU 202 Business Communication II
Credit Hours 3-0-3

Pre-Req: HU 201

This is an advanced course in Business Communication. Team building communication, leadership communication skills, advanced negotiation skills and dealing with conflicts are some of the important areas of this course. At this level students are presented with problem-solving tasks through complex business case studies. This challenging aspect further polishes their communication and interpersonal skills in developing effective solutions for a real-time business challenge. Developing the accuracy of expression in technical writing, and presenting their analyses is also focused upon business challenge.

BA 303 Decision Making and Negotiation
Credit Hours 3-0-3

Pre-Req: None

Managers make decisions every day. They have to negotiate with outside partners and colleagues inside the company about everything, from the allocation of available and leveraged resources to the strategic and tactical moves of the company. Very often, managers make their decisions based on their 'feelings' or through the prism of their personality. The objective of this course is to give students a systematic and objective framework for decision-making and successful negotiation which will help improve their personal effectiveness on one side and the profitability of the company on the other. Knowing oneself is the first step, so a significant part of the course will be devoted to the study of different decision-making styles, helping student to recognize their own style and teaching them the necessary skills to upgrade their judgment and problem-solving techniques.

BA 315 Managerial Accounting & Cost Control
Credit Hours 3-0-3

Pre-Req: None

The course emphasizes the use of managerial accounting information and concentrates on its application for planning activities, controlling operations and making strategic decisions. Other topics include cost accounting, activity based costing, structural and process issues in the design, and operation of management control systems.

BA 322 Financial Management
Hours 3-0-3

Pre-Req: BA 121

Credit

This course builds upon the background provided in core accounting and finance courses. It aims to enhance understanding of theory and practice of the financial management of a firm. Topics include financial analysis and planning, capital budgeting process, long term financing, working capital management and mergers and acquisitions.

BA 424 Financial Institutions and Markets
Credit Hours 3-0-3

PreReq: BA 121

A theoretical course is designed to provide a broad framework of the financial system as well as an insight into the nature and operations of different financial institutions and markets. These sectors

include banking, the non-banking financial institutions, the stock market, the bond market and the foreign exchange markets.

BA 343 Strategic Marketing
Credit Hours 3-0-3

PreReq: BA 241

This course includes the study of organization from the viewpoint of marketing. Key areas of this course include understanding strategy, business and market strategies, market vision and structure, demand estimation, consumer behavior, segment target and positioning, strategic brand management, and services, product promotion and pricing management. There is a strong emphasis on the quantitative side.

BA 354 Human Resource Management (HRM)
Credit Hours 3-0-3

PreReq: BA 151

The HRM course focuses on importance of human capital in modern business. It highlights proactive and productive use of human capital for attainment of organization's strategic objectives. It emphasizes professional approach to maximize return on investment through development of visionary policies to attract, train and retain human capital, determine compensations and grievance handling procedures, set objectives, develop standards, appraise performance, and review results for meeting up challenges facing today's organizations.

BA 356 Entrepreneurship
Hours 3-0-3

PreReq: BA 151

Credit

Objectives of this course include introducing the virtues of entrepreneurship to business graduates and preparing them to set up their own enterprises. It discusses the role of entrepreneurship in economic growth and highlights personal entrepreneurship characteristics as well as managerial, legal, financial, marketing, and informational needs of new enterprises.

BA 357 E-Commerce
3-0-3

PreReq: BA 157

Credit Hours

This course includes ERP System and its extension to inter-enterprise commerce. Diverse application issues are discussed in class including business interface with customers, logistics, portals, web markets, auctions, managing channel conflicts, disintermediation, leveraging a traditional business on the web, competition among traditional companies in e-commerce, payments, alliances and acquisitions.

BA 464 Project Management
Hours 3-0-3

PreReq: BA 121 & BBA 151

Credit

This course deals with the core concepts of project management framework, project management lifecycle and methodologies, basic project planning, scheduling and control functions. A study of how organizations are using project management as competitive edge.

Examines the organization, planning, and controlling of projects and provides practical knowledge on managing project scope, schedule and resources. Topics include project life cycle, work breakdown structure and Gantt charts, network diagrams, scheduling techniques, and resource allocation decisions.

BA 368 Business Law
Hours 2-0-2

PreReq: None

Credit

BA 363 Business Research Methods
Credit Hours 3-0-3

PreReq: MA 205

The study of business research considers gathering of market-related data from individuals and organizations and using it effectively to yield valuable information. Particular emphasis is placed on problem formulation, research design, questionnaire construction, and sampling. Its study includes learning of skills relevant statistical methods and tools for data analysis to obtain accurate quantitative results.

BA 469 Tax Management
Hours 2-0-2

PreReq: None

Credit

This course is designed for the management of tax matters and focuses on the solutions of the practical tax related problems by applying workable approaches. By the end of the course, students are able to understand the importance of taxes, forms of taxes, and methods of computing income under various heads. Students also learn as to how and when appeals or alternative methods of arbitration are adopted and how the application to seek various requests under the tax laws can be made.

Course Code	ELECTIVES (Human Resource Management)
BA 371	Performance and Compensation Management
BA 372	Training and Development
BA 373	Conflict Management
BA 374	Organizational Design and Development
BA 375	Industrial Relations and Negotiations
BA 376	Corporate Diplomacy
BA 377	Change Management
BA 378	Performance and Career Counseling
BA 379	Management Restructuring and Change
BA 380	Human Resource Development

Course Code	ELECTIVES (Marketing)
BA 391	Seminar in Marketing
BA 392	Retail Marketing
BA 393	Marketing of Services
BA 394	Consumer Behavior
BA 395	Advertising and Event Management
BA 396	International Marketing
BA 397	New Product development
BA 398	Brand Management
BA 399	Personal Selling
BA 470	Marketing Research
BA 471	Customer Relationship Management
BA 472	Services Marketing

Course Code	ELECTIVES (Finance)
BA 481	International Finance
BA 482	Seminar in Finance
BA 483	Security Analysis and Portfolio Management
BA 484	Financial Risk Management
BA 485	Islamic Banking and Finance
BA 486	Financial Statement Analysis
BA 487	Derivative Analysis
BA 488	Financial Restructuring
BA 489	Corporate Finance
BA 490	Investments
BA 491	Corporate Governance
BA 492	Micro Finance and SMEs
BA 493	Rural Finance

BS Accounting & Finance

The four-year BS Accounting & Finance program is designed for candidates to acquire not only undergraduate academic degree but also Professional Certification in Accounting and Finance, under this program. The Program is accredited by ACCA UK, The graduated students of BSAF will get exemptions in all 9 foundation level courses of ACCA.

This 8-semester program consists of 139 credit-hours. The first two years of study emphasize broad-based education related to accounting, finance, economics, and business management, while the final year of the program focus on advanced courses and specializations in Accounting and Finance.

A summer internship as well as a research project is also an integral part of the program in order to provide candidates with first-hand experience in dealing with real-time business issues.

Program Summary

Number of Courses	Credit Hrs.
Core: 41	121
Specialization: 04	12
Internship:	03
Project:	03
Total	139

Course Codes	Titles	Cr. Hrs.	
Semester I			
AF 121	Introduction To Computer Applications	3	
AF 141	Principles of Accounting	3	
AF 111	Principles of Management	3	
HU 107	Communication Skills	3	
HU 118	Islamic Studies	2	
MA 104	Business Mathematics	3	
		17	
Semester II			
HU 201	Business Communication – I	3	HU 107
AF 120	Introduction to Psychology & OB	3	
AF 142	Financial Accounting	3	
AF 214	Principles of Marketing	3	
AF 101	Micro and Managerial Economics	3	
HU 115	Pakistan Studies	2	
		17	
Semester III			
AF 251	Introduction to Business Finance	3	AF 141
AF 232	Macroeconomics	3	
AF 146	Cost Accounting	3	AF 141
AF 318	Strategic Management	3	
AF 243	Financial Reporting 1	3	AF 142
MA 300	Introduction to Statistics	3	
		18	
Semester IV			
AF 352	Financial Management	3	AF 251
AF 247	Managerial Accounting	3	AF 146
AF 353	Financial Institutions and Markets	3	AF 251
AF 313	Human Resource Management	3	
AF 344	Financial Reporting 2	3	AF 243
AF 225	Corporate and Business law	3	
		18	
Semester V			
AF 361	Taxation	3	
AF 272	Performance Management & Decision Making	3	AF 247
AF 249	Auditing	3	AF 142
AF 332	Business Ethics	3	
AF 354	Analysis of Financial Statements	3	AF 251
AF 357	Commercial Banking and lending	3	AF 352

		18	
Semester VI			
AF 363	Advanced Audit and Assurance	3	AF 249
AF 356	Corporate Governance	3	
AF 358	Investment and Portfolio Management	3	AF 251
AF 359	International Finance	3	AF 352
AF 316	Operation Management	3	MA 300
AF 262	Advanced Taxation	3	AF 361
		18	
Summer Semester			
AF 429	Internship	3	
		3	
Semester VII			
AF 435	Pak Economy	3	AF 232
AF 455	Islamic Finance	3	AF 352
	Elective I	3	
	Elective II	3	
AF 428	Business Research Methods	3	AF 111
		15	
Semester VIII			
AF 415	Entrepreneurship	3	AF 111
AF 122	Accounting Information System	3	AF 121
AF 498	Business Project	3	
	Elective –III	3	
	Elective –IV	3	
Total Cr. Hrs.		139	

Course Description

AF-141 Principles of Accounting

The objective of this course is to familiarize students with and develop in them a thorough understanding of the accounting concepts, principles and procedures involved in the analysis and recording of business transactions and the preparation of financial statements for service and trading concerns. Accounting concepts and techniques underlying income determination and valuation of current and long-term assets, together with their related internal control measures and their presentation in the financial statements are emphasized.

AF-142 Financial Accounting

Financial accounting is the first in-depth accounting course. Theory, the conceptual framework, development & application of International Financial reporting framework (IFRS) are stressed. Topics include financial statements, Treatment of Inventory & PPE in FS, partnerships & particular emphasis is placed on ethics in accounting & business environment.

AF-243 Financial Reporting I

This subject is an extension of the previous Financial accounting. Financial statements are again the main feature of this paper with the inclusion of consolidated financial statements & additional concepts such as impairment of assets, events after the reporting period & prior years' adjustments etc. Focused must be placed on practical application of IFRSs in the modern business environment.

AF-344 Financial Reporting II

In this subject students are expected to demonstrate application of Accounting for Leases, treatment of deferred & current taxes, Intangible assets & borrowing costs in the Financial statements as per IFRSs. The most important sections of this paper is the practical knowledge of Business combinations & preparation of Consolidated Financial statements after accounting for all acquisition adjustments.

AF-249 Auditing

This course will provide an understanding of Auditing and its process. The role of, standard for, auditing continue to evolve. The traditional audit changes in response to factors such as technological advancement, the changing needs of users of financial information, regulatory changes and the increasingly litigious environment in which the auditors practice. The evolution of auditing stresses the importance of professional judgment, a critical cognitive skill in the practice of auditing. A basic premise of this course is that "concepts" and "procedures" are inseparable. It is difficult to know when the concepts finish and procedures start. A second premise of this course is that the professional must begin with concepts and end with procedures and that is the whole idea of this course.

AF-363 Advanced Audit & Assurance

This course introduces students to auditing principles and practice. Students learn International Auditing Standards, professional and ethical requirements and the Legal & Regulatory Framework to conduct audit engagements. The course covers the complete lifecycle of financial statement audit that covers acceptance of audit engagement, developing a competitive proposal, complying with independence and other ethical requirements, risk assessment and development of audit program, finalization of audit and issuing final auditor's opinion. This course also gives an overview of governance, internal auditing and assurance engagements other than audit.

AF-146 Cost Accounting

The aim of this course is to equip students with the management accounting concepts and techniques used for sound business decision-making. Modules offered include basic cost accounting concepts, their nature and behavior, cost-volume-profit relationships, absorption and variable costing, relevant costs & differential analysis, standard costing and variance analysis, gross profit analysis and capital budgeting techniques.

AF-247 Managerial Accounting

The study of managerial accounting is for internal reporting and decision-making. The course introduces a business-management approach to the development and use of accounting information. Major topics include cost behavior, cost analysis, profit planning and control measures. Accounting for decentralized operations, capital budgeting decisions, and ethical challenges in managerial accounting are also covered.

AF-272 Performance Management & Decision Making

This course is designed to focus on planning and decision making techniques used for raising short-term finance and investing in the project.

To provide the students with a detailed knowledge of Cost and Management Accounting, to enable them to:

- Use the present and traditional approaches of cost accounting in different contexts, and
- Apply the cost and management accounting techniques, and evaluate the desired results in the light of the outcomes.

AF-251 Introduction to Business Finance

This course is aimed at introducing the fundamental tools of business finance. The main concepts examined include financial analysis, financial decision-making, time value of money, valuation of financial assets, risk and return analysis, and management of short-term assets of the firm.

AF-352 Financial Management

The course, building upon the background provided in the core accounting and finance courses, aims to enhance students' understanding of the theory and practice of the financial management of a firm. Topics covered include financial analysis and planning, capital budgeting process, long term financing, working capital management and mergers and acquisitions.

AF-353 Financial Institutions and Markets

This course is designed to provide a look at the broad framework of the financial system, as well as insight into the nature and operations of different financial institutions and markets. These institutions and markets include the banking industry, the non-banking financial institutions, the stock market, the bond market and the foreign exchange market.

AF-354 Analysis of Financial Statements

This course aims at developing a deeper understanding of accounting principles and standards underlying the data being analyzed and the analytical tools and techniques used for meaningful decision-making. The topics nature of financial reporting, balance sheet limitations, revenue exaggeration and expense manipulation, nature and types of reserves, deferred taxes, performance measures and ratios, financial flexibility and leveraged buyouts and growth rates and valuation via restructuring potential. The course is taught largely through case studies and real life business problems, thereby stimulating effective student participation in the learning process.

AF-358 Investments & Portfolio Management

The objective of the course is to study theory and empirical evidence relevant for portfolio management. An emphasis is placed on understanding how an investment professional would allocate funds in a hypothetical portfolio. Major topics include estimation of capital market parameters, trade-off between risk and return, optimal portfolio selection, equilibrium asset pricing models, and delegated portfolio management. Emphasis will be put on development of techniques that should be part of the tool kit of those interested in becoming professional investors and/or researchers in finance. The course material is tilted heavily towards equity markets since there are separate courses that cover fixed income markets and derivative securities.

AF-359 International Finance

This course concentrates on the role of external finance and foreign exchange in a macroeconomic context. The topics covered include a study of the major institutions of international finance, the balance of payments analysis, theories of foreign exchange rate determination, international risk exposures and risk management.

AF-356 Corporate Governance

The course covers the theoretical underpinnings of corporate governance viewed in the historical and contemporary context. It is recognized that perhaps the most significant stakeholder in corporate governance is the shareholder --- in particular, the minority shareholder --- and that adherence to corporate governance norms has a profound impact on engendering investor confidence (thus creating an environment that is attractive for capital). The course deal with the principal aspects/foundations of corporate governance on which it is based; and then, importantly, the diverse as well as widely acknowledged views regarding corporate governance.

AF-357 Commercial Banking & Lending

The course is designed to equip students with knowledge of a Commercial Banking and its regulatory framework and environments in Pakistan, and as it exists in a developed economy. On completion of the course the students shall be able to demonstrate an understanding of the subject matter and financial environments in Pakistan. The course policy envisages positive learning environments in the class. A productive participation conditional on attendance shall be rewarded judiciously. Tardiness and casual attitude shall be strongly discouraged. Zero tolerance for plagiarism and other unfair means of securing credits shall be strictly observed.

AF-455 Islamic Finance

This introductory course is designed to teach delegates the principles of Islamic Banking and to highlight the differences between Islamic and conventional banking. It explores the different products and services commonly found in both the GCC and the Islamic market globally and it assesses the relative advantages and disadvantages of each.

Corporate Finance

This course is aimed at building an analytical understanding of corporate financial decision making. It examines the fundamental question in finance i.e., the ability of companies to make profitable financial decisions using financial theories put forward by different scholars. The course also deals with controversies regarding what businesses do in order to maximize firm value.

AF-101 Micro & Managerial Economics

The objective of this course is to provide the understanding of managerial perspectives of economics through developing theoretical understanding, providing skills for indulging into critical thinking on areas like market forces, elasticity, cost analysis, consumer's and producer's equilibrium, forecasting, and market competitions.

AF-232 Macroeconomics

The focus of this course is upon building concepts in macro-economics such as total output of a country and its growth, GDP multiplier, recession, unemployment and inflation. It also examines how monetary and fiscal policies can be used to achieve the objectives of output growth and price stability. To gain better understanding of macroeconomics, the course begins with a discussion about the problems of scarcity and opportunity costs.

AF-435 Pakistan Economy

The primary aim is to provide theoretical knowledge backed up by country experiences. To achieve this, the course introduces students the major theoretic paradigms and debates on growth and development. It then introduces Pakistan's perspective on policy issues and experience relating to agriculture, trade, industrialization, human development and international financial flows.

AF-111 Principles of Management

The prime focus of the management course is on the functions such as planning, organizing, staffing, leading and controlling. This course is oriented to modern management practices that are essential to organizations with diverse workforce under the changing global, economic, social and technological conditions.

AF-214 Principles of Marketing

This course introduces students to the fundamentals of marketing. Areas of study include determining how to identify consumer needs and satisfy them by making appropriate products, how to make

products available through suitable distribution channels at the right price. It also creates appreciation of the role of marketing in complex business environments and provides basic concepts for further specialization in this field.

AF-313 Human Resource Management

The HRM course focuses on importance of human capital in modern business. It highlights proactive and productive use of human capital for attainment of organization's strategic objectives. It emphasizes professional approach to maximize return on investment through development of visionary policies to attract, train and retain human capital, determine compensations and grievance handling procedures, set objectives, develop standards, appraise performance, and review results for meeting up challenges facing today's organizations.

AF-316 Operations Management

This course covers optimization concepts, linear Programming models, graphical and simplex methods, transportation and assignment models, inventory models, and PERT/CPM. Other topics include electronic commerce, supply chain management, and ERP systems. The course work is intended to strengthen conceptual understanding and skills in the areas of operations, strategy and technology.

AF-415 Entrepreneurship

Objectives of this course include introducing the virtues of entrepreneurship to business graduates and preparing them to set up their own enterprises. It discusses the role of entrepreneurship in economic growth and highlights personal entrepreneurship characteristics as well as managerial, legal, financial, marketing, and informational needs of new enterprises.

AF-318 Strategic Management

This is an advanced management course in strategic planning, policy formulation and implementation to develop an integrated organizational view by inter-relating the functional areas of finance, marketing production, personnel and the general business environment. Case- studies are used to shape class discussions on solving real-life strategic business issues and problems.

AF-428 Business Research Methods

The study of business research considers gathering of market-related data from individuals and organizations and using it effectively to yield valuable information. Particular emphasis is placed on problem formulation, research design, questionnaire construction, and sampling. Its study includes relevant statistical methods and tools for data analysis to obtain accurate quantitative results design, questionnaire construction, and sampling. Its study includes relevant statistical methods and tools for data analysis to obtain accurate quantitative results.

Business Law

This course lays the foundation for the advanced study of business law at the senior graduate level. The Contracts portion of the course substantively deals with topics such as formation and breach of

contracts, statutory interpretation of the Contracts Acts and Sale of Goods Acts. This course also provides a comprehensive understanding of Agency and Partnership laws and the Partnership Act.

AF-361 Taxation

This course is designed for the management of tax matters and focuses on the solutions of the practical tax related problems by applying workable approaches. By the end of the course, students are able to understand the importance of taxes, forms of taxes, and methods of computing income under various heads. Students also learn as to how and when appeals or alternative methods of arbitration are adopted and how the application to seek various requests under the tax laws can be made.

AF-262 Advanced Taxation

This course is an extension of initial tax paper. It emphasizes on building a tax strategy by setting tax objectives and priorities and then negotiating and allocating resources accordingly. This course is developed keeping in mind the global business context where a company's corporate and tax strategies move line by line. It demonstrates the effect of double tax treaties and how financial resources can be optimized by effective tax strategy.

HU-107 Communication Skills

The course combines different strategies to cater to various levels of language learning to meet the diverse communication needs of the student in management sciences. The four skills of language are introduced and reinforced gradually. Areas of fluency and accuracy in communicative situations are stressed upon. The approach is student-centered, and the students are encouraged to interact with their peers and faculty, using teaching machines for further enrichment. Furthermore, the students are given ample practice in spoken skills in the form of presentations and general discussions in the class.

HU-201 Business Communication I

Communicating with colleagues and customers effectively, writing letters, memos, preparing meeting agendas and minutes, preparing professional presentations are routine activities in any business environment. The focus of this course is to develop strong foundations of business communication right from an early stage of the program. At this level the work in different groups in order to sharpen their interpersonal skills.

Students are taught the basics of reading and writing as well as the art of non-verbal communication. At the same time they are trained to make formal presentations as well as are required to work in different groups in order to sharpen their interpersonal skills.

HU-118 Islamic Studies

This course is designed to broaden the intellectual horizon of the students about fundamentals of Islamic creed, the causes of downfall, scientific dimensions of the Quran and basic human rights.

And to create awareness among the students regarding Quran, Sunnah, socio-economic and moral system of Islam.

HU-115 Pakistan Studies

The course highlights the religious, cultural, political and economic aspects of Pakistan as a nation; wherein the students learn and can defend their ideology amongst the comity of nations. A very comprehensive course which will instill into the young minds a strong feeling of nationalism, and justification for the demand of Pakistan.

AF-120 Introduction to Psychology & Organizational Behaviour

Human Behavior familiarizes students with the theories, research findings and concepts attempting to describe and explain human behavior. It attempts to prepare students to monitor people's behavior in organizations and understand why people behave the way they do and not the way they should. A prelude to this is the science of psychology, which will introduce to the students basic concepts of perception, learning, memory, motivation and stress. The areas of psychological disorders and social dynamics are also covered.

BS Aviation Management: Program Overview

The program is designed for candidates who aspire Aviation education as well as an opportunity to develop strong business and management skills after their higher-secondary education. The program shall equip candidates with the knowledge of the various aspects of aviation industry both locally and globally and instill strong business acumen for a successful and ever lucrative aviation career.

The aviation industry in Pakistan is dramatically growing. There is a remarkable increase in people travelling through air in Pakistan. According to statistics more than 20 million passengers travelled through air in Pakistan in 2017 versus 16 million in 2016. IATA reports compound annual growth rate (CAGR) of 9.9% in passenger traffic growth which is twice the world projections for all other regions.

The bilateral open-skies policy of Civil Aviation Authority (CAA) Pakistan and the CPEC induced development of infrastructure has spurred the international airlines to operate through corridors of the national air space. The international passenger traffic crossed 12 million passengers in Pakistan versus 8 million in 2014 with a CAGR of 7.1%.

The Growth in air travel is pushing new airport upgrades and new construction in Islamabad, Multan, Sialkot and Gwadar. Islamabad ranks 2nd in Air Passenger Traffic. There are seven new airlines which have requested for license to start their operations from CAA.

More jobs are opening up in Airport Operations, Airline Management, Flight Operations, Air Navigation, Cargo and Freight Management, Ticketing and Reservations, Food & Beverages/Catering, Travel and Tourism and other Support Services in Pakistan. Globally there are estimated to be more than 62 million jobs which include almost 10 million aviation direct jobs. In

Pakistan the induced jobs are estimated to be more than 5 million with a large increase in the coming years. International airlines, especially from the Middle East are also hiring from Pakistan.

Program Details

Course Code	S#	Semester 1	Pre-Req	Cr. Hr
BA 111	1.	Financial Accounting-I	-	3-0-3
BA 151	2.	Principles of Management	-	3-0-3
HU 101	3.	Communication Skills	-	3-0-3
HU 110	4.	Pakistan Studies	-	3-0-3
BA 113	5.	Introduction to Computer Applications	-	2-1-3
HU 113	6.	Introduction to Psychology	-	3-0-3
		Cr. hr.		18

Course Code	S#	Semester 2	Pre-Req	Cr.Hr
BA 112	1.	Financial Accounting-II	BA 111	3-0-3
BA 131	2.	Microeconomics	-	3-0-3
BA 241	3.	Principles of Marketing	-	3-0-3
HU 102	4.	Skillful Reading and Writing	HU 101	3-0-3
MA 104	5.	Business Mathematics		3-0-3
HU 214	6.	Introduction to Sociology	-	3-0-3
		Cr. hr.		18

	S#	Semester 3		
AM 231	1.	Aviation English	-	2-1-3
AM 241	2.	Introduction to Aviation	-	3-0-3
PH 100	3.	Physics	-	3-0-3
BA 232	4.	Macroeconomics	-	3-0-3
HU 201	5.	Business Communication (New)	-	3-0-3
BA 121	6.	Introduction to Business Finance	-	3-0-3
		Cr. hr.		18

	S#	Semester 4		
MA 205	1.	Business Statistics	-	2-1-3
BA 252	2.	Organizational Behavior	BA 151	3-0-3
AM 261	3.	Weather and Meteorology	-	3-0-3
BA 101	4.	Business Ethics	-	3-0-3
AM 251	5.	Airport Design and Operations	-	3-0-3
AM 243	6.	Aircraft General Knowledge	-	3-0-3
		Cr. hr.		18

S# Semester 5				
AM 371	1.	Aeronautical Decision Making	-	3-0-3
AM 372	2.	Aviation Maintenance Management	-	3-0-3
BA 354	3.	Human Resource Management	-	3-0-3
AM 356	4.	Aviation Legislation	-	3-0-3
AM 342	5.	Introduction to Flight Operations	-	3-0-3
AM 244	6.	Management of Air Cargo	-	3-0-3
		Cr. hr.		18
		Total		138

S# Semester 6				
AM 336	1.	Aviation Marketing	BA 241	3-0-3
AM 335	2.	Aviation Security Management	-	3-0-3
BA 315	3.	Managerial Accounting and Cost Control	-	3-0-3
HU 106	4.	Islamic Studies	-	3-0-3
BA 363	5.	Business Research Methods	-	3-0-3
AM 332	6.	Aviation Economics	BA131	3-0-3
		Cr. hr.		18

S# Semester 7				
AM---	1.	Elective 1	-	3-0-3
AM---	2.	Elective 2	-	3-0-3
AM 433	3.	Airline Finance	BA 121	3-0-3
AM 440	4.	Human Factors in Aviation	-	3-0-3
AM 434	5.	Aviation Policy and Law	-	3-0-3
		Cr. hr.		15

S# Semester 8				
AM---	1.	Elective 3	-	3-0-3
AM---	2.	Elective 4	-	3-0-3
AM 438	3.	Strategic Management in Airlines	-	3-0-3
BA 469	4.	Tax Management	-	3-0-3
AM 497	5.	Final Year Project	BA 363	3-0-3

Electives

CARGO AND FREIGHT		FLIGHT AND OPERATIONS	
AM 491	Equipment Acquisition & Disposal	AM 481	Aircraft Instrumentation and Approach Procedures
AM 492	Transportation and Traffic Management	AM 482	VFR/IFR Communications
AM 493	Warehousing and Distribution	AM 483	Mass and Balance
AM 494	International Shipping	AM 484	Aircraft Procedures and Systems Management
AM 495	Introduction to ALMS	AM 485	Flight Navigation and Simulation
-	-	AM 486	Aero Engines and Propulsion systems

AM 241 INTRODUCTION TO AVIATION

COURSE DESCRIPTION

The course is intended as an introductory course for those pursuing aviation as a profession; or for undergraduates wishing to gain a comprehensive perspective of the development of the field of aviation and aerospace. The course also introduces basic concepts of aviation business, principles and practices associated with the aviation industry. Major areas of aviation are discussed including the contemporary issues in aviation.

COURSE CONTENTS:

1. Aviation History from Inception
2. Aviation Commercial Business Terms
3. Differentiation of Classes of Aviation
4. Aeronautics, Aerospace and Avionics
5. Commercial Aircrafts, types, performance and operations
6. Livery
7. Airports-Types, Functions, Facilities, and Accessibility
8. Airport Management and strategies
9. Airlines–Revenue Management Overview
10. Air Cargo
11. Airline Alliances
12. Performance Management in Aviation
13. Impact of Aviation on Global economy
14. International and domestic Aviation Regulatory organizations

RECOMMENDED BOOKS:

Introduction to Aviation Management, [Andreas Wald](#), [Christoph Fay](#) and [Ronald Gleich](#)
Aviation History (JS319008) – A Jeppesen Publication, [Anne Marie Millbrook](#)
[Flight: The Complete History](#) (of Aviation & Aerospace), by [R. G. Grant](#)
Wings – A History of Aviation from Kites to Space Age, Tom D. Crouch

AM 342 INTRODUCTION TO FLIGHT OPERATIONS

COURSE DESCRIPTION

The purpose of this course is to introduce the student to operational aspects of airline. Topics to be covered include scheduling, routing, dispatching, gate assignments, boarding, fuel management, runway capacity. The objective of this course is to gain familiarization with the basic operations of aviation and airlines operation and study various aspects for effective operations.

COURSE CONTENTS:

1. Basics of Flight scheduling
2. Fleet Assignment
3. Aircraft routing
4. Crew scheduling
5. Manpower planning
6. Operations and Dispatch Optimization
7. Revenue Management
8. Fuel Management system
9. Airline Irregular Operations
10. Gate Assignment
11. Aircraft Boarding strategy
12. Airline Operations and Scheduling
13. Manpower Maintenance Planning
14. Aircraft Tow-tugs
15. Runway Capacity Planning
16. Small Aircraft Transportation System (SATS)

RECOMMENDED BOOKS:

Airline Operations and Scheduling, By Massoud Bazargan, Ashgate

AM 243 AIRCRAFT GENERAL KNOWLEDGE

1. This course will enable the students to familiarize themselves with various day o day commonly used terminologies, in an aviation organization. It will also enable them to easily fit into any of the ground operations sections / departments of an airline as they will be required to work in different departments and will be frequently transferred in different sections to perform duties.
2. AIRCRAFT GENERAL KNOWLEDGE
3. Principles of flight, stability, control, flight maneuvers and lift augmentation devices
4. Principles of Flight and Flight Controls – Aeroplanes
5. Definitions
6. Components of aeroplane, stress terms, structural terms, material used, fatigue.
7. Aeroplane configurations, definitions of shape and reference.

8. Units of measurement: length, area, volume, velocity, mass, weight, pressure (static, dynamic, total), temperature, density, force, power, energy.
9. Airspeeds. IAS, RAS/CAS, EAS, TAS, MACH Number.
10. Reference speeds
11. Terms used to describe aerodynamic phenomena. Boundary layer, laminar flow, turbulent flow, separated flow, ground effect.
12. Derivation of lift
13. Equation of continuity, mass flow
14. Streamline flow
15. Center of pressure, pitching moment

COURSE CONTENTS

Recommended Book(s)

Book as per CPL/ IR course of PCAA

AM 231 AVIATION ENGLISH

COURSE DESCRIPTION

The course is intended towards aviation professionals seeking high level of ICAO defined language proficiency. The course aims to increase confidence in communication and develops the very specific skills defined in ICAO language levels. These are the skills needed to succeed in any level assessment and to function effectively and safely in an aviation environment.

COURSE CONTENTS

1. Linguistic Awareness
2. Management of the Pilot-Controller Relation
3. Events, Domains and sub-domains in Aerodrome Control
4. Runway Incursion: ICAO alphabets, numbers, prepositions, verbs, actions positions
5. Lost: Tenses, abbreviations, Navigation, Co-ordinates, Topographical Features
6. Technology: Datalink, Flight Control, Instrument Blackout, Purpose, instructions, safety, instrument panel
7. Gravity: Ultra light, air race, hydraulic loss
8. Health: consonant clusters, intonation of lists, updating, symptoms of stress
9. Fire
10. Meteorology
11. Landings
12. Fuel
13. Pressure
14. Security

Recommended Books:

Aviation English for ICAO Compliance, Emery and Roberts, MacMillan

<https://atm.airport.ir/documents/799481/16762910/Aviation+English+for+ICAO+compliance.pdf/645af136-04d7-454f-acef-47e1254f24c4>

AM 251 AIRPORT DESIGN AND OPERATIONS

COURSE DESCRIPTION

Traditionally airport design and airport operation have been treated separately, yet they are closely related and influence each other. Poor design adversely affects operations, while sound understanding of operation is needed to enable good design. The aim of this course is to present a new and integrated approach to the two. The student will be presented with an opportunity to learn all the facets of airport design and how each of these work uniquely and in tandem.

COURSE CONTENTS

1. Air Transport and Airports
2. Predicting Traffic
3. Airport Site Selection and Runway System Orientation
4. Runways
5. Runway Strips and Other Areas
6. Taxiways
7. Aprons
8. Pavements
9. Aircraft Ground Handling
10. Aircraft Refueling
11. Cargo
12. Passenger Terminals
13. Airport Security
14. Landside Access
15. Visual Aids for Navigation
16. Electrical Energy Supply
17. Radio Navigation Aids
18. Airport Winter Operation
19. Airport Emergency Services
20. Environmental Control

Book: Airport Design and Operation: Second Edition

ISBN: 978-0-08-045104-6, eISBN: 978-0-08-054643-8 , Edited by: Antonín Kazda, Robert E. Caves, Emerald Publishing.

<https://www.emeraldinsight.com/doi/book/10.1108/9780080546438>

AM 244 MANAGEMENT OF AIRCARGO

Course Description

The course introduces students to the growing, technical and multifaceted Air Cargo industry. Students will understand the role that Air Cargo in the development of Air carrier industry, contractual and legally binding regulations and national and international trade. They will be given an overview of cargo booking, handling and acceptance procedures along with basic understanding of International Aviation. They will also be familiarized with different Associations related with Air Cargo Industry and the future challenges of the Air

Cargo Management. Objective of the course is to equip the students with relevant knowledge of Air Cargo industry. It aims at providing a deeper understanding of the role of Air Cargo in Supply chain Management and its impact and applications in the field of logistics. It will also enable the students to face the challenges in the Air Cargo Industry in a global Logistics perspective.

Course Contents

- **Air Transport Overview:** Means and Modes of Transport The Air Transport Industry, Role of Transport in Economic Development of Country Advantages and Limitations of Air Transport
- **Historical Perspectives**
- **Air Transportation:** Regulators and Associations
- **Introduction to Cargo Management:** Cargo Rating, Familiarization of Cargo Tariffs, Rounding Off of Weights /Dimensions / Currencies, General Cargo Rates, Valuation Charges, Air Cargo Terminology, IATA Cargo Agent, Agency operation ABC Air Cargo Guide Book, TACT Rules, TACT Tariff
- Cargo Booking Acceptance, Acceptance of Special Cargo, IATA Dangerous Goods, Regulation, Perishable Cargo, Valuable Cargo, Restrictions in Acceptance of Cargo, Identification of Cargo Labels
- **Cargo Booking Procedures:** How to Make a Cargo Booking, Mandatory information, Required for Cargo Booking, Handling of Allotments, Airline Booking Procedure
- **Documents in Air Cargo:** Introduction and Overview, Labeling and Marking of Packages, Air Way Bill, Cargo Manifesto, Cargo Transfer Manifesto, Documents Concerning, Postal Mails and Diplomatic Mails, Shipping Declaration for Dangerous Goods
- **Cargo Handling:** Handling Cargo, Cargo Liability & Insurance, Dangerous Goods, Regulations, Important Cargo Companies,
- **Air Way Bill:** Functions of Air Way Bill, Purpose and Validity of Air, Way Bill, Non-Negotiable Air Way Bill, Completion and Distribution of Air Way Bill, Warsaw Conventions /Carriage of Goods by Air Ordinances
- **Export, Insurance and Finance,** International Aviation and IATA rules.

Recommended Books:

Moving Boxes by Air By Peter Morrel

AM 261 WEATHER AND METEOROLOGY

Course Description

The course offers a comprehensive understanding of weather and meteorology and its importance and application in aviation. The main areas include learning structures and composition of heat and thermal responses, atmospheric pressures, winds, clouds, water vapors, precipitation, icing including engine icing, turbulence, weather radars thereby developing skills for interpreting and applying atmospheric observations in making effective decisions for aviation.

Course Contents:

1. The Earth Atmosphere, Structure and Composition
2. Heat and Temperature
3. Heat Transfer
4. Thermal Response
5. Temperature Variations with Altitude
6. Water Vapors
7. Earth Atmospheres Heat Imbalances
8. Atmospheric Pressure and Altimetry
9. Weather Charts
10. Wind
11. Global Circulations and Jet Streams
12. Local Winds
13. Air Masses, Fronts, and the Wave Cyclone Model
14. Vertical Motion and Cloud Formation
15. Atmospheric Stability
16. Clouds
17. Precipitation
18. Adverse Winds
19. Weather Obstructions
20. Turbulence
21. Icing
22. Thunderstorms
23. Weather Radars
24. Tropical Weather, Arctic Weather

Recommended Book:

The Pilots' Weather Handbook, US Department of Transport, FAA, 2016.

AM 336 AVIATION MARKETING**COURSE DESCRIPTION**

Students will learn the role of marketing in the aviation/airport industries. Issues covered include marketing in aviation, the airline marketing, strategic focus and differentiation, the 4ps and relationship marketing in aviation.

COURSE CONTENTS

1. The Market for Air Transport Services
2. The Marketing Environment
3. Airline Business and Marketing Strategies
4. Market Segmentation: Air Passenger Marketing
5. Strategic Marketing Orientation
6. Differentiation and positioning in Airlines
7. Product Analysis in Airline Marketing

8. Pricing and Revenue Management
9. Distributing the Product
10. Airline Brand Management
11. Services Marketing in Aviation
12. Relationship Marketing
13. Sales Management in Aviation

RECOMMENDED BOOKS

Airline Marketing and Management, By Stephen Shaw, 2012

AM 352 AIR TRAFFIC CONTROL MANAGEMENT

COURSE DESCRIPTION

The purpose of this course is to introduce students to Air Traffic Control systems. Elements and requirements of the course will include: basic air traffic control procedures, navigation aids, control tower operations, radar approach and departure regulations, and airport traffic control (ATC).

COURSE CONTENTS

1. Air Traffic Control System Structure
2. Airport Air Traffic Control Communications: Procedures and Phraseology
3. Navigational aids and inputs
4. Air Traffic Control Procedures and Organization
5. Control Tower Procedures
6. Radar Separation
7. The National Airspace Systems
8. FAA/CAA Aviation Administration

RECOMMENDED BOOKS

[Fundamentals of Air Traffic Control](#), [Michael S. Nolan](#), 2010

AM 372 AVIATION MAINTENANCE MANAGEMENT

COURSE DESCRIPTION

Students will perform a comprehensive examination of organizational maintenance policies, programs, and procedures in aviation. Emphasis is on maintenance planning, forecasting and cost control, reliability, safety, and flight schedule performance.

COURSE CONTENTS

1. The importance of maintenance in aviation
2. Introduction to Maintenance Management Concepts
3. Development of Maintenance Programs
4. Aviation Industry Certification Requirements
5. Documentation for Maintenance
6. Requirements of a Maintenance Program

7. The Maintenance and Engineering Organization
8. Technical Training in Maintenance
9. Aircraft Maintenance Management and Material Support
10. Oversight functions
11. Process Oriented Maintenance

RECOMMENDED BOOKS

[Aviation Maintenance Management](#), [Harry Kinnison](#), [Tarig Siddiqui](#), McGraw Hill.

AM 332 AVIATION ECONOMICS

COURSE DESCRIPTION

This course is a study of economic applications to the aviation and aerospace industry. Students will examine the evolution of market forces in the industry with particular emphasis on airlines, airports, and manufacturing. Concepts of yield management, air passenger demand forecasting, price and cost study, airport economics, air and land space optimization strategies, government's role in aviation, international implications of competition and government regulation, economic analysis of safety, and other relevant industry issues are examined. Emphasis is placed on an increasingly international air transportation environment.

COURSE CONTENTS

1. Characteristics and Trends in Airline Operations and Global Economy
2. The Regulation of International Aviation and its economic Impact on the Industry
3. Liberalization in Europe and the US
4. The Structure and Determinants of Airline Costs
5. Aviation Infrastructure: Operations and Ownerships
6. Product Planning
7. Monopolistic and Hybrid Market Structures in Aviation
8. The Economics of Passenger Charters
9. The Role of Supply and Demand in Aviation
10. Forecasting Demand
11. Pricing Policies and Fare Structures
12. The Economics of Air Freight
13. Future Problems and Prospects

Recommended Books

Air Transport Economics: From Theory to Applications by Bijan Vasigh and Ken Fleming, 2013

https://books.google.com.pk/books?id=1FAfDAAQBAJ&pg=PR2&lpg=PR2&dq=aviation+economics+book&source=bl&ots=aYY4z5gPG_&sig=0J1nQUm3NO4fvAS6Ugf_jGsmTR8&hl=en&sa=X&ved=0ahUKewizit7ZsYTaAhUNiKYKHe1mCBQQ6AEltwEwCQ#v=onepage&q=aviation%20economics%20book&f=false

ABC World wide Air Ways Guide, The Air Cargo Traffic (TACT)

AM 356 AVIATION LEGISLATION

COURSE DESCRIPTION

The purpose of the course is to impart essential knowledge and understanding of basic navigation techniques in aircrafts. To comprehend the map projections of earth and

position reference systems, pressure instruments, angular and distance measurements, instruments, radio navigation and flight planning.

COURSE CONTENTS

1. Introduction to Air Navigation
2. Form of the Earth
3. Defining Position on the Earth
4. Angular and Distance Measurement
5. Direction on Earth
6. Elementary Definitions
7. Visit to Nav Demo Room
8. Methods of Position
9. Reporting
10. Altimeter
11. CX 2 Computer
12. Map Reading
13. Direct Indicating Compass.
14. B16 Compass.
15. One in Sixty Rule
16. Pilot Navigation Techniques
17. Tactical Navigation
18. Radio and Radar Aids
19. Ground Controlled Approach
20. Instrument Landing System.
21. Flight Planning

Recommended Book(s)

Flight Navigation and Simulation- Ashgate
JEP605 EASA ATPL General Navigation Manual 10365016

AM 335 AVIATION SECURITY MANAGEMENT

COURSE DESCRIPTION

Security measures at airports have recently been at the highest level in the history of civil aviation. The challenge ahead for the aviation security professional demands the latest technology, the greatest of innovative thinking, and a high degree of cooperation between the private and public sector and among governments. Therefore, this course provides a comprehensive education on understanding different facets of aviation security and the ways and means in which the security measures can be taken for effective flight and airport safety.

COURSE CONTENTS

1. Aircraft security
2. Pre-departure screening
3. Screening and the law
4. Metal detectors, x-ray inspection, and explosives detection
5. Weapons, prisoners, and restricted articles

6. Baggage, cargo, and exempt flights
7. Bomb threat response
8. Airport security
9. Perimeter security and lighting
10. Identification for security
11. Terminal and ramp security
12. Law enforcement, communications, and contingency planning, general aviation security
13. Airline security
14. Investigation management
15. Ticket fraud
16. Ticket stock security
17. Credit card fraud
18. Baggage handling and security
19. Misappropriation and air cargo security problems
20. Physical security of the freight terminal
21. Security procedures for air cargo handling
22. High-value shipments
23. The “people factor” in cargo theft
24. A management approach to cargo security
25. Cargo theft investigation
26. Control by audit and survey
27. Significant incidents
28. The hijacking and terrorism threat

Recommended Books

Airport, Aircraft, and Airline Security (Second Edition), Science Direct, Elsevier
Aviation Security Management, By Andrew R. Thomas 2010

AM 371 AERONAUTICAL DECISION MAKING

COURSE DESCRIPTION

This course has been designed to cover the functions of Air Traffic Control at an Aerodrome as ATC is the Controlling Authority at the aerodrome. It will cover the responsibilities and code of conduct to be followed by the Airline Staff, Ground Handling agencies, fuel companies, catering companies, etc, both in normal working conditions and in case of emergency situations. The major components of the course are to learn Aviation Terminologies, Command and Control Structure of an Aerodrome, Controlling Agencies at Aerodrome and their jurisdiction, Communication procedures at Aerodrome, Flight Initiation / Arrival & Departure Procedures with emphasis on Administrative and Logistical procedures involved.

COURSE CONTENTS

- Introduction to Air traffic services
- Aeronautical Information Services
- Aerodrome Control

- Air Traffic Control
- Obstruction clearance
- Controlled airspace
- Procedures for flight in controlled / uncontrolled airspace
- Communication Procedures on VFR/IFR Flights
- Simple airplane communication
- Radiotelephony procedures
- Local aerodrome R/T procedures
- Messages
- Distress and Urgency communication procedures
- The terms UTC, Pakistan Standards Time.
- Beginning and end of civil twilight from given sunrise and sunset times.
- Carry out conversion between: UTC, Pakistan Standards Time.

Recommended Book(s)

Extract of contents from CPL/ IR course of PCAA

AM 433 AIRLINE FINANCE

COURSE DESCRIPTION

The course offers discussion on industry financial performance; Airline financial statements; Airline financial ratios; Airline valuation; Sources of finance; Equity finance; Airline privatisation; Airline financial planning and appraisal; Risk management: foreign currency, fuel prices and interest rates; Aircraft leasing; Aircraft securitisation; Airline bankruptcy; Industry financial prospects

COURSE CONTENTS:

1. World Airline Financial Results Overview and Implications
2. Airline Financial Statements
3. Airline Financial Ratios
4. Airline Valuation
5. Sources of Finance
6. Equity Finance
7. Airline Privatization
8. Airline Financial Planning and Appraisal
9. Risk Management: Foreign Currency and Fuel Price
10. Aircraft Leasing, Finance Lease, Operating Lease, Wet Lease
11. Sale and Leaseback
12. Aircraft securitization; Airline bankruptcy; Industry financial prospects

Recommended Books:

Peter s. Morrell, **Airline Finance**, Third edition, Ashgate Publishing Company

AM 434 AVIATION POLICY AND LAW

COURSE DESCRIPTION

This course is designed to provide students with essential knowledge about Aviation law. The students are expected to learn about the current laws and regulations within Pakistan as well as international domains specifically regarding the International Civil Aviation Organization (ICAO). The students will be expected to analyze case studies and be aware of the common mistakes committed in the aviation industry.

COURSE CONTENTS

1. Sources of Aviation Law: History and structure of regulation of domestic and international aviation (FAA, DOT, NTSB, TSA, CAA, NAP)
2. DOT statutory authorities and DOT certification of air carriers & regulatory overview
3. International aviation law (Chicago Convention; the Freedoms; bilaterals; ICAO; "Open Skies;" cabotage; foreign ownership; right of establishment; the US-EU agreements)
4. Airlines and Passengers: antitrust, competition, civil rights
5. Competition and the antitrust laws: barriers to entry and anticompetitive conditions
6. Antitrust laws and anticompetitive conduct
7. DOJ and DOT authority over mergers, acquisitions, and code-share agreements
8. Consumer protection – unfair and deceptive practices & unfair methods of competition
9. Anti-discrimination protections for passengers: section 40127 and Air Carrier Access Act
10. Airlines and Passengers: ADA preemption; labor & bankruptcy law
11. Airline Deregulation Act preemption
12. Labor law
13. Bankruptcy law Aircraft
14. Federal Aviation Act preemption
15. CAA aircraft registration, certification, and regulation airmen Federal Aviation Act preemption
16. CAA certification and safety regulation of air carriers, aircraft, and airmen
17. CAA safety rulemaking and judicial review
18. CAA enforcement & NTSB appellate jurisdiction & judicial review
19. Civil rights laws and criminal sanctions applicable to airline personnel
20. International conventions on hijacking, sabotage and other crimes and acts of terrorism
21. Accident investigation and litigation
22. Domestic accident investigation and litigation
23. International accident litigation (Warsaw and Montreal Conventions)
24. Airports
25. Takings Clause and relationship between Federal and local governments
26. Airport expansion; funding of construction & improvements; noise abatement authority
27. CAA safety regulations of airports and regulation of hazards to air navigation
28. Statutory and contractual grant assurances
29. Airport rates and charges and state taxation
30. Passenger Facility Charges) & judicial review

Recommended Books

1. Practical Aviation Law by J. Scott Hamilton, 2011
2. Fundamentals of Aviation Law, 1st Edition by [Raymond Speciale](#), 2006
3. [Foundations of Aviation Law](#), by [Michael W. Pearson](#) and Daniel S. Riley, 2015

4. Companies Ordinance 1984 and
5. Pakistan's National Aviation Policy 2015 (PCAA)

AM 356 AVIATION LEGISLATION

COURSE DESCRIPTION

This course is designed with the aim to provide the students with a clear picture of the rules & regulations which govern any aviation organization. In aviation any department whether it is Flight Operations or ground operations, be it Cargo, catering or Pilot and engineers, every department and person has to follow the rules which are devised by the Regulatory Authority (PCAA).

1. Definition of terms used.
2. Practical use and knowledge of AIP,
3. Practical use and applicability of ANO
4. Jeppessen Airway Manual,
5. NOTAMs and charts for instrument flight to determine facilities and restrictions for selected routes and aerodromes.
6. Practical use of essential documents for determining other minimas such as minimum equipment and fuel on board, crew composition, alternate aerodromes and weather minimas for selected and defined conditions of flight.
7. Civil Aviation rules 94 and ICAO Annexes.
8. Procedures in the event of partial and complete communication
9. Responsibility and function, exchange of aeronautical information.
10. Contents and specification of aeronautical information publications {AIP} Pakistan.
11. NOTAM: Origination, distribution, general specifications for class I and class II distribution, 5 letter codes of Aeronautical Information Circulars (AIC). Origination, specification and distribution of aeronautical information
12. Pilots' responsibilities in respect of preflight and post-flight information.
13. Interference, secrecy of communication.
14. Suspension of service, infringement of procedures.
15. Acceptance transmission and delivery of messages. Cancellation of messages. Time system, Record of Communication both national and international.
16. Establishment of Radio communication.
17. Use of codes and abbreviations, texts; Order of priorities etc.
18. Extract of contents from CPL/ IR course of PCAA

AM 440 HUMAN FACTORS IN AVIATION

COURSE DESCRIPTION

The course offers candidates the psychological, social, biological, and safety aspects of individuals working in organizations in aviation context. The candidates learn to understand how these internal and social aspects interact with external forces of organizational culture and have a strong bearing on human performance. Understanding

these factors become crucial in aviation where optimum human performance is demanded at all times.

COURSE CONTENTS

1. The System Perspective on Human Factors in Aviation
2. The System Safety Perspective
3. The Safety Culture Perspective
4. The High Reliability Organization Perspective
5. Pilot and Crew Performance Issues
6. Information Processing in Aviation
7. Managing Workload, Performance, and Situation Awareness in Aviation Systems,
8. Team Dynamics
9. Flight Training and Simulation as Safety Generators
10. Understanding and Analyzing Human Error in Real-World Operations
11. Cognitive Architectures for Human Factors in Aviation
12. Aircrew Fatigue, Sleep Need and Circadian Rhythmicity
13. Human Factors in Aircraft Design
14. Aviation Displays
15. Crew Station Design and Integration
16. Vehicles and Systems
17. Air Traffic Management and Humans
18. Commentary on NextGen and Aviation Human Factors

Recommended Book

Human Factors in Aviation, Salas and Maurino, 2nd Edition, Elsevier

https://books.google.com.pk/books?id=ohjZXuvVTc0C&printsec=frontcover&source=gbs_ge_summary_r&cad=0#v=onepage&q&f=false

AM 438 STRATEGIC MANAGEMENT IN AIRLINES

COURSE DESCRIPTION

This course is designed for students who are future practitioners in the aviation business and would be expected to structure the gained expertise and academic achievements for greater efficiency in the business. It is aimed to question key established practices in order to constructively propose future ones. Also discussed and studied are practical guidelines and toolkits that airlines will be able to use in their organizations to align business functions and integrate business processes in order to support their defined business model are discussed.

In addition, this course will allow students to recognize that each task and activity in the organization could have a role in identifying value by embedding value-based strategy formulation in day-to-day processes. The described approach is not only a departure from conventional airline planning but is a necessary means to address the fundamental challenges that plague the aviation industry. The course offers a more holistic approach to airline strategy and marketing, by reflecting on today's business models, identifying key attention areas and pressure points, and by proposing a new management approach as

part of a more holistic view of the air transport industry. Furthermore, due to the fact that re-inventing business models today can only be achieved by questioning current practices and related information technology; a few chapters are dedicated to address future business-technology needs.

COURSE CONTENTS

1. Airline woes at industry level and company level.
2. Right sizing the industry and the company.
3. Business transformational methodology
4. Functional integration.
5. Strategic value creation
6. Business Model Optimization.
7. Competitive dynamics theory - application to and implications for the European aviation market
8. Revenue Management & Optimization models.
9. Current and in vogue software and technologies
10. Repositioning & realigning business systems and processes.
11. Strategic innovation and integration in aviation business.

Recommended Books

- Strategic Management in the Aviation Industry, Sascha Albers, Herbert Baum , Edited by Stefan Auerbach , Edited by Werner Delfmann, [Taylor & Francis Ltd](#)
- Designing and Executing Strategy in Aviation Management by [Triant G. Flouris](#), [Sharon L. Oswald](#), Ashgate 2006
- Cruising to Profits: Transformational Strategies for Sustained Airline Profitability. Ricardo Vincent Pilon. Curmill Aviation 2013

MBA (2 years program)

The AUSOM MBA program exposes students to the diverse areas including Finance, Marketing, Supply chain management and Human Resource Management. With a strong focus on cutting-edge knowledge, the program prepares the students for career with reputable firms. The program also prepares graduates to become entrepreneurs. Designed for managers with the ambition to challenge for greater responsibility and more senior positions, The MBA program provides the right platform to enhance executive capabilities.. AUSOM is using Case method of teaching which is used by top business schools around the world. The program also prepares graduates to become great entrepreneurs.

Specializations

Four (4) Specializations

- Marketing
- Human Recourse Management

Four (4) Specializations

- Finance
- Supply Chain Management

Fact File

- Duration
 - 2 years
- Number of Semesters
 - 04
- **Class Timings**
 - Morning Timing
 - 8:30 a.m to 4:30 p.m
 - Evening Timing
 - 6-9 pm

Semester Plan

Semester 1

- Financial Accounting & Reporting
- Business Math & Stats
- Business Economics
- Marketing Management
- Principles of Management
- Entrepreneurship & Innovation

Semester 2

- Managerial Accounting & Cost Control
- Financial Management
- Marketing Strategy
- HRM & Organizational Behavior
- Analysis of Pakistani Industries
- Technology & Operation Management

Semester 3

- Advanced Research Methods
- Elective 1
- Elective 2
- Subject /Thesis/Project (part 1)

Semester 4

- Banking Operations
- Elective 3
- Elective 4
- Subject / Project /Thesis (part 2)

Elective Courses

HR Specializations	Finance Specializations	Marketing Specializations	Supply Chain Management Specializations
• Change Management • Performance & Career Counselling • Human Resource Development • International Human Resource Management • Leadership And Motivation • Organizational Development (Od) • Staffing And Performance Management • Strategic Human Resource Management • Talent Management And Retention • Training And Development	• Commercial Banking & Lending • Advanced Financial Statement • Cost Accounting • Financial Modelling • Financial Risk Management • International Finance • Investments & Portfolio Management • Corporate Valuation • Performance Management & Decision Making • Tax Management	• Analysis And Strategies For Emerging Markets • Consumer Behavior • Digital Marketing • Integrated Marketing Communication • Marketing For Hospitality And Tourism • Strategic Service Marketing • Strategic Brand Management • Agriculture Marketing	• Logistics & Distribution Management • Transportation Management • Agriculture Food Supply Chain • Supply Chain Network Design • Quality Management And Lean Thinking • Production Planning And Inventory Control • Supply Chain Modeling • Supply Chain Finance • Fundamentals Of Supply Chain • Procurement Management

Eligibility Criteria

- Minimum three years' work experience and 16 years of education in any discipline.
- Minimum 2.0/4.00 CGPA or 50% marks in annual system.
- Admission Test & Interview.
- 30 credit hour exemptions for business graduates (based on academic performance and interview)w

MS Management Sciences

This program is of thirty (30) credit hours spread over three semesters including a comprehensive thesis in the last semester. The MS program in Management Sciences is designed primarily for candidates who have a background in a business-related field and are interested in pursuing management studies at a level beyond 16 years of education. Candidates from other disciplines with a background in quantitative techniques and strong communication skills are also considered for this program. It offers specializations in Human Resource Management and Finance. The hallmark of this program is its emphasis on advanced quantitative skills and professional ingenuity enabling students to attract lucrative careers in academia and the corporate sector.

Program Details

Semester I

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	MA 741	Advanced Statistical Techniques	-	3-0-3
2	BA 761	Advanced Research Methods	-	3-0-3
3	BA---	Elective	-	3-0-3
4	BA---	Elective	-	3-0-3
		Total		12

Number of Courses = 4 Credit Hours = 12

Semester II

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 751	International Business	-	3-0-3
2	BA 752	Issues and Challenges in Management	-	3-0-3
3	BA---	Elective	-	3-0-3
4	BA---	Elective	-	3-0-3
		Total		12

Number of Courses = 4 Credit Hours = 12

Semester III

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 799	Thesis	-	6-0-6
		Total		6

Number of Courses = 1 Credit Hours = 6

	Total	
Number of Courses	Credit Hrs.	Labs=0
Core: 4	12	

Specialization: 4	12	
Thesis:	6	
Total Credit Hrs:	30	

Course Description

BA 751 International Business

PreReq: None

Credit

Hours 3-0-3

This is an applied course that emphasizes international business practices from a strategic perspective. Areas of focus include globalization, emerging economies, operations, FDI, trade and its barriers, MNEs and their strategies, environment, cultural and the legal aspects.

BA 752 Issues and Challenges in Management **PreReq: None**

Credit

Hours 3-0-3

This is an advanced level course in management theory and practice. Areas of study include the historic development of management though decision making, the management functions of planning, organizing, leading and controlling. This course also helps in developing students' managerial skills through case analysis, business simulations and real-time projects.

BA 761 Advanced Research Methods

PreReq: None

Credit

Hours 3-0-3

This is an advanced course in business research methods. Its emphasis is on research design, instrument development, data collection techniques and methods of evaluation in a public and applied setting. Additionally, students also become familiar with the policy implications of business research outcomes.

Course Code	ELECTIVES (General Management - HR)
BA 771	Staffing and Performance Management
BA 772	Human Resource Development
BA 773	Leadership and Motivational Skills
BA 774	Organizational Development
BA 775	Industrial Psychology and Collective Bargaining
BA 776	Corporate Ethics
BA 777	Labor Laws

Course Code	ELECTIVES (Finance)
BA 785	SME and Rural Finance
BA 786	Corporate Securities and Regulatory Framework
BA 787	Financial Risk Management
BA 788	International Finance
BA 789	Financial Econometrics
BA 723	Financial Modeling
BA 791	Corporate Valuation
BA 724	Investment Analysis and Corporate Portfolio
BA 793	Financial Derivatives
BA 794	Islamic Banking and Finance

Master of Science in Project Management MS(PM)/MPM

Title of the Degree Program

Master of Science in Project Management – MS (PM)
Duration : 1.5 – 3 years
Credit Hours : 30 SCH
Semesters : 03
*Weekday Regular Evening (Mon-Thu)/Weekend Program (Fri, Sat, Sun)

Eligibility/Admission Criteria

1. Minimum 16 years of education, with at least 2.50/4.00 CGPA or equivalent in last-earned degree from HEC Recognized University/Institute.
2. For award of MS degree HEC requires GRE General / GAT-General Test (at least 50% score). This must be passed before admission in the MS Program.

GAT –General Test is not required for admission in MPM.

3. Candidates who qualify the Admission Test will appear in an interview for final selection.

Proposed Timeframe of commencement

Fall 2015

Program Structure (Road map)

This is a **30 credit hours** program, consisting of 24 credit hours of coursework and 06 credit hours of research, as per the guidelines of HEC.

This program runs in **3 semesters** and completes in **1.5 years**.

Also, the choice of electives is in the following tracks:

Master of Science in Project Management MS(PM)/MPM

- General Project Management
- Information Technology and Software
- Engineering Management
- Supply Chain Management

Program Highlights

The AU MS (PM)/MPM will have a state of the art curriculum consistent with the standards of

PMI® (Project Management Institute).

- It covers all the necessary text to be eligible to sit in **CAPM® (Certified Associate Project Manager)** and **PMP® (Project Management Professional)** certifications.
- The program also offers fundamentals of **PRINCE2®** which is the standard of project management in Europe and followed by international NGOs and social sector organizations.
- The program is based upon two standards for assuring quality and success in project management: **ISO 10006** and **ANSI 99 – 00 – 2000 (PMBOK)**. This means that in the program, all aspects of project management will be presented in the way that a large group of international experts intend. Students later can pursue international **Six Sigma** quality certifications.
- Also, risk management has become very important today and a part of the program is based on **ISO 31000 (Risk Management System)** and **ISO 22301 (Business Continuity Management)**.
- Essential trainings in **PMIS (Project Management Information Systems)** and PM Scheduling softwares, such as **MS Project** and **Primavera** will be a fundamental part of the degree.

Master of Science in Project Management - MS (PM)

Core Courses	18 Cr. Hrs.
Elective Courses	06 Cr. Hrs.
Research Thesis	06 Cr. Hrs.
Total	30 Cr. Hrs.

Semester Wise Breakup of Courses

Semester 1

S.No	Code	Course	Theory-Lab-Credit
1	PM-526	Project Management Essentials	3-0-3
2	PM-546	PM Financial Management	3-0-3
3	PM-586	PM Risk & Quality Management	3-0-3
4	PM-771	Elective - I	3-0-3
Total Credit Hours for Semester 1			12

Semester 2

S.No	Code	Course	Credits
1	MS-602	Advanced Research Methodologies	3-0-3
2	PM-568	PM Information Systems	3-0-3
3	PM-527	Project Monitoring & Evaluation	3-0-3
4	PM-772	Elective - II	3-0-3
Total Credit Hours for Semester II			12

Semester 3

S.No	Code	Course	Credits
1	MS-799	Research Thesis	6-0-6
Total Credit Hours for Semester III			6

Note1: Registration in "Thesis" is allowed provided the student has earned 18 credits and his/her CGPA is equal to or greater than

the 3.0.

Note2: Electives I & II in the tables above will be selected from the list of elective courses provided below. Additionally, please note, the table below is a partial list of electives. These will be updated and changed in response to the changing dynamics of the project sectors.

Elective Courses		
Course Code	Course Title	Credit Hours
PM-771	Project Stakeholder Management	3
PM-772	Project HR & Communications Management	3
PM-773	Program and Portfolio Management	3
PM-774	Business Analysis for Project Managers	3
PM-775	PRINCE2® Methodologies	3
PM-776	Innovation & Technology Management	3
PM-777	Decision Support Systems	3
PM-778	Engineering Management	3
PM-779	ERP Systems	3
PM-780	Software/IT Project Management	3
MS-790	Principles of Supply Chain Management+C15	3
MS-791	Contract Management & Public Procurement	3
MS-792	Global Supply Chain Management	3
MS-793	Analysis of Supply Markets and Supplies	3
MS-794	Logistic Modeling	3
MS-795	Marketing Analytics and Modeling	3
MS-796	Pricing Analytics and Revenue Management	3

Research Thesis

The dissertation is a 15,000–20,000-word piece of research. You choose an appropriate research topic, critically select and apply appropriate research methodology and data collection methods to your chosen research topic, and demonstrate a rigorous understanding of the theory and literature relevant to the issues under investigation.

The thesis is expected to be an individual and original effort on the part of each course participant and must meet all the specifications laid out by the department of business administration which will be communicated to each participant prior to undertaking the research. The steps included are:

- Selection of a topic and taking the approval from PhD research panel
- Proposal Presentation and Defense

- Selection of an advisor with the consent of the PhD research panel
- Preparation of the Research Paper as per the guidelines provided for MS-Thesis at Air University
- Final Presentation, which is also graded by external examiners and the Air University Research Analysts.

Infrastructure

No additional infrastructure seems to be required as such, except PM software installation. The existing classroom, labs, library, etc., will be utilized.

Proposed Research Areas

- Trends in project management
- Project success and failure
- Evidence-based practice in project management
- Project management maturity models research
- Agile, extreme and lean project management
- Project management competence
- Knowledge management in projects
- Project management benchmarking
- Leadership in projects
- Risk and opportunity management
- Change management

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- Reflective project management practice
- Ethics in projects

2014 PMI Sponsored Research Awards Announced

- **Establishing a Theoretically Sound Baseline for Expert Judgment in Project Management**
Paul Szwed
- **Translational Science and Its Effects on Organizational Structure and Program Management**
Dorothy Kirkman, Kevin Wooten, Alix Valenti
- **High-performance capital project front-end: a design commons approach**
Nuno Gil, Rehema Msulwa
- **Scaling Agility: Adapting Agile Principles to Large Projects in Large Organizations**

Yvan Petit, Brian Hobbs

- **Project Management as a Dynamic Collaborative Social Practice: Collaborative Innovation Revisited**

Roula Michaelides, Jeanne Dorle, Elena Antonacopoulou

- **Community engagement strategies during the construction phase of controversial projects**

Melissa Teo

ROAD MAP FOR MSPM (1.5 Years)

Masters in Project Management - MPM

Core Courses	18 Cr. Hrs.
Elective Courses	12 Cr. Hrs.
Total	30 Cr. Hrs.

Semester Wise Breakup of Courses

Semester 1

S.No	Code	Course	Theory-Lab-Credit
1	PM-526	Project Management Essentials	3-0-3
2	PM-546	PM Financial Management	3-0-3
3	PM-586	PM Risk & Quality Management	3-0-3
4	PM-771	Elective - I	3-0-3
		Total Credit Hours for Semester 1	12

Semester 2

S.No	Code	Course	Credits
1	MS-602	Advanced Research Methodologies	3-0-3
2	PM-568	PM Information Systems	3-0-3
3	PM-527	Project Monitoring & Evaluation	3-0-3
4	PM-772	Elective - II	3-0-3
		Total Credit Hours for Semester II	12

Semester 3			
S.No	Code	Course	Credits
1	PM-773	Elective - III	3-0-3
2	PM-774	Elective – IV/ Project -I	3-0-3
		Total Credit Hours for Semester III	6

Core Courses MS (PM)/ MPM Programs		
PM 526	Project Management Essentials	
PM 546	PM Financial Management	
PM 586	PM Risk & Quality Management	
MS 602	Advanced Research Methods	
PM 568	PM Information Systems	
PM 527	Project Monitoring & Evaluation	
MS 799	Research Thesis	

Electives Courses		
General Project Management/Supply Chain/Engineering Management		
PM 771	Project Stakeholder Management	
PM 772	Project HR & Communications Management	
PM 773	Program and Portfolio Management	
PM 774	Business Analysis for Project Managers	
PM 775	PRINCE2® Methodologies	
PM 785	Project - I	
PM 777	Decision Support Systems	
PM 778	Engineering Management	
PM 779	ERP Systems	
PM 780	Software/IT Project Management	
MS 790	Principles of Supply Chain Management	
MS 791	Contract Management & Public Procurement	
MS 792	Global Supply Chain Management	
MS 793	Analysis of Supply Markets and Supplies	
MS 794	Logistic Modeling	
MS 795	Marketing Analytics and Modeling	
MS 796	Pricing Analytics and Revenue Management	

Note: The first 2 semesters for both MS(PM) and MPM will be the same, however, in the last semester, MS(PM) students will opt for MS Thesis, while for MPM students, MS Thesis will be substituted by two courses.

PROGRAM SUMMARY

Here is the MS(PM)/MPM program summary

Master of Science in Project Management – MS (PM) / MPM

Credit Hours Offered in First Semester : 12

*Weekday Regular Evening (Mon-Thu)/Weekend Program (Fri, Sat, Sun)

MS(PM) Course Structure

Core Courses (06)	18 Cr. Hrs.
Elective Courses (02)	06 Cr. Hrs.
Research Thesis	06 Cr. Hrs.
Total	30 Cr. Hrs.

MPM Course Structure

Core Courses (06)	18 Cr. Hrs.
Elective Courses (04)	12 Cr. Hrs.
Total	30 Cr. Hrs.

Duration : 1.5 -3 Years

Credit Hours : 30 SCH Semesters :

Rate Per Credit Hours Tuition Fee: Rs. 4,400

Tuition Fee Per Semester : (4,400 x 12) = Rs. 52,800

Admission Fee (One Time) : Rs. 20,000

Security Fee : Rs. 10,000 (Refundable)

1 st Semester (12 Crd Hrs + Admission + Security) : Rs. 82,800

Tuition Fee 2 nd Semester (12 Credit Hrs) : Rs. 52,800

Tuition 3 rd Semester (06 Credit Hrs) : Rs. 26,400

Eligibility Criteria

1. Minimum 16 years of education, with at least 2.50/4.00 CGPA or equivalent in last-earned degree from HEC Recognized University/Institute.

2. For award of MS degree HEC requires GRE General / GAT-General Test (at least 50% score). This must be passed before admission in the MS Program.

*GAT –General Test is not required for admission in MPM.

3. Candidates who qualify the Admission Test will appear in an interview for final selection.

Core Courses Descriptions

Project Management Essential Credits (3-0-3)

This course provides a comprehensive overview of project management that focuses on applying the core principles to make better decisions, understand consequences and generate success. Relevant for any project in any area of business, the course covers the pragmatic skills and techniques necessary for effective project delivery. Topics include PM context, PM Framework and terminology, Project Lifecycle Management, PM Knowledge Areas and processes and an introduction to effective tools and methods of project management.

Project Management Information Systems Credits (3-0-3)

The objective of this course is to understand the importance of planning and scheduling to the successful completion of a project. This course covers the process of planning, scheduling, and understanding control measures and systems to effectively manage a project. The object of this course is to furnish you with the skills and knowledge you need to effectively plan and schedule a project, and to understand the information that the computer provides. You will learn the elements of project planning and ways to set up meaningful control systems that can help assure the user a successfully completed project. Students will be trained to use notable planning soft wares such as MS Project and Primavera for project scheduling and controlling.

Advanced Research Methodology Credits (3-0-3)

This is an advanced course in business research method. Emphasis is on the research design, instrument development, data collection techniques and methods of evaluation in a public/applied setting. Additionally, students also become familiar with the policy implications of business research outcomes.

Project Financial Management Credits (3-0-3)

This course is designed to equip project managers with the critical skills and knowledge required to effectively manage resource costs associated with their projects while delivering quality outcomes on a timely basis. Specifically, the course introduces a number of financial management and accounting concepts and techniques that can be used to analyze how projects consume resources, create value for a firm and its customers, and how this value may be enhanced. During this course students should learn accounting concepts and the accounting cycle as they apply to projects, understand and analyze financial statements, plan and manage project revenue and cash-flows, engage in project budgeting and project cost control including variance analysis, analyze project financing options, and evaluate capital investment projects.

Project Risk & Quality Management Credits (3-0-3)

Risk and Quality Management as two of the key knowledge areas of project management. This course covers the fundamental aspects, analytical tools, and methods of both areas. In particular, the course covers the basic processes of risk planning, identification, qualitative analysis, quantification, risk response development, and risk control. The course also deals with concepts of quality and their integration into project planning, execution, and control. It addresses the customer and the organizational perspectives on quality, the cost of quality and the use of statistical tools to manage quality improvements in projects.

PM Information Systems Credits (3-0-3)

Project management software increases the ability of the project manager to work more efficiently. The functions of project planning and scheduling, resource allocation, costing and progress monitoring are explored in detail which are the underlying principles of all the major PM softwares available these days. The students are trained in using MS PROJECT®/PRIMAVERA as tools for project scheduling and monitoring.

Through the application of project software tools and techniques students develop the skills required to manage successful projects.

Project Monitoring & Evaluation Credits (3-0-3)

Reliable and intelligent project monitoring allows project teams to make appropriate decisions on a day-to-day basis and ensures that projects are carried out as planned. At the end of the course, students will become familiar with the components of an effective monitoring and evaluation plan, and methods and tools to conduct data collection, statistical analysis and reporting. The course will enable you to prepare the ground for undertaking monitoring and evaluation and analyzing the results. Results Based Monitoring and Evaluation will also help participants understand the key components for effective M&E in order to improve management performance and evidenced based decision making.

PHD Management Sciences

This program is primarily designed for candidates taking academia as their career as well as for those who want mid-level or senior positions in corporate research. Candidates are offered specialization in fields such as Finance, Marketing and Human Resource Management.

Program Details

Course Work

Course work of 18 credit hours preferably in the first year is required, followed by a comprehensive examination for granting candidacy as a PhD.

Comprehensive Examination

Comprehensive Examination is a mandatory requirement for doctoral candidates as per the HEC guidelines. The examination will be held after completion of coursework (usually within 18 months after the student begins his/her doctoral program). Successful completion of the Comprehensive Examination is a requirement for the said program, and precedes defense of the PhD research proposal. Both the comprehensive examination and the PhD research proposal must be completed before a student can be granted Doctoral Candidacy status.

Dissertation Defense

The candidate shall have to defend his/her research proposal in a Proposal Defense Examination (PDE) in front of the Guidance and Evaluation Committee (GEC) in at most two attempts.

Foreign Expert Evaluation

The PhD Dissertation must be evaluated by at least two PhD experts from technologically/academically advanced foreign countries in addition to local Committee's evaluation.

Plagiarism Check

The Plagiarism Check shall be conducted on Dissertation before its submission to two foreign experts.

Open Defense

An open defense of Dissertation shall be required after positive evaluation of Thesis.

Research Paper

Acceptance/publication of at least one research paper in an HEC approved "Y" category journal is a requirement for the award of PhD degree.

Duration

The minimum time required for the completion of PhD degree is four years and the maximum time allowed is six years.

Program Details

Semester I

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 851	Management Thoughts and Philosophy	-	3-0-3
2	BA 862	Advanced Techniques in Data Analysis	-	3-0-3
3	BA---	Elective I	-	3-0-3
		Total		9

Number of Courses = 3 Credit Hours = 9

Semester II

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 863	Modeling in Management	-	3-0-3
2	BA---	Elective II	-	3-0-3
3	BA---	Elective III	-	3-0-3
		Total		9

Number of Courses = 3 Credit Hours = 9

Semester III

No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Credits)
1	BA 899	Thesis/Dissertation	-	30-0-30

Number of Courses = 1 Credit Hours = 30

	Total	
Number of Courses	Credit Hrs.	Labs=0
Core: 3	9	
Specialization: 3	9	
Thesis/Dissertation:	30	
Total Credit Hrs:	48	

Course Description

BA 851 Management Thoughts and Philosophies PreReq: None

Credit

Hours 3-0-3

This course intends to develop an understanding of how different management philosophies have developed over a period of time. This would be achieved by studying the process through which different management thinkers have gone through while formulating their thoughts and theories. More focus is given to contemporary thinkers/philosophers/gurus of management. The central rationale for the module is that the students of management must study the past to shed light on the present. Historical perspectives contribute to more logical and coherent picture of the present. By tracing the origin and development of management philosophies through the decades, we can better understand the analytical and conceptual tools of the profession.

BA 862 Advanced Techniques in Data Analysis PreReq: None**Credit Hours 3-0-3**

This course examines a variety of quantitative research methods and procedures including decision analysis, sampling techniques, probability theory, statistical inference, regression and time-series analysis, and mathematical programming. In addition, emphasis is put on multivariate techniques including cluster analysis, principal components analysis, and confirmatory factor analysis. In addition, multivariate analysis of variance is covered followed by decision trees and structural equation models.

BA 863 Modeling in Management**PreReq: None****Credit Hours 3-0-3**

This course includes understanding of system analysis, flow diagrams, choosing and solving mathematical equations both analytically and numerically, data exploration and modeling. Strong emphasis is placed on studying models including models' dimensionless form, asymptotic behavior, sensitivity and outputs. Typical models include a priori theorising conceptual models, uncertainty-based reasoning models, multi-attribute decision-making models, generalized linear models, nonlinear models and statistical decision models. Students are also exposed to test the models' assumptions, structure, prediction of previously unused data, estimating model parameters, comparing two models for the same system etc. Models are used for predictions with estimates of precision and decision support. The ethos of the course is focused on the utilization of data related to management fields of Human Resource, Finance and Marketing for research modeling processes

PhD Electives

Course Code	ELECTIVES (Human Resource Management)
BA 871	Advanced Topics in Human Resource Management
BA 872	Quantitative Methods in the Applied Behavioral Sciences
BA 873	Strategic HRM: Concepts and Applications
BA 874	Human Capital Management: Acquisition, Development and Retention
BA 875	Knowledge Management & HRIS
BA 876	Legal Systems, Labor Relations, and Regulatory Practices.

Course Code	ELECTIVES (Finance)
BA 881	Capital Risk Management
BA 882	Basel I & II
BA 883	Venture Capital and Private Equity
BA 884	Global Asset and Wealth Management
BA 885	Financial Theory
BA 886	Dynamic Asset Pricing Theory
BA 887	Empirical Finance

Course Code	ELECTIVES (Marketing)
BA 891	Behavioral Research in Marketing
BA 892	Marketing Data Mining
BA 893	Marketing Strategy and Management
BA 894	Bayesian Inference: Methods and Applications
BA 895	Quantitative Research in Marketing: Models and Methods
BA 896	Topics in Advertising and Integrated Marketing Communications (IMC)
BA 897	The Psychology of Judgment and Decision Theory
BA 898	Topics in Consumer Behavior

Grading Policy

Class participation	15%
Quizzes/Assignments	5%
Presentation	5%
Term project/Presentation	10%
Mid Term Exam	20%
Final Exam	45%
Total	100%

Journal of Business & Economics (JBE) ISSN: 2075-6909

The Journal of Business & Economics (JBE) is an internationally refereed journal published by Faculty of Administrative Sciences having an aim to encourage and publish theoretical as well as practical, issue-oriented, research papers on broadly defined areas of business management and economics. To ensure high-quality publications, all papers are subject to rigorous screening process and peer-review by national and international scholars with strong academic and research background in their areas of expertise.

JBE aims to reaffirm top-notch research and development in academic circles and business markets. The published articles are intended for providing enriched resource to local, regional as well international readership. The journal delivers an opportunity to develop a strong basis for conceptual and professional growth by sharing latest research findings and best practices in business and economics. The primary ambition of JBE is to bridge academia and practitioners throughout local and internal business environment. In a larger canvas, JBE aspires to build a platform for informed-debate on current uses of third world: economic competitiveness, efficiency, and sustainable development. The bi-annual Journal of Business & Economics (JBE), first printed in 2009, is regularly published in volumes with two issues i.e. January-June and July-December. JBE is recognized by HEC in Y category since April, 2012.

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Farooq Rasheed Air University, Islamabad, Pakistan

Kaiser Janjua Air University, Islamabad, Pakistan

Uzma Mushtaq Air University Islamabad, Pakistan

Achievements and Awards

1st Runner-up IBA Invent 2013 Entrepreneurship Challenge

Out of 1,600 students, 350 teams, belonging to 140 HEC recognized universities, only 16 teams could make it to the finals including AU. In each of the four categories, our teams competed for up to Rs. 175,000 to help them start their businesses. AU's team was the 1st Runner up bagging Rs. 100,000/- .

- Outstanding Diplomacy Award MEMS committee, GIKI Model United Nations 2013
- Entopia Winners: Business Case Simulation-LUMS Synergies 2013
- Among Top 5 Best Teams: NASCON Business Competition-FAST 2013
- Best delegate ECOFIN committee, NUST International Model United Nations 2013.
- Runner Up Certificate at DICE 2013 Business Plan Competition, UOG.
- AU's BBA candidate participating in United National Model Turkey 2013
- The "Honorable Mentions" of GIKI MediaFest 2013.

Faculty of Basic & Applied Sciences

The Faculty of Basic and Applied Sciences comprises of three departments: **The Department of Computer Science, Department of Mathematics and Department of Physics**. In all, a total of 50 faculty members and 20 labs engineers/teaching assistants are working in the three departments. They include **20** faculty members having their PhD degrees from leading universities. The PhD faculty members have specializations in topology, image processing, communication networks, software engineering, numerical analysis, mathematical modeling and computer simulation, radiation physics, solar energy, nanotechnology and computational sciences. The Department of Computer Science offers a four-year BS program in computer sciences BS Information Technology, BS Cyber Security, MS Computer Science and PhD Computer Science. The Department of Mathematics offers BS Mathematics, MS degree program in Mathematical Modeling and Scientific Computing and PhD the Department of Physics is offering BS Physics, MS/PhD degree program in Applied Physics.

PROF. DR. ASGHARI MAQSOOD, SI

Dean Faculty of Basic and Applied Sciences



Welcome to the Faculty of Basic and Applied Sciences at the Air University.

The Faculty of Basic and Applied Sciences is as old as the University itself. Department of Computer Sciences, Mathematics and Physics constitute this faculty. Basic Sciences is the backbone of any Engineering program including Electrical Mechatronics & Mechanical Engineering.

The undergraduate program of Computer Sciences was launched initially in 2002. In 2010 MS- Mathematical Modeling & Computer Simulation were introduced successfully. In 2013, the Master Degree program of Applied Physics was launched. From fall 2015 we have launched undergraduate programs in Mathematics and Physics. We have also started postgraduate studies leading to MS/Ph. D in Computer Sciences and Ph. Ds in Mathematics and Physics.

The Faculty has one mission; excellence in teaching, research and innovation, and we excel in all. We aim to take small number of students in lecture sessions, so that the professors get to know their students and engage them in scientific discussions. The target is to have thorough theoretical understanding of the subject and to provide an opportunity for practice. Additional objective of this faculty is strengthening the ties between the Basic Sciences, Engineering and Medical Sciences. Initial experimental

laboratories for all the undergraduate programs are available. The Physics post graduate laboratories are under progress.

Our professors have an excellent background of research in terms of impact factor, number of papers and their citations. In fact, Department of Physics stands at number five among the nationwide universities as reported by PCST 2013. The faculty is recipient of national and international awards including SI, Pride of performance, HEC best university teacher, Pakistan Academy of sciences Gold Medal, South Asia Publication and PCST awards.

We expect our graduates to be passionate scientists and engineers who are committed to improving the quality of human life through knowledge and technology. As Dean, I welcome the students in all the programs. Let us together build on the tradition of academic excellence at Air University.

Department of Computer Science

The Department of Computer Science offers a Four-year BS (CS) program. The program is designed to impart in-depth theoretical and practical knowledge of computer science to under-graduate students at appropriate levels. Elective courses prepare students for a career in the industry related to computers. Students are also encouraged to gain practical work experience at local software companies.

Faculty Members

1. **Dr. kashif kifayat**, Professor, Chair Department Computer Science,
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Education: PhD Cyber Security Liverpool John Moores University UK 2008,
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6. **Mr. Omer Ishaq**, Assistant Professor
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7. **Dr. Atta ur Rehman Khan**, Associate Professor
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BCS CIIT, Pakistan.

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Education: PhD (Engineering Management) in progress. E&ME- NUST MS
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11. **Mr. Sabih ul Hassan**, Lecturer

Education: MS (Embedded Systems & Control
Engineering), University of Leicester, UK (2008) BS Software Engineering, Air
University, Islamabad (2003 – 2007)
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of small world networks, transitions of self-driven particles, applications of arm
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12. **Mr. Faisal Fayyaz**, Lecturer

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14. Mr. Asif Jamal, Lecturer

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17. Ms. Farah Haneef, Lecturer

Education: PhD (Cont.) Quaid-e-Azam University, Islamabad

M-Phil (Computer Science) Quaid-e-Azam University, Islamabad

BS (Computer Science) (Gold-Medalist) PMAS Arid Agriculture University, Rawalpindi

Research Interests: Social Networks Analysis, Software Testing, Algorithm Design and Development.

Contact: Farah.Haneef@mail.au.edu.pk

18. Mr. Muhammad Shoaib Zafar, Lecturer (on study leave)

Education: PhD (Cyber Security) Beijing University, China (Continued)

MS (Software Engineering) NUST College of E & ME, Pakistan

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19. Ms. Sobia Rasheed Malik, Lab Engineer

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BS Computer Science

The BS (CS) is a four year professional degree program consisting of core courses in science, mathematics, programming and computing, with specialization courses in Image Processing, Computer Vision, Game Design and Multimedia Technology etc. The specialization courses are offered in close collaboration with national and international software industry requirements so that the students are well prepared for changing trends and demands. Students have to complete 130 credit hours with a minimum CGPA of 2.0 to earn the degree. Modern technology is utilized to impart knowledge through lecturing with the use of audio visual aids as well as practical hands on training in the labs and through case studies and projects.

The curriculum is designed as per HEC recommendations and provides core knowledge of specialized technologies. Every student has to take Elective courses to fulfill the BS degree requirement. Team and individual projects are assigned during various courses as well in the final year to inculcate team spirit, coordination and team work as well as leadership qualities in the students. The degree program endeavors to produce graduates who could pursue higher education abroad or join the industry in the public or private sector enterprises.

Semester I

S. No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Total)
1.	HU 119	English Comprehension and Composition	-	3-0-3
2.	PH XXX	Applied Physics	-	3-0-3
3.	HU 115	Pakistan Studies	-	2-0-2
4.	CS 101	Introduction to Information and Communication Technologies	-	2-0-2
	CL 101	Introduction to Information and Communication Technologies Lab	-	0-1-1

5.	CS 102	Programming Fundamentals	-	3-0-3
	CL 102	Programming Fundamentals Lab	-	0-1-1
		Total		13-2-15

Semester II

S. No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Total)
1.	HU XXX	Communication & Presentation Skills	-	3-0-3
2.	MA XXX	Calculus & Analytical Geometry	-	3-0-3
3.	CS 162	Object Oriented Programming	CS 102	3-0-3
	CL 162	Object Oriented Programming Lab	CS102	0-1-1
4.	HU XXX	Islamic Studies/Ethics	-	2-0-2
5.	EE 222	Digital Logic Design	-	3-1-4
		Total		14-2-16

Semester III

S. No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Total)
1.	CS 110	Professional Practice	-	3-0-3
2.	CS 213	Data Structures& Algorithms	CS 162	3-0-3
	CL 213	Data Structures& Algorithms	CS 162	0-1-1
3.	CS XXX	Computer Organization& Assembly Language	EE 222	3-0-3
	CL XXX	Computer Organization& Assembly Language Lab	EE 222	0-1-1
4.	MA 105	Multivariable Calculus	-	3-0-3
5.	MA XXX	Discrete Structure	-	3-0-3
		Total		15-2-17

Semester IV

S. No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Total)
1.	MA 301	Probability & Statistics	-	3-0-3
2.	CS 231	Operating Systems	CS 213	3-0-3
	CL 231	Operating Systems	CS 213	0-1-1
3.	CS 303	(Mobile Computing)(as specialization elective-I)	Nil	2-0-2
	CL 303	Mobile Computing Lab	Nil	0-1-1
4.	CS 282	Database Systems	CS 213	3-0-3
	CL 282	Database Systems Lab	CS 213	0-1-1
5.	MA 201	Linear Algebra	-	3-0-3
		Total		14-3-17

Semester V

S. No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Total)
1.	CS XXX	Computer Networks	Nil	3-0-3
	CL XXX	Computer Networks Lab	Nil	0-1-1
2.	MA XXX	Numerical Computing	MA105	3-0-3
3.	CS 313	Design and Analysis of Algorithms	CS 213	3-0-3
4.	BA XXX	Management Elective– I	-	3-0-3
5.	CS 366	Visual Programming	-	3-0-3
	CL 366	Visual Programming Lab	Nil	0-1-1
		Total		15-2-17

Semester VI

S. No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Total)
1.	CS 341	Theory of Automata	MA 204	3-0-3
2.	SE 371	Artificial Intelligence	-	3-0-3
3.	SE 225	Software Engineering	-	3-0-3
	SL225	Software Engineering Lab		0-1-1
4.	CS 4XX	Specialization Elective – II	-	3-0-3
5.	CS XXX	Specialization Elective –III	-	3-0-3
6	CS 494	Final Project-I	-	0-1-1
		Total		15-3-17

Semester VII

S. No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Total)
1.	HU XXX	Technical & Business Writing	Nil	3-0-3
2.	CS 4XX	Parallel & Distributed Computing	CS 231	3-0-3
	CL 4XX	Parallel & Distributed Computing Lab	CS 231	0-1-1
3.	CS 4XX	Information Security	-	3-0-3
4.	CS 495	Final Project – II	CS 494	0-2-2
5.	CS 4XX	Specialization Elective – IV	-	3-1-4
		Total		12-4-16

Semester VIII

S. No.	Course Code	Course Title	Prerequisite	Credit Hrs (Theory – Lab – Total)
1.	CS 471	Compiler Construction	CS 341	3-0-3
	CL 471	Compiler Construction Lab	CS 341	0-1-1
2.	CS 4XX	Specialization Elective – V	-	3-0-3
3	CS 4XX	Specialization Elective – VI	-	3-0-3
4	BA 356	Entrepreneurship	-	3-0-3
5	HU 4XX	Chinese (Foreign Language)	-	2-0-2
6.	CS 496	Final Project-III	CS 495	0-3-3
		Total		14-4-18
		Grand Total		133 Credit Hours

Course Description

CS 161 - Computer Programming

History and basic components of a computer system, approaches to solving problems using computers, flow charts, pseudo-code, problem solving in C++, control structures, functions, structures, arrays and strings, pointers and advanced topics in arrays, file handling, sorting and searching, debugging programs.

CS 162 - Object Oriented Programming

Introduction to object-oriented concepts, analysis and development using C++, Object oriented problem solving, programme design process, classes, methods, objects and encapsulation. File I/O, exception handling, operator and function overloading, virtual functions, derived classes, inheritance and polymorphism.

CS 213 - Data Structures & Algorithms

Introduction to data structures and algorithms, arrays, stacks, infix, postfix and prefix notations, recursion, backtracking, binary search, queues, linked lists, trees, graphs and

operations, algorithm performance, complexity issues, sorting algorithms, searching algorithms, hashing, dynamic memory management.

CS 222 - Computer Architecture

Introduction to microcomputer, microprocessor register and ALU design, control unit design, instruction cycle, memory types and read/write cycles, memory mapping, address decoding, address decoder design, interrupts, polling, I/O devices interfacing, DMA, bus arbitration, introduction to RISC architecture.

CS 231 - Operating Systems

Overview and history of operating systems, Operating systems concepts, structures and functions, Memory management, process scheduling, process synchronization, Device and file management, concurrent processes, and deadlocks, UNIX system administration and LINUX programming.

CS 252 - Computer Communication & Networks

Analogue & digital transmission, network layers; network models (OSI, TCP/IP); and protocol standards, Network topologies, data communications, LAN and WAN, Networking technologies, Transmission media, circuit and packet switching networks, Routing protocols.

CS 282 - Database Systems

Introduction to basic database concepts, different data models, data storage and retrieval techniques and database design techniques, Relational data model and database management system (DBMS) concepts, Data models, conceptual, logical and physical database design and evaluation, database normalization, query languages, query optimization, security, integrity and concurrency protocols.

CS 331 - System Programming

Study of various utilities of operating systems covering both UNIX and DOS, System calls, interrupt handling, inter-process communications, Handling devices through various ports, Network handling and device drivers, Threads and sockets.

CS 341 - Theory of Automata

Regular languages, regular expressions and finite state machines, deterministic & non-deterministic finite state machines, pushdown automata, context free grammar, Turing machines.

CS 366 - Visual Programming

Elements of visual programming, web and windows forms and controls, mouse events, properties, multiple-document interface, processing files, accessing databases, dynamic data exchange, object linking and embedding.

CS 431 - Design & Analysis of Algorithms

Introduction, Comparison sorting, integer sorting & selection: lower bounds, dynamic programming, graph representation, traversal, ordering, shortest paths, greedy algorithms, minimum spanning tree, string algorithms, NP-completeness and approximation.

CS 442 - Distributed Systems

Introduction to distributed systems, communication, naming and name services, processes, synchronization, fault tolerance, distributed file systems, distributed transaction processing, replication, object-based systems, document-based systems, coordination-based systems, security in distributed systems.

CS 163-Introduction to Information and Communication Technology

After studying this *course*, you should be able to: understand the meaning of all the terms highlighted in the text. demonstrate an awareness of the main processes in an *ICT* system (sending, receiving, storing, retrieving, manipulating, conveying). demonstrate an awareness of some of the hardware, ...

CS 494/495/496 - Final Year Project-I, II& III

Implementing and managing a practical software project. Research and planning, conceiving and developing a real and substantial project related to computer science. The project is spread over the last three semesters (Semester 6, 7& 8). The final grade is awarded at the end of the eighth semester after the demonstration/presentation of the project and submission of the project report.

SE 223 - Object-Oriented Analysis & Design

Object-oriented software development process, OO methodologies and workflows, gathering system requirements, analyzing system requirements to determine use cases and domain model of the problem domain (the Requirements model), creating a system architecture (the Architecture model) supporting the nonfunctional requirements (NFRs) and development constraints, creating a system design (the Solution model) supporting the functional requirements (FRs)

SE 225 - Software Engineering

Software life cycle, software requirement definition and specifications, software design: object oriented and function oriented, user interface design. Program design and techniques: software process models, software testing & maintenance, software project management.

SE 421 - Software Project Management

Project Management knowledge areas, processes and phases, resource identification, software size estimation, budgeting and costing, project planning and scheduling, customer relationship management, technical resource management, configuration management, outsourcing, team selection, risk management, software process management, process improvement framework.

CS xxx - Design and Analysis of Algorithms

Prerequisites: Discrete Structure, Data Structures and Algorithms

Objectives: Detailed study of the basic notions of the design of algorithms and the underlying data structures. Several measures of complexity are introduced. Emphasis on the structure, complexity, and efficiency of algorithms.

CS xxx - Human Computer Interaction

Course Structure: Lectures: 2, Labs:1 Credit Hours: 3

Prerequisites: Data Structures and Algorithms

Objectives: This course introduces the human issues of usability and its importance. It considers the implications of human understanding on the usability of computer systems and the importance of understanding the context of use. It describes guidelines for use of different media and interface styles. Topics include Usability Design principals, standards and models, evaluation techniques. Groupware, pervasive and ubiquitous applications.

Course Outlines:

The Human, Computer and Interaction, Usability paradigm and principles, Introduction to design basics, HCI in software process, Design rules, prototyping, evaluation techniques, task analysis, Universal design and User support and Computer Supported Cooperative Work. Introduction to specialized topics such as Groupware, pervasive and ubiquitous applications.

Resources:

1. Human-Computer Interaction, 3/E Alan Dix, Computing Dept, Lancaster University

Janet E. Finlay, Leeds Metropolitan University, Gregory D. Abowd, Georgia Institute of Technology, Russell Beale, University of Birmingham ISBN-10: 0130461091

ISBN-13: 9780130461094 Publisher: Prentice Hall

2. Designing the User Interface: Strategies for Effective Human-Computer Interaction, 4/E

Ben Shneiderman, University of Maryland Catherine Plaisant, University of Maryland ISBN-10: 0321197860 ISBN-13: 9780321197863 Publisher: Addison-Wesley

Electives for Software Engineering

SE 315 - Web Application Development

Build and deploy secure, scalable web applications using the MVC 3 framework in ASP.NET. Develop powerful application controllers with practical URLs to ensure application robustness. Produce a clean, maintainable code base using the Model View Controller (MVC 3) architecture, create flexible views for user interaction with view helpers, design rich user interfaces with Ajax and jQuery, secure applications using authentication and role-based authorization.

SE 327 - Software Requirements Engineering

Overview and importance of software requirements, standards and models related to requirements, RE process, techniques for eliciting software requirements, models for analyzing requirements translating higher-level business and user requirements into software product requirements. Concept of operations document, software requirements specification and a data dictionary. Establish requirements baselines, traceability, and requirements change. Requirements related metrics.

SE 329 - Software Architecture

Overview of SDLC, engineering design vs. software design, design heuristics and principles, reusability, metrics and quality of design, frameworks and architecture, framework development approaches, service-oriented architectures, middleware architectures, design patterns, architectural patterns, design issues for distributed and real-time software, re-engineering and reverse engineering.

SE 422 - Software Quality Assurance & Testing

Introduction to software quality, quality metrics, quality control vs. quality assurance, software process certification, inspections and review, software validation and verification, software testing, white-box and grey-box testing, user acceptance testing, testing metrics and complexity, development of test-cases, automated software testing.

CS 445 - Computer Graphics

Image formation, perspective view, rigid and non-rigid transforms, interpolation techniques, shadow formation, ray tracing and animation of articulated objects, Lighting and collision detection, Introduction to OpenGL.

CS xxx - Computer Animation

Main techniques covered in this course include key-framing, story-boarding, Kinematics, physically based dynamics modeling, Motion capture, Scene composition, lighting, and sound track generation, advanced topics such as dynamic simulation of flexible and rigid objects, facial animation, and behavioral/AI based animation are also studied.

Electives for Communication & Networks

CS 341 - Network Programming

This course focuses on the programming aspects of computer networking. This course aims to teach how to design and implement network programs, protocols and systems in a distributed environment. The main topics of interest are Internet Addressing, TCP/IP, Server and Client Sockets, Secure Sockets, Multicast Sockets, Network Layer Protocols, Port Scanners, Denial of Service Attacks, Multicast Routing, Real-Time Transport Protocol, Remote Method Invocation, SMTP, Multithreading and Multiplexing.

CS 441 - Internet & High-level Protocols

Multiple access protocols (CSMA/CD, CSMA/CA, reservation, polling, token passing, FDMA, TDMA, CDMA). Connecting

backbone networks, virtual LANs, routing and forwarding. Network layer addressing (IP). Classful addressing, sub-netting. Dynamic address configuration, network address translation. IP v4, v6, ARP and ICMP protocols. Layering models in OSI and TCP/IP. Static routing and dynamic routing, routing methods (RIP, OSPF, BGP).

CN 443 - Information & Network Security

Cryptology and simple cryptosystems; conventional encryption techniques, stream and block ciphers, The advanced encryption

standard. Hash functions, number theory and algorithm complexity. Public key Encryption. RSA and Discrete Logarithms. Digital signatures. Key management schemes, Identification schemes, Dial-up security. Kerberos and directory authentication. Emerging Internet security standards.

CS 446 - Wireless & Mobile Communication

Link-Layer Protocols, Multiple Access Protocols, Wireless Local Area Networks, IEEE 802.11 Wireless Networks, Power Issues in 802.11 Networks, Wireless Multihop

Networks: Vehicular Ad hoc Networks, Mobile Ad hoc Networks, and Wireless Sensor Networks, Mobile Communication, Routing Protocols for Wireless Networks, Network Simulation and Performance Evaluation.

CS xxx – Digital Forensics for Networks

Network forensics is a sub-branch of digital forensics relating to the monitoring and analysis of computer network traffic for the purposes of information gathering, legal evidence, or intrusion detection. Network forensics focuses on security and law enforcement. Security involves monitoring a network for anomalous traffic and identifying intrusions. The law enforcement part involves analysis of captured network traffic, such as reassembling transferred files, searching for keywords and parsing human communication such as emails or chat sessions. Topics include: Forensic Modeling and Principles, Forensics Analytics, Mobile Device Forensics, Hacker Methodology, Resource-Kits and Third-Party Tools, Network Log Analysis and Wireless Forensics.

CS 303 – Mobile Computing

Mobile applications, wireless media (infrared, radio, and microwave): frequencies, range, bandwidth, cellular systems, terrestrial and satellite communication systems, software architecture and middleware for mobile systems, Wireless Application Protocol, OS for mobile devices, APIs and application development for mobile devices, security and maintenance of mobile computing systems.

CS 305- Multimedia Technology

This course is designed for students to get deep knowledge of Multimedia systems to become an integral part of our heterogeneous computing and communication environment. The World Wide Web, digital entertainment and other widely used applications are using not only text and image but also video, audio and other continuous media.

Electives for Databases

CS 379 - Advanced Databases

This course is intended for students who wish to specialize in database management systems or wish to practice the advanced techniques involved in optimization of data storage, database design and queries. This course covers advanced topics like physical storage and access methods, query optimization, transaction processing, concurrency control, crash recovery and distributed databases.

CS 440 Data Warehousing

Data model for data warehouses, architectural components, logical and physical design, OLAP, data marts, de-normalization, star and snowflake schema, dimensional modeling,

indexing and joining techniques, extraction, transformation and loading, data quality management.

CS 448 Distributed Databases

This is a course that covers advanced topics in databases. After introducing the concepts of entity-relation modeling and relational data models, the students move onto topics such as distributed query processing and optimization, distributed concurrency control, distributed reliability protocols, and distribution architectures. The course culminates with how web data is managed, plus load balancing & clustered databases.

CS 450 Data Mining

Pre-Req: CS 440

Data pre-processing, cleaning, integration, reduction, mining frequent patterns, association rule mining, classification, decision trees, Bayesian classifiers, rule based classification, prediction, cluster analysis, clustering algorithms, outlier analysis, text and web mining.

Electives for Computational Intelligence

CS 438 - Introduction to Artificial Intelligence

Overview of artificial intelligence, issues and application, knowledge representation, searching techniques, pruning, heuristics, production systems, adversarial search, bayesian inference, graphical models, expert systems, neural networks, robotic navigation, planning.

CS 461 - Computer Vision

Topics include image types, image formation, filtering, interpolation and re-sampling, edge and feature detection, texture analysis, generalized Hough transform, multi-view geometry, stereo vision, graph-cuts, shape representation and matching using shape contexts. Scale space theory and generative model based vision.

CS 462 - Biomedical Image Processing

Topics include image acquisition techniques, image formats, image reconstruction, low level image analysis techniques, shape representation and variability modeling, shape matching, deformable models and active contours. Diffusion tensor tractography, Image registration, image interpolation and distance metrics, medical image visualization using scalar, vector and tensor visualization techniques.

CS 463 - Computational Intelligence

Introduction to Intelligent Systems, Human Intelligence and Computational Intelligence, Neural Networks (Single and Multi-Layer Feedforward Neural Networks, Associative Memories, Learning Vector Quantization, Self-Organizing Maps, Applications to Pattern Recognition), Fuzzy Logic (Introduction, Fuzzy Sets, Fuzzy Classifiers), Evolutionary

Computation (Introduction To Genetic Algorithms, Models, Operators, Selection Schemes, Application To Optimization), Hybrid Intelligent Systems.

CS 449 - Information Coding and Number Theory

In this course the focus will be on the mathematical background that makes modern cryptography work as well as the mathematics behind cryptanalysis. This is mainly some parts of algebra and some from number theory

CS 304- Computer Game Design

You have a great idea for a game. Turning that idea into a reality doesn't just about know the tools. In this course, student will practice moving from game concept through design documentation, prototyping and testing. Numerous elements go into the overall process of game design. These range from topics such as idea generation, story, character, and game world development, game mechanics & level design, and user experience design. By the end of this course, students will not only understand how games are made, but they will have completed three game projects and have the knowledge, skills, tools and resources to start making their own games in Unity3D

Bachelor of Science in Information Technology BSIT

Introduction and Date of Commencement

The department of Computer Science proposes to start an undergraduate program in Information Technology from Fall 2018. According to ACM Curricula 2005⁶: “Information Technology” is a label that has two meanings. In the broadest sense, the term information technology is often referred to computing. Furthermore, it also refers to undergraduate degree programs that prepare students to meet the computer technology needs of business, government, healthcare, schools, and other kinds of organizations. Curriculum Guidelines for Undergraduate Degree Programs in Information Technology (2008) explains that “Information Technology (IT) in its broadest sense encompasses all aspects of computing technology. IT, as an academic discipline, is concerned with issues related to advocating for users and meeting their needs within an organizational and societal context through the selection, creation, application, integration and administration of computing technologies.”

Mission

To prepare students for successful careers as I.T. professionals to make a positive contribution to society.

Program Objectives

The Bachelor of Science in Information Technology (BSIT) is comprised of various tracks including, database administration, multimedia systems, Web Technology and network administration and management. The program focuses on the roles of IT professionals ranging from installing applications to designing computer networks and databases to meet the needs of the industry and government. The development, management, and maintenance of IT systems are key competitive factors that are essential to business success in today's world.

The courses are designed to provide students with the competencies necessary to plan, customize, manage and secure network and operating system configurations for optimum business applications and plan, design and maintain professional quality websites and internet applications for e-commerce and other business applications.

Educational Objectives

- Ensure students develop the teamwork, interpersonal and communication skills required as an information technology professional
- To ensure students are well equipped to meet the requirements of both industrial and commercial organizations for information technology specialists
- To develop technical skills such as systems analysis and design
- To obtain technical and basic business education with an appropriate combination of theoretical knowledge and practical skills
- To have a well-rounded education that enables them to conduct themselves as responsible professionals are aware of ethical issues and societal needs and problems

Outcomes

- To be able to contribute to innovation and development within their business, workplace, or community

- To be able to operate effectively in work and community situations and are aware of environments in which they will be contributing
- Ability to evaluate, apply, and manage technologies in various fields of IT, including software applications, management information systems, digital media publishing, Web site development and management, databases, and computer networks
- To design and conduct experiments to resolve IT hardware and software problems
- To be able to assess user needs and the impact of technological solutions in the societal context
- Communicate effectively in oral, written, and in graphical modes

Sustainability of BS IT Program

BSIT program is as sustainable as BSCS. Up till now there is nearly no advertisement of Computer Science/IT related jobs which do not include IT graduates. Jobs based on BSIT are being offered in various sectors including:

1. Schools/colleges level teaching jobs in Pakistan
2. Federal/Provincial public service commission jobs for various departments
3. Mobile app development
4. Internet marketing
5. Web development jobs in public/private sectors (national/international) level
6. Graphic designing jobs (national/international)
7. Database administration jobs (national/international)
8. Network administration jobs
9. Freelancing

Scope of the Program:

These days, IT sector is so well evolved that it is directly or indirectly influencing the working of various other sectors and industries. IT sector acts as a supporting figure for various sectors such as healthcare, aviation, education, manufacturing sector, telecommunications sector, various Government initiatives and Departments etc. Graduates may take up jobs such as Web Developer and Designer, Data Security

officer, Database manager, Application Developer, Information Technology Engineer, Network Administrator etc.

Semester 1 (18 Cr. Hrs.)			
Course Code	Course	Cr. Hrs.	Pre-Req
CS 102	Programming Fundamentals (Comp. Core)	3-0-3	Nil
CL 102	Programming Fundamentals Lab	0-1-1	NIL
EE XXX	Basic Electronics (Comp. Supporting)	3-0-3	Nil
MA XXX	Calculus and Analytical Geometry	3-0-3	Nil
CS 101	Introduction to Information and Communication Technologies (Gen. Edu)	2-0-2	Nil
Cl 101	Introduction to Information and Communication Technologies Lab	0-1-1	Nil
HU XXX	Functional English(English-I) (Gen. Edu)	3-0-3	Nil
HU XXX	Islamic Studies/Ethics (Gen. Edu.)	2-0-2	Nil
	Total	16-2-18	

The startup scenario also recruits talented IT professionals. So, those who are looking for a creative and challenging work environment may land a job in the startup sector. One may also use IT skills and start their own venture or even a consultancy firm also. Similarly, graduates can also go for higher studies to pursue a successful career in research and development.

Semester 3 (19 Cr. Hrs.)			
Course Code	Course	Cr. Hrs.	Pre-Req
CS 213	Data Structures and Algorithms (Comp. Core)	3-0-3	CS 162
CL 213	Data Structures and Algorithms Lab	0-1-1	CS 162
CS 204	Computer Communication and Networks (Comp. Core)	2-0-2	Nil
CL 204	Computer Communication and Networks Lab	0-1-1	Nil
HUXXX	Uni. Elective-II	3-0-3	Nil
IT 201	Information Systems (IT – Supporting)	3-0-3	Nil
HU XXX	Technical and Report Writing (English-III) (Gen. Edu.)	3-0-3	Nil
MA 201	Linear Algebra (Comp. Supporting)	3-0-3	Nil
	Total	17-2-19	

Semester 4 (18 Cr. Hrs.)			
Course Code	Course	Cr. Hrs.	Pre-Req
HU XXX	Uni. Elective-III	3-0-3	Nil
IT 202	Internet Architecture & Protocols (IT – Supporting)	3-0-3	CS204
CS 103	Object Oriented Programming (Comp. Core)	3-0-3	CS213
CL 103	Object Oriented Programming Lab	0-1-1	CS213
CS 203	Software Engineering (Comp. Core)	3-0-3	CS213
CL 103	Database Systems (Comp. Core)	3-0-3	CS213
CL 282	Database Systems Lab	0-1-1	CS213
EE222	Digital Logic Design (Comp. Core)	3-0-3	Nil
CL 282	Discrete Structures (Comp. Core)	3-0-3	Nil
MAXXX	Multimedia Systems and Design (IT Core)	3-0-3	Nil
CS 207	Uni. Elective-I	3-0-3	Nil
HU XXX	Communication Skills (English-II) (Gen. Edu.)	3-0-3	Nil
CL 207	Pakistan Studies (Gen. Edu.)	3-0-3	Nil
HU 101			
HU 115			
MA 201			
	Total	16-2-18	
	Total	17-2-19	

Semester 5 (18 Cr. Hrs.)			
Course Code	Course	Cr. Hrs.	Pre-Req
IT XXX	IT Elective-I	3-0-3	Nil
CS 301	Operating Systems (Comp. Core)	3-0-3	CS213
IT 301	OO Analysis & Design (IT – Supporting)	3-0-3	CS203
IT 300	DB Administration & Management (IT – Supporting)	2-0-2	CS282
IL 300	DB Administration & Management Lab (IT – Supporting)	0-1-1	CS282
IT 302	Web Systems and Technologies (IT Core)	3-0-3	CS282
IT 303	Technology Management (IT Core)	3-0-3	Nil
	Total	17-1-18	

Semester 6 (19 Cr. Hrs.)			
Course Code	Course	Cr. Hrs.	Pre-Req
CS 473	Human Computer Interaction (Comp. Core)	3-0-3	Nil
IT 304	Systems and Network Administration (IT Core)	2-0-2	CS301
IL 304	System and Network Administration	0-1-1	CS301
IT XXX	IT Elective II	3-0-3	Nil
IT XXX	IT Elective –III	3-0-3	Nil
IT 307	System Integration and Architecture (IT Core)	3-0-3	CS203
IT 308	IT Project Management (IT – Supporting)	3-0-3	CS203
CS 494	Final project-I	0-1-1	Nil
	Total	17-2-19	

Semester 7 (14 Cr. Hrs.)			
Course Code	Course	Cr. Hrs.	Pre-Req
IT 401	Network Security (IT Core)	3-0-3	CS204
IT XXX	IT Elective IV	3-0-3	Nil
IT XXX	IT Elective V	3-0-3	Nil
IT 404	Cloud Computing (IT Core)	3-0-3	IT 200
CS 495	Final Project II	2-0-2	CS 494
	Total	14-0-14	

Semester 8 (11 Cr. Hrs.)			
Course Code	Course	Cr. Hrs.	Pre-Req
CS 406	Professional Practices (Gen. Edu.)	2-0-2	Nil
IT XXX	IT Elective VI	3-0-3	Nil
IT XXX	IT Elective VII	3-0-3	Nil
CS 496	Final Project-III	3-0-3	CS 495
	Total	11-0-11	
	Grand Total	136	

BS Cyber Security

Currently, the Department of Computer Science offers only one bachelor's program i.e., Bachelors of Science in Computer Science (BS-CS). The program is running successfully and has attracted a good number of students. Our multitalented graduates are already shinning in the market and are bringing good name to the university. Considering the stability of the exiting program and high interested of new students in the Department of Computer Science, we have decided to propose a new program that is aligned with the latest trends and demands of the local and international markets. Considering the best interests of Pakistan and Air University, we here propose a new program i.e., *Bachelors of Science in Cybersecurity*.

2. PROGRAMME AIMS

This programme is designed with specific aims in mind that are mentioned follows:

- Provide students with fundamental computing, cyber security, maths, engineering and humanity courses which are essential to develop strong knowledge base of computing and cyber security experts and researchers.
- Produce cyber security specialists to meet the current and future demands of the country to protect national assets against internal and external cybersecurity threats.
- Attract International jobs/companies by creating a local pool of talented and skilled professionals.
- Contribute toward establishing Pakistan cybersecurity industry.
- Make Air University a pioneer in this field at Pakistan level and one of the renowned Universities for Cybersecurity internationally.
- Attract international students from the neighbouring countries to bring good name to Air University and help improve the University ranking.
- Produce graduates that are more employable and highly paid.

3. SIGNIFICANCE OF THE PROGRAMME

Cybercrime is a growing problem worldwide. McAfee estimates that cybercrime costs the global economy \$400 billion annually. It particularly affects the developed world, but developing countries are at higher risk due to the lack of expertise and shortage of security professionals with adequate skills and experience to effectively combat this rising threat. Cybersecurity is a rapidly growing challenge with new sophisticated zero-day attacks costing economies billions per year. The scale of the problem, rapid technology advancement, and technical nature of cyber-attacks widens the cybersecurity skills gap. According to defense analysts, this gap can put future of any country at risk.

Cybersecurity education and training is fundamental to overcome the aforementioned skills gap. In this regard, many countries have initiated various programs to promote and develop cybersecurity education programs. For instance, the US has a National Initiative for Cybersecurity Education (NICE), and the UK Government has a strategic partnership with academia, led by the Government Communications Headquarters (GCHQ), Engineering and Physical Sciences Research Council (EPSRC), and Cabinet Office and Department for Business, Innovation and Skills. Similarly, many countries throughout the Europe are running cybersecurity programs to meet their national demands.

For the past few years, Pakistan is constantly under cyberattacks and requires a pool of skillful cybersecurity professionals to defend the country and work in the national interest. Hence, there is a desperate need to design an international standard curriculum that can meet the local, as well as, international raising demands of the cybersecurity professionals.

In this regard, the Department of Computer Science at Air University would like to initiate the first step and propose a four year BS Cybersecurity program. To ensure high quality and meet the international standards, we have consultant various cybersecurity programs that are run by renowned Universities around the world.

This program is designed to develop students' strong base in computing and give them a set of cybersecurity skills to design, deploy, and manage secure systems, audit security standards, and prevent existing systems from cyberattacks. The courses are carefully incorporated from multiple disciplines, such as mathematics, engineering and humanities, to prepare students from every aspect. The computing and cybersecurity specialized courses are designed as a blend of theory and lab work; to provide deep understanding of the technical concepts and hand-on tools.

The assessment criteria consist of such activities that will improve students' decision making, teamwork, leaderships, and communication skills. During this degree programme, temporary placement opportunities will be arranged for the students which will allow them to apply and improve their professional skills, and prepare for the industry. The program is designed with an objective to prepare students for different career choices with cybersecurity as their main speciality.

Semester I

S.No	Course Code	Courses	Credit Hrs. (Theory-Lab-Credits)	Pre-Req
1.	HUXXX	Communication and Presentation Skills	3-0-3	-
2.	CY100	Introduction to Cyber security and Digital Forensics	2-0-2	-
3.	HU118	Islamic Studies	2-0-2	-
4.	CS101	Introduction to Information & Communication Technologies	2-0-2	-

	CL 101	Introduction to Information & Communication Technologies Lab	0-1-1	
5.	CS102	Programming Fundamentals	3-0-3	-
	CL 102	Programming Fundamentals Lab	0-1-1	
6.	EE202	Basic Electronics	2-1-3	-
Credit Hours = 17			14-3-17	

Semester II

S.No	Course Code	Courses	Credit (Theory-Lab-Credits)	Hrs.	Pre-Req
1.	MAXXX	Discrete Structures	3-0-3		-
2.	CY101	Information Assurance	2-0-2		-
3.	CS162	Object Oriented Programming	3-0-3		CS 102
	CL 162	Object Oriented Programming Lab	0-1-1		CS 102
4.	MAXXX	Calculus & Analytical Geometry	3-0-3		-
5.	HU119	English Comprehension and Composition	3-0-3		-
6.	HU115	Pakistan Studies	2-0-2		-
Credit Hours = 17			16-1-17		

Semester III

S.No	Course Code	Courses	Credit (Theory-Lab-Credits)	Hrs.	Pre-Req
1.	MA201	Linear Algebra	3-0-3		-
2.	CS213	Data Structure & Algorithm	3-0-3		CS 162
	CL 213	Data Structure & Algorithm Lab	0-1-1		CS 162
3.	EE222	Digital Logic and Design	3-1-4		-
4.	CS203	Software Engineering	3-0-3		-
5.	CY201	Computer Networks	3-0-3		-
	CL201	Computer Networks Lab	0-1-1		
Credit Hours = 18			15-3-18		

Semester IV

S.No	Course Code	Courses	Credit (Theory-Lab-Credits)	Hrs.	Pre-Req
1.	CS231	Operating Systems	3-0-3		CS 213
	CL 231	Operating Systems Lab	0-1-1		CS 213
2.	CS206	Assembly Language and Computer Organization	3-0-3		
	CS 206	Assembly Language and Computer Organization Lab	0-1-1		
3.	HUXXX	Technical & Business Writing	3-0-3		-
4.	CY202	Network Security	3-0-3		
5.	CS282	Database Systems	3-0-3		CS 213
	CL 282	Database Systems Lab	0-1-1		CS213
Credit Hours = 18			15-3-18		

Semester V

S.No	Course Code	Courses	Credit Hrs. (Theory-Lab-Credits)	Pre-Req
1.	HUXXX	University Elective I	3-0-3	-
2.	CS224	Computer Architecture	3-0-3	
3.	CY300	Secure Software Development	2-0-2	-
	CL300	Secure Software Development Lab	0-1-1	
4.	CY301	Ethical Hacking & Defence I	3-0-3	
	CL 301	Ethical Hacking & Defence I Lab	0-1-1	
5.	CY306	Cybersecurity Elective I	3-0-3	-
	CL 306	Cybersecurity Elective I Lab	0-1-1	
Credit Hours = 17			14-3-17	

Semester VI

S.No	Course Code	Courses	Credit Hrs. (Theory-Lab-Credits)	Pre-Req
1.	CY303	Vulnerability Assessment & Reverse Engineering	3-0-3	
	CL303	Vulnerability Assessment & Reverse Engineering Lab	0-1-1	
2.	CY302	Ethical Hacking and Defence II	3-0-3	
	CL302	Ethical Hacking and Defence II Lab	0-1-1	
3.	CY305	Cyber security Elective II	3-0-3	-
4.	BAXXX	University Elective II	3-0-3	-
5.	CY498	Final Project-I	0-1-1	-
6.	MA301	Probability and Statistics	3-0-3	-
Credit Hours = 18			15-3-18	

Semester VII

S.No	Course Code	Courses	Credit Hrs. (Theory-Lab-Credits)	Pre-Req
1.	CY400	Cyber security Elective III	3-0-3	-
2.	CY401	Cyber security Elective IV	3-0-3	-
3.	CY402	Cyber security Elective V	2-0-2	-
	CL 402	Cyber security Elective V Lab	0-1-1	
4.	CY499	Final Project – II	0-2-2	-
5.	BAXXX	University Elective III	3-0-3	-
Credit Hours = 14			11-3-14	

Semester VIII

S.No	Course Code	Courses	Credit Hrs. (Theory-Lab-Credits)	Pre-Req
1.	CY403	Information Security	3-0-3	-
2.	BAXXX	University Elective IV	3-0-3	-
3.	BAXXX	University Elective V	1-0-1	-
4.	CY500	Final Project - III	3-0-3	-
5.	CS110	Professional Practices	2-0-2	-
Credit Hours = 11			11-0-11	

Total Credits = 112-21-130

Student will eligible for the award of BS Cyber security degree if successfully completed 130 credits.

MS Computer Science Program

The Master of Science in Computer Science program provides students the opportunity to combine a sound foundation in Computer Science with concentrated knowledge in the latest developments in particular areas. The program provides preparation in the advanced principles and processes of computation and training in applying these principles in application areas in industry, science, government, and business. The program emphasizes on course work along with practical assignments and research project.

The two-year MS Computer Science program consists of four core courses and four electives from various areas of specializations.

Semester Wise Study Plan

S. #.	Course Code	Course Title	Credit Hours
Semester –I			
1	CS 640	Advanced Theory of Computation	3
2	CS 673	CS Elective I	3
3	CS XXX	CS Elective II	3
Semester Cr. Hrs.			9
Semester –II			
1	CS 641	Advanced Analysis of Algorithm	3
2	CS XXX	CS Elective III	3
3	CS XXX	CS Elective IV	3
Semester Cr. Hrs.			09
Semester –III			
1	CS XXX	CS Elective IV	3
2	CS XXX	CS Elective VI	3
3	CS 605	Thesis (partial Registration)	6
Semester Cr. Hrs.			12
Semester –IV			
		Thesis (continue)	6
Semester Cr. Hrs.			-
Total Cr. Hrs.			30

Important Notes:

1. Students with inadequate background will need to cover the prescribed deficiency courses before joining the main MS CS Program.
2. Students must select at least two elective courses from the Specialization Area. Other two elective courses may be selected from other Specialization Areas as offered.
3. Due to the advanced nature of the MSCS program and research orientation, the instructor of a course can re-design the objectives and contents of the course in consultation with the Chair Department.

Core Courses:-

Below is a list of the four core courses followed by the course contents

Sr. #	Code	Title	Pre-Requisite	Cr. Hrs.
1	CS 640	Advanced Theory of Computation	-	3
2	CS 641	Advanced Analysis of Algorithm	Data Structures & Algorithms	3
3	CS 650	Advanced Operating Systems	Operating Systems	3
4	CS 673	Advanced Computer Architecture	Digital Logic Design	3

Course Contents

Course Code	Course Name	Cr. Hours	Prerequisite
CS 640	Advanced Theory of Computation	3+0 = 3	None

Course Contents: Automata theory, formal languages, Turing machines, computability theory and reducibility, computational complexity, determinism, non-determinism, time hierarchy, space hierarchy, NP completeness, selected advanced topics.

Course Code	Course Name	Cr. Hours	Prerequisite
CS 641	Advanced Analysis of Algorithm	3+0 = 3	Data Structures and Algorithms

Course Contents: Advanced algorithm analysis including the introduction of formal techniques and the underlying mathematical theory. NP-completeness. Search Techniques. Randomized Algorithms. Heuristic and Approximation Algorithms. Topics include asymptotic analysis of upper and average complexity bounds using big-O, little-o, and theta notation. Fundamental algorithmic strategies (brute-force, greedy, divide-and-conquer, backtracking, branch-and-bound, pattern matching, and numerical approximations) are covered. Also included are standard graph and tree algorithms. Additional topics include standard complexity classes, time and space tradeoffs in algorithms, using recurrence relations to analyze recursive algorithms, non-computable functions, the halting problem, and the implications of non-computability. Algorithmic animation is used to reinforce theoretical results. Upon completion of the course, students should be able to explain the mathematical concepts used in describing the complexity of an algorithm, and select and apply algorithms appropriate to a particular situation.

Course Code	Course Name	Cr. Hours	Prerequisite
CS 650	Advanced Operating Systems	3+0 = 3	Operating Systems

Course Contents:

Introduction, Characterization of Modern Operating Systems; file systems, memory management techniques, Process scheduling and resource management, System Models, Architectural models, Interposes Communication, Issues of Security in Distributed Systems (Partial coverage), Distributed File System, Concurrency Control in Distributed Systems, Problems of coordination and agreement in Distributed Systems, Replication – Advantages and requirements, Fault-tolerant services, Mobile and Ubiquitous Computing

Course Code	Course Name	Cr. Hours	Prerequisite
CS 673	Advanced Computer Architecture	3+0 = 3	Computer Architecture

Course Contents: This course is aimed at the hardware aspects of parallel computer architectures including the design and protocols evaluation for memory coherence, inter-connection networks and system scalability. Advanced topics in this course will cover multiprocessors on a chip, reconfigurable computing and power aware designs. Various coarse-grained and fine-grained architectures with reference to SIMD and MIMD designs should also be covered.

Elective Courses:-

Specialization Area elective courses are not limited to the list provided in this document. More Courses can be added to specialization areas. Students must select at least two elective courses from the Specialization Area. Other two elective courses may be selected from other Specialization Areas.

S. #.	Code	Course Title	Prerequisite	Credit Hours
Software Engineering				
1	CS 601	Advanced Software Development		3
2	CS 602	Advanced Topics in Software Engineering		3
3	CS 603	Object Oriented Software Engineering		3
4	CS 604	Software Quality Assurance		3
5	CS 705	Requirements Engineering		3
6	CS 606	Software Architecture		3
7	CS 607	Agent Oriented Software Engineering		3
8	CS 608	Software Project Management		3
9	CS 609	Software Design		3
10	CS 610	Software Engineering & Formal Specifications		3
11	CS 611	Empirical Software Engineering		3
12	CS 612	Software Process Improvement		3
13	CS 613	Component-Based Software Engineering		3
14	CS 614	Safety-Critical Systems		3
15	CS615	Analysis and Design of Cyber-Physical Systems		3
Information Management				
16	CS 616	Advanced Database Management Systems		3
17	CS 617	Multimedia Database Systems		3
18	CS 618	Database Design		3
18	CS 619	Transaction Processing		3
19	CS 620	Distributed Databases		3
20	CS 621	Data Mining		3
21	CS 622	Spatial and Temporal Databases		3
22	CS 623	Data Warehousing		3
23	CS 624	Object Oriented Databases		3
24	CS 625	Advanced Topics in Databases		3
25	CS 626	Information Security		3
26	CS 627	Cryptography		3
27	CS 628	Information Retrieval Techniques		3

System Engineering				
28	CS 629	Digital Signal Processing		3
29	CS 630	Control Systems and Robotics		3
30	CS 631	Real Time Systems		3
31	CS 632	Parallel & Distributed Systems		3
32	CS 633	Embedded System		3
33	CS 634	ASIC Design		3
Communications and Networking				
34	CS 635	Advanced Networking		3
35	CS 636	Network Security		3
36	CS 637	Advanced Topics in Computer Networking		3
37	CS 638	Broadband & Satellite Communication		3
38	CS 639	Mobile and Pervasive computing		3
39	CS 640	Wireless Networks		3
40	CS 641	Network Programming		3
41	CS 642	Information Security		3
42	CS 643	Network Performance Evaluation		3
43	CS 644	Network Management		3
44	CS 645	Enterprise Networking		3
45	CS 646	Cryptography		3
Distributed Computing				
46	CS 647	Cluster Computing		3
47	CS 648	Distributed Computing		3
48	CS 649	Cloud Computing		3
49	CS 650	Autonomous Computing		3
50	CS 651	Grid Computing		3
Programming Language Design and Translators				
51	CS 652	Advanced Compiler Design I		3
52	CS 653	Advanced Compiler Design II		3
53	CS 654	Programming Language Semantics		3
54	CS 655	Theory of Programming Languages		3
55	CS 656	Functional Programming		3
56	CS 657	Logic Programming		3
57	CS 658	Algorithms and complexity		3
58	CS 659	Geometric Algorithms		3
59	CS 660	Parallel Algorithms		3
Artificial Intelligence				
60	CS 661	Design of Intelligent Systems		3
61	CS 662	Machine Learning		3
62	CS 663	Data Mining		3
63	CS 664	Text Mining		3
64	CS 665	Neural Networks		3
65	CS 666	Mathematical Reasoning		3
66	CS 667	Decision Support Systems		3
67	CS 668	Computer Vision		3
68	CS 669	Automated Reasoning		3
69	CS 670	Knowledge based systems		3
70	CS 671	Natural Language Processing		3
71	CS 672	Agents		3
72	CS 673	Robotics		3
73	CS 674	Symbolic Computation		3

74	CS 675	Semantic Web	3
75	CS676	Bioinformatics	3
76	CS677	Social Network Analysis	3
77	CS678	Probability, Random Variables and Stochastic Processes	3
78	CS679	Evolutionary Computing	3
79	CS680	Computational and Fuzzy Intelligence	3
80	CS681	Pattern Classification and Recognition	3
81	CS682	Medical Image Processing	3
82	CS683	Advanced Evolutionary Computing	3
83	CS684	Special Topics in Computational Intelligence and Pattern Recognition	3
Computer Architecture and Organization			
84	CS 685	Embedded Systems	3
85	CS 686	Parallel and Distributed Systems	3
Human Computer Interaction			
86	CS 687	Human Computer Interaction	3
87	CS 688	Intelligent User Interfaces	
88	CS 689	Rich Internet Applications	3
89	CS 690	Graphical User Interfaces	3
90	CS 691	Multimedia Systems Development	3
91	CS 692	Interactive-Systems Development	3
Operating Systems			
92	CS 693	Concurrent and Distributed Systems	3
93	CS 694	Real- Time Systems	3
Web Engineering			
94	CS 695	Semantic Web	3
95	CS 695	Web Services	3
Graphics and Visual Computing			
96	CS 696	Advanced Computer Graphics	3
97	CS 697	Image Processing	3
98	CS 698	Multimedia & Hypermedia System	3
99	CS 699	Virtual Reality	3
100	CS 701	Information Visualization	3
101	CS 702	Geographical Information Systems	3
102	CS 703	Computer Animation	3
103	CS 704	Genetic Algorithms	3
104	CS705	Graph Theory	3

PhD(Computer Science)Program

The Ph.D. program is designed to prepare students for a career in research. As such, it requires considerable self-directed study and independent research. The Ph.D. program is individually tailored to each student, requiring close cooperation between the student and his or her research adviser. Students are expected to identify their area of research during the first year of study, obtaining a faculty adviser who will agree to supervise the dissertation research.

The PhD program in Computer Science puts emphasis on rigorous coursework and cutting edge research that should be published in peer-reviewed international conferences and journals. All PhD students are encouraged to tackle both coursework and research in parallel; success in both these components is a requirement for the award of the PhD degree.

DISTRIBUTION OF TOTAL CREDIT HOURS

Semester	Task	Status	Credit Hours
1	Coursework	Ok	09
2	Coursework	Ok	09
3	[Coursework]+Comprehensive Exam, Thesis Supervisor Selection	Ok	06
4	Research Proposal + Research Proposal Defense	Ok	09
5	Research + Publication	Ok	09
6	Thesis write-up+ External Review+ Thesis Defense	If not completed	06
[7]	Extension...		

Category or Area	Credit Hours
PhD Course Work	18
PhD Research Credits	30
Total Credit Hours	48

Semester Wise Study Plan

S. #.	Course Code	Course Title	Credit Hours
Semester –I			
1	CS XXX	Course work	3
2	CS XXX	Course work	3
3	CS XXX	Course work	3
			Semester Hrs. Cr. 09

Semester –II			
1	CS XXX	Course work	3
2	CS XXX	Course work	3
3	CS XXX	Course work	3
			Semester Hrs. Cr. 09
Semester –III			
1		Comprehensive Exam	
2	CS XXX	PhD research	06
			Semester Hrs. Cr. 06
Semester –IV			
1	CS XXX	PhD research	09
			Semester Hrs. Cr. 09
Semester-V			
1	CS XXX	PhD Research	09
			Semester Hrs. Cr. 09
Semester- VI			
1	CS XXX	PhD Thesis Write-up and Defense	06
			Semester Hrs. Cr. 06
Semester VII (Extension if Not Completed			
1	CSXXX	Continuation of PhD Research/Thesis write-up/Defense	
Total Credits			48

Important Notes:

**All doctoral scholars will take all core courses of the department and any additional courses specified by Supervisor/GEC. Only relevant graduate level courses or equivalent will be counted towards the coursework requirements of PhD.

Area Of Specialization:

Specialization area courses are not limited to the list provided in this document. More Courses can be added to specialization areas. Students with the recommendation of supervisor/GEC may select the required courses for successful completion of PhD program. The area of specialization is not only limited as mentioned in the document. Upon the availability of faculty the list can be extended.

S. #.	Code	Course Title	Prerequisite	Credit Hours
Software Engineering				
1	CS 601	Advanced Software Development		3
2	CS 602	Advanced Topics in Software Engineering		3
3	CS 603	Object Oriented Software Engineering		3
4	CS 604	Software Quality Assurance		3
5	CS 705	Requirements Engineering		3
6	CS 606	Software Architecture		3

7	CS 607	Agent Oriented Software Engineering		3
8	CS 608	Software Project Management		3
9	CS 609	Software Design		3
10	CS 610	Software Engineering & Formal Specifications		3
11	CS 611	Empirical Software Engineering		3
12	CS 612	Software Process Improvement		3
13	CS 613	Component-Based Software Engineering		3
14	CS 614	Safety-Critical Systems		3
15	CS615	Analysis and Design of Cyber-Physical Systems		3
Information Management				
16	CS 616	Advanced Database Management Systems		3
17	CS 617	Multimedia Database Systems		3
18	CS 618	Database Design		3
18	CS 619	Transaction Processing		3
19	CS 620	Distributed Databases		3
20	CS 621	Data Mining		3
21	CS 622	Spatial and Temporal Databases		3
22	CS 623	Data Warehousing		3
23	CS 624	Object Oriented Databases		3
24	CS 625	Advanced Topics in Databases		3
25	CS 626	Information Security		3
26	CS 627	Cryptography		3
27	CS 628	Information Retrieval Techniques		3
System Engineering				
28	CS 629	Digital Signal Processing		3
29	CS 630	Control Systems and Robotics		3
30	CS 631	Real Time Systems		3
31	CS 632	Parallel & Distributed Systems		3
32	CS 633	Embedded System		3
33	CS 634	ASIC Design		3
Communications and Networking				
34	CS 635	Advanced Networking		3
35	CS 636	Network Security		3
36	CS 637	Advanced Topics in Computer Networking		3
37	CS 638	Broadband & Satellite Communication		3
38	CS 639	Mobile and Pervasive computing		3
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42	CS 643	Network Performance Evaluation		3
43	CS 644	Network Management		3
44	CS 645	Enterprise Networking		3
45	CS 646	Cryptography		3
Distributed Computing				
46	CS 647	Cluster Computing		3
47	CS 648	Distributed Computing		3
48	CS 649	Cloud Computing		3
49	CS 650	Autonomous Computing		3
50	CS 651	Grid Computing		3

Programming Language Design and Translators			
51	CS 652	Advanced Compiler Design I	3
52	CS 653	Advanced Compiler Design II	3
53	CS 654	Programming Language Semantics	3
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55	CS 656	Functional Programming	3
56	CS 657	Logic Programming	3
57	CS 658	Algorithms and complexity	3
58	CS 659	Geometric Algorithms	3
59	CS 660	Parallel Algorithms	3
Artificial Intelligence			
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61	CS 662	Machine Learning	3
62	CS 663	Data Mining	3
63	CS 664	Text Mining	3
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65	CS 666	Mathematical Reasoning	3
66	CS 667	Decision Support Systems	3
67	CS 668	Computer Vision	3
68	CS 669	Automated Reasoning	3
69	CS 670	Knowledge based systems	3
70	CS 671	Natural Language Processing	3
71	CS 672	Agents	3
72	CS 673	Robotics	3
73	CS 674	Symbolic Computation	3
74	CS 675	Semantic Web	3
75	CS676	Bioinformatics	3
76	CS677	Social Network Analysis	3
77	CS678	Probability, Random Variables and Stochastic Processes	3
78	CS679	Evolutionary Computing	3
79	CS680	Computational and Fuzzy Intelligence	3
80	CS681	Pattern Classification and Recognition	3
81	CS682	Medical Image Processing	3
82	CS683	Advanced Evolutionary Computing	3
83	CS684	Special Topics in Computational Intelligence and Pattern Recognition	3
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87	CS 688	Intelligent User Interfaces	
88	CS 689	Rich Internet Applications	3
89	CS 690	Graphical User Interfaces	3
90	CS 691	Multimedia Systems Development	3
91	CS 692	Interactive-Systems Development	3

		Operating Systems		
92	CS 693	Concurrent and Distributed Systems		3
93	CS 694	Real- Time Systems		3
		Web Engineering		
94	CS 695	Semantic Web		3
95	CS 695	Web Services		3
		Graphics and Visual Computing		
96	CS 696	Advanced Computer Graphics		3
97	CS 697	Image Processing		3
98	CS 698	Multimedia & Hypermedia System		3
99	CS 699	Virtual Reality		3
100	CS 701	Information Visualization		3
101	CS 702	Geographical Information Systems		3
102	CS 703	Computer Animation		3
103	CS 704	Genetic Algorithms		3
104	CS705	Graph Theory		3

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Department of Mathematics

The Department of Mathematics (DoM) at Air University (AU) was established in the year 2004 under the Faculty of Basic and Applied Sciences (FBAS) as a supporting department for engineering, computer sciences and business administration. The department was supposed to teach mathematics courses to undergraduate students in all three departments. The emphasis was to teach mathematics as applications which help the students to understand engineering and statistical based subjects in individual departments. The department was mainly focused on undergraduate teaching.

In the year 2008, it was felt that the department should have its own degree (BS/MS/PhD) in Mathematics. Initially the curriculum was developed for the MS in Mathematical Modeling and Scientific Computing which was launched in 2009. Later on in 2015, the department launched BS and PhD programs in mathematics and improved its MS program by including more fields of mathematics. The title of the MS program was changed to MS Mathematics.

The minimum qualification of teaching faculty is Masters of Philosophy (M.Phil.) in mathematics. Currently there are 12 faculty members holding PhD degrees from national and international universities.

Mathematics is the life line of engineering. Engineering Mathematics has developed rapidly alongside technological progress with an aim to equip graduates with a strong mathematical background to develop and apply their skills to the solution of real-world problems. On the other hand, it has always been an important part of business studies. As a result, developing specialized Mathematics courses to suit Engineering and Management programs require dedicated research and effort. The Department of Mathematics works in close collaboration

with Engineering and Administrative Sciences departments for developing required courses.

Vision and Mission of the Department

The Department of Mathematics promotes excellence in the teaching and learning of mathematics and its applications, encourages industrial research and an appreciation of the intrinsic beauty of mathematics. To advance its mission, the DoM provides a foundation for critical thinking by developing skills in problem solving; and offers a broad selection of courses that can be tailored according to diverse students' needs.

To be a model department focused on the solutions of real world scientific and engineering problems, meeting the criteria of the nation and enhancement and sustenance of the academic environment conducive to excellence in teaching and research.



Faculty

- 1 **Dr. Nabeela Kousar;** Assistant Professor, Chair, Department of Mathematics
Education: PhD (2009), Shanghai Jiao Tong University, China; M.Phil, M.Sc., Quaid-I-Azam University
Research Interest: Computational Mathematics
- 2 **Dr. Rashid Mahmood;** Assistant Professor
Education: PhD (2012), Computational Mathematics, TU Dortmund, Germany, M.S. Mathematics; CIIT Islamabad
Research Interest: CFD, Lattice Boltzmann Methods Finite Element Methods
- 3 **Dr. Kamran Usman;**
Education: PhD (2013), CFD, TU Dortmund, Germany, M.Sc., M. Phil, Mathematics; QAU

Islamabad

Research Interest: CFD, Particulate Flows, Collision Models in Particulate Flows.

4 Dr. Khalil Ahmad; Assistant Professor

Education: PhD (2014), CIIT Islamabad, M.Phil. Mathematics, BZU. Multan, M.Sc. Mathematics, Islamia University Bahawalpur

Research Interest: Complex Analysis, Topology

5 Dr. Atif Hasan Soori; Assistant Professor

Education: PhD (2015), Algebraic Geometry, East China Normal University, China, M.S., International Islamic University

Research Interest: Homological Algebra, Commutative Algebra, Algebraic Geometry, Information Geometry.

6 Dr. Muhammad Shoaib Arif; Assistant Professor

Education: PhD (2015), Information Geometry, Beijing Institute of Technology, China, M.Phil. Mathematics, Quaid-I-Azam University

Research Interest: Intuitionistic Fuzzy Semi-Group, Information Geometry.

7 Dr. Iffat Zehra; Assistant Professor

Education: , PhD (2016), M.Phil., M.Sc., Mathematics, Quaid-I-Azam University

Research Interest: Computational Fluid Dynamics

8 Dr. Sameena Bibi; Assistant Professor

Education: PhD (2016), CIIT Islamabad , M.Phil. Mathematics, Quaid-I-Azam University

Research Interest: Computational Mathematics

9 Dr. Mahwish Bano; Assistant Professor

Education: PhD (2017), M.Phil. Mathematics; M.Sc. Mathematics; Quaid-I-Azam University

Research Interest: Fuzzy Sets, Algebra, Crypto-systems

10 Dr. Sadia Ahsan; Assistant Professor

Education: PhD (2017), CIIT Islamabad, M.Phil., Quaid-I-Azam University

Research Interest: Chromatography

11 Dr. Waqas Sarwar Abbasi; Assistant Professor

Education: PhD (2017) , MS Mathematics , CIIT Islamabad

Research Interest: CFD, Fluid Solid interaction, Flow around bluff bodies, LBM

12 Dr. Tanzeela Shaheen; Assistant Professor (IPFP)

Education: PhD (2017), MPhil Mathematics , Quaid-I-Azam University

Research Interest: Fuzzy Sets, Rough Sets

13 Ms. Amara Nawaz Cheema; Assistant Professor (PhD in progress)

Education: M.Phil., Statistics, Quaid-I-Azam University

Research Interest: Research Methods and Techniques

14 Mr. Asif Mehmood; Lecturer (PhD in progress)

Education: M.Phil. Statistics, M.Sc. Statistics,

Quaid-I-Azam University

Research Interest: Various Sampling techniques with inclusion probability proportional to size sampling

15 Mr. Tauseef Ahmed; Lecturer

Education: M.Phil. Statistics, Quaid-I-Azam University

Research Interest: Experimental Design & Econometrics

16 Ms. Ambreen Khan; Lecturer

Education: M.Phil., M.Sc., Mathematics, Quaid-I-Azam University

Research Interest: Fluid Dynamics, Wave Mechanics

17 Ms. Rabil Tabassum; Lecturer (PhD in progress)

Education: M.S Mathematical Modeling & Scientific Computing Air University, M.Sc. Mathematics, University of Wah

Research Interest: Differential Equations

18 Mr. Musaddiq Ibrahim; Lecturer

Education: M.Phil., Statistics, Quaid-I-Azam University

Research Interest: Paired Comparison in Bayesian Statistics

Faculty on Leave

19 Ms. Maimoona Munir; Lecturer (Study leave)

Education: MS. Mathematical Modeling & Scientific Computing Air University,

Research Interest: Shallow water flows

20 Ms. Noreen Akram; Lecturer (Study leave)

Education: M.Phil., M.Sc., Mathematics, Quaid-I-Azam University

Research Interest: Fluid Dynamics, Wave Mechanics

21 Ms. Seemab Bashir Abbasi; Lecturer (Study leave)

Education: M.Phil Mathematics, Quaid-I-Azam University Islamabad

Research Interest: Wave Mechanics, Fluid Mechanics

22 Ms. Afeera Rizwan; Lecturer (Extra ordinary leave)

Education: MS Mathematics, COMSATS Islamabad

Research Interest: Fluid Mechanics

BS in Mathematics

Introduction

Faculty of Basic and Applied Sciences (FBAS) proposes an undergraduate BS program in Mathematics which will covers the needs of those who want to pursue their postgraduate study and research in the field of Mathematics and also who require a strong base of mathematics while working in allied technological areas. As, Faculty of Basic and Applied Sciences (FBAS) is successfully running their MS programs in Mathematical Modeling and Scientific Computing launched in 2009. However, the students enrolled generally have a weak undergraduate background. The new proposed BS program will act as a feeder for our graduate program. As such, it seems important that for a strong graduate program in Mathematics in Air University, a BS program should also be started by the Department of Mathematics at FBAS - AU.

Program Objectives

The BS scheme of studies aims to establish the base for lifelong education by creating essential concepts and equipping the student with necessary techniques, needed to start a career of research, development, teaching or financial applications involving mathematics. The training of mathematicians should inculcate creative thinking and make them capable to critically analyze a problem and to equip them with problem-solving skills. Problem solving in the classroom should prepare them to problem solving in the laboratories, and, eventually, problem solving in the industry. The program aims to produce graduates who:

1. Have an appropriate combination of theoretical knowledge and practical skills to advance professionally in mathematics and related fields.

2. Are able to use mathematical tools and language to understand the physical world around us.
3. Are able to adapt to and succeed in a dynamic global environment.
4. Are prepared to participate in lifelong learning opportunities.
5. Are prepared for a professional career in education, or in business, industry and research institutions.
6. Are prepared to continue formal education and obtain advanced degrees in mathematics or related fields.
7. Aspire to evolve as integral part of society through their knowledge and professional skills.

Title of the program

Degree offered will be BS in Mathematics.

Eligibility criteria

The Intermediate (Part I and II) examination with Physics, Mathematics and Chemistry from any Board of Intermediate and Secondary Education in Pakistan. Applicant must have scored 50% or more marks.

OR

An examination equivalent to the Intermediate. Such candidates are required to submit an Equivalence Certificate issued by the Inter-Board Chairman Committee, Islamabad before the semester starts. This certificate must indicate the marks equivalent to marks in Intermediate.

AU Entry Test

a.	English/general knowledge	-	30%
b.	Physics	-	30%
c.	Mathematics	-	40%

Program of Studies

The BS program in Mathematics is based on four years of education after higher secondary school. In the first two years, students will be offered core courses of Physics and Mathematics along with some humanities courses. After two years, the students will take advance courses from

Mathematics. This scheme of studies is adopted in different American and European Engineering Universities.

While designing the curriculum for this proposed program, the guidelines of Higher Education Commission (HEC) and the curriculum of BS Mathematics IIUI, CIIT, National University of Science & Technology (NUST), Lahore University of Management Sciences (LUMS), Quaid-e-Azam University (QAU) and some leading international universities have been taken into account.

Scheme of Studies for BS in Mathematics (4-Year Program)

Domains	Number of Courses	Number of Credit Hours
Compulsory Courses	9	26
General Courses	7	23
Core Courses	10	30
Advanced Courses	12 + Project	36 + 6
Elective Courses	4	12
	42 + Project	127 + 6

Core courses are designed to provide basic knowledge to build concepts that are essential to take up further studies in specialized areas. The advanced courses (between 12-14) will be selected from the Mathematics stream

Details are given in the following table

Compulsory Courses		General Courses		Core Courses		Advanced Courses including Research Project		Elective Courses	
9 Courses		7 Courses		10 Courses		12 Courses		4 Courses	
26 Credit Hours		23 Cr. Hours		30 Credit Hours		36 Credit Hours		12 Credit Hours	
Title	Cr. Hr.	Title	Cr. Hr.	Title	Cr. Hr.	Title	Cr. Hr.	Title	Cr. Hr.
English/Functional English	3	Principles of Chemistry	3	Calculus I	3	Real Analysis-I	3	Elective - I	3
English/Communication Skills	3	Introductory Biology	3	Multivariable Calculus	3	Differential Geometry-I	3	Elective - II	3
English/Technical Writing	3	G-I	3	Ordinary Differential Equations	3	Theory of Viscous Fluids -I	3	Elective - III	3
English/Humanities- I Self Development	3	G-II	3	Linear Algebra	3	Fundamentals of Optimization	3	Elective - IV	3
Islamic Studies	2	Physics I/Mechanics	4	Numerical Analysis and Computation	3	Mathematical Statistic-I	3		
Pakistan Studies	2	Physics II/Electricity and Magnetism	4	Complex Analysis	3	Real Analysis-II	3		
Computer Algebra System	3	Waves and Oscillation	3	Probability & Statistics	3	Partial Differential Equations	3		
Elementary Computer Programming	4			Group Theory	3	Functional Analysis-I	3		
Software Packages	3			Set Topology	3	Analytical Dynamics	3		
				Discrete Mathematics	3	Fundamentals of Operation Research	3		
						Mechanics	3		
							3		
Total	26		23		30		36		12

Semester-Wise Breakdown

1 st Semester				2 nd Semester			
Course Code	Course Title	Prerequisite	Cr. Hr.	Course Code	Course Title	Prerequisite	Cr. Hr.
PH-107	Physics I – Basic Mechanics		3-1-4	PH-108	Physics II – Electricity and Magnetism		3-1-4
MA-101	Calculus I		3-0-3	MA-105	Multivariable Calculus	MA-101	3-0-3
HU-xxx	English I		3-0-3	CH-100	Principles of Chemistry		3-0-3
HU-118	Islamic Studies		2-0-2	HU-115	Pakistan Studies		2-0-2
CS-160	Elementary Computer Programming		3-1-4	HU-xxx	English II		3-0-3
				HU-xxx	Humanities-I		3-0-3
Total			16	Total			18
3 rd Semester				4 th Semester			
Course Code	Course Title	Prerequisite	Cr. Hr.	Course Code	Course Title	Prerequisite	Cr. Hr.
HU-xxx	English III		3-0-3	MA-254	Mechanics		3-0-3
PH-202	Waves and Oscillation		3-0-3	HU-xxx	G-I		3-0-3
MA-215	Ordinary Differential Equations	MA-105	3-0-3	MA-202	Numerical Analysis and Computation	MA-215, MA-201	2-1-3
MA-201	Linear Algebra		3-0-3	MA-209	Complex Analysis		3-0-3
BIO-101	Introductory Biology		3-0-3	MA-301	Probability & Statistics		3-0-3
MA-223	Computer Algebra System		3-0-3				
Total			18	Total			15
5 th Semester				6 th Semester			
Course Code	Course Title	Prerequisite	Cr. Hr.	Course Code	Course Title	Prerequisite	Cr. Hr.
MA-362	Real Analysis-I	MA-105	3-0-3	MA-363	Real Analysis-II	MA-362	3-0-3
MA-372	Group Theory		3-0-3	MA-312	Partial Differential Equations	MA-215	3-0-3
MA-382	Differential Geometry-I		3-0-3	MA-365	Functional Analysis-I		3-0-3
MA-373	Set Topology		3-0-3	MA-352	Analytical Dynamics		3-0-3
MA-342	Fundamentals of Optimization	MA-105	3-0-3	MA-345	Fundamentals of Operation Research		3-0-3
HU-xxx	G-II		3-0-3	MA-333	Mathematical Statistic-I		3-0-3
Total			18				18

7 th Semester				8 th Semester			
Course Code	Course Title	Prerequisite	Cr. Hr.	Course Code	Course Title	Prerequisite	Cr. Hr.
MA-404	Discrete Mathematics		3-0-3	MA-422	Theory of Viscous Fluids -I		3-0-3
MA-425	Software Packages		3-0-3	MA-4xx	Elective - II		3-0-3
MA-436	Mathematical Statistic-II	MA-333	3-0-3	MA-4xx	Elective - III		3-0-3
MA-4xx	Elective - I		3-0-3	MA-4xx	Elective - IV		3-0-3
MA-498	Final Year Project		3-0-3	MA-499	Final Year Project		3-0-3
Total			15				15

Elective Courses

The elective subjects (minimum 6) will be selected in consultation with the supervisor from the list shown below keeping in view the students thesis / project / area of specialization. These courses will provide in depth knowledge in the area of specialization and lay foundation for future doctoral research.

List of Electives

Course Code	Course Title	Prerequisite	Cr. Hr.	Course Code	Course Title	Prerequisite	Cr. Hr.
MA-414	Integral Equations		3-0-3	MA-443	Variational Calculus	MA-215	3-0-3
MA-465	Measure Theory		3-0-3	MA-426	Numerical Optimization	MA-342	2-1-3
MA-482	Differential Geometry-II	MA-382	3-0-3	MA-475	Algebraic Topology	MA-373	3-0-3
MA-423	Numerical Solution of ODEs	MA-215	2-1-3	MA-455	Elasticity		3-0-3
MA-463	Complex Analysis-II	MA-209	3-0-3	MA-429	Fundamentals of Finite Element Method	MA-312	2-1-3
MA-464	Functional Analysis-II	MA-365	3-0-3	MA-445	Monte Carlo Simulations	MA-333	3-0-3
MA-424	Theory of Viscous Fluids -II	MA-422	3-0-3	MA-417	Special Functions	MA-215	3-0-3
MA-254	Mechanics		3-0-3	MA-472	Rings and Fields		3-0-3

Detailed Course Contents

MA-101 Calculus I

Limits, Continuity, Derivatives, The Chain Rule, Applications of derivatives, Mean Value theorem, Extreme Values, Curve Sketching, Integration, Integration by substitution running the chain rule backwards, Applications of integrals, Techniques of integration, Transcendental Functions-Natural Log and Exponential functions, L'Hôpital's Rule, inverse trigonometric function, hyperbolic functions Infinite Series, Complex Numbers

Text Book:

1. ANTON, BIVENS & DAVIS, CALCULUS , Laurie Rosatone, (10th Edition) (2012).

Reference Books:

2. Thomas and George.B., Calculus and Analytical Geometry, Addison-Wesley,(11th Edition).
3. Ronald E Walpole and Raymond H. Myers, Probability and Statistics for Engineers and Scientists, Macmillan publishing Company, New York, 7th edition,(2001).

MA-105 Multivariable Calculus

Conic Sections (hyperbola, parabola, ellipse circles), Vectors in IR (dot product, vector product) lines and planes, geometry of space curves, Multivariable Calculus (double integral, area volume, surface area, Jacobian, parametric equation and polar coordinates, multiple Integrals, Calculus of Vector Fields (line integral, surface integral independence of path, Green's theorem, divergence theorem, Stokes' theorem).

Text Book:

1. ANTON, BIVENS & DAVIS, CALCULUS, Laurie Rosatone, (10th Edition) (2012).

Reference Books:

2. Thomas and George.B., Calculus and Analytical Geometry, Addison-Wesley,(11th Edition).
3. Ronald E Walpole and Raymond H. Myers, Probability and Statistics for Engineers and Scientists, Macmillan publishing Company, New York, 7th edition,(2001).

MA-106 Ordinary Differential Equations

First-order differential equations and their applications, linear differential equations with constant coefficients and their applications, Euler- Cauchy equations, method of variation of parameters, theory of power series method, Legendre's equations, Bessel's Equation. Introduction to system of differential equations. Laplace transform and its applications. Introduction to partial differential equations.

Text Book:

1. Dennis G. Zill, Differential Equations, Prindle, Weber and Schmidt (3rd Edition), (1982).

Reference Books:

2. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and sons, (9th Edition), (2006).
3. Earl D. Rainville, Phillip E. Bedient, Elementary Differential Equations Prentice Hall, Upper Saddle River, NJ07458 (8th Edition), (1997).

MA-201 Linear Algebra

Basic Concepts, Matrix Operations, System of Linear Equations, Linear Independence, Iterative Solutions of Linear System, Introduction to Linear Transformations, Inverse of a Matrix, Matrix Factorization, Introduction to Determinants, Cramer's Rule, Vector Spaces, Eigenvalues and its Applications, Inner Product Spaces, Orthogonality, The Gram- Schmidt Process.

Text Book:

1. David C. Lay, Linear Algebra and its Applications, Pearson Education, (3rd Edition), (2004).

Reference Books:

2. Erwin Kreyszig, Advanced Engineering Mathematics, Jhon Wiley and Sons, (8th Edition), (1982).
3. Howard Anton, Chris Rorres, Elementry Linear Algebra, Jhon Wiley and Sons, (8th Edition), (2000).

MA-202 Numerical Analysis & Computation

Solution of non-linear equations (bisection method, secant method and Newton's method), solution of linear algebraic equations, interpolation, numerical integration, finite difference, numerical solutions of ordinary differential equations (Euler's method, Runge-Kutta, boundary value problems). Computer implementation (Matlab(Retd) and C)

Text Book:

1. Numerical Methods using MATLAB, John H. Mathews, Kurtis D. Fink, (4th Edition), (2009).

Reference Books:

1. Numerical Analysis , Richard L. burden, J. Douglas Faires, 7th Edition, Thomson Books/Cole (2005).
2. Numerical Analysis: A Practical Approach, Melvin J. Maron, Macmillan Company, Inc, New York.(1998)
3. Applied Numerical Analysis, Curtis F. Gerald and Patrick O. Wheatley, 6th Edition, Addison Wesley, Longman (2002).

MA-209 Complex Analysis

A quick review of Complex numbers, Analytic function and their properties, elementary functions of Complex variable, Integration of complex functions, Cauchy-Goursat theorem, Cauchy integral formula, Fundamental theorem of algebra. Series representation of analytic function, Residues and poles, evaluation of improper real integrals, Mappings by Elementary functions, Conformal mappings and their properties, some simple applications of conformal mappings.

Text Book:

1. Dennis G. Zill, Patrick D. Shanahan, Complex Variables with Applications, Jones and Bertlett, (2nd Edition), (2003).

Reference Books:

2. Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, (8th Edition), (1999).
3. Ruel V. Churchill, James Ward Brown, Complex Variables and Applications, McGraw-HILL, (4th Edition), (1984).

MA-301 Probability and Statistics

This course provides an elementary introduction to probability and statistics with applications. Topics include: basic probability models; combinatorics; random variables; discrete and continuous

probability distributions; statistical estimation and testing; confidence intervals; and an introduction to linear regression.

Text Book:

1. Ronald E Walpole and Raymond H. Myers, Probability and Statistics for Engineers and Scientists, Macmillan publishing Company, New York, 8th edition,(2005).

Reference Book:

2. Statistics for Engineers and sciences, William Madenhall and Terry Sincich 4th Edition, Prentice Hall.
3. Advance level Statistics, 3rd Edition, J-Crawshaw and J chambers.
4. Statistics for business and Economics, Paul Newbold, 4th Edition, Pentice Hall.

MA-362 Real Analysis - I

Ordered sets, supremum and infimum, completeness properties of the real numbers, limits of numerical sequences, limits and continuity, properties of continuous functions on closed bounded intervals, derivatives in one variable, the mean value theorem, sequences of functions, power series, point-wise and uniform convergence, functions of several variables, open and closed sets and convergence of sequences in R^n , limits and continuity in several variables, properties of continuous functions on compact sets, differentiation in n – space, the Taylor series in R^n with applications, the inverse and implicit function theorems.

Reference Book:

1. Robert G. Bartle, Donald R. Sherbert. Introduction to Real Analysis, 4th Edition, John Willey, New York (2011)
2. RL. Brabenec, obert. Introduction to Real Analysis, PWS Publishing Company,(1997)

MA-372 Group Theory

Definition and Examples of Groups, Order of Group, Order of an Element, Abelian Groups, Subgroups, Cyclic Groups. Fundamental Theorem of Cyclic Group , Complexes and Coset Decomposition of Groups, Index of Subgroup in a Group., Lagrange's Theorem and Applications, Centre of a Group, Normalizer in a Group, Centralizer in a Group, Conjugacy Relation and Congruence Relation in a Group. 16, Subgroup, Cyclic groups, Coset decomposition of a group, Lagrange's theorem and its consequences, Conjugacy classes, Centralizers and Normalizes, Normal subgroups and Quotient groups, Definition of a homomorphism, Endomorphism and automorphism, Isomorphism theorems and related results, Definitions and basic results of, Cosets, left cosets and right cosets, Doublecosets and related theorems, Cauchy's theorems for abelian groups, Cauchy's theorems for general groups, Sylow's Theorems.

Reference Book:

1. ABSTRACT ALGEBRA by D. S. Dummit and R. M. Foote, 2nd Edition, John Wiley & Sons, Inc.
2. A FIRST COURSE IN ABSTRACT ALGEBRA by J. B. Fraleigh, 7th Edition, Pearson Education

MA-382 Differential Geometry I

Historical background; Motivation and applications. Index notation and summation convention; Space curves; The tangent vector field; Re parametrization; Arc length; Curvature; Principal normal;

Binormal; Torsion; The osculating, the normal and the rectifying planes; The Frenet-Serret Theorem; Spherical images; Sphere curves; Spherical contacts; Fundamental theorem of space curves; Line integrals and Green's theorem; Local surface theory; Coordinate transformations; The tangent and the normal planes; Parametric curves; The first fundamental form and the metric tensor; Normal and geodesic curvatures; Gauss's formulae; Christoffel symbols of first and second kinds; Parallel vector fields along a curve and parallelism; The second fundamental form and the Weingarten map; Principal, Gaussian, Mean and Normal curvatures; Dupin indicatrices; Conjugate and asymptotic directions; Isometries and the fundamental theorem of surfaces.

Reference Books:

1. Kuhnelt, Wolfgang. *Differential Geometry: Curves – Surfaces – Manifolds*. Student mathematical library, vol. 16. Providence, RI: American Mathematical Society, 2002.
2. Gray, Alfred, Simon Salamon, and Elsa Abbena. *Modern Differential Geometry of Curves and Surfaces with Mathematica*. Boca Raton, FL: Chapman & Hall/CRC, 2006.
3. Millman, R.S and Parker, G.D. *Elements of Differential Geometry* (Prentice-Hall Inc., New Jersey, 1977).

MA-373 Set Topology

Metric Spaces, open sets, closed sets, convergence and continuity in metric Spaces Course, Topological spaces, bases and subspaces, product topology, subspace topology, closed sets and limit points, closure, interior and boundary, Housdorff spaces, homomorphism, homomorphic spaces, compactness, connectedness, first-countable and second countable spaces, regular and normal spaces.

Reference Book:

1. E. Paul Long, An Introduction to general topology.
2. J. F. Simmons, Introduction to topology modern analysis, McGraw Hill, New York

MA-342 Fundamentals of Optimization

Linear programming, simplex method, duality theory, unconstrained optimization, optimality conditions, one dimensional problems, multi-dimensional problems, method of steepest decent, constrained optimization with equality constraints, optimality conditions, Lagrange multipliers, Hessians and bordered Hessians. Inequality constraints and Kuhn-Tucker theorem.

Reference Book:

1. D. Bertsimas and J. N. Tsitsiklis, Introduction to Linear Optimization.
2. D. G. Luenberger, Linear and Nonlinear Programming. Addison-Wesley, 1984.
3. S. P Boyd and L. Vandenberghe, [Convex Optimization](#)
4. W. L. Winston, Introduction to Mathematical Programming Duxbury Press, Second Edition, 1995.
5. R. Vanderbei, Linear Programming: Foundations and Extensions Princeton University Press

MA-363 Real Analysis - II

Series of numbers and their convergence, series of functions and their convergence, Dabroux upper and lower sums and integrals, Dabroux integrability, Riemann sums and the Riemann integral, Riemann integration in R^2 , change of order of variables of integration. Riemann integration in R^3 , and R^n , Riemann-Steiltjes integration, Functions of bounded variation, the length of a curve in R^n .

MA-333 Mathematical Statistics - I

This course provides a brief review of basic probability concepts and distribution theory. It covers mathematical properties of distributions needed for statistical inference.

Measure of central tendency, measure of dispersion, measure of skewness and kurtosis, Sample spaces, events (Borel sets), axioms and laws of probability, independence, conditional probability, Bayes Theorem, discrete and continuous random variables and vectors, distribution functions, densities, *Expectation & Functions of Random Variables*, *Specific Parametric Distributions-Univariate*: Binomial, Poisson, Hypergeometric, geometric, negative binomial, exponential, gamma, normal and related families, exponential families, Joint distributions, conditional distributions, independence of random variables, probability inequalities for random variables (Chebyshev, Jensen), Multivariate distributions: trinomial, multinomial, bivariate normal, Random samples, central limit theorem, laws of large numbers, Slutsky's theorem, Normal models, order statistics

Reference Book:

1. *Introduction to Mathematical Statistics*, Hogg and Craig, Prentice Hall, Upper Saddle River
2. *Mathematical Statistics with Applications*, by D.D. Wackerly, W. Mendenhall and R.L. Scheaffer, Duxbury Press, 6th edition(2002)

Reference Book:

1. Robert G. Bartle, Donald R. Sherbert. *Introduction to Real Analysis*, 4th Edition, John Willey, New York (2011)
2. RL. Brabenec, obert. *Introduction to Real Analysis*, PWS Publishing Company,(1997)

MA-312 Partial Differential Equations

Partial differential equations of the first order. Nonlinear PDEs of first order Applications of 1st order partial differential equations. **Partial differential equations of second order**, Mathematical modeling of heat, Laplace and wave equations. Classification of 2nd order PDEs Boundary and initial conditions. Reduction to canonical form and the solution of 2nd order PDEs, Technique of separation of variable for the solution of PDEs with special emphasis on Heat, Laplace and wave equations. The method of spherical means, Kirchhoff's formula and Minkowskian geometry, Geometric energy estimates for wave equations. Laplace, Fourier and Hankel transform for the solution of PDEs and their application to boundary value problems.

Reference Books:

1. Haberman, R., *Elementary Applied Partial Differential Equations*, Prentice Hall, Inc.New Jersey, 1983.
2. Sneddon, I.N., *Elements of Partial Differential Equations*, McGraw-Hill Book Company, 1987.
3. Zauderer, E., *Partial Differential Equations of Applied Mathematics*, John Wiley & Sons, Englewood Cliff, New York, 1983.

MA-365 Functional Analysis-I

Metric Spaces, open sets, closed sets, convergence, completeness, normed Spaces,Banach spaces, Bounded and continuous linear operators and functionals, Dual spaces, Finite dimensional spaces, Inner-product space, Hilbert space, orthogonal and orthonormal sets, orthogonal complements, Gram-Schmidt orthogonalization process, representation of functionals, Reizrepresentation theorem, weak and weak* Convergence.

Reference Book:

1. Dover Kreyszig E, *Introductory Functional Analysis with Applications*, John Wiley,New York.

MA-254 Classical Mechanics

Kinematics: Rectilinear motion of particles. Uniform rectilinear motion, uniformly accelerated rectilinear motion. Curvilinear motion of particle, rectangular components of velocity and acceleration. Tangential and normal components. Radial and transverse components. Projectile motion.

Kinetics: Work, power, kinetic energy, conservative force fields. Conservation of energy, impulse, torque. Conservation of linear and angular momentum. Non-conservative forces.

Simple Harmonic Motion: The simple harmonic oscillator, period, frequency. Resonance and energy. The damped harmonic oscillator, over damped, critically damped and under damped. Motion, forces and vibrations. Central Forces and Planetary Motion: Central force fields, equations of motion, potential energy, orbits. Kepler's law of planetary motion.

Introduction to rigid and elastic bodies: degree of freedom, translations, rotations, instantaneous axis and center of rotation, motion of the center of mass. Euler's theorem and Chasles' theorem. Rotation of a rigid body about a fixed axis, moments and products of inertia. Parallel and perpendicular axis theorem. Motion of Rigid Bodies in Three Dimensions: General motion of rigid bodies in space.

Euler Equations of Motion of a Rigid Body: Force free motion. Free rotation of a rigid body with an axis of symmetry. Free rotation of a rigid body with three different principal moments. The Eulerian angles, angular velocity and kinetic energy in terms of Euler angles.

Reference Book:

1. E. DiBenedetto, Classical Mechanics. Theory and Mathematical Modeling, Birkhauser Boston, 2011.
2. John R. Taylor, Classical Mechanics, University of Colorado, 2005.
3. H. Goldstein, Classical Mechanics, Addison-Wesley Publishing Co., 1980.
4. C. F. Chorlton, Text Book of Dynamics, Ellis Horwood, 1983.
5. M. R. Spiegel, Theoretical Mechanics, 3rd Edition, Addison-Wesley Publishing Company, 2004.
6. G. R. Fowles and G. L. Cassiday, Analytical Mechanics, 7th edition, Thomson Brooks/COLE, USA, 2005.

MA-352 Analytical Dynamics

Constraints, Degree of freedom, General 3-D rigid body dynamics, Holonomic and non-holonomic constraints. *Generalized co-ordinates*, general equation of dynamics, Lagrange's equations, conservation laws, ignorable co-ordinates. Lagrange's equations for holonomic systems, Explicit form of Lagrange's equation in terms of tensors. Hamilton's principle, principle of least action, Hamilton's equations of motion, Hamilton-Jacobi Method. Poisson Brackets (P.B's); Poisson's theorem; Solution of mechanical problems by algebraic technique based on (P.B's). Small oscillations and normal modes, vibrations of strings, transverse vibrations, normal modes, forced vibrations and damping, reflection and transmission at a discontinuity, Longitudinal vibrations, Rayleigh's principle.

Reference Books:

1. Chorlton, F., Textbook of dynamics, Van Nostrand, 1963.
2. G. Meirovitch. L., Methods of Analytical Dynamics, McGraw-Hill, 1970.
3. Murray R. Spiegel, Theory and problems of theoretical mechanics. SI (metric) edition McGraw-Hill, New York, 1967.
4. D.T. Greenwood, Principles of Dynamics (2nd Edition)

MA-345 Fundamentals of Operations Research

Introduction to Operations Research and real life Phases, Introduction to Linear Programming (LP) with examples, Graphical Solutions to Mathematical Model with Special Cases, Simplex Algorithm and its different cases, Big M Method and Two Phase Method, Sensitivity Analysis/ Post Optimality Analysis, Duality and its Economic Interpretation, Dual Simplex Method, Scheduling and Blending Problems, The Transportation Problems, The Transshipment Problems, The Assignment Problems, Integer Programming, Network Models, Inventory Models, Dynamic Programming and Queuing Theory.

Reference Book:

1. Hamdy A. Taha, Operations Research - An Introduction, (Macmillan Publishing Company Inc., New York, 1987).

MA-436 Mathematical Statistics - II

Functions of Random Variables: Distribution function technique; Transformation technique: One variable, several variables; Moment-generating function technique

Sampling Distributions: The distribution of the mean; The distribution of the mean: Finite populations; The Chi-Square distribution; The t distribution; The F distribution

Regression and Correlation: Linear regression; The methods of least squares; Normal regression analysis; Normal correlation analysis; Multiple linear regression; Multiple linear regression (matrix notation)

Reference Books:

1. J. E. Freund, *Mathematical Statistics*, (Prentice-Hall Inc).
2. Hogg and Craig, *Introduction to Mathematical Statistics*, (Collier Macmillan).
3. Mood, Greyill and Boes, *Introduction to the Theory of Statistics*, (McGraw Hill).
4. R. E. Walpole, *Introduction to Statistics*, latest edition, (Macmillan Publishing Company London)
5. M. R. Spiegel, L. J. Stephens, *Statistics*, (McGraw Hill Book Company)

MA-404 Discrete Mathematics

Proportional and first-order logic, Equivalence, inference and method of proof, Mathematical induction, diagonalization principle, Basic counting, Recursion, Graphs, Trees, Spanning Trees Set operations, relations, functions, Boolean algebra, Truth tables and minimization of Boolean expressions, Applications to computer science and engineering.

Reference Books:

1. Discrete Math and Applications, Rosen, (latest edition)
2. Discrete Math and Applications, Susanna S. Epp

MA-422 Theory of Viscous Fluids I

Eulerian approach, Lagrangian description, Properties of fluids, Transport properties, Kinematic

properties, thermodynamics properties, Boundary conditions for viscous flows and heat conducting flows problems, Conservation of mass (equation of continuity), conservation of momentum (equations of Navier-Stokes equations), conservation of energy (energy equations), Dimensionalization and dimensionless parameters in viscous flow, Vorticity transport equation, Stream function, Steady flow, unsteady flow, creeping flow and boundary layer flow, Couette flows, Poiseuille flow, Couette Poiseuille flow between parallel plates, Stokes first problem, Stokes second problem, Unsteady flow between two infinite plates, Asymptotic suction flows: uniform suction on a plane, flow between parallel plates with top suction and bottom injection

Reference Book:

1. Frank M. White, Viscous Fluid Flow, Second Edition, McGRAW-HILL, Inc.
2. Hermann Schlichting, Boundary-layer Theory, Seventh Edition, McGraw-Hill Series in Mechanical Engineering.
3. G.K. Batchelor, An introduction to fluid dynamics, Cambridge University Press.

MA-414 Integral Equations

Integral equation formulation of boundary value problems, classification of integral equations, method of successive approximation, Hilbert-Schmidt theory, Schmidt's solution of non-homogeneous integral equations, Fredholm theory, case of multiple roots of characteristic equation, degenerate kernels. Introduction to Wiener-Hopf technique.

Reference Book:

1. B. Noble., Methods based on the Wiener-Hopf technique, Pergamon Press, 1958.
2. Abdul J. Jerri., Introduction to integral equations with applications, Marcel Dekker Inc. New York, 1985.

MA-465 Measure Theory

Measure Spaces with measure, measurable function, idea of σ fields, outer measure, Lebesgue measure, measurable sets, complete measure spaces, measurable functions, Egorov's theorem, Lebesgue Integration, comparison between Riemann integration and Lebesgue integration, L_2 -space, the Riesz-Fischer theorem.

Reference Book:

1. Holmes PR, Measure Theory, van Nostrand, New York.
2. D. L. Cohn, Measure Theory, Birkhauser 1980.

MA-423 Numerical solutions of ODEs

Some Theorems from the Theory of Differential Equations; Initial Value Problems for First Order Ordinary Differential Equations and for Systems of First Order Ordinary Differential Equations Linear Difference; Equations with Constant Co-efficient, The General Linear Multistep Methods; Convergence; Order and Error Constant; Local and Global Truncation Error; Consistency and Numerical Stability; General Methods for Finding Intervals of Absolute and Relative Stability; Predictor-Corrector Methods; Derivation of Classical Runge-Kutta Methods; Runge-Kutta Methods of order Greater Than Four; Error Estimates and Error Bounds for Runge Kutta Methods; Comparison with P Predictor-Corrector Methods; Implicit Runge-Kutta Methods.

Reference Book:

1. Greenspan, Numerical solutions of ODE's for classical Relativistic and Nanosystems, 2006.
2. C. E. Froberg, Numerical mathematics, The Benjamin Cummings Pub. Com. Inc., 1985.
3. G. M. Phillips, P. J. Taylor, Theory and Applications of Numerical Analysis, Academic Press, 1973.
4. W. E. Pre et al., Numerical Recipes, Cambridge University Press, 1986.

MA-472 Rings and Fields

Rings and Fields, Definitions and Examples of subrings, Ideals, homomorphisms and related theorems. Properties of subrings and Ideals, product of Ideals, Intersection and Sum of ideals. Homomorphism theorems. Prime ideals, Principal ideals, Maximal ideals, regular rings, Internal and External direct sums of rings. Polynomial rings, Matrix rings and their properties. Unique factorization domain, factorization theory. Principal ideal domains and Euclidean domains, arithmetic in Euclidean domains.

Reference Books:

1. Fraleigh, J.A., A First Course in Abstract Algebra, Addison Wesley Publishing Company, 1982
2. Herstein, I.N., Topics in Algebra, John Wiley & Sons 1975
3. Lang, S., Algebra, Addison Wesley 1965
4. Hartley, B., and Hawkes, T.O., Ring, Modules and Linear Algebra, Chapman and Hall, 1980.

MA-482 Differential Geometry II

Definition and examples of manifolds; Differential maps; Submanifolds; Tangents; Coordinate vector fields; Tangent spaces; Dual spaces; Multilinear functions; Algebra of tensors; Vector fields; Tensor fields; Integral curves; Flows; Lie derivatives; Brackets; Differential forms; Introduction to integration theory on manifolds; Riemannian and semi-Riemannian metrics; Flat spaces; Affine connections; Parallel translations; Covariant differentiation of tensor fields; Curvature and torsion tensors; Connection of a semi-Riemannian tensor; Killing equations and Killing vector fields; Geodesics; Sectional curvature.

Reference Books:

1. Kuhnel, Wolfgang. *Differential Geometry: Curves – Surfaces – Manifolds*. Student mathematical library, vol. 16. Providence, RI: American Mathematical Society, 2002.
2. Gray, Alfred, Simon Salamon, and Elsa Abbena. *Modern Differential Geometry of Curves and Surfaces with Mathematica*. Boca Raton, FL: Chapman & Hall/CRC, 2006.
3. [A. Pressley](#), *Elementary Differential Geometry*, 2nd Edition, Springer (2012) Millman, R.S and Parker, G.D. *Elements of Differential Geometry* (Prentice-Hall Inc., New Jersey, 1977).
5. M. K. Jain, Numerical Solution of Differential Equations, Wiley Eastern Ltd.
6. W. E. Milne, Numerical Solution of Differential Equations, Dover Pub. Inc., N.Y.

MA-463 Complex Analysis-II

Review of basic complex analysis, Maximum modulus principle, Schwarz lemma, Phragmen-Lindel of theorems, zeros of analytic functions, Jensen's formula, Weierstrass factorization theorem, gamma function, Stirling's approximation.

Reference Books:

1. S. Lang, complex analysis, Springer- Verlag.
2. Ahlfors, complex analysis.

MA-464 Functional Analysis-II

Brief review of complex functions and complex integrations, class of analytic functions, Riemann Mapping Theorem, class of univalent functions, class of convex univalent and starlike univalent functions, close-to-convex functions, Coefficient bounds, growth and distortion results of functions contained in subclasses of the class of univalent functions, class of Caratheodary functions with positive real part and related classes, functions with bounded radius rotation, functions with bounded boundary rotation, differential subordination, Hadamard product (or convolution), some linear differential and integral operators.

Reference Books:

1. Rudin W, Functional Analysis, 1973, McGraw Hill, New York
2. M. A. Naimark, normed algebras, WollersNoordhoff 1972.

MA-424 Theory of Viscous Fluids -II

Similarity solution, Berman problem, Plane stagnation flow, axisymmetric stagnation flow, flow near an infinite rotating disk, Jeffery Hammel flow in a wedge shaped region and it solution for small wedge angle, Stokes solution for an immersed sphere, Derivation of boundary-layer equations for two-dimensional flow, The laminar boundary layer equations, The approximate method due to the von Karman and K. Pohlhausen for two dimensional flows, Blasius problem of flat plate flow, Falker-Skan wedge flows, Heat transfer for Falker-Skan flows, two dimensional steady free convection, viscous flows over a stretching sheet, thin film flows.

Reference Books:

1. Frank M. White, Viscous Fluid Flow, Second Edition, McGRAW-HILL, Inc.
2. Hermann Schlichting, Boundary-layer Theory ,Seventh Edition, McGraw-Hill Series in MechanicalEngineering.
3. G.K. Batchelor, An introduction to fluid dynamics,Cambridge University Press.

MA-443 Variational Calculus

Introduction, functional, Fundamental theorem of variational calculus, Euler-Lagrange Equation, Brachistochrone problem, variation of end point, Isoperimetric problems, Dido problem, Geodesics problems, Euler-Lagrange equation with Several variables.

Reference Books:

1. Curant, R. and [D. Hilbert](#): Methods of Mathematical Physics, Vol I. Interscience Press, 1953.
2. Elsgolc, L.E.: Calculus of Variations, Pergamon Press Ltd., 1962.
3. Weinstock, Robert: Calculus of Variations with Applications to Physics and Engineering, Dover, 1974.

MA-426 Numerical Optimization

Gradient method, subgradient method, proximal gradient method, Nesterov's acceleration technique, alternating direction method of multi-pliers, coordinate descent method, and

stochastic/randomized algorithms. Applications of these optimization methods for solving problems in contemporary applications arising from big data analytics, machine learning, statistics, signal processing

Reference Books:

1. J. Nocedal and S.J. Wright, Numerical Optimization, Springer, 2006
2. Nesterov, Introductory Lectures on Convex Optimization: A Basic Course, Kluwer, 2003

MA-475 Algebraic Topology

Quotient topology, homotopy of paths, the fundamental group, covering spaces, fundamental group of the circle, retraction and fixed points, Borsuk-Ulam theorem, deformation retracts and homotopy type, fundamental groups of various surfaces, direct sums of Abelian groups, free products of groups, free groups, Seifert-van Kampen theorem and applications.

Reference Books:

1. Allen Hatcher, Algebraic Topology, 2001.
2. Tom Dieck, Tammo, Algebraic topology, *European Mathematical Society* (2010).

MA-455 Elasticity

Introductory mathematical concepts, Deformation and strain, Stress, Plane theory of elasticity (Cartesian coordinates), Plane theory of elasticity (polar coordinates), Three-dimensional elasticity theory, Prismatic bars subjected to end loads, General solutions of elasticity,

Reference Books:

1. Arthur P. Boresi, Ken P. Chong, James D. Lee. "Elasticity in Engineering Mechanics", (latest edition) John Wiley & Sons, Inc., 2011,

MA-429 Fundamentals of Finite Element Method

The course will emphasize the solution of real life problems using the finite element method underscoring the importance of the choice of the proper mathematical model, discretization techniques and element selection criteria.

Introduction to finite element analysis, Direct stiffness approach: Spring elements, Bar and truss elements, Introduction to differential equations and strong formulation, Principle of minimum potential energy and weak formulation, Finite element formulation of linear elastostatics, The constant strain triangle, The quadrilateral element, Practical considerations in FEM modeling, Convergence of analysis results, Higher order elements, Isoparametric formulation.

Reference Books:

1. A First Course in the Finite Element Method Author: Daryl Logan Year Published: 2011 Edition: Fifth Publisher: Cengage Learning.

MA-445 Monte Carlo Simulations

This course gives a broad overview of Monte Carlo methods. These methods include many important tools for students interested in applied probability, finance and statistics, Pseudo-random numbers and quasi-random numbers, Generating random variables, Generating stochastic processes, Markov Chain Monte Carlo, Variance reduction, Gradient estimation, Stochastic optimization.

Reference Books:

1. Glasserman, P. Monte Carlo Methods in Financial Engineering. Springer, 2004.
2. Kroese, D. P., T. Taimre and Z. Botev. Handbook of Monte Carlo Methods. Wiley, 2011.
3. Robert, C. P. and G. Casella. Monte Carlo Statistical Methods, Second Edition. Springer, 2005.

MA-417 Special Functions

Definition and properties of Gamma function, Beta function, Incomplete Gamma function, Definition and generating function of Legendre polynomials. Recurrence relation and Legendre polynomials, Recurrence relation and Legendre differential Equations, Rodrigue's formula, Hermite polynomials, Bessel functions An integral form of Bessel functions and orthogonality, Differential equation solvable with Bessel functions.

Reference Books:

1. L. C. Andrews, Special functions for Engineers and Applied Mathematics, McMillan Publishing Company.
2. N.W. Lebedev, Special functions and their applications, Dover Publishing Inc., 1972
3. E.D. Rainvill, Special Functions, McGraw Hill, 1992

MA-223 Computer Algebra System

Matlab: general design principles, user facilities, data structures, use of hashing, etc. Brief comparison of systems. Algebraic structures: overview, basic concepts and algorithms. Arbitrary precision operations on integers, rationals, reals, polynomials and rational expressions. Importance of greatest common divisors and their efficient computation for integers and univariate polynomials (using modular methods). Multivariate polynomial systems: solution of sets of equations over the complex numbers; construction and use of Groebner bases; relevant algebraic structures and results. Reliable solution of systems of polynomial equations in one variable; Sturm sequences, continued fractions method. Relevant QAA Computing Curriculum Sections: Data Structures and Algorithms, Simulation and Modelling, Theoretical Computing.

Reference Books:

1. von zur Gathen and J. Gerhard, Modern Computer Algebra, Cambridge University Press, second edition, 2003.
2. K. O. Geddes, S. R. Czapor and G. Labahn, Algorithms for Computer Algebra, Kluwer Academic Publishers (1992).
3. J.H. Davenport, Y. Siret and E. Tournier, Computer Algebra; systems and algorithms for algebraic computation, Academic Press 1988.
4. D.E. Knuth, Seminumerical Algorithms, second dedition, Addison-Wesley 1981.

MA-425 Software Packages

Maple and Mathematica: overview, basic concepts and algorithms. Arbitrary precision operations on integers, rationals, reals, polynomials and rational expressions. Solution of systems of polynomial equations, Solution of ODEs, Plotting. Matlab-Simulink, Built in BVP solvers

Reference Books:

1. Mastering MATLAB 6 (Prentice Hall), Duane Hanselman, Bruce Littlefield
2. Solving applied Mathematical Problems with Matlab, D. Xue, Y. Chen, CRC press (2009).
3. J.H. Davenport, Y. Siret and E. Tournier, Computer Algebra; systems and algorithms for algebraic computation, Academic Press 1988.
4. D.E. Knuth, Seminumerical Algorithms, second dedition, Addison-Wesley 1981.

INTRODUCTION OF MS MATHEMATICS

Objectives

MS Mathematics is meant to provide a rigorous introduction to graduate-level Mathematics. Our MS program is aiming chiefly at students who will continue to a PhD in Mathematics, but who want to strengthen their mathematical background prior to entering doctoral studies. At the same time, several doctoral students in other departments who have the need for advanced Mathematical training find our program of interest.

BS & PhD are general programs which cover all fields of Mathematics while our previous program MS Mathematical Modeling & Scientific Computing (MMSM) covered only Mathematical Modeling. For better growth of the department, there was a need of general MS Mathematics which could cover all the field of Mathematics including Mathematical Modeling.

Scope

The MS Mathematics aims to equip graduates with a strong mathematical background to develop and apply their skills to the solution of problems in both pure and applied mathematics. The aim of the program is to provide students advanced knowledge in mathematics and related fields so that they are able to work as a mathematical professional, or are qualified for training as a scientific researcher. It offers students the opportunity to specialize in a particular area of interest to them. It also aims to produce graduates with high level of analytic and numerical skills which will definitely help the graduates in teaching and research fields.

Date of the Commencement of the Program

Change in title from MS Mathematical Modeling & Scientific Computing to MS Mathematics was approved in Academic Council on 10 June 2015.

MS Mathematics was formally started in Semester Fall 2015.

Eligibility criteria

The applicant has to meet the following minimum eligibility requirements:

1. 16years education with major in Mathematics or related discipline, Minimum CGPA 2.5/4.0.
2. GAT General by NTS with at least 50% score /AU entry test with at least 60% score that

must be taken before admission to MS program.

3. Candidates will have to appear in the interview for final selection.

Program Length

The two year program consists of 24 credits of course work followed by 6 credits of research work. The first semester comprises of four core courses. The second semester comprises of four elective courses. The second year is dedicated for research thesis. The student can take maximum four courses and minimum three courses in each semester. Out of four core courses, the student must take two courses from the field of pure mathematics and two courses from the field of Applied Mathematics. The courses will be offered on the availability of the present faculty.

Program Details

Semester-Wise Breakdown

First Year					
Semester I			Semester II		
S.No.	Course Title	Cr. Hr	S.No.	Course Title	Cr. Hr
1	Core-I	3-0-3	1	Elective-I	3-0-3
2	Core-II	3-0-3	2	Elective-II	3-0-3
3	Core-III	3-0-3	3	Elective-III	3-0-3
4	Core-IV	3-0-3	4	Elective-IV	3-0-3
Total		12	Total		12

Second Year	
MA-799 MS Thesis	6 Credit Hours

List of Core courses

Course Code	Course Title	Cr. Hrs
MA-688	Applied Linear Algebra	3-0-3
MA-670	Approximation Theory	3-0-3
MA-634	Riemannian Geometry	3-0-3
MA-564	Advanced Functional Analysis	3-0-3
MA-524	Advanced Group Theory	3-0-3
MA 622	Geometric Function Theory	3-0-3
MA-525	Advanced Ring Theory	3-0-3
MA-636	Advanced Algebraic Topology	3-0-3
MA 644	Advanced Engineering Mathematics	3-0-3

MA-680	Applied Partial Differential Equations	3-0-3
MA-502	Numerical Methods	3-0-3
MA-646	Introduction to Modeling and Simulation	3-0-3
MA-650	FEM for Partial Differential Equations	3-0-3

List of Elective Courses for Post Graduate (PG) Studies

Course Code	Course Title	Cr. Hrs
MA 501	Quantitative Analysis and Techniques	3-0-3
MA-645	Advanced Numerical Techniques	3-0-3
MA-744	Deterministic Operations Research	3-0-3
MA-773	Perturbation Methods	3-0-3
MA-742	Optimization Techniques	3-0-3
MA-746	Tools for Mathematical Modeling and Simulation	3-0-3
MA 775	Numerical Solutions of Differential Equations	3-0-3
MA-788	Advanced Computational Methods	3-0-3
PH 500	Basics of Physics	3-0-3
MA-700	Computational Fluid Dynamics	2-1-3
MA-770	Modeling and Simulation of Dynamical Systems	3-0-3
MA-662	Linear Partial Differential Equations	3-0-3
MA-684	Mathematical Methods	3-0-3
MA-780	Solid Mechanics	3-0-3
MA-686	Stochastic Differential Equations	3-0-3
MA 782	Topics in Fluid Mechanics	3-0-3
MA 784	Mathematical Methods for Signal Processing	3-0-3
MA 772	Mathematics for Geosciences	3-0-3
MA-786	Waves and Compressible Flow	3-0-3
MA 623	Symmetry Methods for Differential Equations	3-0-3
MA 624	Hilbert Space Methods	3-0-3
MA 625	Variational Inequality & Convex Analysis	3-0-3
MA 627	Commutative Algebra	3-0-3
MA 724	Homological Algebra	3-0-3
MA 737	Algebraic Geometry-I	3-0-3
MA 765	Banach Algebras and C*-Algebras	3-0-3
MA 626	Algebraic Number Theory and its Applications	3-0-3
MA 734	Information Geometry-I	3-0-3
MA 741	Advanced Statistical Techniques	3-0-3
MA787	Particulate Flows	3-0-3

Detailed Course Contents

MA 688 Applied Linear Algebra

Linear Algebra is a central and widely applicable part of Mathematics. It is estimated that many (if not most) computers in the world are computing with matrix algorithms at any moment in time whether these be embedded in visualization software in a computer game or calculating prices for some financial option. This course builds on elementary linear algebra and in it we derive, describe and analyze a number of widely used constructive methods (algorithms) for various problems involving matrices.

Reference Book:

1. Applied Linear Algebra, Peter J. Olver, Chehrzad Shakiban, Prentice-Hall, 2006.

MA 670 Approximation Theory

Normed Spaces, Approximation by Algebraic Polynomials ,Exercises on Approximation by Polynomials, Approximation by Trigonometric Polynomials, Exercises on Trigonometric Polynomials, Characterization of Best Approximation, Exercises on Chebyshev Polynomials, Simple Application of Chebyshev Polynomials, Lagrange Interpolation, Orthogonal Polynomials, Gaussian Quadrature

Reference Book:

1. Approximation Theory and Methods, M.J.J.D. Powell, 1982

MA-742 Optimization Techniques

Dynamics programming and variational calculus. Control systems optimization, Deterministic discrete-time control systems, Deterministic continuous-time optimal control, Stochastic control systems, Infinite Horizon Problems, constrained and unconstrained optimization control problems, convex optimization, Geometric problems, distance between sets, Algorithms for convex optimization (Gradient descent method, Steepest descent method).

Reference Books:

1. S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004 (has electronic version from the author's website)
2. D. Bertsekas, Dynamic Programming and Optimal Control I, third ed., Athena Scienti_c, 2005

MA-746 Tools for Mathematical Modeling and Simulation

This course will focus on model development, simulation & implementation of models, and visualization of results using MATLAB tools. After the completion of this course students should be able to build mathematical models of physical systems from the first principles and to use software tools.

Different types of mathematical models-deterministic, stochastic, static, dynamic and transient models etc. Some examples of mathematical models from environmental, biological sciences and technological domains. Modeling process, identification of involved processes and sub-processes, mathematical formulations of individual (sub) processes, Solution Algorithm development-Linear, nonlinear Algebraic equations, Computer implementation of the model-Using Symbolic computation. Use of computer model for analysis, control and design of the system, Evaluation of what-if scenarios with varied data, Numerical Simulation-Introduction, structure of Continuous and Discrete Simulation models, Special purpose simulation languages. Application of simulation models. Case Studies for different domains. Use of Commercial software for simulating results.

Reference Books:

1. Kai Veltn, Mathematical Modeling and Simulation, Introduction for Scientists and Engineers, Wiley 2009.
2. MATLAB user's manual by Mathworks Inc.

3. Simulink user's manual by Mathworks Inc.

MA-775 Numerical Solutions of Differential Equations

The General Linear Multistep Methods, Convergence; Order and Error Constant, Local and Global Truncation Error, Consistency and Numerical Stability, Attainable order of Stable Methods. Problems in Applying Linear Multistep Methods, General Methods for Finding Intervals of Absolute and Relative Stability, Predictor-Corrector Methods, Order and Convergence of the General Explicit One-Step Method, Derivation of Classical Runge-Kutta Methods, Runge-Kutta Methods of order Greater Than Four, Error Estimates and Error Bounds for Runge Kutta Methods;, Comparison with P Predictor-Corrector Methods, Implicit Runge-Kutta Methods. Finite difference formulas and discretization methods, Multi-level schemes, Convergence, stability and consistency, The local truncation error.

Reference Books:

1. Greenspan, Numerical solutions of ODE's for classical Relativistic and Nano systems, 2006.
2. C. E. Froberg, Numerical mathematics, The Benjamin Cummings Pub. Com. Inc., 1985.
3. M. K. Jain, Numerical Solution of Differential Equations, Wiley Eastern Ltd.
4. W. E. Milne, Numerical Solution of Differential Equations, Dover Pub. Inc., N.Y.
5. LeVeque, Randall J. Finite Difference methods for Ordinary and Partial Differential Equations. Philadelphia, PA: Society for Industrial and Applied Mathematics, 2007.

MA-645 Advanced Numerical Techniques

Approximation of derivatives through Taylor series, truncation error, order of convergence, Parabolic Partial Differential Equations, Explicit methods, Implicit methods, Numerical solutions of elliptic, parabolic and hyperbolic PDEs, Numerical Solution to System of linear and nonlinear equations, Condition number and spectral properties of a matrix, Newton and fixed point methods, applications in MATLAB.

Reference Books:

1. Applied Numerical Methods with software, S. Nakamura, Prentice-Hall 1991
2. Computational Fluid Dynamics by Klaus A. Hoffmann EES, 2000
3. Numerical Analysis by R. L. Burden 5th Edition 2000

MA-744 Deterministic Operations Research

Prerequisite: Multivariable calculus and linear algebra

Linear, integer, nonlinear and dynamic programming, classical optimization problems, network theory. CGU

Reference Books:

1. B. E. Gillett, Introduction to Operations Research, (Tata McGraw Hill Publishing Company Ltd., New Delhi).
2. F. S. Hillier and G. J. Lieberman, Operations Research, (CBS Publishers and Distributors, New Delhi, 1974).
3. C. M. Harvey, Operations Research, (North Holland, New Delhi, 1979).

MA-773 Perturbation Methods

Difference equations, Dimensional analysis, Expansions, Approximate solutions of linear differential equations, order symbols, Asymptotic series, Quadratic and cubic algebraic equations and its solutions by perturbation method, Regular perturbation, Singular perturbation, Boundary layer, The method of matched asymptotic expansion, equations with large parameter, , Solution of partial differential equations by perturbation methods, Asymptotic expansion of integrals Laplace's method, Watson's Lemma, Riemann-Lebesgue lemma.

Reference Books:

1. A.Nayfeh, Perturbation methods.
2. I.Stakgold, Boundary Value Problems of Mathematical Physics.
3. B.Noble, Methods based on the Wiener-Hopf technique for the solution of Partial Differential Equations.

MA-788 Advanced Computational Methods

Numerical Solution to System of linear equations, Finite Difference method , Taylor series, finite difference equations, Finite difference approximations of derivatives and mixed partial derivatives, Parabolic Partial Differential Equations, Explicit methods, Implicit methods , Elliptic Partial Differential Equations, The Jacobi Iteration Method, The Point Gauss-Seidel Iteration Method, The Line Gauss-Seidel Iteration Method, Point Successive Over-Relaxation Method (PSOR), Line Successive Over-Relaxation Method (LSOR) , The Alternating Direction Implicit Method (ADI), Hyperbolic Partial Differential Equations, Lax method, Mid-point Leap frog, Lax-Wendroff methods, MacCormack method, upwind schemes, modified R-K methods, TVD schemes, Uniform Grid, Staggered Grid (Marker and Cell method), Numerical Algorithms (Applications), Multi-Grid Methods.

Reference Books:

Applied Numerical Methods with software, S. Nakamura, Prentice-Hall 1991

1. Computational Fluid Dynamics by Klaus A. Hoffmann EES, 2000
2. Numerical Analysis by R. L. Burden 5th Edition 2000

PH 500 Basics of Physics

Measurements and units, Basic Quantities, International system of units, British system of units and their inter-conversion, force and motion, friction and drag force, viscosity, newton's law of motion, newton's law of universal gravitation, conservation laws, thermal properties, Newton's law of cooling, electric and magnetic properties, charge, current, capacitor, resistor, inductor, Ohm's law, Coulomb's law, Faraday's laws, Elastic Properties; Stress, Strain, Hooks law, Torsion

Reference Book:

1. Fundamentals of Physics, Extended Edition, David Halliday, Robert Resnick, Jearl Walker

MA 502 Numerical Methods

This course is an advanced introduction to applications and theory of numerical methods for solution of differential equations, especially of physically-arising partial differential equations, with emphasis on the fundamental ideas underlying various methods. Topics include finite differences, spectral methods, well-posedness and stability, boundary and nonlinear instabilities. The course assumes familiarity with basic (numerical) linear algebra and will involve a certain amount of programming in MATLAB or any programming language of your choice.

Reference Books:

1. R. L. Burden, J. D. Fairs; An Introduction to Numerical Analysis, 1993.
2. G. D. Smith, Numerical Solutions of P.D.Es, 1999.
3. J. H. Wilkinson, The Algebraic Eigenvalue Problems, 1965.
4. U. Asher et al., Numerical solution of Boundary Value Problems in ODE's, 1986.
5. Numerical Mathematics, Matheus Grasselli, Dmitry Pelmvovsky, Jonez Batlett, 2009

MA 644 Advanced Engineering Mathematics

Pre requisite: Undergraduate Engineering Mathematics Applied calculus, application of numerical linear algebra, vector calculus, Ordinary and Partial Differential Equations; solution techniques with exact and

approximate methods. Coupled equations. Difference equations. Integro-differential equations and solution techniques. Integral equations (Volterra and Fredholm type). Exact solutions for infinite and semi-infinite systems, Optimization of multivariable calculus, quadratures, Laplace and Fourier transformations.

Reference Books:

1. Advanced Engineering Mathematics, Kreyzick
2. Introduction to optimization, FEM Principles and Applications, P.E. Lewis, J.P. Ward

MA 646 Introduction to Modeling and Simulation

This course surveys the basic concepts of computer modeling in science and engineering using discrete particle systems and continuum fields. It covers techniques and software for continuum methods to study fundamental physical phenomena encountered in the fields of computational physics, chemistry, mechanics, materials science, biology, and applied mathematics. Applications are drawn from a range of disciplines to build a broad-based understanding of complex structures and interactions in problems where simulation is on equal footing with theory and experiment.

Reference Book:

1. Simulation Fundamentals, B.S. Bunnett.

MA 650 FEM for Partial Differential Equations

A presentation of the fundamentals of modern numerical techniques for a wide range of linear and nonlinear elliptic, parabolic and hyperbolic partial differential equations and integral equations central to a wide variety of applications in science, engineering, and other fields. Topics include: Mathematical Formulations; Finite Difference and Finite Volume Discretizations; Finite Element Discretizations; Boundary Element Discretizations; Direct and Iterative Solution Methods.

Reference Books:

1. The Finite Element Method, P.E. Lewis & J.P. Ward

MA 700 Computational Fluid Dynamics

Pre-requisite: Undergraduate course on Fluid Mechanics/Dynamics Numerical solution of 1D, 2D and 3D Transport equations, Euler's equations, Burger's equations, Incompressible Navier-Stokes equations, compressible Navier-Stokes equations, advanced numerical techniques, multi-grid methods, and spectral methods.

Reference Book:

1. Computational Fluid Dynamics, K.A. Hoffmann, S.T Chang EES, USA

MA 770 Modeling and Simulation of Dynamical Systems

This course is about modeling multi-domain engineering systems at a level of detail suitable for design and control system implementation. It also describes Network representation, state-space models, Multiport energy storage and

dissipation, Legendre transforms Nonlinear mechanics, transformation theory, Lagrangian and Hamiltonian forms, and Control- relevant properties. The application examples may include electro- mechanical transducers, mechanisms, electronics, fluid and thermal systems, compressible flow, chemical processes, diffusion, and wave transmission.

Reference Book:

1. Modeling and Simulations of Dynamical Systems, Robert L Dutoods, Kent L. Lawrence

MA 662 Linear Partial Differential Equations

This course covers the classical partial differential equations of applied mathematics: diffusion, Laplace/Poisson, and wave equations. It also includes methods and tools for solving these PDEs, such as separation of variables, Fourier series and transforms, eigenvalue problems, and Green's functions.

Reference Book:

1. Linear Partial Differential Equations for Scientists and Engineers, Myint-U, Tyn, and Lokenath Debnath, 4th Edition, 2006.

MA 684 Mathematical Methods

Modeling and conservation laws, Scaling and non-dimensionalisation, Simple boundary layer theory, Nonlinear oscillations, Multiple scale methods, Ordinary differential equations: hysteresis and stability, SturmLiouville systems, Integral equations and eigenfunctions, Partial differential equations: shocks, similarity solutions, Calculus of Variations; optimal control.

Reference Books:

1. Strang, Gillbert,; ‘ Computational Science and Engineering’, Welleslet-Cambridge Press, 2007.
2. D. L. Powers, Boundary Value Problems and Partial Differential Equations, Academic Press, 2005.
3. W. E. Boyce, Elementary Differential Equations, John Wiley and Sons, 2005.
4. M. L. Krasnov, G. I. Makarenko and A. I. Kiselev, Problems and Exercises in the Calculus of Variations, Imported Publications, Inc., 1985.
5. A. D. Snider, Partial Differential Equations: Sources and Solutions, Prentice Hall Inc., 1999.

MA 680 Applied Partial Differential Equations

Systems of partial differential equations, characteristics, Weak solutions, Riemann's function, Maximum principles, comparison methods, well- posed problems, and Green's functions for the heat equation and for Laplace's equation, Fredholm alternative and Green's functions for non-self-adjoint problems, application of delta functions, Further development of hyperbolic equations, Cauchy-Kovalevskaya theorem, Riemann invariants, shocks and weak solutions, causality.

Reference Book:

1. Introduction to Partial Differential Equations, Habermann.

MA 780 Solid Mechanics

Lagrangian and Eulerian descriptions of motion, analysis of strain, Balance laws of continuum mechanics, Frame-indifference, Constitutive equations for a nonlinear elastic material. Linear elasticity as a linearization of nonlinear elasticity. Incompressibility and models of rubber. Exact solutions for incompressible materials, phase transformations, shape-memory effect.

Reference Book:

1. An Introduction to the theory of Elasticity, R. J. Atkin, N. Fox, 1980.

MA 686 Stochastic Differential Equations

Strong solutions, questions of existence and uniqueness, diffusion processes, Cameron Martin formula, weak solution and martingale problem. Some selected applications chosen from topics including option pricing and stochastic filtering.

Reference Book:

1. Stochastic Differential Equations, An introduction with Applications, B. Oksendal, 6th Edition.

MA 782 Topics in Fluid Mechanics

Convection, stability, boundary layers, parameterized convection, Rotating flows, atmosphere and oceans, Waves, geostrophy, boilers, condensers, fluidised beds. Flow régimes. Homogeneous, drift-flux, two-fluid models. Ill-posedness, waves, density wave oscillations. Coatings and foams. Gravity flows, Droplet dynamics, contact lines, Drying and wetting, Foam drainage.

Reference Books:

1. Frank M. White, Viscous Fluid Flow, Second Edition, McGRAW-HILL, Inc.
2. G.K. Batchelor, An introduction to fluid dynamics, Cambridge University Press.

MA 784 Mathematical Methods for Signal Processing

Introduction to signal processing, Signal formation and sampling in MRI and FMRI, Representation of a signal in the frequency domain (Fourier methods), Compression (wavelets), Filter operations for attenuation of a signal, Extracting information from a signal without a model (PCA, ICA), De-noising, Applications in speech and biomedical signal processing, Applications in learning how the brain functions (FMRI).

Reference Book:

1. Mathematical Methods and Algorithms for Signal Processing, Todd K. Moon, Wyn C. Stirling, Prentice Hall, 2008.

MA 772 Mathematics for Geosciences

The course starts with some background to the geology, geophysics and engineering involved in the recovery of oil from deep inside the Earth. Flow through porous media - balance laws, Darcy's law, analytical and numerical methods, Grid generation and geometric modeling - surface modeling, structured and unstructured grids, stochastic sampling, groundwater modeling, the study of subsurface pollution and remediation, and even to problems outside the geosciences.

Reference Books:

1. The Theory of Critical Phenomena, J. J. Binney, N. J. Dowrick, A. J. Fisher and M. E. J. Newman, 1992.
2. Fundamentals of Numerical Reservoir Simulation, D. W. Peaceman, 1977.

MA 786 Waves and Compressible Flow

Equations of inviscid compressible flow including flow relative to rotating axes, Models for linear wave propagation including Stokes' waves, Inertial waves, Rossby waves and simple solutions, Theories for Linear waves: Fourier Series, Fourier integrals, method of stationary phase, dispersion and group velocity. Flow past thin wings, simple wave flows applied to one-dimensional unsteady gas flow and shallow water theory, Shock Waves: weak solutions, Rankine Hugoniot relations, oblique shocks, bores and hydraulic jumps.

Reference Book:

1. Waves and Compressible Flow, H. Ockendon, J. R. Ockenden, 2004.

MA 741 Advanced Statistical Techniques

This is an advanced course in statistical analysis which highlights the significance of planning, collection, analysis and interpretation of complex data. Students are taught to devise research problems and hypothesis and prepare the necessary tests to avoid Type I or Type II errors. The course also utilizes extensive use of univariate, bivariate and discriminant analysis. The last few units stress on deriving useful information from the tests in order to help students make smart decisions.

Reference Books:

1. Introduction to the theory of statistics, Mood A. M., Graybill F. A. Boes D. C. 1998.

2. Introduction to statistical inference, Kiefer, Jack C.
3. Statistical Inference, George Casella, Roger L. Berger

MA 501 Quantitative Analysis and Techniques

It covers a vast variety of mathematical concepts including linear equations and functions, quadratic and polynomial functions, exponential and logarithmic functions, matrix algebra, set theory, permutations and combinations, probability, random variables, frequency distribution time series, measures of central tendency, measures of dispersion, estimation, forecasting and index numbers.

Reference Books:

1. Frank S. Budnick, Applied Mathematics for Business, Economics and Social sciences, McGraw Hill, New York, 4th edition, (1993).
2. Levin Rubin, Statistics for Management, Printice Hall International, 7th edition(1998)

MA-623 Symmetry Methods for Differential Equations

Introduction to symmetry methods, Symmetry methods for ODEs and PDEs manually and by using computer packages, Invariants, canonical variables using the symmetries of differential equations, solution of ODEs and PDEs using classical methods, Linearization of the ODE and system of ODEs using point symmetries, Computation of the first integrals for ODEs and conservation laws for PDEs using suitable methods, Exact solutions of ODEs and PDEs via first integrals and conservation laws.

Reference Books:

1. CRC handbook of Lie group analysis of differential equations, Volume 1: Symmetries, exact solutions and conservation laws by Nail H. Ibragimov (CRC Press)
2. Applications of Lie groups to differential equations by Peter J Olver (Springer - Verlag)
3. Differential equations: Their solution using symmetries by Hans Stephani (Cambridge University Press)

MA-622 Geometric Function Theory

Brief review of complex functions and complex integrations, class of analytic functions, Riemann Mapping Theorem, class of univalent functions, class of convex univalent and starlike univalent functions, close-to-convex functions, Coefficient bounds, growth and distortion results of functions contained in subclasses of the class of univalent functions, class of Caratheodary functions with positive real part and related classes, functions with bounded radius rotation, functions with bounded boundary rotation, differential subordination, Hadamard product (or convolution), some linear differential and integral operators.

Reference Books:

1. L. V. Ahlfors, Conformal Invariants. Topics in Geometric Function Theory, McGraw–Hill, New York, 1973.
2. J. H. Shapiro, Composition Operators and Classical Function Theory, Springer-Verlag, Berlin, Heidelberg, New York, 1993.
3. Goodman, A.W., Univalent functions, Vol. I & II, polygonal publishing house, Washington, New Jersey (1983).
4. Duren, P. L., Univalent functions, Grundlehren der Math. Wissenschaften, Springer-Verlag, NewYork-Berlin (1983).

MA-624 Hilbert Space Methods

Vector spaces, Normed Spaces, Inner Product spaces, Completeness, Hilbert Spaces, Linear and bounded operators, Orthoprojections, Isometric and unitary operators, Continuous functions of self-adjoint operators, Coercivity, Elliptic forms, Regularity, closed operators, adjoint and eigenfunction expansions, Spectral Integrals, Differential Operators in $L^2(a, b)$.

Reference Books:

1. Karl E. Gustafson, Introduction to Partial Differential Equations and Hibbert Space Methods 1997.
2. R. A. Kennedy, P. Sadeghi, Hilbert Space Methods in Signal Processing, 2013.

MA-625 Variational Inequality & Convex Analysis

Basic concepts, Existence and uniqueness results. Fixed-points formulation, Wiener-Hopf equations, Equivalence between variational inequalities and Wiener-Hopf equations, Iterative methods, Auxiliary principle techniques, Dynamical systems, Sensitivity analysis, convergence analysis, numerical solutions of obstacle problems, variational inclusions, resolvent equations, applications . Convex sets, convex hull, their properties, separation theorems, hyperplane, Best approximation theorem and its applications, Farkas and Gordan Theorems, Extreme points and Polyhedral. Convex functions, Basic Definitions, properties, various generalizations, differentiable convex functions, subgradient, characterization and applications in linear and nonlinear optimization, complementarity problems and its equivalent formulations.

Reference Books:

1. D. Kinderlehrer and G. Stampacchia, An introduction to Variational Inequalities and their Applications, SIAM Publishing Co., Philadelphia, PA, 2000.
2. M.Asam Noor, Some Developments in general variational inequalities, Applied Mathematics and Computation, Vol. 152, 2004, pages 199-277.

MA-627 Commutative Algebra

Basics of ring theory, Field extensions, algebraic extensions, Galois extensions, Algebraic sets, Algebraic varieties, Zarisky Topology, Nullstellensatz, Primary submodules and ideals, primary decompositions, associated primes, support of a module, integral elements, integral closures, Normalization, localization rings and modules, Extension theorems, valuation rings, Discrete Valuation Rings (D.V.R.), Graded rings and modules, completion of a module, The Krull intersection theorem, Regular local rings.

Reference Books:

1. M.F. Atiyah, I.G. Macdonald; Introduction to commutative algebra, Addison-Wesley Publishing Co. (1969).
2. D. Eisenbud; Commutative Algebra with a view toward Algebraic Geometry, Springer-Verlag GTM 150 (1995).
3. Pierre Antoine Grillet, Abstract Algebra, GTM 242 second edition, Springer-Verlag (2007).

MA-525 Advanced Ring Theory

Rings, Ideals, homomorphisms, first isomorphism theorem, second isomorphism theorem, third isomorphism theorem, quotient rings, rings of polynomials and formal power series, maximal and prime ideals, principle ideal domain, unique factorization domain, modules, direct sums and products, module homomorphisms, factor modules, free modules, projective and injective modules, Noetherian and Artinian rings and modules.

Reference Books:

1. Thomas W. Hungerford, Algebra, GTM 73, Springer-Verlag (1974)
2. Pierre Antoine Grillet, Abstract Algebra, GTM 242 second edition, Springer-Verlag (2007).

MA-724 Homological Algebra

Algebras over a ring, Categories, Functors, duality, products and coproducts, pullbacks, pushouts, adjoint functor, abelian category, projective objects, injective objects, free objects, Functors Ext and Tor, derived functors, complexes, long-exact sequences, Functors Ext_A^n and Tor_n^A , Cohomology of groups.

Reference Books:

1. P. J. Hilton, U. Stambach, A course in Homological Algebra, Springer-Verlag GTM 4 (1971).
2. Pierre Antoine Grillet, Abstract Algebra, GTM 242 second edition, Springer-Verlag (2007).

MA-787 Particulate Flows

Direct Numerical Simulations of Particulate Flow. The Arbitrary Lagrange-Euler (ALE) Methods. The Fictitious Domain Methods. Fictitious Domain Methods with Volume distributed Lagrange Multipliers for Dirichlet Problems. Incompressible Viscous Flow with Moving Rigid Boundary. Treatment of Collisions. Numerical

Simulation of the Motion of a Single Ball Falling in an Incompressible Viscous Fluid. Numerical Simulation of the Motion and Interaction of Two Circular Disks Sedimenting in a Single Ball Falling in an Incompressible Viscous Fluid. Direct Numerical Simulation of Incompressible Viscous Flow Around Moving Airfoils. Rayleigh-Taylor Instability for Particulate Flow.

Reference Books:

1. A. Prosperetti and G. Tryggvason, Computational Methods for Multiphase Flow, Cambridge University Press, 2009
2. R. Glowinski, Handbook of Numerical Analysis-Numerical Methods for Fluids (Part 3), Elsevier, 2003

MA-737 Algebraic Geometry-I

Course introduction (varieties, morphisms, rational maps), Hilbert's Nullstellensatz, Blowups, Presheaves, Sheaves, Schemes, Properties of Schemes, Separated and Proper morphisms, Sheaves of modules, Divisors, Projective Morphisms, Differentials, Cohomology of sheaves, Cohomology of Projective spaces, The Serre-Duality Theorem, Algebraic Curves, Riemann-Roch Theorem, Hurwitz's Theorem, Elliptic Curves, Classification of curves in P^3 .

Reference Books:

1. Robin Hartshorne, Algebraic Geometry, GTM 52, Springer-Verlag (1977).
2. I. R. Shafarevich, Algebraic Geometry I-IV, Springer-Verlag.

MA-524 Advanced Group Theory

Group operations, orbit and stabilizer, p-groups, Sylow groups, Sylow's Theorem, solvable groups, nilpotent groups, Free groups, Action on a group, group presentations, isomorphism theorems, Jorder-Hölder Theorem, Cohomology groups.

Reference Books:

1. Abstract Algebra by D. S. Dummit and R. M. Foote, 2nd Edition, John Wiley & Sons, Inc.
2. A First Course In Abstract Algebra by J. B. Fraleigh, 7th Edition, Pearson Education

MA-734 Information Geometry-I

Information geometry, Statistical manifolds (Ammari &Murray), Submanifolds, Tangent space of statistical manifolds, Exponential families, Distance on statistical manifolds, Dual connections, Dualistic structure of Exponential Family, Symplectic geometry, Matrix manifolds, Matrix manifold second order geometry, Riemannian Newton method, Extended Hamilton algorithm, Riemannian gradient algorithm.

Reference Books:

1. Shun-ichi Amari,"Methods of information Geometry" AMS Oxford University Press.
2. P. A. Absil, Robert Mahony," Optimization algorithms on matrix manifolds" Princeton university press and Princeton and oxford.
3. Manfredo Perdigao do Carmo, Riemannian Geometry, Birkhauser Publisher 1992.
4. John M. Lee, Riemannian Manifold: An Introduction to Curvature, Springer-Verlag, 1997.

MA-634 Riemannian Geometry

Differentiable Manifold, Smooth mappings, Partition of unity, Tangent space, smooth vector field, smooth tensor field, stokes theorem, vector bundles, Riemannian metric, Examples of Riemannian metric, Affine connection, Riemannian connection, Geodesic, Exponential mapping, Geodesic convex neighborhood, Hopf Rinow Theorem, Curvature tensor, Sectional curvature, Ricci curvature, Ricci Identity, Jacobi fields, Cartan Hamadard Theorem, Cartan Ambrose Theorem, Bonnet Myers Theorem, Lie Groups.

Reference Books:

1. Manfredo Perdigao do Carmo, Riemannian Geometry, Birkhauser Publisher 1992.
2. John M. Lee, Riemannian Manifold: An Introduction to Curvature, Springer-Verlag, 1997.

MA-765 Banach algebras and C*-algebras

A brief review of Hilbert space, Basic definitions of linear operators, mostly on Hilbert space, Compact operators on Hilbert Spaces, Definition of a Banach algebra, Spectrum, spectral radius, holomorphic functional calculus, The weak and weak* topologies, Alaoglu's Theorem, Krein-Milman Theorem, Maximal ideal space of a commutative Banach algebra, Gelfand transform, Definition of a C*-algebra, Foundations of the general theory of C*-algebras: continuous functional calculus, positive elements, ideals, quotients, approximate identities, States and representations: GNS construction. Existence of irreducible representations.

Reference Books:

1. Rudin W, Functional Analysis, 1973, McGraw Hill, New York.
2. Dover Kreyszig E, Introductory Functional Analysis with Applications, John Wiley, New York.

MA-636 Advanced Algebraic Topology

Homotopy, Cell complexes, operations on spaces, The Fundamental Group, Fundamental group of the circle, Induced homomorphisms, Van Kampen's Theorem, covering spaces, lifting properties, Simplicial and Singular Homology groups, Mayer-Vietoris Sequences, Cohomology groups, The Universal Coefficient Theorem, A Künneth Formula, Poincare Duality, The Duality Theorem.

Reference Books:

1. Hatcher A, Algebraic Topology, 2002, Cambridge University Press.
2. Dover Kreyszig E, Introductory Functional Analysis with Applications, John Wiley, New York.

MA 564 Advanced Functional Analysis

Banach algebra, Ideal, homomorphism, quotient algebra, Wiener's lemma Gelfand's theory of commutative Banach algebras, the notions of Gelfand's topology, radicals Gelfand's transforms, basic properties of spectra, Gelfand-Mazur theorem, symbolic calculus, differentiation, analytic functions, integration of A-Valued functions, normed rings, Gelfand-Naimark theorem, involutive algebras, normed involutive algebra, C*-algebras, positive functions, a characterization of C*-algebras, applications of C*-algebras to differential operators.

Reference Books:

1. Introductory Functional Analysis with Applications, by E. Kreyszig (1978).
2. Functional Analysis: Applications in Mechanics and Inverse Problems, by L.P. Lebedev, I.I. Vorovich and G.M.L. Gladwell (1996).
3. Applied Functional Analysis, Applications to Mathematical Physics, by E. Zeidler (1995).

MA 626 Algebraic number theory and its Applications

This course is a first course in algebraic number theory. Topics to be covered include number fields, class numbers, Dirichlet's units theorem, cyclotomic fields, local fields, valuations, decomposition and inertia groups, ramification, basic analytic methods, and basic class field theory. An additional theme running throughout the course will be the use of computer algebra to investigate number-theoretic questions; this theme will appear primarily in the problem sets.

Reference Books:

1. Serge Lang, Algebraic Number Theory, GTM Springer-Verlag (1994).
2. Robert B. Ash, A course on Algebraic Number Theory, Dover Publications (2010).

Proposed research Areas

After the successful completion of coursework the following specializations can be pursued in the research.

- **Computational Mathematics**
- **Fluid Mechanics**
- **Geometric Function Theory**
- **Information Geometry**
- **Algebraic Geometry**
- **Algebra**
- **Computational Fluid Dynamics**

PhD in Mathematics

Introduction

The PhD program is for the students interested in pursuing advanced research in Applied and pure mathematics. This is a continuation of the MS program offered by the department of Mathematics. This program provides the students with a wide background in mathematics through research oriented courses.

Aim

The main aim of the doctoral program in mathematics is to prepare qualified graduate students to become productive workers in industry, government and academic research scholars capable of implementing Mathematics in industries, to students and to the mathematical community. The program is planned to develop a fundamental understanding of certain fields of mathematics, deep understanding of a major field of interest, the ability to formulate and recognize significant research problems, and the ability to analyze problems, reach solutions, and transmit ideas to others.

Title of the program

Doctor of Philosophy in Mathematics

Program Length

Ph. D. in Mathematics is a 48 credit hour program beyond Master's Degree. Students are required to complete a minimum of six courses of 6xx/7xx/8xx level, equivalent to 18 credit hours of course work in the student's chosen area of specialization. These courses can be selected from the list of post graduate (PG) courses. The student is allowed to take at most two courses from any other department if needed. Students are required to have at least one course with 8xx course code and at most three courses with 6xx code.

Eligibility criteria

4. 18 years education in mathematics or related discipline, Minimum CGPA 3.0/4.0 or 75% marks.
5. For award of PhD degree HEC requires GRE Mathematics test that must be taken before admission to PhD program.

6. Candidates will have to appear in the interview for final selection.
- 7.

Qualifying Examination

A PhD student shall be required to pass Comprehensive Examination and Subject Examination.

8. **Comprehensive Examination (CE)** is based on PhD/MS level courses approved in the plan of study of the student. The mode of examination is comprehensive written test and grading is pass or fail. The paper for the CE will be prepared and checked by the concerned department.
9. **Subject Examination (SE):** After passing CE, the students appear in SE which is meant to assess the approach of tackling research problems. The mode of examination is presentation of proposed research before the committee appointed by HOD comprising three examiners including the supervisor. The supervisor will be the chair of that committee.

Assessment

The award of PhD degree will be assessed on the following basis:

- Maintaining a CGPA of at least 3.0/4.0 in the course work as per university policy.
- Passing of the Comprehensive exam.
- **A PhD candidate must have to publish at least one research paper from his/her PhD thesis/dissertation in HEC recognized “X” & “W” category journals only. (Applicable to PhD Scholars enrolled in PhD program after 10 January, 2010).**
- Two positive reports about the student’s research work from international referees in the relevant field.
- Successful open defense of the Ph. D. thesis.

Date of commencement

Fall 2015

Detailed Course Contents

MA-742 Optimization Techniques
Optimization by equality constraints, Direct substitution method and Lagrange multiplier method, necessary and sufficient conditions for an equality constrained optimum with bounded independent variables. Inequality constraints and Lagrange multipliers. Kuhn-Tucker Theorem. Multidimensional optimization by Gradient method. Convex and concave programming. Calculus of variation and Euler Lagrange equations. Functionals depending on several independent variables. Variational problems in parametric form. Generalized mathematical formulation of dynamics programming. Non-linear continuous models. Dynamics programming and variational calculus. Control theory.
Reference Books:

1. S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004 (has electronic version from the author's website)
2. D. Bertsekas, Nonlinear Programming, Athena Scientific, 1999

MA-746 Tools for Mathematical Modeling and Simulation

This course will focus on model development, simulation & implementation of models, and visualization of results using MATLAB tools. After the completion of this course students should be able to build mathematical models of physical systems from the first principles and to use software tools.

Different types of mathematical models-deterministic, stochastic, static, dynamic and transient models etc. Some examples of mathematical models from environmental, biological sciences and technological domains. Modeling process, identification of involved processes and sub-processes, mathematical formulations of individual (sub) processes, Solution Algorithm development-Linear, nonlinear Algebraic equations, Computer implementation of the model-Using Symbolic computation. Use of computer model for analysis, control and design of the system, Evaluation of what-if scenarios with varied data, Numerical Simulation-Introduction, structure of Continuous and Discrete Simulation models, Special purpose simulation languages. Application of simulation models. Case Studies for different domains. Use of Commercial software for simulating results.

Reference Books:

1. Kai Veltn, Mathematical Modeling and Simulation, Introduction for Scientists and Engineers, Wiley 2009.
2. MATLAB user's manual by Mathworks Inc.
3. Simulink user's manual by Mathworks Inc.

MA-775 Numerical Solutions of Differential Equations

The General Linear Multistep Methods, Convergence; Order and Error Constant, Local and Global Truncation Error, Consistency and Numerical Stability, Attainable order of Stable Methods. Problems in Applying Linear Multistep Methods, General Methods for Finding Intervals of Absolute and Relative Stability, Predictor- Corrector Methods, Order and Convergence of the General Explicit One-Step Method, Derivation of Classical Runge-Kutta Methods, Runge-Kutta Methods of order Greater Than Four, Error Estimates and Error Bounds for Runge Kutta Methods;, Comparison with P Predictor-Corrector Methods, Implicit Runge-Kutta Methods. Finite difference formulas and discretization methods, Multi-level schemes, Convergence, stability and consistency, The local truncation error.

Reference Books:

1. Greenspan, Numerical solutions of ODE's for classical Relativistic and Nano systems, 2006.
2. C. E. Froberg, Numerical mathematics, The Benjamin Cummings Pub. Com. Inc., 1985.
3. M. K. Jain, Numerical Solution of Differential Equations, Wiley Eastern Ltd.
4. W. E. Milne, Numerical Solution of Differential Equations, Dover Pub. Inc., N.Y.1

5. LeVeque, Randall J. Finite Difference methods for Ordinary and Partial Differential Equations. Philadelphia, PA: Society for Industrial and Applied Mathematics, 2007.

MA-823 Modern Algebra and Applications

Introduction of Classical Algebra , Modern Algebra, Binary Operations, Algebraic Structures, Boolean Algebras, Groups, Quotient Groups, Symmetry Groups in Three Dimensions, Monoids and Machines, Monoids and Semigroups, Finite-State Machines, Quotient Monoids and the Monoid of a Machine, Latin Squares, Orthogonal Latin Squares, Finite Geometries, Magic Squares, Geometrical Constructions, Constructible Numbers, Duplicating a Cube, Trisecting an Angle, Squaring the Circle, Constructing Regular Polygons, Error-Correcting Codes.

Reference Book:

1. William J. Gilbert, Modern Algebra with Applications, John Wiley & Sons, Inc., publication, 2nd edition, 2000.

MA-645 Advanced Numerical Techniques

Approximation of derivatives through Taylor series, truncation error, order of convergence, Parabolic Partial Differential Equations, Explicit methods, Implicit methods , Numerical solutions of elliptic, parabolic and hyperbolic PDEs, Numerical Solution to System of linear and nonlinear equations, Condition number and spectral properties of a matrix, Newton and fixed point methods, applications in MATLAB.

Reference Books:

1. Applied Numerical Methods with software, S. Nakamura, Prentice-Hall 1991
2. Computational Fluid Dynamics by Klaus A. Hoffmann EES, 2000
3. Numerical Analysis by R. L. Burden 5th Edition 2000

MA-744 Deterministic Operations Research

Prerequisite: Multivariable calculus and linear algebra

Linear, integer, nonlinear and dynamic programming, classical optimization problems, network theory. CGU

Reference Books:

1. B. E. Gillett, Introduction to Operations Research, (Tata McGraw Hill Publishing Company Ltd., New Delhi).
2. F. S. Hillier and G. J. Lieberman, Operations Research, (CBS Publishers and Distributors, New Delhi, 1974).
3. C. M. Harvey, Operations Research, (North Holland, New Delhi, 1979).

MA-773 Perturbation Methods

Difference equations, Dimensional analysis, Expansions, Approximate solutions of linear differential equations, order symbols, Asymptotic series, Quadratic and cubic algebraic equations and its solutions by perturbation method, Regular perturbation, Singular perturbation, Boundary layer, The method of matched asymptotic expansion, equations with large parameter, , Solution of partial differential equations by perturbation methods,

Asymptotic expansion of integrals Laplace's method, Watson's Lemma, Riemann-Lebesgue lemma.

Reference Books:

1. A.Nayfeh, Perturbation methods.
2. I.Stakgold, Boundary Value Problems of Mathematical Physics.
3. B.Noble, Methods based on the Wiener-Hopf technique for the solution of Partial Differential Equations.

MA-788 Advanced Computational Methods

Numerical Solution to System of linear equations, Finite Difference method , Taylor series, finite difference equations, Finite difference approximations of derivatives and mixed partial derivatives, Parabolic Partial Differential Equations, Explicit methods, Implicit methods , Elliptic Partial Differential Equations, The Jacobi Iteration Method, The Point Gauss-Seidel Iteration Method, The Line Gauss-Seidel Iteration Method, Point Successive Over-Relaxation Method (PSOR), Line Successive Over-Relaxation Method (LSOR) , The Alternating Direction Implicit Method (ADI), Hyperbolic Partial Differential Equations, Lax method, Mid-point Leap frog, Lax-Wendroff methods, MacCormack method, upwind schemes, modified R-K methods, TVD schemes, Uniform Grid, Staggered Grid (Marker and Cell method), Numerical Algorithms (Applications), Multi-Grid Methods.

Reference Books:

1. Applied Numerical Methods with software, S. Nakamura, Prentice-Hall 1991
2. Computational Fluid Dynamics by Klaus A. Hoffmann EES, 2000
3. Numerical Analysis by R. L. Burden 5th Edition 2000

MA-807 Stochastic Operations Research.

Stochastic models of inventory, reliability, queuing, sequencing, and transportation. Applications of these models to problems arising in industry, government, and business.

Reference Books:

1. B. E. Gillett, Introduction to Operations Research, (Tata McGraw Hill Publishing Company Ltd., New Delhi).
2. F. S. Hillier and G. J. Lieberman, Operations Research, (CBS Publishers and Distributors, New Delhi, 1974).
3. C. M. Harvey, Operations Research, (North Holland, New Delhi, 1979).

MA-815 Magneto hydro dynamics

Equations of electrodynamics, Equations of Fluid Dynamics, Ohm's law equations of magneto hydro dynamics. Motion of a viscous electrically conducting fluid with linear current flow, steady state motion along a magnetic field, wave motion of an ideal fluid. Magneto-sonic waves. Alfvén's waves, damping and excitation of MHD waves, characteristics lines and surfaces. Kinds of simple waves, distortion of the profile of a simple

wave, discontinuities, simple and shock waves in relativistic magneto hydro dynamics, stability and structure of shock waves, discontinuities in various quantities, piston problem, oblique shock waves.

Reference Books:

1. P. A. Davidson, An introduction to Magnetohydrodynamics, Cambridge texts in Applied Mathematics, 2001.
2. J. P. Freidberg, Ideal Magnetohydrodynamics, 1987.
3. J. P. Goedbloed and S. Poedts, Principles of Magnetohydrodynamics, 2004.

MA-817 Monte Carlo & Quasi-Monte Carlo Methods

Prerequisites: A graduate course in probability theory, a basic course in numerical methods, and facility in programming a computer using a language such as FORTRAN, C++.

This is an advanced course in which stochastically- motivated mathematical methods are applied to problems of various kinds (e.g. radiation transport, semiconductor, geological and financial modeling, or statistical mechanics) that can be solved by simulations carried out on a computer. Problems studied in this way include the most naturally formulated as integral equations over relatively high dimensional phase spaces, as well as those in which estimates of integrals of functions of a large number of variables are sought. This should be regarded as an advanced course in the applications of probability theory to numerical analysis.

Reference Books:

1. Ross, S. M. Simulation, Fifth Edition. Academic Press, 2012.
2. Rubinstein, R. and D. P. Kroese. Simulation and the Monte Carlo Method. Wiley, 2007

MA-843 Nonlinear Optimization

Prerequisites: linear algebra, multivariate calculus, and (preferably) experience in programming in Mat lab.

This course will survey widely used methods for continuous optimization, focusing on both theoretical foundations and implementation as numerical software. Topics include linear programming (optimization of a linear function subject to linear constraints), line search and trust region methods for unconstrained optimization, and a selection of approaches (including active-set, sequential quadratic programming, and interior methods) for constrained optimization.

Reference Books:

1. S. Boyd and L. Vandenberghe, Convex Optimization, Cambridge University Press, 2004 (has electronic version from the author's website)
2. D. Bertsekas, Nonlinear Programming, Athena Scienti_c, 1999
3. J. Nocedal and S.J. Wright, Numerical Optimization, Springer, 2006
4. Nesterov, Introductory Lectures on Convex Optimization: A Basic Course, Kluwer, 2003

MA-854 Mathematical and Numerical aspects of CFD codes

This graduate level course will focus on finite element and finite volume based CFD codes. The topics to be addressed include convection dominated transport problems with standard finite element approximations, analysis of accuracy and stability issues, Lax-Wendroff and Taylor-Galerkin methods for unsteady convective transport, streamline diffusion, edge-

oriented stabilization, jump-stabilization, Non-linear high resolution schemes base on flux correction. Practical implementations using softwares ANSYS and Featflow. The students are expected to solve a number of one and two dimensional

Reference Book:

1. S. Turek, Efficient Solvers for incompressible Flow problems, Springer 1999.
2. D. Kuzman, A guide to Numerical Methods for transport Equation, Friedrich-Alexander-Universitat Erlangen-Nuremberg, 2010.
3. R. Glowinski, Numerical Methods for Fluids, 2003.

MA-818 Advance Integral Equations

Transforms covered will include: Fourier, Laplace, Hilbert, Hankel, Mellin, Radon, and Z. The course will be relevant to mathematicians and engineers working in communications, signal and image processing, continuous and digital filters, wave propagation in fluids and solids, etc.

Problems using the techniques covered in this course.

Reference Books:

1. Lovitt, W.V., Linear integral equations, Dover Publications 1950.
2. Smith, F., Integral equations, Cambridge University Press.
3. Tricomi, F.G., Integral equations, Interscience, 1957.

MA- 857 Numerical Simulations of Turbulent and Multiphase flows

This graduate level course is concerned with numerical simulation of turbulence in single-phase flows and multiphase/multicomponent systems. The underlying mathematical models are derived from the fundamental equations of fluid mechanics using suitable averaging procedure. The topics include a self-contained introduction to Reynolds Averaged Navier-Stokes Equations (RANS) models, Large Eddy Simulations (LES),

Reference Books:

1. C. D. Wilcox, Turbulence Modeling for CFD. DWC Industries, 1998.
2. B.Mohammadi and O. Pironneau, Analysis of the k-epsilon turbulence model. John Wiley & Sons, 1994.
3. D.A. Drew and S. L. Passman, Theory of Multicomponent Fluids, Springer,1998.

MA- 824 Differential Subordination Theory and applications

Subordination, Hypergeometric functions, Integral operators, second order differential subordination and applications, first order linear differential subordination and applications, special differential subordinations, higher order differential subordinations, applications of differential subordination in other fields.

Reference Book:

1. Miller, S. S. & Mocanu, P. T., Differential Subordination Theory and Applications. Marcel Dekker Inc., New York, Basel (2000).

MA- 825 Convolution in Geometric Function Theory and Applications

Introduction of convolution product. Basic and algebraic properties of Hadamard Product, Hadamard Product and Some Linear differential and integral operators, convolution on

some subclasses of the class of univalent functions, convolution on functions with bounded boundary, bounded radius and bounded Mocanu variations, some problems on convolution and at some of the relations between the convolution and the subordination, Applications of convolution in geometric function theory and other related fields.

Reference Book:

1. Stephan Ruscheweyh, Convolutions in Geometric Function Theory. Sem. Math. Sup., vol. 83. Presses University Montreal, Montreal (1982).

MA-820 Advance Dynamics

Equations of dynamic and its various forms. Equations of Langrange and Euler. Jacobi's elliptic functions and the qualitative and quantitative solutions of the problem of Euler and Poisson. The Problems of Langrange and Poisson. Dynamical system. Equations of Hamilton and Appell. Hamilton-Jacobi theorem. Separable systems. Holder's variational principle and its consequences.

Reference Books:

1. D. T. Greenwood, Classical Dynamics (Dover, 1997).
2. F. Chorlton, Chorlton Text Book of Dynamics (Ellis Horwood, 1983).
3. H. Goldstein, C. P. Poole and J. L. Safko, Classical Mechanics (Addison-Wesley Publishing Co., 2003).

MA-821 Number Theory

Number Theory is often considered one of the most beautiful and elegant topics in mathematics. We will study properties concerning the integers, such as divisibility, congruences, and prime numbers. More advanced topics include encryption, quadratic reciprocity, and Diophantine approximation. Finally we will introduce elliptic curves and see how these curves relate to the proof of Fermat's last theorem.

Reference Books:

1. D.M. Burton, Elementary Number Theory, McGraw-Hill, 2007.
2. S.B. Malik , Basic Number Theory, Vikas Publishing house, 1995.
3. K.H. Rosen, Elementary Number Theory and its Applications, 5th edition, Addison-Wesley, 2005.
4. I. Niven, H.S. Zuckerman, H.L. Montgomery, An Introduction to the theory of Numbers, John Wiley and Sons, 1991.
5. A. Adler, J.E. Coury, The Theory of Numbers, Jones and Bartlett Publishers, 1995.

PH 500 Basics of Physics

Measurements and units, Basic Quantities, International system of units, British system of units and their inter-conversion, force and motion, friction and drag force, viscosity, newton's law of motion, newton's law of universal gravitation, conservation laws, thermal properties, Newton's law of cooling, electric and magnetic properties, charge, current, capacitor, resistor, inductor, Ohm's law, Coulomb's law, Faraday's laws, Elastic Properties; Stress, Strain, Hooks law, Torsion

Reference Book:

MA 502 Numerical Methods

This course is an advanced introduction to applications and theory of numerical methods for solution of differential equations, especially of physically-arising partial differential equations, with emphasis on the fundamental ideas underlying various methods. Topics include finite differences, spectral methods, well-posedness and stability, boundary and nonlinear instabilities. The course assumes familiarity with basic (numerical) linear algebra and will involve a certain amount of programming in MATLABTM or any programming language of your choice.

Reference Books:

1. R. L. Burden, J. D. Fairs; An Introduction to Numerical Analysis, 1993.
2. G. D. Smith, Numerical Solutions of P.D.Es, 1999.
3. J. H. Wilkinson, The Algebraic Eigenvalue Problems, 1965.
4. U. Asher et al., Numerical solution of Boundary Value Problems in ODE's, 1986.
5. Numerical Mathematics, Matheus Grasselli, Dmitry Pelinovsky, Jonez Batlett, 2009

MA 644 Advanced Engineering Mathematics

Pre requisite: Undergraduate Engineering Mathematics Applied calculus, application of numerical linear algebra, vector calculus, Ordinary and Partial Differential Equations; solution techniques with exact and approximate methods. Coupled equations. Difference equations. Integro-differential equations and solution techniques. Integral equations (Volterra and Fredholm type). Exact solutions for infinite and semi- infinite systems, Optimization of multivariable calculus, quadratures, Laplace and Fourier transformations.

Reference Books:

1. Advanced Engineering Mathematics, Kreyzick
2. Introduction to optimization, FEM Principles and Applications, P.E. Lewis, J.P. Ward

MA 646 Introduction to Modeling and Simulation

This course surveys the basic concepts of computer modeling in science and engineering using discrete particle systems and continuum fields. It covers techniques and software for statistical sampling, simulation, data analysis and visualization, and uses statistical, quantum chemical, molecular dynamics, Monte Carlo, mesoscale and continuum methods to study fundamental physical phenomena encountered in the fields of computational physics, chemistry, mechanics, materials science, biology, and applied mathematics. Applications are drawn from a range of disciplines to build a broad-based understanding of complex structures and interactions in problems where simulation is on equal footing with theory and experiment. A term project allows development of individual interests. Students are mentored by a coordinated team of participating faculty from across the Institute.

Reference Book:

1. Simulation Fundamentals, B.S. Bunnett.

MA 650 FEM for Partial Differential Equations

A presentation of the fundamentals of modern numerical techniques for a wide range of linear and nonlinear elliptic, parabolic and hyperbolic partial differential equations and integral equations central to a wide variety of applications in science, engineering, and other fields. Topics include: Mathematical Formulations; Finite Difference and Finite Volume Discretizations; Finite Element Discretizations; Boundary Element Discretizations; Direct and Iterative Solution Methods.

Reference Books:

1. The Finite Element Method, P.E. Lewis & J.P. Ward

MA 700 Computational Fluid Dynamics

Pre-requisite: Undergraduate course on Fluid Mechanics/Dynamics Numerical solution of 1D, 2D and 3D Transport equations, Euler's equations, Burger's equations, Incompressible Navier-Stokes equations, compressible Navier-Stokes equations, advanced numerical techniques, multi-grid methods, and spectral methods.

Reference Book:

1. Computational Fluid Dynamics, K.A. Hoffmann, S.T Chang EES, USA

MA 770 Modeling & Simulation of Dynamical Systems

This course is about modeling multi-domain engineering systems at a level of detail suitable for design and control system implementation. It also describes Network representation, state-space models, Multiport energy storage and dissipation, Legendre transforms Nonlinear mechanics, transformation theory, Lagrangian and Hamiltonian forms, and Control- relevant properties. The application examples may include electro- mechanical transducers, mechanisms, electronics, fluid and thermal systems, compressible flow, chemical processes, diffusion, and wave transmission.

Reference Book:

1. Modeling and Simulations of Dynamical Systems, Robert L Dutoods, Kent L. Lawrence

MA 670 Approximation Theory

Normed Spaces, Approximation by Algebraic Polynomials ,Exercises on Approximation by Polynomials, Approximation by Trigonometric Polynomials, Exercises on Trigonometric Polynomials, Characterization of Best Approximation, Exercises on Chebyshev Polynomials, Simple Application of Chebyshev Polynomials, Lagrange Interpolation, Orthogonal Polynomials, Gaussian Quadrature

Reference Book:

1. Approximation Theory and Methods, M.J.J.D. Powell, 1982

MA 662 Linear Partial Differential Equations

This course covers the classical partial differential equations of applied mathematics: diffusion, Laplace/Poisson, and wave equations. It also includes methods and tools for solving these PDEs, such as separation of variables, Fourier series and transforms, eigenvalue problems, and Green's functions.

Reference Books:

1. Linear Partial Differential Equations for Scientists and Engineers, Myint-U, Tyn, and Lokenath Debnath, 4th Edition, 2006.

MA 684 Mathematical Methods

Modeling and conservation laws, Scaling and non-dimensionalisation, Simple boundary layer theory, Nonlinear oscillations, Multiple scale methods, Ordinary differential equations: hysteresis and stability, SturmLiouville systems, Integral equations and eigenfunctions, Partial differential equations: shocks, similarity solutions, Calculus of Variations; optimal control.

Reference Books:

1. Strang, Gillbert,; ' Computational Science and Engineering', Welleslet-Cambridge Press, 2007.
2. D. L. Powers, Boundary Value Problems and Partial Differential Equations, Academic Press, 2005.
3. W. E. Boyce, Elementary Differential Equations, John Wiley and Sons, 2005.
4. M. L. Krasnov, G. I. Makarenko and A. I. Kiselev, Problems and Exercises in the Calculus of Variations, Imported Publications, Inc., 1985.
5. A. D. Snider, Partial Differential Equations: Sources and Solutions, Prentice Hall Inc., 1999.

MA 680 Applied Partial Differential Equations

Systems of partial differential equations, characteristics, Weak solutions, Riemann's function, Maximum principles, comparison methods, well- posed problems, and Green's functions for the heat equation and for Laplace's equation, Fredholm alternative and Green's functions for non-self-adjoint problems, application of delta functions, Further development of hyperbolic equations, Cauchy-Kovalevskaya theorem, Riemann invariants, shocks and weak solutions, causality.

Reference Book:

1. Introduction to Partial Differential Equations, Habermann.

MA 688 Applied Linear Algebra

Linear Algebra is a central and widely applicable part of Mathematics. It is estimated that many (if not most) computers in the world are computing with matrix algorithms at any moment in time whether these be embedded in visualization software in a computer game or calculating prices for some financial option. This course builds on elementary linear algebra and in it we derive, describe and analyze a number of widely used constructive methods (algorithms) for various problems involving matrices.

Reference Book:

1. Applied Linear Algebra, Peter J. Olver, Chehrzad Shakiban, Prentice-Hall, 2006.

MA 780 Solid Mechanics

Lagrangian and Eulerian descriptions of motion, analysis of strain, Balance laws of continuum mechanics, Frame-indifference, Constitutive equations for a nonlinear elastic material. Linear elasticity as a linearization of nonlinear elasticity. Incompressibility and models of rubber. Exact solutions for incompressible materials, phase transformations, shape-memory effect.

Reference Book:

1. An Introduction to the theory of Elasticity, R. J. Atkin, N. Fox, 1980.

MA 686 Stochastic Differential Equations

Strong solutions, questions of existence and uniqueness, diffusion processes, Cameron Martin formula, weak solution and martingale problem. Some selected applications chosen from topics including option pricing and stochastic filtering.

Reference Book:

1. Stochastic Differential Equations, An introduction with Applications, B. Oksendal, 6th Edition.

MA 782 Topics in Fluid Mechanics

Convection, stability, boundary layers, parameterized convection, Rotating flows, atmosphere and oceans, Waves, geostrophy, boilers, condensers, fluidised beds. Flow régimes. Homogeneous, drift-flux, two-fluid models. Ill-posedness, waves, density wave oscillations. Coatings and foams. Gravity flows, Droplet dynamics, contact lines, Drying and wetting, Foam drainage.

Reference Books:

1. Frank M. White, Viscous Fluid Flow, Second Edition, McGRAW-HILL, Inc.
2. G.K. Batchelor, An introduction to fluid dynamics, Cambridge University Press.

MA 784 Mathematical Methods for Signal Processing

Introduction to signal processing, Signal formation and sampling in MRI and FMRI, Representation of a signal in the frequency domain (Fourier methods), Compression (wavelets), Filter operations for attenuation of a signal, Extracting information from a signal without a model (PCA,ICA), De-noising, Applications in speech and biomedical signal processing, Applications in learning how the brain functions (FMRI).

Reference Book:

1. Mathematical Methods and Algorithms for Signal Processing, Todd K. Moon, Wyn C. Stirling, Prentice Hall, 2008.

MA 772 Mathematics for Geo-Sciences

The course starts with some background to the geology, geophysics and engineering involved in the recovery of oil from deep inside the Earth. Flow through porous media - balance laws, Darcy's law, analytical and numerical methods, Grid generation and geometric modeling - surface modeling, structured and unstructured grids, stochastic sampling, groundwater modeling, the study of subsurface pollution and remediation, and even to problems outside the geosciences.

Reference Books:

1. The Theory of Critical Phenomena, J. J. Binney, N. J. Dowrick, A. J. Fisher and M. E. J. Newman, 1992.
2. Fundamentals of Numerical Reservoir Simulation, D. W. Peaceman, 1977.

MA 786 Waves and Compressible Flow

Equations of inviscid compressible flow including flow relative to rotating axes, Models for linear wave propagation including Stokes' waves, Inertial waves, Rossby waves and simple solutions, Theories for Linear waves: Fourier Series, Fourier integrals, method of stationary phase, dispersion and group velocity. Flow past thin wings, simple wave flows applied to one-dimensional unsteady gas flow and shallow water theory, Shock Waves: weak solutions, Rankine Hugoniot relations, oblique shocks, bores and hydraulic jumps.

Reference Book:

1. Waves and Compressible Flow, H. Ockendon, J. R. Ockenden, 2004.

MA 741 Advanced Statistical Techniques

This is an advanced course in statistical analysis which highlights the significance of planning, collection, analysis and interpretation of complex data. Students are taught to devise research problems and hypothesis and prepare the necessary tests to avoid Type I or Type II errors. The course also utilizes extensive use of univariate, bivariate and discriminant analysis. The last few units stress on deriving useful information from the tests in order to help students make smart decisions.

Reference Books:

1. Introduction to the theory of statistics, Mood A. M., Graybill F. A. Boes D. C. 1998.
2. Introduction to statistical inference, Kiefer, Jack C.
3. Statistical Inference, George Casella, Roger L. Berger

MA 501 Quantitative Analysis and Techniques

It covers a vast variety of mathematical concepts including linear equations and functions, quadratic and polynomial functions, exponential and logarithmic functions, matrix algebra, set theory, permutations and combinations, probability, random variables, frequency distribution time series, measures of central tendency, measures of dispersion, estimation, forecasting and index numbers.

Reference Books:

1. Frank S. Budnick, Applied Mathematics for Business, Economics and Social sciences, McGraw Hill, New York, 4th edition, (1993).
2. Levin Rubin, Statistics for Management, Printice Hall International, 7th edition(1998)

MA-623 Symmetry Methods for Differential Equations

Introduction to symmetry methods, Symmetry methods for ODEs and PDEs manually and by using computer packages, Invariants, canonical variables using the symmetries of differential equations, solution of ODEs and PDEs using classical methods, Linearization of the ODE and system of ODEs using point symmetries, Computation of the first integrals for ODEs and conservation laws for PDEs using suitable methods, Exact solutions of ODEs and PDEs via first integrals and conservation laws.

Reference Books:

1. CRC handbook of Lie group analysis of differential equations, Volume 1: Symmetries, exact solutions and conservation laws by Nail H. Ibragimov (CRC Press)
2. Applications of Lie groups to differential equations by Peter J Olver (Springer-Verlag)
3. Differential equations: Their solution using symmetries by Hans Stephani (Cambridge University Press)

MA-622 Geometric Function Theory

Brief review of complex functions and complex integrations, class of analytic functions, Riemann Mapping Theorem, class of univalent functions, class of convex univalent and starlike univalent functions, close-to-convex functions, Coefficient bounds, growth and distortion results of functions contained in subclasses of the class of univalent functions, class of Caratheodary functions with positive real part and related classes, functions with bounded radius rotation, functions with bounded boundary rotation, differential subordination, Hadamard product (or convolution), some linear differential and integral operators.

Reference Books:

1. L. V. Ahlfors, Conformal Invariants. Topics in Geometric Function Theory, McGraw–Hill, New York, 1973.
2. J. H. Shapiro, Composition Operators and Classical Function Theory, Springer-Verlag, Berlin, Heidelberg, New York, 1993.
3. Goodman, A.W., Univalent functions, Vol. I & II, polygonal publishing house, Washington, New Jersey (1983).
4. Duren, P. L., Univalent functions, Grundlehren der Math. Wissenschaften, Springer-Verlag, NewYork-Berlin (1983).

MA-624 Hilbert Space Methods

Vector spaces, Normed Spaces, Inner Product spaces, Completeness, Hilbert Spaces, Linear and bounded operators, Orthoprojections, Isometric and unitary operators, Continuous functions of self-adjoint operators, Coercivity, Elliptic forms, Regularity, closed operators, adjoint and eigenfunction expansions, Spectral Integrals, Differential Operators in $L^2(a, b)$.

Reference Books:

1. Karl E. Gustafson, Introduction to Partial Differential Equations and Hilbert Space Methods 1997.
2. R. A. Kennedy, P. Sadeghi, Hilbert Space Methods in Signal Processing, 2013.

MA-625 Variational Inequality & Convex Analysis

Basic concepts, Existence and uniqueness results. Fixed-points formulation, Wiener-Hopf equations, Equivalence between variational inequalities and Wiener-Hopf equations, Iterative methods, Auxiliary principle techniques, Dynamical systems, Sensitivity analysis, convergence analysis, numerical solutions of obstacle problems, variational inclusions, resolvent equations, applications . Convex sets, convex hull, their properties, separation theorems, hyperplane, Best approximation theorem and its applications, Farkas and Gordan Theorems, Extreme points and Polyhedral. Convex functions, Basic Definitions, properties, various generalizations, differentiable convex functions, subgradient, characterization and applications in linear and nonlinear optimization, complementarity problems and its equivalent formulations.

Reference Books:

1. D. Kinderlehrer and G. Stampacchia, An introduction to Variational Inequalities and their Applications, SIAM Publishing Co., Philadelphia, PA, 2000.
2. M.Asam Noor, Some Developments in general variational inequalities, Applied Mathematics and Computation, Vol. 152, 2004, pages 199-277.

Proposed research Areas

After the successful completion of course work the following specializations can be pursued in the course of the doctorate degree.

- **Computational Mathematics**
- **Fluid Mechanics**
- **Algebra, Geometry and Algebraic Theory**
- **Information Geometry**
- **Algebraic Geometry**

Department of Physics

Physics is one of the most important sciences. It provides the base for a wide range of applications, particularly in engineering, science and technology. The department of Physics offers courses to all the Engineering disciplines to strengthen the present engineering programs at this University. The department has launched MS degree programme in Applied Physics with specialization in Energy Technology, Nano Science and Technology, and Computational Physics from Fall-2013.

Dr. Asghari Maqsood, SI, Professor
Fellow Pakistan Academy of Sciences
Education: Ph.D Physics, Gothenburg University, Sweden, M.Sc
Experimental Physics, University of Oxford, UK; M.Phil Nuclear
Physics, QAU, Islamabad; M.Sc Physics, University of the Punjab,
Lahore.
Research Interests: Materials Science, Nanomaterials, Single crystals,
Thermal Transport, Materials synthesis

Dr. Muhammad Atif; Assistant Professor
Education: PhD Physics, Vienna University of
Technology, Vienna, Austria; M.Phil Physics, M.Sc
Physics, QAU, Islamabad.
Research Interest: Magnetostrictive Materials,
Magnetoelectric Composites, Nanomaterials,
Materials Synthesis.

Dr. Muhammad Atif; Assistant Professor
Education: PhD Physics, Vienna University of
Technology, Vienna, Austria; M.Phil Physics, M.Sc
Physics, QAU, Islamabad.
Research Interest: Magnetostrictive Materials,
Magnetoelectric Composites, Nanomaterials,
Materials Synthesis.

Dr. Rubina Nasir; Assistant Professor
Education: PhD Physics, QAU, Islamabad; MS
Nuclear Engineering, PIEAS, Nilore, Islamabad;
M.Sc Physics, QAU Islamabad.
Research Interest: Theoretical Condensed Matter
Physics, Computational Physics, Radiation
Physics.

Dr. Zulqurnain Ali; Assistant Professor
Education: PhD Physics, Philipps University, Germany; M.Phil Physics, M.Sc Physics, QAU, Islamabad.
Research Interest: Nanomedicine, Colloidal nanoparticle, Biophotonics

Mr. Amir M Khan; Lecturer (on study leave)
Education: M.Phil Physics, M.Sc. Physics, QAU, Islamabad.
Research Interests: Condensed Matter Physics, Nanoparticle Physics.

Mr. Muhammad Kashif Ali; Lecturer
Education: M.Phil Physics, QAU Islamabad; M.Sc. Physics, Punjab University, Lahore.
Research Interests: Theoretical Plasma Physics, Electrodynamics.

Ms. Tashfeen Zehra; Lecturer (on study leave)
Education: M.Phil Physics, M.Sc. Physics, QAU.
Research Interests: Condensed Matter Physics, Nanomaterials.

Ms. Anum Zaidi; Lecturer
Education: M.Phil Physics, QAU, Islamabad; BS Physics, University of Wah, Wah Cantt.
Research Interests: Material Science, Thin films

Ms. Tayyaba Firdous; Lecturer (on study leave)
Education: M.Phil Physics, QAU Islamabad; M.Sc. Physics, UET, Lahore.
Research Interests: Condensed Matter Physics, Nanoparticle Physics, High Temperature Superconductivity, Thermal Physics, Laser Matter Interactions.

Mr. Muhammad Ubaid Khan;
Teaching Assistant, Education: M. Phil Physics; AIOU, Islamabad, M.Sc. Physics, Peshawar University. Peshawar
Research Interests: Material Science

Mr. Muhammad Fakhar Zia; Lecturer (on study leave)
Education: MS Physics, CIIT, Islamabad; M.Sc. Physics, BZU, Multan.
Research Interests: Nanomaterials and Nanostructures especially one dimensional nanostructures.

Mr. Mozaffar Hussain; Assistant Professor (on study leave)
Education: M.Phil. Physics, QAU Islamabad; M.Sc. Physics, Islamia University, Bahawalpur.
Research Interests: High Temperature Superconductivity, Nanoparticle Physics.

Master of Science in Applied Physics (MSAP)

MS program focuses on Renewable energy, Nano Science & Technology and Computational Physics in which physicist and engineers could join hands for producing qualified manpower for meeting the growing demand of professionals in these areas. The program will require approximately two years for completing an MS degree. Its graduates trained in the experimental, theoretical, and computational aspects of material science and technology are expected to be active members of interdisciplinary teams for identifying, formulating and solving problems of national interest.

This program is for candidates with 16 years of education in a related discipline (M.Sc Physics/ BS Physics/ BS Engineering/BS Electronics) and GAT-General with minimum 50 percent marks. The two year program consists of 24 credits of course work followed by 6 credits of research work. The first semester comprises three core courses. The second semester comprises of one core course, one specialization and one elective course. The third semester comprises of one specialization and one elective course along with research work whereas the fourth semester is dedicated for research thesis. MS Applied Physics is an evening program; classes are conducted at 03:00-08:00 pm.

PROGRAMMES	DURATION	ELIGIBILITY CRITERIA
MS Applied Physics	2 years	M.Sc. Physics / BS Physics / BS Engineering /BS Electronics from HEC recognized institute or equivalent with minimum CGPA 2.5/4.00 or 60% marks. GRE General /GAT-General test with min. 50% score. Selection: Test/Interview.

MS Applied Physics Program Details

I SEMESTER (Fall)

Course Code	Course Title	Cr. Hrs
PH-601	Methods of Mathematical Physics	(3-0-3)
PH-602	Electrodynamics	(3-0-3)
PH-603	Material Science	(3-0-3)

Number of Courses = 3

Credit Hours = 9

II SEMESTER (SPRING)

I Course Code	Course Title	Cr. Hrs
	Methods of Mathematical Physics	
	Electrodynamics	
	Material Science	
PH-762	Experimental Techniques	(3-0-3)
PH- 710	Physics and Chemistry of nano materials	(3-0-3)
PH-604	Advance quantum Mechanics	(3-0-3)

Number of Courses = 3

Credit Hours = 9

III SEMESTER (Fall)

Course Code	Course Title	Cr. Hrs
PH-7xx	Specialization – II* (NST) or Specialization – II* (ET) or Specialization – II* (CP)	(3-0-3) (3-0-3) (3-0-3)
PH-7xx	Elective – II*	(3-0-3)
PH-799	Thesis / Dissertation	(3-0-3)

Number of Courses = 2

Credit Hours = 9

IV SEMESTER (Spring)

Course Code	Course Title	Cr. Hrs
PH-799	Thesis / Dissertation	(3-0-3)

Number of Courses = 0

Credit Hours = 3

*All the Specialization and Elective Courses are to be selected from the list of areas of specialization given below:

Nano Science and Technology (NST)

Course Code	Specialization - (NST)	Cr. Hrs
PH-710	Physics and Chemistry of Nanomaterials	(3-0-3)
PH-711	Condensed Matter Physics	(3-0-3)

Electives (NST)

Course Code	Course Title	Cr. Hrs
PH-760	Semiconductor Theory	(3-0-3)
PH-761	Physics of magnetic materials	(3-0-3)
PH-762	Experimental Techniques	(3-0-3)
PH-763	Surface Physics	(3-0-3)
PH-764	Optical Properties of Solids	(3-0-3)
PH-765	Conducting polymers	(3-0-3)
PH-766	Biophysics	(3-0-3)

Energy Technologies (ET)

Course Code	Specialization - (ET)	Cr. Hrs
PH-720	Renewable Energy Sources	(3-0-3)
PH-721	Physics of Solar Cells	(3-0-3)

Electives (ET)

Course Code	Course Title	Cr. Hrs
PH-770	Environmental Physics	(3-0-3)
PH-771	Photovoltaic Technology	(3-0-3)
PH-772	Solar Thermal Power Technology	(3-0-3)
PH-773	Bio-Energy Technology	(3-0-3)
	Computational Physics (CP)	

Course Code	Specialization - (CP)	Cr. Hrs
PH-730	Computational Physics	(3-0-3)
PH-731	Mathematical Modeling & Computer Simulation	(3-0-3)

Electives (CP)

Course Code	Course Title	Cr. Hrs
PH-776	Monte Carlo Computer Simulation	(3-0-3)
PH-777	Non-Linear Dynamics in Physics	(3-0-3)
PH-778	Computational Statistical Physics	(3-0-3)
PH-779	Computational Condensed Matter Physics	(3-0-3)

Course Description

PH 100 Physics

Vector algebra, Motion of Particle in one, two and three dimensions, Projectile motion, Uniform Circular motion, Force, mass, Newton's laws, Tension and Normal force, Frictional forces, Concept of free body diagram, Electrostatic force, electrostatic field, Electric dipole, Electric flux, Gauss 's law, Electrostatic potential, magnetic field, Biot-Savart law, Effect of

magnetic field on current carrying conductors, Ampere's Law, How magnetism is used in a computer, Band theory, Insulators, metals, semiconductors, doped semiconductors, The p-n junction, The junction rectifier, LED, Transistor.

PH 103 Applied Physics

Vector algebra, Motion in two and three dimensions,

Force and motion, Newton's laws, Application of Newton's second law for some specific forces, Friction, Rotation, Moment of inertia, Torque, Rotational Energy, Simple Harmonic Motion, Waves, Waves speed, Energy and Power of traveling waves, Doppler's effect. Electrostatic force, electrostatic field, Electric dipole, Electric flux, Gauss 's law, Electrostatic potential, magnetic field, Biot-Savart law, Effect of magnetic field on current carrying conductors, Ampere's Law, Magnetic dipole, Faraday's law of electromagnetic induction, Energy stored in electric and magnetic fields, Introduction to solid state Physics, Superconductivity, Semiconductors and Modern trends in Atomic Physics.

PH 105 Physics I

Vector and Scalars, Motions in 2 and 3 dimensions, projectile motion, uniform circular motion, Force and acceleration, Newton's laws, frictional force, Work, Energy, Kinetic and Potential Energy, Gravitational force, Conservation of energy, Rotational motion, Angular velocity, Torque, Rotational Inertia, Oscillations, Simple Harmonic motion, Harmonic Oscillator, Waves, Transverse and Longitudinal waves, Wave speed, Energy and Power of Waves, Standing Waves.

PH 106 Physics II

Electric charge, Coulomb's Law, Electric field, electric flux, Gauss's Law, Electric potential, Capacitors, Electric current, Ohm's law, Magnetic fields, Ampere's Law, Inductors, Faraday's Law, Energy stored in magnetic fields, magnetic materials, induced magnetic fields. The Electromagnetic Model, Vector Analysis, Static Electric Fields, Solution of Electrostatic Problems, Steady Electric Currents. Electromagnetic

waves, Poynting vector, Interference, Diffraction.

MS Applied Physics

PH-601 Methods of Mathematical Physics

Second Order Differential Equations: Partial differential equations, Series solutions, a second solution, non-homogeneous equations, Green function. Sturm Liouville Theory: Self – Adjoint ODE's, Hermitian Operators, Gram-Schmidt Orthogonalization. Laplace transforms and inverse Laplace transforms, Laplace transform of periodic functions. The convolution integral. Bessel Function: Bessel functions of first kind, Bessel function of 2nd kind, Neumann functions, Hankel functions. Legendre Functions: Generating function, recurrence relations, orthogonal, associated Legendre function, spherical Harmonics, applications to spheroidal coordinate system Special Functions: Hermite Functions, Laguerre Functions, Chebyshev polynomials, hypergeometric functions. Fourier Transforms: Fourier transforms and inverse fourier transforms, fourier transform of periodic functions, the convolution



integral, Sturm- Liouville theory of orthogonal functions. Integral Transform Method: Solution of homogenous and inhomogeneous differential equations using Fourier and Laplace integral Transform Methods. Integral Equations: Integral equations integral transforms. Generating functions, Neumann series, Degenerate kernels, Hilbert-Schmidt theory. Nonlinear Differential Equations and its Solutions: Classification of nonlinear differential equation and its solutions.

PH-602 Electrodynamics

Maxwell equations and Maxell's displacement current, vector and scalar potential, Gauge Transforms, Lorentz and Coulomb gauge. Green's function for conducting and non-conducting sphere, Greens function for wave equation, Retarded solutions for the fields, one dimensional Green's function, two and three dimensional Green's functions, Dirac Delta function, properties and uses. Poynting's theorem and conservation laws, Poynting theorem in linear and dispersive medium, solution for harmonic fields, transformation properties of electromagnetic fields and sources—under rotation. Plane wave in a non

conducting medium, linear and circular polarization, Stokes parameters, reflection and refraction of electromagnetic waves, polarizations by reflection and total internal reflection. Anomalous dispersion and resonant absorption, low frequency response of electric conducting, Index of Refraction and absorption. Simplified model of propagation of e. m. wave in the ionosphere and magnetosphere, magneto hydrogenic wave, spreading of a pulse and its propagates in a dispersive medium, arrival of signal after propagation through a dispersive medium. Fields at the surface of and within a conductor, cylindrical cavities and wave guides, modes in a rectangular waveguides, energy flow and attenuation in waveguides. Power losses in a cavity and Q of a cavity, Schulman resonances, multimode propagation in optical fibers. Modes in a planer slab dielectric waveguides, modes in circular fibres, Fields in a hollow metallic wave guide.

PH-603 Material Science

Bonding in elemental materials (covalent, metallic and van der waals bonding), Bonding in multielement materials (ionic, mixed ionic–covalent bonding, hydrogen bonding), Effects of nature of bonding on materials properties. Basic structural and symmetry concepts, Concept of diffraction in a periodic lattice, Structural information from x-ray diffraction and other diffraction techniques, crystal structures of metals and ceramic materials. Point defects (vacancies, interstitial, impurities, F-centers) and their stability lines and extended defects (dislocations, grain boundaries, interfacial, surface and volumetric defects). Effect of defects on the properties of materials. Amorphous materials / glasses (glass formation, glass transition and crystallization of glasses), random close packing in metallic glasses, continuous random networks in



covalent glasses. Basic concepts, equilibrium phase diagrams, phase transformation – basic concepts, kinetics, metastable versus stable transformations, microstructures development, multi component and multi phase systems, alloys, equilibrium structures, phase separation. geometry of interphases, coherent and commensurate interfaces, stacking period and interplanar spacing, defects on surfaces, experimental determination and creation of surfaces, surface characterization techniques (LEED, RHEED, MBE, STM, AFM) and their principles. Introductions to soft matter, colloidal dispersions, gels and gelations, liquid crystals; structures and textures in liquid crystals. Polymers; molecular weights, molecular structures, stereo and geometric isomerism, thermoplastics, crystallinity of polymers, copolymers, biological molecules, concept of self assembly in block copolymers and biomolecules.

PH-604 Advanced Quantum Mechanics

Time evolution and Schrödinger equation, the Schrödinger versus the Heisenberg picture, interaction picture. Symmetries, conservation laws and degenerates. Discrete symmetries, Parity or space inversion, Lattice Translation as discrete symmetries Classical radiation field, Creation, annihilation and number operators, Quantization of radiation field. Relativistic Quantum Mechanics of Spin 1/2 particles, probability conservation in Relativistic quantum, the Dirac equation, Simple solutions, non-relativistic approximations, plane wave solutions Relativistic invariance of Dirac equation transformation properties of Dirac bilinear, adjoint Dirac equation, equation of continuity, constant of motion The Klein- Gordon Equation, Derivation and Covariance, Klein's Paradox and Zitterbewegung.

PH-710 Physics and Chemistry of Nanomaterials

The nanoscale, historical background, quantum confinement, size dependent properties, types of nanomaterials, fullerenes, nanowires, nanotubes, thinfilm. From subatomic physics to chemical systems, Atomic and electronic structure (review). Types of chemical bonds and bonding, Periodic table / chemical properties, Solid state physics / materials properties. One-Dimensional nanomaterials (Nanowires & nanorods), Two-Dimensional nanomaterials (Thin films and monolayers), Carbon-based nanomaterials (Carbon nanotubes, Graphene, Nanostructured carbon), Organometallic compounds, Silicon structures and materials, Metals and high performance Alloys, Glasses and ceramics. Physical methods, mechanical – ball milling, melt mixing, evaporation, ion sputtering, laser ablation, laser pyrolysis, chemical vapour deposition, molecular beam epitaxy. Chemical methods: colloidal synthesis & capping of nanomaterials. microscopes – optical, SEM, TEM, STM, AFM, diffraction techniques – XRD, EXAFS neutron diffraction, spectroscopes—UV – visible-IR absorption, FTIR, Photoluminescence.



Mechanical; Electrical –classification – metals, semiconductors, insulators, band structures; mobility, resistivity, Hall effect, Magneto – resistance. Optical absorption & transmission, photoluminescence, electroluminescence, thermoluminescence. Electronic and magnetic properties of Materials, Spintronics and magnetic materials, Ferrofluids, magnetic thin films. Supramolecular chemistry and biomolecules, Biomimetic nanosystems.

PH-711 Condensed Matter Physics

Band theory and electron correlations: Single electron in a periodic potential, many electrons in a periodic potential, Hartree-Fock-LDA and beyond. Fermi liquid theory and elementary excitations: Quasiparticles and Landau parameters, thermodynamics of a Fermi liquid. Second quantization: Second quantization for fermions and bosons, Quadratic Hamiltonians and canonical transformations. Quantization of lattice vibrations. Green's functions: Green's function and response functions, Dyson and Bethe-Salpeter equations, perturbation methods and Feynman diagrams, zero temperature versus finite temperature formulation. Fermi liquid theory: microscopic formulation: Landau quasiparticles as poles of Green's function, Landau parameters, conservation law and Ward identities. Quantum magnetism: Spin waves, spin path integral, quantum non-linear sigma model. Modern applications: Kondo effect, quantum phase transitions, non-Fermi liquid.

PH-720 Renewable Energy Sources

Introduction, importance of energy, world energy demand. Conventional energy sources, renewable sources; potential, availability and present status of renewable sources. Solar energy, physical principle of

conversion of the solar radiation into heat, flat-plate collectors. Concentrating collectors, basic principle and components of wind energy conversion system, types and performance of wind machines. Biomass conversion technology, thermal gasification of biomass; alternative; liquid fuels, biogas generation, classification of biogas plants. Geothermal sources, hydro-thermal geo- pressure, petro- thermal and magma resources, advantages and limitation of geothermal energy. Introduction, global generation growth rate, prospects of nuclear fusion, safety and health hazards issues, global resources and their assessment. Classification, micro, mini, small and large resources. Principles of energy conversions, turbines, working and efficiency of from to small power systems, environmental impacts.

PH-721 Physics of Solar Cells

An introduction to solar energy, direct and in direct sources of solar energy. Review of semiconductor properties, materials and structural characteristics effecting cell performance. Short-circuit current limit, open-circuit voltage limits, effects of temperatures, short-circuit current losses, open-circuit voltage losses, fill factor losses, efficiency measurement. Optimal cell design consideration, collection probability of generated carriers, junction depth, lateral resistance of top layers, doping of substrates, back surface fields, top-layer limitations, dead layers, high doping effects. Contribution to saturation current density, top-contact design, optical design, antireflection coating, textured surfaces, spectral response, silicon single crystal wafers for solar cells and modules, module construction, cell operating temperatures, module durability and circuit design. Advance materials for solar cell, pre and post surface modification of solar cells, polishing and

chemical etching of basic photovoltaic materials. Annealing in various environments, ion-implantation, energy storage, power control and system sizing. Uses of solar cells in water pumping and residential systems, central power plants for space applications.

PH-730 Computational Physics

Introduction to symbolic computing (Matlab, Mathematica and Simulink), introduction to computers, errors estimation, methods for roots of nonlinear equations, linear system simulations (Gauss-elimination, Jacobi method, Gauss-Seidel method, LU decomposition), Eigen-value problems; Linear and nonlinear regressions, computational integration and differentiation, Ordinary Differential Equations (Euler method, Improved Euler method, KR-methods), Multi-step methods; Partial differential equations, introduction to Monte Carlo methods, Genetic Algorithms.

PH-731 Mathematical Modeling & Simulation

Introduction to mathematical modeling, fundamentals of simulation, Introduction to Matlab and Simulink, block model development in Simulink, first order models (examples from fluids, biophysics, physics, electrical systems and mechanical systems), second order systems and models (example on homogeneous and non-homogeneous linear systems coupled or simultaneous systems (examples from fluids and population, electrical and mechanical systems), nonlinear systems and simulation methods; stochastic models and simulation methods (discrete and continuous systems), probability density functions and sampling methods, random walks, introduction to MC techniques.

PH-760 Semiconductor Theory

Crystal Structure, Atomic Bonding, Intrinsic and Extrinsic Semiconductors, Energy Bands, Density of States, Nearly Free Electron Model, Kronig-Penny Model, Energy Bands for Intrinsic and Extrinsic Semiconductors Fermi-Dirac Statistics, Carrier Concentrations in Thermal Equilibrium in Intrinsic Semiconductors and Semiconductors with Impurity Levels. Constant Relaxation Time, Electrical conductivity, the Hall Effect, Transverse Magnetoresistance, Scattering Mechanisms. The Boltzmann Transport Equation, Conductivity and Magnetoconductivity in Parabolic and Ellipsoidal Bands, Thermoelectric and Thermomagnetic Effects, Quantum Transport. Diffusion processes, Diffusion and Drift of Carriers, The Continuity Equation, Direct and Indirect Recombination of Electrons and Holes, Steady State Carrier Injection, Optical Absorption, Interband Transitions, Photoconductivity, Luminescence. Ohmic, Blocking and Neutral Metal-Semiconductor Contacts, PN-Junction under Equilibrium Conditions, Forward and Reverse-Biased Junctions, Reverse-Bias Breakdown, Deviations from the Simple Theory.

PH-761 Physics of magnetic materials

Magnetism & various magnetic materials with their applications, classical and quantum phenomenology of magnetism. orbital motion of a single electron, spin states of a single electron, states of isolated ions, ions in magnetic fields, spectroscopic investigations Quantum Mechanics, Magnetism and Bonding in Metals. Spontaneous magnetic order, ferromagnetisms in elements, ferromagnetism in alloys, ferromagnetism in non-metallic compounds, ferromagnetism & anti-ferromagnetism, linear and helical magnetism.

magnetocrystalline anisotropy, shape anisotropy and stress anisotropy diamagnetism of isolated atoms and ions, diamagnetism of crystalline solids, diamagnetic resonance or cyclotron resonance, the main classes of paramagnetic solids, paramagnetism due to ions of rare-earth and transition elements, paramagnetism of metals, free radicals and molecular paramagnetism, paramagnetic relaxation. Soft Magnetic Materials theory and applications. Amorphous Materials: magnetism and disorder. Magnetism in Small Structures exchange coupling and nanocrystals.

PH-762 Experimental Techniques

Solution of differential equations of higher order. Gaussian quadrature. Random numbers. Monte-Carlo methods. Resume of theory of errors and experimental statistic. Least-square fit to a polynomial. Nonlinear functions. Data manipulation, smoothing, interpolation and extrapolation, linear and parabolic interpolation. High vacuum techniques. Physical principles of diffusion and rotary pumps. Ultra high vacuum by ionization. Sorption and cryogenics. Measurement of pressure, Leak detection. X-ray, electron and neutron diffraction techniques.

PH-763 Surface Physics

The surface as an especially important object for physical investigation. Influence of the surface on physical properties of objects. Clean and covered surfaces. Adsorption and catalysis. What is UHV: Vacuum concepts and UHV hardware. The methods to get clean surfaces. The structure of surfaces. Short overview of modern experimental techniques. Lattice concept. 3 D crystal structures, 2D surface structures. Specific types of surface, fcc, hcp, bcc and stepped surfaces and a discussion of their relative energies.

More complex reconstruction, stability, growth mechanisms, adsorption. Desorption and experimental probes of surface structure such as LEED and RHEED. The structure of semi-conductor surfaces. The surface structures of very small metal particles. Adsorption mechanisms and kinetics chemisorption vs. physisorption, the kinetics of adsorption, potential energy curves and adsorption energetics. Adsorption mechanisms and kinetics for low coverages Langmuir Isotherms, derivation, adsorbate phase diagrams and phase transitions. Experimental probes of surface structure such as LEED and RHEED. Growth processes, vibrational spectroscopy, catalysis, Desorption. Band theory, Free electron theories and the work function. The electronic structure of semiconductor surfaces, Electron emission processes. Magnetic processes at surfaces. Electron diffraction and quasi – elastic scattering, comparison of particle scattering techniques. Electron spectroscopes, Discussion of the merits of different types of electron energy analysers and electron detectors. Signal processing and spectral analysis. Theory and practice of Auger electron spectroscopy, Quantification of Auger spectra, Auger depth. Profiling. Comparison of particle scattering techniques, An Introduction to the theory and practice of SIMS, SIMS imaging and depth profiling, Auger depth profiling, theory and practice of Rutherford. Back scattering. Classification of microscopy techniques, Basic concepts in Surface imaging and localized spectroscopy, Imaging XPS, Optical microscopy, STEM. SEM. SPM. An introduction to the theory and practice of scanning Tunneling Microscopy, Scanning probe microscopy techniques, Atomic Force Microscopy.

PH-764 Optical Properties of Solids

Maxwell equations, dielectric optical response, refractive index and absorption, Lorentz oscillator model, dispersion relations, Lyddane-Sachs-Teller relation, Drude theory and basic plasma optics, Kramers-Kronig relations, polaritons, dielectric tensor, longitudinal plasma oscillations. Optical and acoustic phonons, monatomic lattice dispersion relations, diatomic lattice, n -dimensional crystals, effective charges, Bose functions, optical excitation of phonons, infrared absorption, phonon polaritons, light scattering, Raman and Brillouin scattering, coherent Raman spectroscopy. Direct and indirect gap semiconductors, energy and momentum conservation in band-to-band transitions, optical absorption and quantum mechanical time-dependent perturbation theory, dipole-allowed optical transition in the parabolic band approximation, indirect optical transitions, excitons, two-particle Schrodinger equation, selection rules, first-class dipole allowed transitions, second-class dipole allowed transitions, excitonic absorption in first-class dipole allowed transitions, excitonic luminescence, examples of important semiconductors. Quantum confinement, bandgap offset, quantum wells, envelope function approach, particle-in-box, subbands, superlattices, compositional variations, lattice mismatch, optical transitions and selection rules, excitons in quantum wells. Franz-Keldysh effect, DC Stark effect, exciton ionization, quantum-confined dc-Stark effect. Overview of Semiconductor Optical Nonlinearities: Phase-space blocking, screening, bandgap renormalization, thermal nonlinearities, optical Stark effect, two-photon absorption. Basic operation principles of LED's and lasers, doping p-n junctions forward and reverse bias, I-V curves,

semiconductor lasers, photodetectors.

PH-765 Conducting polymers

Basics of conducting polymers Synthesis, structures and morphology; Conductivity Properties: Semiconductor models and conductivity mechanisms in conducting polymers; Doping reactions: Composites, copolymers, conductive polymer thin films; Electrochromic and electrochemical properties of conducting polymers; Solubility and processing of conducting polymers; conducting polymer coatings, Characterization methods: Electrical, mechanical and electrochemical characterizations; Application fields of conducting polymers: Sensor applications, photovoltaic applications; supercapacitor applications, recent activities in the field of conducting polymers.

PH-766 Biophysics

Introduction, Chemical bonding, Energies forces and bonds, Energy bands, Thermodynamics and statistical mechanics, Reaction rates, Transport processes, Biological polymers, Biological membranes, Biological energy, Movement of organisms, Excitable membranes, Nerve signals, Memory, Biological motors.

PH-770 Environmental Physics

Principal layers, troposphere, stratosphere, mesosphere, thermosphere, Ideal gas model revisited, exponential variation of pressure with height, Escape velocity, Temperature structure and lapse rate. The Sun as the prime source of energy for the earth, Solar energy input, cycles daily and annual, Spectrum of solar radiation reaching the earth, Total radiation and the Stefan Boltzmann, Wien and Kirchoff Laws, Radiation balance at the earth's surface and determination of the surface temperature, Ozone layers

and depletion, CO₂, methane, H₂O and the Greenhouse effect. Properties of water, The hydrologic cycle, Measuring the water content of the atmosphere; humidity. Thermodynamics of moist air and cloud formation, Growth of water droplets in clouds, Rain and thunderstorms. Measuring the wind; the Beaufort scale, Origin of winds; the atmosphere as a heat engine, The principal forces acting on an air parcel, Cyclones and anticyclones, Thermal gradients and winds, Global convection and global wind patterns. Soils and soil types, Water flow through soils and rocks, Soil temperatures. Energy demands and energy resources, Environmental problems of energy production, Nuclear power, Renewable energy sources; hydro-electric, wave and wind power, biomass, solar, Energy conservation; design of buildings. Atmospheric pollution; acid rain: Systems approaches to environmental issues, Acid rain as a regional problem. Sound and noise: Definition of the decibel and A-weighted sound levels, Measures of noise levels; effect of noise levels on hearing, Domestic noise; design of partitions.

PH-771 Photovoltaic Technology

Early attempts at solar, declining costs of PV, Definition of Gen I, Gen II, and Gen III PV technologies, Solar resources planet-wide, Applications, Utility scale, "Distributed grid" rooftop applications, Current usage of solar PV. Capacity factor calculations, Comparison of solar PV to other Methods, Daily energy demand variations and peak usage, Energy storage methods and Costs, Differences in economic case for point of use PV versus utility scale power generation. Monocrystalline Si, Polycrystalline Si, Si thin film, CdTe and CIGS, High performance multijunction cells. Cell classification, Front side ribbon soldering, Cell interconnects and "stringing", Electrical circuit assembly, Laminate

assembly, CPV. Power output, footprint, and cost: Effects of latitude and climate, Tracking Systems, Balance of system (inverters, mounting racks, installation costs). a-Si, CIGS, CdTe, Exotics. Discrete cell panels; Construction overview, Stringing, Layout, Wiring, Final Test. Thin Film Panels; Construction overview, Advantages over discrete, Fabrication techniques, Test. PQ standards & measurements, Case studies.

PH-772 Solar Thermal Power Technology

Models for radiation analysis and beam radiation calculations, evaluation and estimation of the solar resources. Thermal conversion of solar radiation, the concentration of solar radiation, overview of solar concentrating technology. Parabolic trough, paraboloid dish: continuous type and Fresnel type. single axis and double axis trackings. Solar Parabolic trough; design considerations, tracking and control systems, thermal design of receivers. Solar parabolic dish; design considerations, Sterling engine, Brayton cycle, tracking and control systems. Solar tower concepts; tower design, heliostat design, receiver types, tracking and control systems. Material and product/technology overview for the above technologies. Linear Fresnel reflector, Solar chimney. Technology overview, design considerations, materials. Performance study, site selection and land requirement.

PH-773 Bio-Energy Technology

Current energy consumption, overview of biofuel/bioenergy and biorefinery concepts. Fundamental concepts in understanding biofuel/bioenergy production Renewable feedstocks and their production. Feedstocks availability, characterization and attributes for biofuel/bioenergy

production Biomass preprocessing: drying, size reduction, and densification. Various biofuels/bioenergy from biomass. Biomass conversion to heat and power: thermal gasification of biomass, anaerobic Digestion. Biomass conversion to biofuel: thermochemical conversion, syngas Fermentation Biochemical conversion to ethanol: biomass pretreatment. Different enzymes, enzyme hydrolysis, and their applications in ethanol production Biodiesel production from oil seeds, waste oils and algae. Environmental impacts of biofuel production. Energy balance and life-cycle analysis of biofuel production. Value-added processing of biofuel residues and co-products.

PH-776 Monte Carlo Methods

Introduction to stochastic techniques, random number generation, probability theory, probability distribution functions, discrete and continuous pdfs, direct sampling methods, rejection techniques, importance sampling methods, random walks, diffusion and biased diffusion, Metropolis algorithm and its applications, error estimation and error reduction techniques, multivariate distributions, random walk filters, applications of MC methods (Ising model, Heisenberg model in statistical physics, neutron transport, radiation transport, study cases using large computer codes using MC methods such as GEANT-4, MCNP etc.,)

PH-777 Non-Linear Dynamics in Physics

Dynamical systems, phase space, Poincare section, spectral analysis, Basin of attraction, bifurcation diagrams; the Logistic map, period doubling, Lyapunov exponents, entropy; Characterization of chaotic attractors; prediction of chaotic states, method of analogues, linear approximation method, modification

of chaotic states; spatio-temporal chaos, intermittency; Quantum maps, chaos in non-equilibrium statistical mechanics, driven systems; inter-mode traces in the propagator for particle in the box.

PH-778 Computational Statistical Physics

Review of thermodynamics and Statistical Mechanics. Empirical equation of state. Ideal gas laws. Van der Waal's equation. Critical Phenomenon. Hugoniot equation. Mie-Gruneisen equation. Semi-empirical theory of Gruneisen ratio. Theoretical calculations of equation of state. Exactly soluble models. Classical ideal gas. Non-interacting Fermi gas. Non-interacting Bose gas. Paramagnets. Ising model. Approximate methods. Thomson-Fermi model. Debye-Huckel theory. Statistical mechanics of Plasmas. Cluster expansions. Computer based calculations of equation of state. Methods of molecular dynamics and Monte Carlo Techniques.

PH-779 Computational Condensed Matter Physics

Scattering theory, quantum scattering, calculation of cross-sections; Variational techniques, solution of generalized eigenvalue problems; Hartree-Fock method, the helium atom, many electron system, Slater determinants; Density functional theory, local approximation, exchange and correlation, applications; Molecular dynamics simulations, molecular systems, Langevin dynamics, ensembles and integrators, quantum molecular dynamics; Stochastic techniques; quantum Monte Carlo: variational diffusion, path-integral

BS Physics

Description of Proposed Program

1. Program Overview

Faculty of Basic and Applied Sciences (FBAS) proposes an undergraduate BS program in Physics which will covers the needs of those who pursue their postgraduate study and research in the field of Physics and also who require a strong base of physics and mathematics while working in allied technological areas. As, Faculty of Basic and Applied Sciences (FBAS) is successfully running their MS program in Applied Physics launched in 2013. However, the students enrolled generally have a weak undergraduate background. The new proposed BS program will act as a feeder for our graduate program. As such, it seems important that for a strong graduate program in Applied Physics in Air University, a BS program should also be started by the Department of Physics at FBAS - AU.

2. Course of Study

The BS program in Physics is based on four years of education after higher secondary school. In the first two years, students will be offered core courses of Physics and Mathematics along with some Humanities and Science minor courses. After two years, students will take advance courses from Physics.

While designing the curriculum for this proposed program, the guidelines of Higher Education Commission (HEC) and the curriculum of BS Physics at National University of Science & Technology (NUST), Lahore University of Management Sciences (LUMS), Quaid-e-Azam University (QAU) and some leading international universities have been taken into account.

Structure of Program

Total : 131 credit hour

Division of Credit hours

(a) Course work : 125 (15-18 credit hour per semester)

- Core courses

Physics : 23 credit hours

- Mathematics : 21 credit hours
- Science minor : 10 credit hours
- Humanities courses : 10 credit hours
- Advance courses : 40 credit hours
- Elective courses : 21 credit hours

(b) Thesis / Research Project : 06 credit hours

Core Courses:

Core courses are designed to provide basic knowledge to build concepts that are essential to take up further studies in both specialized areas.

Physics	Mathematics
General Physics I – Basic Mechanics	Calculus I
General Physics II – Electricity and Magnetism	Calculus II / Multivariable Calculus
Heat and Thermodynamics	Ordinary Differential Equations
Waves and Oscillation	Linear Algebra
Modern Physics	Numerical Analysis and Computation
Classical Mechanics	Complex Analysis
Electrodynamics	Probability & Statistics

Science minor Courses:

Science minor
Computer Programming
Applied Chemistry
Introductory Biology

Humanities Courses:

Humanities
English / Technical Writing
Islamic Studies
Pakistan Studies
Communication Skills

Advanced Courses:

The advanced courses (minimum 14) will be selected from the Physics stream (see Page 8).

Elective Courses:

The elective subjects will be selected in consultation with the supervisor from the list shown in List of Electives (Page 9) keeping in view the students thesis/ project/ area of specialization. These courses will provide in depth knowledge in the area of specialization and lay foundation for future postgrad studies/research.

3. Title of the Degree

BS in Physics

4. Eligibility / Admission Criteria

As per AU policy, i.e., the Intermediate examination with Physics, Mathematics and Chemistry from any Board of Intermediate and Secondary Education in Pakistan 'OR' An examination equivalent to the Intermediate, such candidates are required to submit an Equivalence Certificate issued by the Inter-Board Chairman Committee, Islamabad before the semester starts. Applicant must have scored 50% or more marks.

AU Entry Test

a.	English	-	30%
b.	Physics	-	30%
d.	Mathematics	-	40%

5. Proposed Timeframe of Commencement

Fall 2015

6. Requirements

1. One dedicated class room for 50-60 students for the first year and a second dedicated class room of the same size from the 2nd year onward.

The present undergraduate physics teaching lab would be sufficient for the first year provided the EE Department defer offering its Physics course to spring semester. Otherwise another undergraduate physics lab of the same size would be needed for conducting labs during the first year. Whereas, an additional teaching lab would be required from the 2nd year onward.

Lab I: About Rs. 4M will be needed to setup the listed experiments (Page 18) for Semester V.

Lab II: About Rs. 6M will be needed to setup the listed experiments (Page 22) for Semester VI.

One lab engineer/teaching assistant during the first year and another lab engineer / teaching assistant from 2nd year onward.

Additional two faculty members would be required from the 2nd year onward.

One visiting FM in Semester-III will be required for Introductory Biology course.

Funds will be needed for final year projects (FYP's).

7. Faculty

Core Faculty

1. Dr. Abdullah Sadiq, Dean, Faculty of Basic & Applied Sciences, AU.
2. Dr. Muhammad Anwar, Chair Department of Physics, AU.
3. Dr. Asghari Maqsood, Professor, Department of Physics, AU.
4. Dr. Muhammad Atif, Assistant Professor, Department of Physics, AU.
5. Dr. Rubina Nasir, Assistant Professor, Department of Physics, AU.
6. Dr. Zulqurnain Ali, Assistant Professor, Department of Physics, AU.
7. Mr. M. Kashif Ali, Lecturer, Department of Physics, AU.
8. Ms. Anum Zaidi, Lecturer, Department of Physics, AU.
9. Mr. M. Ubaid Khan, Teaching Assistant, Department of Physics, AU.

Faculty on Leave

1. Mr. Aamir Minhas Khan (PhD student, China)

*He is expected to join department on **July 2015**.*

2. Ms. Tayyaba Firdous (PhD student, Canada)

She is expected to join department on July 2016.

3. Mr. Mozaffar Hussain (PhD student, China)

He is expected to join department on July 2016.

4. Mr. Muhammad Fakhar Zia (PhD student, Saudi Arabia)

He is expected to join department on December 2016.

5. Ms. Tashfeen Zehra (PhD student, Netherlands)

She is expected to join department on December 2016.

8. Proposed Fees Details

Program	Total Credit Hours	Tuition Fee Rate (Per Cr. Hr.)	Estimated Total Cost of Degree Program	Credit Hours 1 st Semester	Tuition Fee as Per Cr. Hr. for 1 st Semester
Bachelor of Science in Physics	131	Rs. 2,813/-	Rs. 368,503/-	16	Rs. 45,008/-

9. Recommendations

- The proposed program has already been recommended by DBS, FBS and UFC.
- Need formal recommendation from Academic Council for launching BS program in Fall 2015.

BS Program in Physics

SEMESTER - I

Course Code	Course Title	Cr.Hrs
PH-105	Physics I – Basic Mechanics	3-1-4
MA-101	Calculus I	3-0-3
HU-104	English / Technical Writing	3-0-3
HU-118	Islamic Studies	2-0-2
CS-161	Computer Programming	3-1-4

SEMESTER - II

Course Code	Course Title	Cr.Hrs
PH-106	Physics II – Electricity and Magnetism	3-1-4
MA-105	Calculus II / Multivariable Calculus	3-0-3
CH-101	Applied Chemistry	3-0-3
HU-115	Pakistan Studies	2-0-2
HU-101	Communication Skills	3-0-3

SEMESTER - III

Course Code	Course Title	Cr.Hrs
PH-201	Heat and Thermodynamics	3-0-3
PH-202	Waves and Oscillation	3-0-3
MA-106	Ordinary Differential Equations	3-0-3
MA-201	Linear Algebra	3-0-3
BIO-101	Introductory Biology	3-0-3

SEMESTER - IV

Course Code	Course Title	Cr.Hrs
PH-203	Modern Physics	3-0-3
PH-204	Classical Mechanics	3-0-3
PH-205	Electrodynamics	3-0-3
MA-202	Numerical Analysis and Computation	3-0-3
MA-209	Complex Analysis	3-0-3
MA-304	Probability & Statistics	3-0-3

SEMESTER - V

Course Code	Course Title	Cr. Hrs
PH-301	Methods of Mathematical Physics	3-0-3
PH-302	Physical Electronics	3-0-3
PH-303	Quantum Mechanics I	3-0-3
PH-304	Circuit Electronics	3-0-3
PH-305	Electromagnetic and Relativity Theory	3-0-3
PH-306	Lab - I	0-2-2

SEMESTER - VI

Course Code	Course Title	Cr. Hrs
PH-307	Methods of Mathematical and Computational Physics	3-0-3
PH-308	Quantum Mechanics II	3-0-3
PH-309	Solid State Physics I	3-0-3
PH-310	Atomic & Molecular Physics	3-0-3
PH-311	Nuclear Physics	3-0-3
PH-312	Lab - II	0-2-2

SEMESTER - VII

Course Code	Course Title	Cr. Hrs
PH-401	Statistical Mechanics	3-0-3
PH-402	Solid State Physics II	3-0-3
PH-4xx	Elective - I	3-0-3
PH-4xx	Elective - II	3-0-3
PH-4xx	Elective - III	3-0-3
PH-498	Final Year Project	03

SEMESTER - VIII

Course Code	Course Title	Cr. Hrs
PH-4xx	Elective - IV	3-0-3
PH-4xx	Elective - V	3-0-3
PH-4xx	Elective - VI	3-0-3
PH-4xx	Elective - VII	3-0-3
PH-499	Final Year Project	03

List of Electives

Course Code	Course Title	Cr. Hrs
PH-403	Digital Electronics	3-0-3
PH-404	Computational Physics	3-0-3
PH-405	Introduction to Photonics	3-0-3
PH-411	Introduction to Nanomaterials	3-0-3
PH-412	Electronics Materials and Devices	3-0-3
PH-413	Smart Nanomaterials	3-0-3
PH-414	Surfaces and Interfaces	3-0-3
PH-415	Characterization of Materials	3-0-3
PH-416	Functional properties of materials	3-0-3
PH-431	Particle Physics	3-0-3
PH-432	Plasma Physics	3-0-3
PH-433	Group Theory	3-0-3
PH-434	Lasers and Quantum Optics	3-0-3
PH-435	Introduction to Quantum Computation	3-0-3
PH-436	Quantum Information Theory	3-0-3

CONTENTS OF BS COURSES

PH-105 Physics I – Basic Mechanics

Credit Hours: Four (3-1-4)

Objectives:

The main objective of this course is to understand the different motions of objects on a macroscopic scale and to develop simple mathematical formalisms to analyze such motions. This is a calculus - based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Basic Concepts: Units and Dimensions, SI Units, Changing Units, Scalars and Vectors, Adding Vectors: Graphical as well as Component Method, Multiplying Vectors: Dot and Cross Products.

Motion in One, Two and Three Dimensions: Position & Displacement, Velocity and Acceleration, Motion under Constant Acceleration, Projectile Motion, Uniform Circular Motion, Relative Velocity and Acceleration in One and Two Dimensions, Inertial and Non-Inertial Reference Frames.

Newton's Laws: Newton's Laws of Motion and their Applications involving some particular forces including Weight, Normal Force, Tension, Friction, and Centripetal Force, Newton's Law of Gravitation, Gravitational Potential Energy, Escape Velocity, Kepler's Laws, Satellite Orbits & Energy.

Work and Kinetic Energy: Work done by Constant and Variable Forces: Gravitational and Spring Forces, Power, Conservative and Non-conservative Forces, Work and Potential Energy, Isolated Systems and Conservation of Mechanical Energy, Work Done by External Forces including Friction and Conservation of Energy.

System of Particles: Motion of a System of Particles and Extended Rigid Bodies, Center of Mass and Newton's Laws for a System of Particles, Linear Momentum, Impulse, Momentum & Kinetic Energy in One and Two Dimensional Elastic and Inelastic Collisions.

Rotational Motion: Rotation about a Fixed Axis, Angular Position, Angular Displacement, Angular Velocity and Angular Acceleration, Rotation under Constant Angular Acceleration, relationship between Linear and Angular Variables, Rotational Inertia, Parallel-axis Theorem, Torque and Newton's Law for Rotation, Work and Rotational Kinetic Energy, Power, Rolling Motion, Angular Momentum for a single Particle and a System of Particles, Conservation of Angular Momentum, Precession of a Gyroscope, Static Equilibrium involving Forces and Torques, Determination of moment of inertia of various shapes i.e. for disc, bar and solid sphere.

Angular Momentum: Angular Velocity, Conservation of angular momentum, effects of Torque and its relation with angular momentum.

Simple Harmonic Motion (SHM): Amplitude, Phase, Angular Frequency, Velocity and Acceleration in SHM, Linear and Angular Simple Harmonic Oscillators, Energy in SHM, Simple Pendulum, Physical Pendulum, SHM and Uniform Circular Motion, Damped Harmonic Oscillator.

Special Theory of Relativity: Inertial and non-inertial frame, Postulates of Relativity, The Lorentz Transformation, Derivation, Assumptions on which inverse transformation is derived, Consequences of Lorentz transformation, Relativity of time, Relativity of length, Relativity of mass, Transformation of velocity, variation of mass with velocity, mass energy relation and its importance, relativistic momentum and Relativistic energy.

Reference Books:

- D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed. 2010.
- R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed. 2010.
- R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.
- F. J. Keller, W. E. Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill. 2nd ed. 1992.
- D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed. 2008.

Mechanics Lab:

1. To measure the density of Sphere, wires and disc by using Vernier Calliper and Screw Gauge.
2. Vector analysis and equilibrium of forces with the help of Force Table.
3. Find the coefficient of friction of different surfaces with the help of Inclined Plane.
4. Find the value of g by Atwood machine (by using pulley).
5. Instantaneous and average velocity with the help of Air Track System.
6. Observation of Newton's Laws with the help of Air Track System.
7. Elastic Collision and Conservation of momentum with the help of Air Track System.
8. Conservation of energy with the help of Air Track System.
9. Find spring constant of different springs by using hook's law.

PH-106 Physics II – Electricity and Magnetism

Pre-requisite: Mechanics, Calculus I

Credit Hours: Four (3-1-4)

Objectives:

The main objective of this course is to understand the Physics of Electromagnetism and to develop simple mathematical formalisms to analyze the electromagnetic fields and interactions. This is a calculus-based introductory course with maximum emphasis on applying the acquired knowledge to solving problems.

Electrostatics: Electric Charge, Conductors and Insulators, Coulomb's Law, Electric Fields due to a Point Charge and an Electric Dipole, Electric Field due to a Charge Distribution, Electric Dipole in an Electric Field, Electric Flux, Gauss' Law and its Applications in Planar, Spherical and Cylindrical Symmetry.

Electric Potential: Equipotential Surfaces, Potential due to a Point Charge and a Group of Point Charges, Potential due to an Electric Dipole, Potential due to a Charge Distribution, Relation between Electric Field and , Electric Potential Energy.

Capacitors and Capacitance: Parallel Plate, Cylindrical and Spherical capacitors, Capacitors in Series and Parallel, Energy Stored in an Electric Field, Dielectrics and Gauss' Law.

DC Circuits: Electric Current and Current Density, Resistance and Resistivity, Ohm's Law, Power in Electric Circuits, Semiconductors and Superconductors, Work, Energy, and EMF, Resistances in Series and Parallel, Single and Multi-loop Circuits, Kirchhoff's Rules, RC Circuits, Charging and Discharging of a Capacitor.

Magnetic Field and Magnetic Force: Crossed Electric and Magnetic Fields and their Applications, Hall Effect, Magnetic Force on a Current Carrying Wire, Torque on a Current Loop, Magnetic Dipole Moment, Magnetic Field Due to a Current, Force between two Parallel Currents, Ampere's Law, Biot-Savart Law: Magnetic Field due to a Current, Long Straight Wire carrying Current, Solenoids and Toroids, A current-carrying Coil as a Magnetic Dipole, Inductance, Faraday's Law of Induction, Lenz's Law, Induction and Energy Transfers, Induced Electric Fields, Inductors and Inductances, Self Inductance, RL Circuits, Energy Stored in a Magnetic Field, Energy Density, Mutual Induction.

Alternating Fields and Currents: LC Oscillations, Damped Oscillations in an RLC circuit, Alternating Currents, Forced Oscillations, Resistive, Capacitive, and Inductive Loads, RLC series Circuit, Power in AC Circuits, Transformers, Gauss' Law for Magnetism, Induced Magnetic Fields, Displacement Current, Spin & Orbital Magnetic Dipole Moment, Diamagnetism, Paramagnetism, Ferromagnetism, Hysteresis.

Reference Books:

1. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley & Sons, 9th ed. 2010.
- R. A. Serway and J. W. Jewett, "Physics for Scientists and Engineers", Golden Sunburst Series, 8th ed. 2010.
- R. A. Freedman, H. D. Young, and A. L. Ford (Sears and Zeemansky), "University Physics with Modern Physics", Addison-Wesley-Longman, 13th International ed. 2010.
- F. J. Keller, W. E. Gettys and M. J. Skove, "Physics: Classical and Modern, McGraw Hill. 2nd ed. 1992.
- D. C. Giancoli, "Physics for Scientists and Engineers, with Modern Physics", Addison-Wesley, 4th ed. 2008.

Electricity and Magnetism Lab:

- To observe the charge behavior with help of Electroscope.
- To estimate the amount of charge on a small piece of paper or comb.
- Charging and discharging of the capacitors.
- To find the resistance of galvanometer, by using half deflection method.
- To convert galvanometer into voltmeter.
- To convert galvanometer into ammeter.
- Magnetic Forces on Wires Experiment
 - . Relationship between Force versus Current
 - . Relationship between Force versus Length of Wire

- . Relationship between Force versus Magnetic Field
- . Relationship between Force versus Angle
- 8. Faraday's Law of electromagnetic induction.
 - (i) Induced emf.
 - (ii) Conservation of Energy.

PH-201 Heat and Thermodynamics

Pre-requisites: PH-105

Credit Hours: Three (3)

Objectives:

To understand the fundamentals of heat and thermodynamics.

Basic Concepts and Definitions in Thermodynamics: Thermodynamic system, Surrounding and

Boundaries. Type of systems. Macroscopic and microscopic description of system. Properties and state of the substance: Extensive and Intensive properties, Equilibrium, Mechanical and Thermal Equilibrium. Processes and Cycles: Isothermal, Isobaric and Isochoric. Zeroth Law of Thermodynamics, Consequence of Zeroth law of Thermodynamics. The state of the system at Equilibrium.

Heat and Temperature: Temperature, Kinetic theory of ideal gas, Work done on an ideal gas, Review of previous concepts.

Internal energy of an ideal gas: Equipartition of Energy, Intermolecular forces, Qualitative discussion, The Virial expansion, The Van der Waals equation of state.

Thermodynamics: First law of thermodynamics and its applications to adiabatic, isothermal, cyclic and free expansion. Reversible and irreversible processes. Second law of thermodynamics, Carnot theorem and Carnot engine. Heat engine, Refrigerators. Calculation of efficiency of heat engines. Thermodynamic temperature scale: Absolute zero, Entropy, Entropy in reversible process, Entropy in irreversible process. Entropy and Second law of thermodynamics, Entropy and Probability. Thermodynamic Functions: Thermodynamic functions (Internal energy, Enthalpy, Gibb's functions, Entropy, Helmholtz functions), Maxwell's relations, TdS equations, Energy equations and their applications. Low Temperature Physics, Joule -Thomson effect and its equations. Thermoelectricity: Thermocouple, Sebeck's effect, Peltier's effect, Thomson effect.

Introduction to Statistical Mechanics: Statistical distribution and mean values, Mean free path and microscopic calculations of mean free path. Distribution of Molecular Speeds, Distribution of Energies, Maxwell distribution, Maxwell Boltzmann energy distribution, Internal energy of an ideal gas, Brownian Motion Legvaian equation, Qualitative description.

Reference Books:

1. D. Halliday, R. Resnick and K. Krane, "Physics", John Wiley, 5th ed.2002.
2. D. Halliday, R. Resnick and J. Walker, "Fundamentals of Physics", John Wiley, 9th ed. 2010.
3. M. W. Zemansky, "Heat and Thermodynamics", McGraw Hill, 7th ed.1997.
4. M. Sprackling, "Thermal Physics" McMillan 1991.
5. B. N. Roy, "Principle of Modern Thermodynamics", Institute of Physics, London 1995.

PH-202 Waves and Oscillations

Pre-requisites: PH-105, MA-105

Credit Hours: Three (3)

Objectives:

To develop a unified mathematical theory of oscillations and waves in physical systems.

Simple and Damped Simple Harmonic Oscillation: Mass-Spring System, Simple Harmonic Oscillator Equation, Complex Number Notation, LC Circuit, Simple Pendulum, Quality Factor, LCR Circuit.

Forced Damped Harmonic Oscillation: Steady-State Behavior, Driven LCR Circuit, Transient Oscillator Response, Resonance.

Coupled Oscillations: Two Spring-Coupled Masses, Two Coupled LC Circuits, Three Spring Coupled Masses, Normal Modes, Atomic and Lattice Vibrations.

Transverse Waves: Transverse Standing Waves, Normal Modes, General Time Evolution of a Uniform String, Phase velocity, Group Velocity.

Longitudinal Waves: Spring Coupled Masses, Sound Waves in an Elastic Solid, Sound Waves in an Ideal Gas.

Traveling Waves: Standing Waves in a Finite Continuous Medium, Traveling Waves in an Infinite Continuous Medium, Energy Conservation, Transmission Lines, Reflection and Transmission at Boundaries, Electromagnetic Waves.

Wave Pulses: Fourier Series and Fourier Transforms, Bandwidth, Heisenberg's Uncertainty Principle.

Multi-Dimensional Waves: Plane Waves, Three-Dimensional Wave Equation, Laws of Geometric Optics, Waveguides, Cylindrical Waves.

Interference and Diffraction of Waves: Double-Slit Interference, Single-Slit Diffraction.

Reference Books:

1. J. Pain, "The Physics of Vibrations and Waves", John Wiley, 6th ed. 2005.
2. P. French, "Vibrations and Waves", CBS Publishers (2003).
3. F. S. Crawford, Jr., "Waves and Oscillations", Berkeley Physics Course, Vol. 3, McGraw-Hill, 1968.
4. A. Hirose, and K. E. Lonngren, "Introduction to Wave Phenomena", Krieger Publications, 2003.

PH-203 Modern Physics

Pre-requisites: PH-105, PH-106

Credit Hours: Three (3)

Objectives:

To understand the non-classical aspects of Physics, the emphasis is on the applications of Quantum Physics in microscopic-scale Physics, atomic and molecular structure and processes.

Motivation for Non--Classical Physics: Quantum interference, blackbody radiation and ultraviolet catastrophe, Planck's quantization.

Wave-Particle Duality: Photoelectric effect, Compton effect, production and properties of X-rays, diffraction of X-rays, concept of matter waves, deBroglie relationship, electrons are waves, electron diffraction, particulate nature of matter, contributions of Faraday (atoms exist), Thomson (electron

exists), Rutherford (nucleus exists) and Bohr (quantization of energies inside an atom), wave packets and wave groups, dispersion, Heisenberg uncertainty principle, direct confirmation

of quantization through Franck-Hertz experiment and spectroscopy, working of electron microscopes.

Quantum Mechanics in One Dimension: The concept of a wave function, time independent Schrodinger equation and interpretation of the equation, solving the Schrodinger equation for a free particle, for a particle inside an infinite box, relationship between confinement and quantization, working of a CCD camera.

Quantum Mechanical Tunneling: Concept of tunneling, reflection and transmission of wave functions from barriers, applications: radioactivity, scanning tunneling microscope, decay of black holes.

Quantum Mechanics in Three Dimensions: The Hydrogen atom, orbitals, angular momentum and its quantization, orbital magnetism, Zeeman effect, concept of spin, Pauli's exclusion principle, Building of the periodic table, magnetic resonance and MRI, why is iron magnetic? White dwarfs, and neutron stars.

From Atoms to Molecules and Solids: Ionic bonds, covalent bonds, hydrogen bonds, molecular orbitals, how crystals are different from amorphous solids? Why and how do metals conduct electricity? Bands in solids, semiconductors, introduction to LED's and lasers, introducing grapheme.

Nuclear Structure: Size and structure of nucleus, nuclear forces, radioactivity and nuclear reactions, radiocarbon dating.

Reference Books:

1. R.A. Serway, C.J. Moses and C.A. Moyer, "Modern Physics", Brooks Cole, 3rd ed. 2004.
2. Paul A. Tipler and Ralph A. Llewellyn, "Modern Physics", W H Freeman and Company 6th ed. 2012.
3. Arthur Beiser, "Concepts of Modern Physics", McGraw-Hill, 6th ed. 2002.
4. R. M. Eisberg and R. Resnick, "Quantum Physics of Atoms, molecules, Solids, Nuclei and Particles", John Wiley, 2nd ed. 2002.

PH-204 Classical Mechanics

Pre-requisites: PH-105

Credit Hours: Three (3)

Review of Newtonian Mechanics: Frame of reference, orthogonal transformations, angular velocity and angular acceleration, Newton's laws of motion, Galilean transformation, conservation laws, systems of particles, motion under a constant force, motions under variable force, time-varying mass system.

The Lagrange Formulation of Mechanics and Hamilton Dynamics: Generalized co-ordinates and constraints, D'Alembert's principle and Lagrange's Equations, Hamilton's principle, integrals of motion, nonconservative system and generalized potential, Lagrange's multiplier method, the Hamiltonian of a dynamical system, canonical equations, canonical transformations, Poisson brackets, phase space and Liouville's theorem.

Central Force Motion: The two-body problem, effective potential and classification of orbits,

Kepler's laws, stability of circular orbits, hyperbolic orbits and Rutherford scattering, center of mass co-ordinate system, scattering cross-sections.

Motion in Non-inertial Systems: Accelerated translational co-ordinate system, dynamics in rotating co-ordinate system, motion of a particle near the surface of the earth.

The Motion of Rigid Bodies: The Euler angles, rotational kinetic energy and angular momentum, the inertia tensor, Euler equations of motion, motion of a torque-free symmetrical top, stability of rotational motion.

Reference Books:

1. T. L. Chow, "Classical Mechanics", John Wiley, 1995.
2. T. Kibble and F. Berkshire, "Classical Mechanics", World Scientific, 5th ed. 2004.
4. M. Sprackling, "Thermal Physics" McMillan 1991.

PH-205 Electrodynamics

Pre-requisites: PH-106, MA-105

Credit Hours: Three (3)

Review of Calculus: vector algebra and calculus, Cartesian coordinates spherical coordinates.

The Dirac Delta Function: Review of vector calculus using example of Dirac Delta function, the divergence of $\mathbf{r}/r^2$, the one-dimensional and the three dimensional Dirac delta functions. The theory of vector fields: the Helmholtz theorem, potentials.

Electrostatics: The electric field: introduction, Coulomb's law, the electric field, continuous charge distributions. Divergence and curl of electrostatic fields: field lines, flux and Gauss's law, the divergence of $\mathbf{E}$, applications of Gauss's law, the curl of $\mathbf{E}$. Electric potential: introduction to potential, comments on potential, Poisson's equation and Laplace's equation, the potential of a localized charge distribution, summary, electrostatics boundary conditions, Work and energy in electrostatics: the work done to move a charge, the energy of a point charge distribution, the energy of a continuous charge distribution, comments on electrostatic energy. Conductors: basic properties, induced charges, surface charge and the force on a conductor, capacitors.

Special Techniques: Laplace's equation: introduction, Laplace's equation in one, two and three dimensions, boundary conditions and uniqueness theorems, conductors and second uniqueness theorems.

The Method of Images: The classic image problem, induced surface charge, force and energy, other image problems.

Multi-pole Expansion: Approximate potential at large, the monopole and dipole terms, origin of coordinates in multi-pole, expansions, the electric field of a dipole.

Electric Fields in Matter: Polarization: dielectrics, induced dipoles, alignment of polar molecules, polarization. The field of a polarized object: bound charges, physical interpretation of bound charges, and the field inside a dielectric. The electric displacement: Gauss's law in the presence of dielectrics, a deceptive parallel, boundary conditions. Linear Dielectrics: susceptibility, permittivity, dielectric constant, boundary value problems with linear dielectrics, energy in dielectric systems, forces on dielectrics.

Magnetostatics: The Lorentz Force law: magnetic fields, magnetic forces, currents. The Biot-Savart Law: steady currents, the magnetic field of a steady current. The divergence and curl of $\mathbf{B}$: straight-line currents, the divergence and curl of $\mathbf{B}$, applications of Ampere's law, comparison of

magnetostatics and electrostatics. Magnetic Vector Potential: the vector potential, summary, magnetic boundary conditions, multi-pole expansion of the vector potential.

Magnetic Fields in Matter: Magnetization, diamagnets, paramagnets, ferromagnets, torques and forces on magnetic dipoles, effect of a magnetic field on atomic orbits, magnetization. The Field of a Magnetized Object: bound currents, physical interpretation of bound currents, and the magnetic field inside matter. The auxiliary field H : Ampere's law in magnetized materials, a deceptive parallel, boundary conditions. Linear and nonlinear media: magnetic susceptibility and permeability, ferromagnetism.

Reference Books:

1. D. J. Griffiths, "Introduction to Electrodynamics", Prentice Hall, 3rd ed.1999.
2. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 5th ed. 2009.
3. F. Melia, "Electrodynamics", University of Chicago Press, 2001.
4. Hearld J and W. Muller-Kristen, "Electrodynamics", World Scientific Publishing, 2nd ed. 2011.

PH-301 Methods of Mathematical Physics

Pre-requisites: PH-105, MA-106, MA-201

Credit Hours: (Three) 3

Objective(s):

To develop the mathematical background of student in vectors, tensors, matrices and some of their uses in the world of physics, to give basic understanding of group theory and complex variables used in physics.

Review of vector analysis: definitions, rotation of coordinate axes, scalar product, cross product, addition of vectors.

Differential operators, gradient, divergence, curl, integration of vector fields, Gauss' theorem, Stokes' theorem, Gauss' law, Poisson's equation.

Definition of delta function, representations including plane wave expansion, generalization to 3 dimensions.

Vector analysis in curvilinear coordinates, orthogonal coordinates in R^3 , circular and spherical coordinates, definition of tensors, contraction, direct product, quotient rule, pseudo tensors, dual tensors, tensor derivative operators.

Determinants, matrices, orthogonal and unitary matrices, matrix diagonalization, trace theorem, relation between determinants and traces.

Finite and infinite sequences, limit of a sequence.

Finite and infinite series, tests of convergence, alternating series, algebra of series, series of functions, Taylor's expansion and power series, Bernoulli numbers, Euler-Maclaurin formula, asymptotic series, infinite products

Fourier series and analysis, use and application to physical systems. orthogonality and orthonormality, complete sets of functions, Gibbs phenomenon, discrete and continuous Fourier transform.

Complex algebra, functions of a complex variable, Cauchy-Riemann conditions, integration of complex functions, calculus of residues, Cauchy's theorem, Laurent expansion, dispersion relations.

Recommended Books:

1. G. Arfken, H. J. Weber, and F. E. Harris, "Mathematical Methods for Physicists", Academic Press, 7th ed. 2012.
2. K. F. Riley, M. P. Hobson, S. J. Bence, "Mathematical Methods for Physicists", Cambridge University Press, 2006.
3. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley, 8th ed. 1999.
4. Tai L. Chow, "Mathematical Methods for Physicists", Cambridge University Press, 2002.

PH-302 Physical Electronics

Pre-requisites: PH-205

Credit Hours: Three (3)

The crystal lattice, basic quantum mechanics, energy bands, elemental semiconductors, compound semiconductors, alloys, semiconductors electrons, holes, density-of-states, effective mass, carrier concentration, doping, recombination, the Fermi energy, quasi -Fermi energies, mobility, conductivity, Hall effect, optical properties of semiconductors, carrier drift and diffusion.

Diodes (pn junction, Schottky, LED's, laser diodes, solar cells and photodiodes), bipolar transistors, field effect transistors: JFET's, MESFETs, MODFETs and MOSFET's.

Recommended Books:

1. Donald A. Neamen, "Semiconductor Physics and Devices: Basic Principles",

McGraw-Hill, 2003.

PH-303 Quantum Mechanics I

Pre-requisites: PH-203

Credit Hours: Three (3)

Historical motivation: wave-particle duality, photo-electric effect, instability of atoms, black body catastrophe.

Observables and operators, postulates of mechanics, measurement problems, the state function and expectation values, Schrödinger wave equation.

Time-independent Schrödinger equation and one-dimensional problems, stationary states, superposition principle, free particles, infinite and finite square well, harmonic oscillator, and delta-function potential.

Hilbert space, Dirac notation, linear transformations, discrete and continuous basis vectors, hermitian and unitary operators.

Compatible observables, commutators, uncertainty principle, minimum uncertainty states.

Time development of state functions, symmetries and conservation laws, conservation of parity, operators for time and space translations.

Waves incident on potential barrier, reflection and transmission coefficients, WKB method.

Quantum mechanics in three-dimensions, cartesian and spherical forms of Schrodinger equation, separation of variables.

Rotational symmetry, angular momentum as a generator of rotations, spherical harmonics and their properties. Completeness and orthonormality properties.

Recommended Textbook:

1. D.J. Griffiths, "Introduction to Quantum Mechanics", Addison-Wesley, 2nd ed. 2004.
2. R. Liboff, "Introductory Quantum Mechanics", Addison-Wesley, 4 ed. 2002.
3. N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.

PH-304 Circuit Electronics

Pre-requisites:

Credit Hours: Three (3)

Ohm's law, Kirchoff's voltage and current laws, the superposition principle, multi-path circuits.

Source transformation, maximum power transfer theorem, Thevenin-Norton equivalent circuits, linear system analysis basics.

Introduction to semiconductors, intrinsic and extrinsic semiconductors, temperature dependence of carrier concentrations, electrons and holes.

Basic principles of pn junctions, built-in potential, and space charge layers, forward and reverse bias, the diode equation.

Ideal diodes, terminal characteristics of junction diodes, modeling the diode forward characteristic, operation in the reverse breakdown region.

Rectifier circuits, limiting and clamping circuits, special diodes (Zener and tunnel diodes) and applications.

Fully controlled single phase SCR bridge rectifier and rectifier circuits, switch mode power supplies.

Bipolar Junction Transistors (BJT), device structure and physical operation, current-voltage characteristics, DC analysis and biasing techniques, small-signal operation and models, single stage amplifier, transfer functions, BJTs as a switch.

Basic operational amplifiers, inverting and non-inverting, differential modes, gain and bandwidth, frequency response, nonlinear applications.

Principles of feedback, stability, oscillator circuits, analysis in real time and frequency space

Recommended Books:

1. A.S. Sedra and K.C. Smith, "Microelectronic Circuits", Oxford University Press, 5th Edition, 2007.
2. D.S. A. Neamen, "Semiconductor Physics and Devices", McGraw – Hill

Science/Engineering/Math, 3rd Edition, 2002.

3. J. O. Bird, "Electrical Circuit Theory and Technology", Newnes (an Imprint of Butterworth – Heinemann Ltd), 2nd Revised Edition, 2003.

PH-305 Electromagnetic and Relativity Theory

Pre-requisites: PH-205

Credit Hours: Three (3)

Electrodynamics: Electromotive force: Ohm's law, electromotive force, motional emf, electromagnetic induction: Faraday's law, the induced electric field, inductance, energy in magnetic fields, Maxwell's equations: electrodynamics before Maxwell, how Maxwell fixed Ampere's law, Maxwell's equations, magnetic charges, Maxwell's equations in matter, boundary conditions.

Conservation Laws: Charge and energy: the continuity equation, Poynting's theorem, momentum: Newton's third law in electrodynamics, Maxwell's stress tensor, conservation of momentum, angular momentum.

Electromagnetic Waves: Waves in one dimension: the wave equation, sinusoidal waves, boundary conditions, reflection and transmission, polarization, electromagnetic waves in vacuum: the wave equation for E and B, monochromatic plane waves, energy and momentum in electromagnetic waves, electromagnetic waves in matter: propagation in linear media, reflection and transmission at normal incidence, reflection and transmission at oblique incidence, absorption and dispersion: electromagnetic waves in conductors, reflection at a conducting surface, the frequency dependence of permittivity, guided waves: wave guides, the waves in a rectangular wave guide, the coaxial transmission line.

Potentials and Fields: The potential formulation: scalar and vector potentials, gauge transformations, Coulomb gauge and Lorentz gauge, continuous distributions: retarded potentials, Jefimenko's equations, point charges: Lienard-Wiechert potentials, the field of a moving point charge.

Radiation, Dipole Radiation: What is radiation, electric dipole radiation, magnetic dipole radiation, radiation from an arbitrary source, point charges: power radiated by a point charge, radiation reaction, the physical basis of the radiation reaction.

Electrodynamics and Relativity: The special theory of relativity: Einstein's postulates, the geometry of relativity, the Lorentz transformations, the structure of space-time, relativistic mechanics: proper time and proper velocity, relativistic energy and momentum, relativistic kinematics, relativistic dynamics, relativistic electrodynamics: magnetism as a relativistic phenomenon, how the field transform, the field tensor, electrodynamics in tensor notation, relativistic potentials.

Recommended Books:

1. D. J. Griffiths, "Introduction to Electrodynamics", ed. Prentice Hall, 3rd ed. 1999.
2. M. N. O. Sadiku, "Elements of Electromagnetics", Oxford University Press, 5th ed. ed. 2009.
3. F. Melia, "Electrodynamics", University of Chicago Press, 1st ed. 2001.
4. Hearld J and W. Muller-Kristen, "Electrodynamics", World Scientific Publishing, 2nd ed. 2011.

PH-306 Lab-I

Pre-requisites:

Credit Hours: Two (2)

No.	Name of Experiment	Purpose of the Experiment
1	Rectifier	In this experiment, diodes are used to rectify an AC signal, and to build part of the basic circuitry of a power supply.
2	Clipping and Clamping Circuits	To steady the diode applications in a clipping and clamping circuits.
3	Transistor	The purpose of this experiment is to investigate how the npn transistor operates as a digital switch.

4	Multi-vibrator	The purpose of this experiment to study the operation of (i) Bistable, (ii) Monostable, and (iii) Astable.
5	Basic op-amp circuits	To steady op-amp as, (i) Integrator, (ii) differentiator, (iii) Voltage Follower.
6	Digital Circuit	To steady Basic logic Gates (NAND,NOR,NOT,XOR)

PH-307 Methods of Mathematical and Computational Physics

Pre-requisites: PH-301

Credit Hours: Three (3)

Vector spaces, basis vectors, linear independence, function spaces.

Review of differentiation and integration, continuity and differentiability, functions of many variables.

First order differential equations, general solution by integration, uniqueness property.

Second order differential equations with constant coefficients, Euler linear equations, singular points, series solution by Frobenius' method, solution space, Wronskian, uniqueness.

Special functions: gamma and beta functions, Stirling's series, Legendre equation, Associated Legendre functions, Hermite equation and polynomials, Laguerre equation and associated polynomials, Bessel's equation and solutions, spherical Bessel functions.

Use of Mathematica for items 2-5 above: students will be given practice questions to solve using a computer.

Second order linear partial differential equations, Laplace equation, wave equation, solution of Poisson equation

Definition of probability, simple properties, random variables, binomial distribution, Poisson and Gaussian distributions, central limit theorem, statistics.

Numerical methods: interpolation, root finding, numerical integration, matrix manipulation, numerical solutions of ODE's, least square fit.

Recommended Texts:

1. G. Arfken, H. J. Weber, and F. E. Harris, "Mathematical Methods for Physicists", Academic Press, 7th ed. 2012.

2. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley, 8th ed. 1999.

3. J. Douglas Faires and Richard L. Burden, "Numerical Analysis", Brooks, 8th ed., 2005.

4. Tai L. Chow, "Mathematical Methods for Physicists", Cambridge University Press, 2002.

PH-308 Quantum Mechanics II

Pre-requisites: PH-303

Credit Hours: Three (3)

Motion of a particle in a central potential. Separation of variables, effective potential, solution for the Coulomb problem. Spectrum of the hydrogen atom.

Spin as an internal degree of freedom, intrinsic magnetic moment, intrinsic angular momentum,

spin-orbit interaction and total angular momentum.

Identical particles: Many-particle systems, system of distinguishable noninteracting particles, systems of identical particles, symmetrization postulate, Pauli exclusion principle and the periodic table.

Time-independent perturbation theory: Nondegenerate perturbation theory, degenerate perturbation theory. The variational principle: Variational theorem, variational approximation method, the ground state of helium atom.

The WKB approximation: WKB wave functions, general connection rules across a classical turning point, tunneling.

Time-dependent perturbation theory: A perturbed two-level system, perturbation by an electromagnetic wave, transition into a continuum of states-Fermi's golden rule, Oscillator strengths, selection rules.

Scattering: Classical scattering theory, quantum scattering theory, partial wave analysis, phase shifts, the Born approximation.

The adiabatic approximation: The adiabatic theorem, Berry's phase, the Aharonov-Bohm effect.

Recommended Books:

1. D.J. Griffiths, "Introduction to Quantum Mechanics", Addison-Wesley, 2nd ed. 2004.
2. R. Liboff, "Introductory Quantum Mechanics", Addison-Wesley, 4th ed. 2002.
3. N. Zettili, "Quantum Mechanics: Concepts and Applications", John Wiley, 2nd ed. 2009.

PH-309 Solid State Physics I

Pre-requisites: PH-303

Credit Hours: Three (3)

Crystal Structure: Lattices and basis, Symmetry operations, Fundamental Types of Lattice, Position and Orientation of Planes in Crystals, Simple crystal structures.

Crystal Diffraction and Reciprocal Lattice: Diffraction of X-rays, Neutrons and electrons from crystals; Bragg's law; Reciprocal lattice, Ewald construction and Brillouin zone, Fourier Analysis of the Basis.

Phonons and Lattice: Quantization of Lattice Vibrations, Phonon momentum, inelastic scattering by phonons, Lattice Vibrations for Monoatomic and diatomic basis, Optical Properties in the Infrared Region.

Thermal Properties of Solids: Lattice heat Capacity, Classical model, Einstein Model, Enumeration of normal modes, Density of state in one, two or three dimensions, Debye model of heat capacity, Comparison with experimental results, thermal conductivity and resistivity, Umklapp processes.

Electrical Properties of Metals: Classical free electron theory of metals, energy levels and density of orbital's in one dimension, effect of temperature on the Fermi-Dirac distribution function, properties of the free electron gas, electrical conductivity and Ohm's Law, thermal and electrical conductivities of metals and their ratio, motion of free electrons in magnetic fields, cyclotron frequency, static magneto conductivity and Hall Effect along with Applications.

Recommended Books:

1. C. Kittel, "Introduction to Solid State Physics", John Wiley, 8th ed. 2005.
2. N. W. Ashcroft and N. D. Mermin, "Solid State Physics", Rinehart & Winston, 1976.

3. S. R. Elliott, "The Physics and Chemistry of Solids", John Wiley, 1998
4. M. A. Omar, "Elementary and Solid State Physics", Pearson Education, 2000.
5. H. M. Rosenberg, "The Solid State", Oxford Science Publication, 3rd ed. 1988.
6. M. A. Wahab, "Solid State Physics", Narosa Publishing House, 1999.

PH-310 Atomic and Molecular Physics

Pre-requisites: PH-203, PH-303

Credit Hours: Three (3)

Objective(s):

To provide an introduction to the structure and spectra of atoms and molecules. To prepare students for more advanced courses on Physics of Atoms, Molecules and Photons.

One Electron Atoms: Review of Bohr Model of Hydrogen Atom, Reduced Mass, Atomic Units and Wavenumbers, Energy Levels and Spectra, Schrodinger Equation for One-Electron Atoms, Quantum Angular Momentum and Spherical Harmonics, Electron Spin, Spin-Orbit interaction. Levels and Spectroscopic Notation, Lamb Shift, Hyperfine Structure and Isotopic Shifts. Rydberg Atoms.

Interaction of One-Electron Atoms with Electromagnetic Radiation:

Radiative Transition Rates, Dipole Approximation, Einstein Coefficients, Selection Rules, Dipole Allowed and Forbidden Transitions. Metastable Levels, Line Intensities and Lifetimes of Excited States, Shape and Width of Spectral Lines, Scattering of Radiation by Atomic Systems, Zeeman Effect, Linear and Quadratic Stark Effect.

Many-Electron Atoms: Schrodinger Equation for Two-Electron Atoms, Para and Ortho States, Pauli's Principle and Periodic Table, Coupling of Angular Momenta, L-S and J-J Coupling. Ground State and Excited States of Multi-Electron Atoms, Configurations and Terms.

Molecular Structure and Spectra: Structure of Molecules, Covalent and Ionic Bonds, Electronic Structure of Diatomic Molecules, Rotation and Vibration of Diatomic Molecules, Born-Oppenheimer Approximation. Electronic Spectra, Transition Probabilities and Selection Rules, Frank-Condon Principle, H₂⁺ and H₂. Effects of Symmetry and Exchange. Bonding and Antibonding Orbitals. Electronic Spin and Hund's Cases, Nuclear Motion: Rotation and Vibrational Spectra (Rigid Rotation, Harmonic Vibrations). Selection Rules. Spectra of Triatomic and Polyatomic Molecules, Raman Spectroscopy, Mossbauer Spectroscopy.

Recommended Books:

1. C. J. Foot, "Atomic Physics", Oxford University Press, 2005.
2. B. H. Bransden and C. J. Joachain, "Physics of Atoms and Molecules", Pearson Education, 2nd ed. 2008.
3. W. Demtroder, "Atoms, Molecules and Photons", y, Springer, 2nd ed. 2010.
4. C. N. Banwell and E. M. McCash, "Fundamentals of Molecular Spectroscopy", McGraw-Hill, 4th ed. 1994.
5. J. M. Hollas, "Basic Atomic & Molecular Spectroscopy", John Wiley, 2002.

PH-311 Nuclear Physics

Pre-requisites: PH-203, PH-303

Credit Hours: Three (3)

Objective(s): To understand the nuclear structure using different nuclear models. To understand the nature of nuclear forces. To give understanding of radioactivity and nuclear reactions.

History: Starting from Becquerel's discovery of radioactivity to Chadwick's neutron.

Basic Properties of Nucleus: Nuclear size, mass, binding energy, nuclear spin, magnetic dipole and electric quadrupole moment, parity and statistics.

Nuclear Forces: Yukawa's theory of nuclear forces. Nucleon scattering, charge independence and spin dependence of nuclear force, isotopic spin.

Nuclear Models: Liquid drop model, Fermi gas model, Shell model, Collective model.

Theories of Radioactive Decay: Theory of Alpha decay and explanation of observed phenomena, measurement of Beta ray energies, the magnetic lens spectrometer, Fermi theory of Beta decay, Neutrino hypothesis, theory of Gamma decay, multipolarity of Gamma rays, Nuclear isomerism.

Nuclear Reactions: Conservation laws of nuclear reactions, Q-value and threshold energy of nuclear reaction, energy level and level width, cross sections for nuclear reactions, compound nucleus theory of nuclear reaction and its limitations, direct reaction, resonance reactions, Breit-Wigner one level formula including the effect of angular momentum.

Recommended Books:

1. E. Segre, "Nuclei and Particles", Benjamin-Cummings, 2nd ed. 1977.
2. Kaplan, "Nuclear Physics", Addison-Wisely, 1980.
3. Green, "Nuclear Physics", McGraw-Hill, 1995.
4. K. S. Krane, "Introducing Nuclear Physics", John Wiley, 3rd ed. 1988.
5. B. Povh, K. Rith, C. Scholtz, F. Zetsche, "Particle and Nuclei", 1999.

PH-312 Lab-II

Pre-requisites:

Credit Hours: Two (2)

S. No		Experiment
1	Semiconductors	Band gap in Semiconductors
2	Magnetism	Magnetic Phase Transitions of a Ferromagnetic Alloy
3	Optics	Michelson Interferometer
4	Heat	Latent heat of vaporization of Liquid Nitrogen and Specific Heats of Metals
5	Magnetism	Electromagnetic induction and Working of Read-Write Operations in Magnetic Media
6	Waves	Vibrations on a String and Resonance
7	Nuclear Physics	Natural Radioactivity and Statistics
8	Modern Physics	Measurement of Planck's Constant and using a Light Bulb
9	Modern Physics	Electron Energy Loss Investigated Through Noble Prize

		Winning Frank-Hertz Experiment
10	Modern Physics	Verification of de Broglie's Hypothesis by Electron Diffraction from Graphite
11	Modern Physics	Imaging Electron Trajectories: e/m Measurement with a magic Eye and ImageJ
12	Modern Physics	Zeeman Effect

PH-401 Statistical Mechanics

Pre-requisites: PH-201, MA-105, MA-304

Credit Hours: Three (3)

Review of Classical Thermodynamics: States, macroscopic vs. microscopic, "heat" and "work", energy, entropy, equilibrium, laws of thermodynamics, Equations of state, thermodynamic potentials, temperature, pressure, chemical potential, thermodynamic processes (engines, refrigerators), Maxwell relations, phase equilibria.

Foundation of Statistical Mechanics: Phase Space, Trajectories in Phase Space, Conserved Quantities and Accessible Phase Space, Macroscopic Measurements and Time Averages, Ensembles and Averages over Phase Space, Liouville's Theorem, The Ergodic Hypothesis, Equal a priori Probabilities. Specification of the state of a system, concept of ensembles, elementary probability calculations, distribution functions, statistical interpretation of entropy (Boltzmann theorem).

Statistical Ensembles: Microcanonical ensemble, canonical ensemble and examples (e.g., paramagnet), calculation of mean values, calculation of partition function and its relation with thermodynamic quantities, the grand canonical ensemble and examples (e.g. adsorption), calculation of partition function and thermodynamic quantities.

Simple Applications of Ensemble Theory: Monoatomic ideal gas in classical and quantum limit, Gibb's paradox and quantum mechanical enumeration of states, equipartition theorem and examples (ideal gas, harmonic oscillator), specific heat of solids, quantum mechanical calculation of paramagnetism.

Quantum Statistics: Indistinguishability and symmetry requirements, Maxwell-Boltzmann statistics, Bose-Einstein and photon statistics, Fermi-Dirac statistics (distribution functions, partition functions). Examples: polyatomic ideal gas (MB), black body radiation (photon statistics), conduction electrons in metals (FD), Bose condensation (BE).

Systems of Interacting Particles: Lattice vibrations in solids, van der Waals gas, mean field calculation, ferromagnets in mean field approximation.

Recommended Books:

1. F. Reif, "Fundamentals of Statistical and Thermal Physics", Waveland Pr Inc, 2008.
2. W. Brewer, F. Schwabl, "Statistical Mechanics", Springer, 2nd ed. 2006.
3. T. L. Hill, "Statistical Mechanics", World Scientific Publishing Company, (2004).
4. K. Huang, "Statistical Mechanics", John Wiley, 2nd ed. 1987

PH-402 Solid State Physics II

Pre-requisites: PH-309

Credit Hours: Three (3)

Dielectric Properties of Solids: Polarization, Depolarization, Local and Maxwell field, Lorentz field, Clausius-Mossotti relation, Dielectric Constant and Polarizability, Measurement of dielectric constant, ferroelectricity and ferroelectric crystals, Phase Transitions, First and 2nd order phase transitions, Applications

Semiconductors: General properties of semiconductors, intrinsic and extrinsic semiconductors, their band structure, carrier statistics in thermal equilibrium, band level treatment of conduction in semiconductors and junction diodes, diffusion and drift currents, collisions and recombination times

Optical Properties: Interaction of light with solids, Optical Properties of Metals and Non-Metals, Kramers Kronig Relation, Excitons, Raman Effect in crystals, optical spectroscopy of solids.

Magnetic Properties of Materials: Magnetic dipole moment and susceptibility, different kinds of magnetic materials, Langevin diamagnetic equation, Paramagnetic equation and Curie law, Classical and quantum approaches to paramagnetic materials. Ferro-magnetic and anti – ferromagnetic order, Curie point and exchange integral, Effect of temperature on different kinds of magnetic materials and applications.

Superconductivity: Introduction to superconductivity, Zero-Resistance and Meissner Effect, Type I and Type II superconductors, Thermodynamic fields, Two fluid model, London equations, BCS and Ginzburg Landau Theory, Vortex Behaviour, Critical Current Density, Josephson effect and applications.

Recommended Books:

1. C. Kittel, "Introduction to Solid State Physics", John Wiley, 8th ed. 2005.
2. N. W. Ashcroft and N. D. Mermin, "Solid State Physics", Rinehart & Winston, 1976.
3. G. Burns, "High Temperature Superconductivity: An Introduction", Academic Press, 1992.
4. M. Fox, "Optical Properties of Solids", Oxford University Press, 2nd ed. 2010.
5. N. A. Spaldin, "Magnetic Materials: Fundamentals and Device Applications", Cambridge University Press, 2nd ed. 2010.

List of Electives

PH-403 Digital Electronics

Pre-requisites: PH-304

Credit Hours: Three (3)

Review of Number Systems: Binary, Octal and Hexadecimal number system, their inter-conversion, concepts of logic, truth table, basic logic gates.

Boolean Algebra: De Morgan's theorem, simplification of Boolean expression by Boolean Postulates and theorem, K-maps and their uses. Don't care condition, Different codes. (BCD, ASCII, Gray etc.). Parity in Codes.

IC Logic Families: Basic characteristics of a logic family. (Fan in/out, Propagation delay time, dissipation, noise margins etc. Different logic based IC families (DTL, RTL, ECL, TTL, CMOS). **Combinational Logic Circuit:** Logic circuits based on AND – OR, OR-AND, NAND, NOR Logic, gate design, addition, subtraction (2's compliments, half adder, full adder, half subtractor, full subtractor encoder, decoder, PLA. Exclusive OR gate.

Sequential Logic Circuit: Flip-flops clocked RS-FF, D-FF, T-FF, JK-FF, Shift Register, Counters (Ring, Ripple, up-down, Synchronous) A/D and D/A Converters.

Memory Devices: ROM, PROM, EPROM, EEPROM, RAM, (Static and dynamic) Memory mapping techniques

Micro Computers: Computers and its types, all generation of computers, basic architecture of computer, micro processor (ALU, UP Registers, Control and Time Section). Addressing modes, Instruction set and their types, Discussion on 8085/8088, 8086 processor family, Intel Microprocessor Hierarchy

Micro-controller/ Embedded System: Introduction to Embedded and microcontroller based systems, The Microprocessor and microcontroller applications and environment, microcontroller characteristics, features of a general purpose microcontroller, Microchip Inc and PIC microcontroller, Typical Microcontroller examples:, Philips 80C51 & 80C552 and Motorola 68Hc05/08, Interfacing with peripherals.

Recommended Books:

1. M. M. Mono, "Digital Logic and Computer Design", Prentice Hall, 1995.
2. R. Tokheim, "Digital Electronics", McGraw Hill, 7th ed. 2007.
3. B. B. Brey, "The Intel Microprocessors: Architecture, Programming and Interfacing", Merrill, 2nd ed. 1991.
4. Thomas L. Floyd, "Electronics Fundamentals: Circuits, Devices and Applications", Prentice Hall, 8th ed. 2009.
5. T. Wilmshurst, "The Design of Small-Scale Embedded Systems", Palgrave, 2001.

PH-404 Computational Physics

Pre-requisites:

Credit Hours: Three (3)

Computer Languages: A brief introduction of the computer languages like Basic, C, Pascal etc. and known software packages of computation

Numerical Methods: Numerical Solutions of equations, Regression and interpolation, Numerical integration and differentiation. Error analysis and technique for elimination of systematic and random errors

Modeling & Simulations: Conceptual models, the mathematical models, Random numbers and random walk, doing Physics with random numbers, Computer simulation, Relationship of modeling and simulation. Some systems of interest for physicists such as Motion of Falling objects, Kepler's problems, Oscillatory motion, Many particle systems, Dynamic systems, Wave phenomena, Field of static charges and current, Diffusion, Populations genetics etc

Recommended Books:

1. M. L. De Jong, "Introduction to Computational Physics", Addison Wesley, 1991.
2. S. T. Koonini, "Computational Physics", the Benjamin-Cummings, 1985.
3. H. Gould, J. Tobochnik and W. Christian, "An Introduction to Computer Simulation Methods", Addison Wesley, 3rd ed. 2006.
4. S. C. Chapra and R. P. Chanle, "Numerical Methods for Engineers with Personal Computer Applications", McGraw-Hill, 1990.
5. S. C. Chapra, "Applied Numerical Methods with MATLAB for Engineers and Scientists", McGraw-Hill, 2nd ed. 2006..

PH-405 Introduction to Photonics

Pre-requisites: PH-202, PH-304, MA-201

Credit Hours: Three (3)

Guided Wave Optics: Planar slab waveguides, Rectangular channel waveguides, Single and multi-mode optical fibers, waveguide modes and field distributions, waveguide dispersion, pulse propagation

Gaussian Beam Propagation: ABCD matrices for transformation of Gaussian beams, applications to simple resonators

Electromagnetic Propagation in Anisotropic Media: Reflection and transmission at anisotropic interfaces, Jones Calculus, retardation plates, polarizers

Electro-optics and Acousto-optics: Linear electro-optic effect, Longitudinal and transverse modulators, amplitude and phase modulation, Mach-Zehnder modulators, Coupled mode theory, Optical coupling between waveguides, Directional couplers, Photoelastic effect, Acousto-optic interaction and Bragg diffraction, Acousto-optic modulators, deflectors and scanners
Optoelectronics: p-n junctions, semiconductor devices: laser amplifiers, injection lasers, photoconductors, photodiodes, photodetector noise.

Recommended Books:

1. B. E. A. Saleh and M. C. Teich, "Fundamentals of Photonics", John Wiley, 2nd ed. 2007.
2. J-M. Liu, "Photonic Devices", Cambridge University Press, 2009.
3. A. Yariv and P. Yeh, "Photonics: Optical Electronics in Modern Communications",

Oxford University Press, 2006.
4. E. Hecht, "Optics", Addison-Wesley, 4th ed. 2001.

PH-411 Introduction to Nanomaterials

Pre-requisites:

Credit Hours: Three (3)

Objective(s):

Introduction to nanomaterials is an introductory course to the students intending to do specialization in nanoscience and nanotechnology. The course includes the brief introduction of nanomaterials, the properties of nanomaterials and their comparison to the bulk materials. The synthesis of nanoparticles of different dimensionalities will be thoroughly discussed. The last section includes the applications of nanomaterials and the safety measurements against toxicity of materials.

An introduction to nanoscience and nanotechnology: Historical perspective, physical properties of bulk and nano-sized nanostructures, surface energy, nucleation and growth of nanostructures, stabilization of nanoparticles, synthesis methods for zero, one and two dimensional nanostructures, discussion of methods, superlattices, self-assembly, Thiol-derivatised monolayer, monolayers of acids, amines and alcohols, Langmuir-Blodgett films, electrochemical deposition lithography techniques, top-down and bottom-up approaches, physical vapor deposition, chemical vapor deposition, sputtering, applications of nanoparticles, material safety and application

Recommended Books:

1. G. Cao, "Nanostructures and Nanomaterials: Synthesis, Properties and Applications", World Scientific Publishing Co. Pte. Ltd., 2004.
2. C. W. Shong, S. C. Haur, A. T. S. Wee, "Science at the Nanoscale", Pan Stanford Publishing Pte. Ltd. 2010.

PH-412 Electronics Materials and Devices

Pre-requisites: PH-302, PH-304

Credit Hours: Three (3)

Semiconductor Fundamentals: Composition, purity and structure of semiconductors, energy band model, band gap and materials classification, charge, effective mass and carrier numbers, density of states, the Fermi function and equilibrium distribution of carriers, doping, *n* and *p*-type semiconductors and calculations involving carrier concentrations, EF etc., temperature dependence of carrier concentrations, drift current, mobility, resistivity and band bending, diffusion and total currents, diffusion coefficients, recombination-generation, minority carrier life times and continuity equations with problem solving examples.

Device Fabrication Processes: Oxidation, diffusion, ion implantation, lithography, thin-film deposition techniques like evaporation, sputtering, chemical vapour deposition (CVD), epitaxy etc.

PN Junction and Bipolar Junction Transistor: Junction terminology, Poisson's equation, qualitative solution, the depletion approximation, quantitative electrostatic relationships, ideal diode equation, non-idealities, BJT fundamentals, Junction field effect transistor, MOS fundamentals, the essentials of MOSFETs.

Dielectric Materials: Polarization mechanisms, dielectric constant and dielectric loss, capacitor dielectric materials, piezoelectricity, ferroelectricity and pyroelectricity.

Optoelectronic Devices: Photoconductors, photovoltaics and photodetectors, photodiodes and photovoltaics, solar cell basics, LEDs, Lasers, displays, LCDs.

Magnetism and Magnetic Materials: Basics of magnetism, hysteresis loops, magnetic domains and anisotropy, hard and soft magnetic materials, transformers, DC motors and data storage.

Recommended Books:

1. R. F. Pierret, "Semiconductor Device Fundamentals", Addison Wesley, 2nd ed. 1996.
2. N. Braithwaite, and G. Weaver, "Electronic Materials", MA: Butterworth, 2nd ed. 1990.
3. S. O. Kasap, "Electronic Materials and Devices", McGraw-Hill, 3rd ed. 2005.
4. R. C. O'Handley, "Modern Magnetic Materials: Principles and Applications", Wiley Inter-Science, 1999.
5. D. Jiles, "Introduction to Magnetism and Magnetic Materials", Chapman & Hall, 2nd ed. 1998.

PH-413 Smart Nanomaterials

Pre-requisites: PH-411

Credit Hours: Three (3)

Brief introduction of nanoparticles, its scope , magnetic nanoparticles inside and everywhere around , most extensively studied magnetic nanoparticles and their preparation, metals, nanoparticles of rare earth metals, oxidation of metallic nanoparticles, magnetic alloys , Fe–Co alloys, magnetic oxides, magnetic moments and their interactions with magnetic fields. Bohr magneton, spin and orbital magnetic moments, magnetic dipole moments in an external magnetic field, the spontaneous magnetization, anisotropy, domains, the spontaneous magnetization,

temperature dependence of the magnetization in the molecular field approximation, Curie temperature in the Weiss Heisenberg model curie temperature in the stoner model, the meaning of exchange in the Weiss Heisenberg and stoner models, thermal excitations: spin waves, the magnetic anisotropy, the shape anisotropy ,the magneto-crystalline anisotropy. Magnetic microstructure: magnetic domains and domain walls, ferromagnetic domains, antiferromagnetic domains, magnetization curves and hysteresis loops, magnetism in small particles, thermal stability, magnetism of metals, band theoretical results for the transition metals, basic results for the density of states, prediction of magnetic properties. Rare earth metals: band theory versus atomic behavior, spectroscopic tests of the band model of ferromagnetism , resistivity of transition metals, spin conserving electron transitions in metals, transitions between opposite spin states in metals ,classification of transitions between opposite spin states. Detection of transitions between opposite spin magnetism of nanoparticles: effects of size, shape, and interactions, magnetism of nanoparticles in the view of atomic and solid state physics, magnetic finite-size effects and characteristic magnetic lengths, single-domain particles, shape effects, super paramagnetism, surface effects , matrix effects. Inter-particle interaction effects nanoparticles of typical magnetic materials: illustrative examples antiferromagnetic nanoparticles, semiconductor magnetic nanoparticles, some applications of magnetic nanoparticles high-density information magnetic storage traditional, new applications of Ferro fluids, magnetic nanoparticles and spintronics.

Recommended Books:

1. J. Stohr and H.C. Siegmann, "Magnetism From Fundamentals to Nanoscale Dynamics", Springer, Stanford, 2006.
2. Sergey P. Gubin, "Magnetic Nanoparticles", WILEY-VCH Verlag GmbH & Co. Moscow,

Russia, 2008.

PH-414 Surfaces and Interfaces

Pre-requisites: PH-411

Credit Hours: Three (3)

The brief introduction of structure of surfaces, defects, interaction of defects and their observation, electronic states, charge distribution at surfaces, elasticity theory of surface defects, thermodynamics of flat and curved surfaces, statistical thermodynamics i.e. the free energy, vapor pressure of solid surfaces, adsorption of molecules and ions, desorption, chemical bonding, surface phonons, adsorbate modes, inelastic scattering of atoms and electrons, optical techniques for scattering observations electronic, optical and magnetic properties of surfaces and the diffusion phenomenon.

Recommended Books:

1. H. Ibach, "Physics of surfaces and interfaces", Springer-Verlag Berlin Heidelberg, 2006.

PH-415 Characterization of Materials

Pre-requisites: PH-411

Credit Hours: Three (3)

Overview of characterization techniques, light microscopy, Scanning Electron Microscopy (SEM),

Scanning Tunneling Microscopy (STM), Particle Size Analyzer, Transmission Electron Microscopy (TEM), Scanning Force Microscopy (SFM), Energy-Dispersive X-Ray Spectroscopy (EDS), Electron Energy-Loss Spectroscopy in the Transmission Electron Microscope, Scanning Transmission Electron Microscopy (STEM), XRD. Experimental methods for structure determination-X-rays, properties of X-rays, diffraction of X-rays, experimental methods and crystal determination techniques, X-Ray Photoelectron Spectroscopy (XPS), Photoluminescence (PL) and Fourier Transform Infrared Spectroscopy (FTIR), Raman Spectroscopy, Solid State Nuclear Magnetic Resonance (NMR) and Hall Effects (electrical properties measurements).

Recommended Books:

1. C Ricbard Brundle, Charles A. Evans, Jr.Sbaun Wihon, "Encyclopedia of materials characterization", Manning Publications Co. 1992.
2. K.C. Barua, "Introduction to Condensed Matter Physics", Narosa Publishing House, 2007.

PH-416 Functional properties of materials

Pre-requisites: PH-411

Credit Hours: Three (3)

Overview of quantum mechanics, electrons in a crystal field, Electrical properties: band theory of metals and semiconductors, Fermi energy, density of states, effective mass, conductivity of electrons in metals and semiconductors – classical and quantum mechanical treatment,

conduction in polymers, metal oxides, dielectric properties, ferroelectricity, piezoelectricity, Electronic properties: free electrons with and without damping, reflectivity, Lorentz equations, Harmonic oscillators, optical spectra of materials conduction and dispersion, Magnetic properties: Curie law, Langevin theory of para- and dia-magnetism, molecular field theory, Heisenberg exchange interaction, Weiss field, point-charge approximation, crystal fields, field induced and 4f electron anisotropy, Magnetic properties: Origin of atomic moments, paramagnetism of free ions, Brillouin function, Curie law, Langevin theory of para- and dia-magnetism, molecular field theory, Heisenberg exchange interaction, Weiss field, point-charge approximation, crystal fields, field induced and 4f electron anisotropy, Caloric effects, magnetic anisotropy permanent magnets, domain walls, coercivity, hysteresis loop, exchange coupling in rare-earth magnets, hard ferrites, soft magnetic materials, random-anisotropy model, soft magnetism and grain size, Heat capacity, classical theory, Debye model, Einstein model, electronic contribution, thermal conduction in metals and alloys (classical and quantum consideration), thermal conduction of dielectrics, electrical, optical and magnetic properties in nano regime

Recommended Books:

1. R. F. Hummel, "Electronic properties of materials", 3rd ed. Springer-Verlag New York, Inc. 2001.
2. J. Stöhr, H. C. Siegmann, "Magnetism from fundamental to Nanoscale", Springer-Verlag Berlin Heidelberg, 2006.

PH-431 Particle Physics

Pre-requisites: PH-308, PH-311

Credit Hours: Three (3)

Quarks and leptons, Yukawa and electromagnetic interactions, weak, strong and gravitational interactions, current conservation in the Maxwell's equations, Lorentz and gauge invariance in electromagnetism, the Klein-Gordon equation, the Dirac equation, Lorentz transformation of spinors, solutions of the Dirac equation, electromagnetic interactions via gauge principle, the quantum field, Lagrangian and Hamiltonian formalism, relativity, mass and four dimensions, qualitative introduction to interactions, the interaction picture and S-matrix, the decay and scattering amplitude, the Yukawa exchange, the complex scalar field, the Dirac field and the spin statistics, Coulomb scattering of spin 0 and spin 1/2 particles, spin 0 and spin 1/2 scattering, electron-pion scatterings crossing symmetry, Compton scattering, electron-muon scattering, electron-proton elastic and inelastic scattering, the parton model, the quark parton model, the Drell-Yan process, electron-positron annihilation into hadrons.

Recommended Books:

1. *Quarks and Leptons*, An Introductory Course in Modern Particle Physics" by F. Halzen and A.D. Martin, Publisher: Wiley; 1st edition (January 6, 1984)
2. *An Introduction to Quantum Field Theory*, by M.E. Peskin and D.V. Schroeder, Publisher: Addison Wesley Publishing Company, 1995.
3. *Collider Physics*, by V.D. Barger, R.J.N. Phillips, Publisher: Westview Press; Upd Sub edition (December 17, 1996)
4. *A Modern Introduction to Particle Physics*, Fayyazuddin and Riazuddin, Publisher: World Scientific Pub Co Inc. 2nd Edition, September 29, 2000.

PH-432 Plasma Physics

Pre-requisites: PH-202 PH-305

Credit Hours: Three (3)

Introduction to plasmas, how plasmas are produced, Debye length, plasma frequency, number of electrons in a Debye sphere, the de-Broglie wavelength and quantum effects, representative plasma parameters.

Motion of a charged particle in a static uniform magnetic field and in the presence of perpendicular electric and magnetic fields, gravitational drift, gradient and curvature drifts. Motion in a magnetic mirror field, drift-motion in a time varying electric and magnetic fields, adiabatic invariants, conservation of J in time independent fields, the Hamiltonian method and chaotic orbits.

Fluid equations for a plasma, continuity equation, momentum balance equation, equation of state, and two-fluid equations.

Waves in cold plasma, Fourier representation of waves, plasma oscillations, electron and ion waves, sound waves, electrostatic ion waves perpendicular to magnetic field, lower-hybrid frequency.

Electromagnetic waves for unmagnetized and magnetized plasmas, Alfvén waves, magnetosonic waves, and ray paths in inhomogeneous plasmas.

Introduction to controlled fusion: Basic nuclear fusion reactions, reaction rates and power rates and power density, radiation losses from plasmas, operational conditions.

Recommended Books:

1. F. F. Chen, "Introduction to Plasma Physics", 2nd ed. Plenum, 1995.
 2. D. A. Gurnett and A. Bhattacharjee, "Introduction to Plasma Physics: with space and laboratory application", Cambridge University Press, 2005.
 3. T. J. M. Boyd and J. J. Sanderson, "The Physics of Plasmas", Cambridge University Press, 2003.
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PH-433 Group Theory

Pre-requisites:

Credit Hours: Three (3)

Correspondences and transformations, groups, definitions and examples, subgroups, Cayley's theorem, Cosets, Lagrange's theorem, conjugate classes, invariant subgroups, factor groups, homomorphism, direct products, quick review of linear vector spaces, group representations, equivalent representations - characters, construction of representations, invariance of functions and operators, unitary representations, Hilbert space Reducibility/irreducibility of a representation, Schur's Lemmas, orthogonality relations, criteria for irreducibility, group algebra, expansion of functions in basis functions of irreducible representations, representations of direct products, product representations, symmetrized and antisymmetrized products, adjoint representation, conditions for existence of invariants, real representations, Clebsch-Gordan series and coefficients, simply reducible groups, three-j symbols, classification of spectral terms,

perturbation theory, selection rules, coupled systems, coupled systems (cont.), Lie groups, isomorphism, subgroups, mixed continuous groups, one parameter group, structure constants, Lie algebras, compact semisimple Lie groups, linear representations, invariant integration, irreducible representations, the Casimir operator, universal covering group, systems of identical particles and SU(n), angular momentum analysis, the Pauli principle, seniority in atomic spectra, atomic spectra in jj-coupling, isotopic spin, nuclear spectra in L-S coupling, the L-S and jj-coupling shell model.

Recommended Books:

1. M. Hamermesh, "Group Theory and its Applications to Physical Problems", Dover Publications 1989.

PH-434 Lasers and Quantum Optics

Pre-requisites: PH-203, PH-308, PH-310

Credit Hours: Three (3)

Review of quantum mechanics, Dirac's notation, Pauli spin matrices, electromagnetic waves and photons, wavelength and frequencies of electromagnetic radiation.

Spontaneous and stimulated emission, absorption. Maser principle, cavity, gain medium, population inversion, Boltzmann statistics, threshold condition.

Three-level laser, properties of a laser beams, black-body radiation theory. Modes of a rectangular cavity, Raleigh-Jeans and Planck radiation formula.

Semi-classical treatment of the interaction of radiation and matter. Radiative transition rates, Interaction Hamiltonian, dipole approximation, rotating-wave approximation, electric dipole moment, allowed and forbidden transitions, ratio of the electric-dipole transition probability to the magnetic dipole transition probability, transition cross-section, absorption and gain coefficients.

Line-broadening mechanisms. Homogeneous broadening, collision broadening and natural broadening. Wiener-Kinchine and Parseval's theorem. Inhomogeneous and Doppler broadening. Rate equation approach to Laser theory, stationary solution, time-dependent solution, Gain, loss and saturation parameters, lasing condition.

Ray and wave propagation in optical media. Matrix formulation of Geometrical optics. Wave reflection and transmission at a dielectric interface. Diffraction optics in paraxial approximation. Passive optical resonators, plane-parallel (Fabry-Perot) resonator, concentric, confocal, generalized spherical and ring resonator. Eigen-modes and Eigen-values. Stability condition, unstable resonator, photon lifetime and cavity Q.

Q-switching, electro-optical, and acousto-optic Q-switches, saturable absorber Q-switch. Theory of mode-locking, active and passive mode-locking.

Laser excitation techniques, optical, electrical, and chemical pumping, laser pumping, excitation transfer, meta-stable states and lifetimes.

Types of lasers, solid-state, dye and semiconductor lasers, gas, chemical, free electron, and X-ray lasers, laser applications.

Recommended Books:

1. Orazio Svelto, "Principles of Lasers", Plenum Press; 4th Edition, 1998.

2. William T. Silfvast, "Laser Fundamentals", Cambridge University Press, 2004.

PH-435 Introduction to Quantum Computation

Pre-requisites: PH-303, PH-404

Credit Hours: Three (3)

Computer technology and historical background, Basic principles and postulates of quantum mechanics: Quantum states, evolution, quantum measurement, superposition, quantization from

bits to qubits, operator function, density matrix, Schrodinger equation, Schmidt decomposition,

EPR and Bell's inequality, Quantum Computation: Quantum Circuits, Single qubit operation, Controlled operations, Measurement, Universal quantum gates, Single qubit and CNOT gates, Breaking unbreakable codes: Code making, Trapdoor function, One time pad, RSA cryptography, Code breaking on classical and quantum computers, Schor's algorithm, Quantum Cryptography: Uncertainty principle, Polarization and Spin basis, BB84, BB90, and Ekert protocols, Quantum cryptography with and without eavesdropping, Experimental realization, Quantum Search Algorithm.

Recommended Books:

1. M. A. Nielsen and I. L. Chuang, "Quantum Computation and Quantum Information", Foundation Books, 2007.
2. C. P. Williams and S. H. Clearwater, "Exploration in Quantum Computation" Springer, 2nd ed. 2011.
3. P. Bouwmester, A. Ekert, and A. Zeilinger, "The Physics of Quantum Information: Quantum Cryptography, Quantum Teleportation, Quantum Computation", Springer, 2010.
4. R. K. Brylinsky and G. Chen, "Mathematics of Quantum Computation" by Chapman & Hall/CRC, 2002.

PH-436 Quantum Information Theory

Pre-requisites: PH-303

Credit Hours: Three (3)

Review of Quantum Mechanics and overview of Quantum information: Postulates of quantum mechanics, quantum states and observables, Dirac notation, projective measurements, density operator, pure and mixed states, entanglement, tensor products, no-cloning theorem, mixed states from pure states in a larger Hilbert space, Schmidt decomposition, generalized measurements, (CP maps, POVMs), qualitative overview of Quantum Information.

Quantum Communication: Dense coding, teleportation, entanglement swapping, instantaneous transfer of information, quantum key distribution.

Entanglement and its Quantification: Inseparability of EPR pairs, Bell inequality for pure and mixed states, entanglement witnesses, Peres-Horodecki criterion, properties of entanglement measures, pure and mixed state entanglement, relative entropy as entanglement measure, entanglement and thermodynamics, measuring entanglement.

Quantum Information: Classical information theory (data compression, Shannon entropy, von Neumann entropy), fidelity, Helstrom's measurement and discrimination, quantum data compression, entropy and information, relative entropy and its statistical interpretation, conditional entropy, Holevo bound, capacity of a quantum channel, relative entropy and thermodynamics, entropy and erasure, Landauer's erasure.

Quantum Computation: Classical computation (Turing machines, circuits, complexity theory), quantum algorithms (Deutsch's algorithm, Oracles, Grover's algorithm, factorization and quantum Fourier transform), role of entanglement in algorithms (search algorithm), modeling quantum measurements, Bekenstein bound, quantum error correction (general

conditions, stabilizer codes, 3-qubit codes, relationship with Maxwell's demon), fault tolerant quantum computation (overview).

Physical Protocols for Quantum Information and Computation: Ion trap, optical lattices, NMR, quantum optics, cavity QED.

Recommended Books:

1. V. Vedral, "Introduction to Quantum Information Science", Oxford University Press, 2007.
2. M. Nielsen and I. Chuang, "Quantum Computation and Quantum Information", Cambridge University Press, 10th Anv. ed. 2010.
3. W. Steeb and Y. Hardy, "Problems and Solutions in Quantum Computing and Quantum Information", World Scientific Publishing, 3rd ed. 2011.
4. Book on general quantum mechanics: A. Peres, Quantum Theory: Concepts and Methods, Kluwer Academic Publishers (2002).
5. Seth Lloyd's notes on quantum information available online at:
web.mit.edu/2.111/www/notes09/spring.pdf

PhD Physics

Introduction

PhD program of Physics department of Air University (AU) will initially focus on the fields of Materials Science, Nano Science & Technology, Renewable Energy and Computational Physics. The physicists and engineers via this program could join hands for producing qualified manpower for meeting the growing demand of professionals in these areas. The program will require approximately four years for completing a PhD degree. Its graduates trained in the experimental, theoretical, and computational aspects of material science and technology are expected to be active members of interdisciplinary teams for identifying, formulating and solving problems of national interest.

This program is for candidates with 18 years of education in a related discipline (MS/M.Phil Physics). This program consists of 18 credits of course work followed by 30 credits of research work. The first and second semester comprise of three courses each. These courses will be chosen from the approved PG Courses with the advice of GEC members. The comprehensive examination must be passed before the commencement of the research work. The course of study and syllabi for PhD Physics degree of AU shall be submitted by the respective board of studies/Board of faculties to the academic council and the Board of Governors (BOG) for approval. Such courses and syllabi shall become effective from the date of approval by the BOG or such other date as the BOG may determine.

Prerequisite Qualification:

MS/ M. Phil degree in Physics from a Pakistani University or an equivalent degree from any recognized University. A college/university teacher or a member of research staff of a research organization holding a Master's degree in Physics, who has shown undoubted promise for research, may also be considered for admission. These candidates will, however, be required to complete the course work of 24 credit hours.

Duration: Three Years

Total Courses: 6 each of 3 credit hours

Total Credit Requirement: 18

A: For all PhD Physics students PH-605 Advanced Quantum Mechanics-II and PH-606 Statistical Physics will be compulsory. (6 credit hours)

B: Students who have not had the equivalent of PH-601 Methods of Mathematical Physics and PH-602 Electrodynamics at the MS/M. Phil. level would be required to take these two courses as well.

C: For the remaining 12 credit hours the student will be required to select at least 3 courses (9 credit hours) from the approved list of courses for his/her research area. The student may be allowed to select one course from outside his/her area of specialization on the advice of the supervisor. These courses shall be from the list of approved MS/M. Phil. /PhD courses. All the MS/M. Phil. /PhD courses shall be renamed as PG courses.

The list of the PhD physics courses are given on next page.

S. No.	Code	Course Title	Cr. Hrs.	Pre-requisites
1	PH-601	Methods of Mathematical Physics	3	NIL
2	PH-602	Electrodynamics	3	NIL
3	PH-603	Materials Science	3	NIL
4	PH-604	Advanced Quantum Mechanics	3	NIL
5	PH-605	Advanced Quantum Mechanics-II	3	NIL
5	PH-606	Statistical Physics	3	NIL
6	PH-710	Physics and Chemistry of Nanomaterials	3	PH-603
7	PH-711	Condensed Matter Physics	3	PH-603, PH-604
8	PH-712	Thermodynamics of Materials	3	PH-603
9	PH-720	Renewable Energy Sources	3	NIL
10	PH-721	Physics of Solar Cells	3	NIL
11	PH-730	Computational Physics	3	NIL
12	PH-731	Mathematical Modelling & Computer Simulation	3	NIL
13	PH-760	Semiconductor Theory	3	PH-604, PH-603
14	PH-761	Physics of magnetic materials	3	PH-604, PH-603
15	PH-762	Experimental Techniques	3	NIL
16	PH-763	Surface Physics	3	PH-603, PH-710
17	PH-764	Optical Properties of Solids	3	PH-603, PH-604
18	PH-765	Conducting polymers	3	NIL
19	PH-766	Biophysics	3	NIL
20	PH-770	Environmental Physics	3	NIL
21	PH-771	Photovoltaic Technology	3	PH-720, PH-721
22	PH-772	Solar Thermal Power Technology	3	NIL
23	PH-773	Bio-Energy Technology	3	NIL
24	PH-776	Monte Carlo Computer Simulation	3	PH-730
25	PH-777	Non-Linear Dynamics in Physics	3	PH-730
26	PH-778	Computational Statistical Physics	3	PH-605, PH-730
27	PH-779	Computational Condensed Matter Physics	3	PH-711, PH-730
28	PH-780	Special Topics in Physics-I	3	NIL

29	PH-781	Special Topics in Physics-II	3	NIL
30	PH-790	PhD Thesis Research	30	NIL

PhD Students may also opt for PhD courses offered by other departments of AU on the advice of GEC Members and the supervisor.

Qualifying Examination

A PhD student shall be required to pass Comprehensive Examination and Subject Examination.

Comprehensive Examination (CE) is based on PhD courses (PH-601, PH-602, PH-604, PH-606; 12credit-hour) approved in the plan of study of the student. The mode of examination is comprehensive written test and grading is pass or fail. The paper for the CE will be prepared and checked by the concerned department.

Subject Examination (SE): After passing CE, the students appear in SE which is meant to assess the approach of tackling research problems. The mode of examination is presentation of proposed research before the committee appointed by HOD comprising three examiners including the supervisor. The supervisor will be the chair of that committee.

Course Contents

PH-601 Methods of Mathematical Physics

Second Order Differential Equations: Partial differential equations, Series solutions, a second solution, non-homogeneous equations, Green function.

Sturm Liouville Theory: Self – Adjoint ODE's, Hermitian Operators, Gram-Schmidt Orthogonalization. Laplace transforms and inverse Laplace transforms, Laplace transform of periodic functions. The convolution integral.

Bessel Function: Bessel functions of first kind, Bessel function of 2nd kind, Neumann functions, Hankel functions.

Legendre Functions: Generating function, recurrence relations, orthogonal, associated Legendre function, spherical Harmonics, applications to spheroidal coordinate system

Special Functions: Hermite Functions, Laguerre Functions, Chebyshev polynomials, hypergeometric functions.

Fourier Transforms: Fourier transforms and inverse fourier transforms, fourier transform of periodic functions, the convolution integral, Sturm- Liouville theory of orthogonal functions. **Integral Transform Method:** Solution of homogenous and inhomogeneous differential equations using Fourier and Laplace integral Transform Methods.

Integral Equations: Integral equations integral transforms. Generating functions, Neumann series, Degenerate kernels, Hilbert-Schmidt theory.

Nonlinear Differential Equations and its Solutions: Classification of nonlinear differential equation and its solutions.

Reference Books:

1. Mathematical Methods for Physicists, 5th Edition, G. B Arkfen and H. J. Seber., Academic Press (2001).
2. Mathematical Physics, E. Butkov, Addison and Wesley, (1968).

PH-602 Electrodynamics

Maxwell Equations: Maxwell equations and Maxwell's displacement current, vector and scalar potential, Gauge Transforms, Lorentz and Coulomb gauge.

Green's Function: Green's function for conducting and non-conducting sphere, Green's function for wave equation, Retarded solutions for the fields, one dimensional Green's function, two and three dimensional Green's functions, Dirac Delta function, properties and uses.

Macroscopic Electromagnetism: Poynting's theorem and conservation laws, Poynting theorem in linear and dispersive medium, solution for harmonic fields, transformation properties of electromagnetic fields and sources—under rotation.

Electromagnetic Waves and Propagation: Plane wave in a non-conducting medium, linear and circular polarization, Stokes parameters, reflection and refraction of electromagnetic waves, polarizations by reflection and total internal reflection.

Frequency Dispersion Characterizes of Dielectrics: Anomalous dispersion and resonant absorption, low frequency response of electric conducting, Index of Refraction and absorption.

Propagation of Electromagnetic Waves in Ionosphere and Magnetosphere: Simplified model of propagation of e. m. wave in the ionosphere and magnetosphere, magneto hydrogenic wave, spreading of a pulse and its propagation in a dispersive medium, arrival of signal after propagation through a dispersive medium.

Waveguides: Fields at the surface of and within a conductor, cylindrical cavities and wave guides, modes in a rectangular waveguides, energy flow and attenuation in waveguides.

Resonant Cavities: Power losses in a cavity and Q of a cavity, Schumann resonances, multimode propagation in optical fibers.

Modes in a Dielectric Waveguides: Modes in a planar slab dielectric waveguides, modes in circular fibres, Fields in a hollow metallic wave guide.

Reference Books:

1. Classical Electrodynamics, J.D. Jackson, John- Wiley and Sons, (1999).
2. Electromagnetic Theory, J.A Stratton, McGraw Hill, (1941).
3. Electromagnetic Fields and Waves, P. Lorrain and D. R. Corson, W. H. Freeman and Company, New York (1986).

PH-603 Materials Science

Why Study Materials Science and Engineering? Classification of Materials (metals, ceramics, polymers, composites) Structure-Property relationship in materials. Internal Structures (Macro-, micro-, sub-, crystal-, electronic-, nuclear- structures). Properties (Mechanical, electrical and magnetic properties). Equilibrium and Kinetics (stable, unstable and metastable equilibrium). Review of thermodynamics terms (temperature, pressure, internal energy, enthalpy, etc.).

Atomic Structure. Atomic Bonding in Solids. Bonding Forces and Energies. Primary Interatomic Bonds (ionic, covalent, metallic bonding). Secondary Bonding or van der Waals Bonding.

Basic structural and symmetry concepts. Concept of diffraction in a periodic lattice.

Structural information from x-ray diffraction and other diffraction techniques. Crystal structures of metals and ceramic materials.

Point Defects. Vacancies and Self-Interstitials. Impurities in Solids. Specification of Composition. Dislocations–Linear Defects. Interfacial Defects. Bulk or Volume Defects. Atomic Vibrations. Effect of defects on the properties of materials.

Diffusion Mechanism. Steady-State Diffusion. Nonsteady-State Diffusion. Factors that influence Diffusion. Diffusion in Semiconducting Materials.

Amorphous materials / glasses (glass formation, glass transition and crystallization of glasses). Random close packing in metallic glasses. Continuous random networks in covalent glasses. Phase Diagrams: Basic concepts, Phase Equilibria, Binary Isomorphous systems, Binary Eutectic systems, Development of microstructure in isomorphous and binary alloys, Equilibrium diagrams

having intermediate phases or compounds. Phase transformation: Basic concepts, Kinetics of phase transformations, Metastable versus stable transformations, Isothermal transformation diagrams, Continuous cooling transformation diagram.

Reference Books:

1. Materials Science and Engineering an Introduction, W. D. Callister, Jr. John Wiley & Sons Inc., (2007).
2. The physics and chemistry of materials, J. I. Gersten and F. W. Smith, John Wiley & Sons Inc., (2001).
3. Beside text books, hand-outs shall be distributed in some classes.

PH-604 Advanced Quantum Mechanics

Quantum Dynamics: Time evolution and Schrödinger equation, the Schrödinger versus The Heisenberg picture, interaction picture.

Symmetries in Quantum Mechanics: Symmetries, conservation laws and degenerates. Discrete symmetries, Parity or space inversion, Lattice Translation as discrete symmetries *The Quantum Theory of Radiation:* Classical radiation field, Creation, annihilation and number operators, Quantization of radiation field.

Relativistic Quantum Mechanics of Spin 1/2 particles, probability conservation in Relativistic quantum, the Dirac equation, Simple solutions, non-relativistic approximations, plane wave solutions

Relativistic invariance of Dirac equation, transformation properties of Dirac bilinear, adjoint Dirac equation, equation of continuity, constant of motion
The Klein- Gordon Equation, Derivation and Covariance, Klein's Paradox and Zitterbewegung.

Reference Books:

1. Modern Quantum Mechanics (Revised Edition), J.J. Sakurai, Addison-Wesley publishing Company, 1967.
2. Advanced Quantum Mechanics, J.J. Sakurai, Addison-Wesley Publishing Company, 1994.
3. Topics in Advanced Quantum Mechanics, Barry R. Holstein, Addison-Wesley Publishing Company, 1992.

PH-605 Advanced Quantum Mechanics –II

Quantum mechanics of continuous systems, discretization, infinite matrices, calculation of matrix elements between states characterized by continuous variables.
 Concept of classical paths, principle of least action, introduction to path integrals, propagator, simple harmonic oscillator in path integral representation.
 Adiabatic processes, Berry phase in atomic and molecular physics, quantum Hall effect, coherent states.
 Multiple vacua, tunneling phenomena, imaginary time in quantum mechanics, instantons, spontaneous symmetry breaking.
 Bosons and fermions and their relation to spin. Permutational symmetry. Slater determinant for many-fermion systems, Thouless's theorem, anyons and fractional statistics.
 Supersymmetric quantum mechanics.

Superconductivity and superfluidity: Meisner effect, Landau-Ginsburg theory, Cooper pairs. Basics of many body theory, particles and holes, RPA, Feynman diagrams for non-relativistic systems.

Quantum theory of measurement, EPR paradox, Bell's theorem, quantum logic, quantum computation.

Reference Books:

1. Principles of Quantum Mechanics, R. Shankar, 2nd edition, (Springer, 1994).
2. Guide To Feynman Diagrams In The Many-body Problem, Richard D. Mattuck, (Dover, 1992).
4. Modern Quantum Mechanics (Revised Edition), J.J. Sakurai, Addison-Wesley publishing Company, 1967.
5. Advanced Quantum Mechanics, J.J. Sakurai, Addison-Wesley Publishing Company, 1994.
6. Topics in Advanced Quantum Mechanics, Barry R. Holstein, Addison-Wesley Publishing Company, 1992.

PH-606 Statistical Physics

Intensive and extensive quantities, thermodynamic variables, thermodynamic limit, thermodynamic transformations.

Classical ideal gas, first law of thermodynamics, application to magnetic systems, heat and entropy, Carnot cycle. Second law of thermodynamics, absolute temperature, temperature as integrating factor, entropy of ideal gas.

Conditions for equilibrium, Helmholtz free energy, Gibbs potential, Maxwell relations, chemical potential. First-order phase transition, condition for phase coexistence. The statistical approach: phase space, distribution function, microcanonical ensemble, the most probable distribution, Lagrange multipliers.

Maxwell-Boltzmann distribution: pressure of an ideal gas, equipartition of energy, entropy, relation to thermodynamics, fluctuations, Boltzmann factor.

Transport phenomena: collisionless and hydrodynamic regimes, Maxwell's demon, non-viscous hydrodynamics, sound waves, diffusion, conduction, viscosity.

Quantum statistics: thermal wavelength, identical particles, Fermi and Bose statistics, pressure, entropy, free energy, equation of state, Fermi gas at low temperatures, application to electrons in solids and white dwarfs.

The Bose gas: photons, phonons, Debye specific heat, Bose-Einstein condensation,

equation of state, liquid helium.

Canonical and grand canonical ensembles, partition function, connection with thermodynamics, fluctuations. minimization of free energy, photon fluctuations, pair creation.

The order parameter, Broken symmetry, Ising spin model, Ginsburg – Landau theory, mean-field theory, critical exponents, fluctuation-dissipation theorem, correlation length, universality

Reference Books:

1. Introduction to Statistical Physics, Kerson Huang, (Taylor and Francis, 2001).
2. Statistical Mechanics, Raj Kumar Pathria, second edition (India, 1996).

PH-710 Physics and Chemistry of Nanomaterials

When does size matter? Scales of Various Systems, Chemistry: atoms, molecules, clusters, and macromolecules, Materials: zeolites, nanoparticles, colloidal particles, polymeric latexes, Biology: proteins, enzymes, RNAs, DNAs, viruses, bacteria, and cells, How could one change the properties by controlling the dimensions? Why are nanomaterials important?

Synthesis techniques of nanomaterials: Top Down approach, Bottom up approach, Chemical Approaches: Wet Chemical Synthesis of Nanomaterials, Sol gel process with examples. Gas phase synthesis of nanomaterials; Chemical vapor deposition (CVD), Furnace assisted synthesis, Gas Condensation Processing, Sputtered Plasma Processing: Microwave Plasma Processing, Particle precipitation aided CVD, Polymer nanoparticles, Ceramic nanoparticles, Metal nanoparticles, Metal oxide nanoparticles, Magnetic nanoparticles, Semiconductor dots, Dendrimers, Nanofibers Carbon nano tubes.

Electro-Chemistry: Terminology in electrochemistry, Electrolysis-Principle and application, Electrochemical cell, Standard electrode potential, Primary voltaic cell.

Challenges: Control of Sizes or Shapes of Nanostructures and/or Nanomaterials fabrication of functional devices from nanometer-sized structures manipulation, assembly, and integration of nanoscale functional devices, Multifunctional nanoparticles for targeted drug delivery and other biological applications.

Physical Properties: Melting point and other phase transition processes. Chemical Properties: reactivity and catalytic activity.

Electronic and Optical properties: particle in a box, quantum-size-effect (QSE), quantum dots (Q-particles), quantum structures, and artificial atoms.

Electrical Properties: size induced metal-insulator-transition (SIMIT), clusters of metals and semiconductors, and one-dimensional conductive nanowires.

Mechanical Properties: nanostructured beams, and nanocomposites.

Magnetic Properties: nano-scale magnets, transparent magnetic materials, and ultrahigh-density magnetic recording materials.

Reference Books:

1. Nanomaterials and Nanochemistry, C. Bréchégnac P. Houdy M. Lahmani, Springer, 2006.

2. L. Edward, Nanophysics and Nanotechnology, 2006 John Wiley & Sons, Ltd.
3. Molecular Chemistry of Sol-Gel Derived Nanomaterials, Robert Corriu, Nguyen Trong Anh, John Wiley & Sons, Ltd., 2009.
4. Nanostructures and nanomaterials: Synthesis properties and applications, G. Cao, Y. Wang, World Scientific, Singapore, 2011.
5. Nanophysics, N. Gupta, SBS Publishers New Delhi, 2012.
6. Beside text books, hand-outs will be distributed in some classes.

PH-711 Condensed Matter Physics

Band theory and electron correlations: Single electron in a periodic potential, many electrons in a periodic potential, Hartree-Fock-LDA and beyond. Fermi liquid theory and elementary excitations: Quasiparticles and Landau parameters, thermodynamics of a Fermi liquid. Second quantization: Second quantization for fermions and bosons, Quadratic Hamiltonians and canonical transformations. Quantization of lattice vibrations. Green's functions: Green's function and response functions, Dyson and Bethe-Salpeter equations, perturbation methods and Feynman diagrams, zero temperature versus finite temperature formulation. Fermi liquid theory: microscopic formulation: Landau quasiparticles as poles of Green's function, Landau parameters, conservation law and Ward identities. Quantum magnetism: Spin waves spin path integral, quantum non-linear sigma model. Modern applications: Kondo effect, quantum phase transitions, non-Fermi liquid.

Reference Books:

1. Advanced Solid State Physics, by P. Philips, publisher: Westview Press; 1st edition, (2003). Condensed Matter Field Theory, by A. Altland and B. Simons, publisher: Cambridge University Press, 1st edition (2006).
2. Advanced Condensed Matter Physics, by L. M. Sander, publisher: Cambridge University Press, 1st edition (2009).

PH-712 Thermodynamics of Materials

Concepts of Helmholtz free energy and Gibbs free energy. Energy-property relationships, thermal equilibrium and chemical equilibrium. Gibbs-Helmholtz relationships. Equilibrium constant and its variation with temperature, van't Hoff's equation. Clapeyron equation. Fugacity and chemical activity. ideal and regular solution models. Thermodynamics of solutions, Gibbs- Duhem relationship. Homogeneous and heterogeneous nucleation. The effect of temperature and pressure on phase transformation. Mixing functions. Excess functions. Thermodynamic properties and equilibrium phase diagrams. Phase Rule, Gibbs free energy and entropy calculations. Typical equilibrium Phase diagrams. Statistical mechanics/models in thermodynamics.

Reference Books:

1. Thermodynamics of Materials by David V. Ragone, Wiley, vol. 1 (1994).
2. Phase Transformations in Metals and Alloys by D. A. Porter, K. E. Easterling CRC Press, 3rd ed (2003).

PH-720 Renewable Energy Sources

Introduction, importance of energy, world energy demand.

Conventional energy sources, renewable sources; potential, availability and present status of renewable sources.

Solar energy, physical principle of conversion of the solar radiation into heat, flat-plate collectors. Concentrating collectors, basic principle and components of wind energy conversion system, types and performance of wind machines.

Biomass conversion technology, thermal gasification of biomass; alternative; liquid fuels, biogas generation, classification of biogas plants.

Geothermal sources, hydro-thermal geo- pressure, petro- thermal and magma resources, advantages and limitation of geo- thermal energy.

Introduction, global generation growth rate, prospects of nuclear fusion, safety and health hazards issues, global resources and their assessment.

Classification, micro, mini, small and large resources.

Principles of energy conversions, turbines, working and efficiency of from to small power systems, environmental impacts.

Reference Books:

1. Renewable energy sources by Jophn W. Twidell and Anthony D. Seir, E & F.N Sons Ltd London, (1986).
2. Solar energy conversion, A.E Dixon and J.D.Jeslie, Pergamon press, (1979).
3. Biogass, production and utilization, Elizbath C. Oruce, Ann Arbor Sciences, USA, (1981).
4. Wind power, V. denial Hunt, Litton Educational publishing Inc., (1981).

PH-721 Physics of Solar Cells

An introduction to solar energy, direct and in direct sources of solar energy.

Review of semiconductor properties, materials and structural characteristics effecting cell performance.

Short-circuit current limit, open-circuit voltage limits, effects of temperatures, short-circuit current losses, open-circuit voltage losses, fill factor losses, efficiency measurement.

Optimal cell design consideration, collection probability of generated carriers, junction depth, lateral resistance of top layers, doping of substrates, back surface fields, top-layer limitations, dead layers, high doping effects.

Contribution to saturation current density, top-contact design, optical design, antireflection coating, textured surfaces, spectral response, silicon single crystal wafers for solar cells and modules, module construction, cell operating temperatures, module durability and circuit design.

Advance materials for solar cell, pre and post surface modification of solar cells, polishing

and chemical etching of basic photovoltaic materials.

Annealing in various environments, ion-implantation, energy storage, power control and system sizing.

Uses of solar cells in water pumping and residential systems, central power plants for space applications.

Reference Books:

1. Solar Cells: Operating Principles, technology and system applications by Martin A. Green, Prentice-Hall, Inc., (1982).
2. Solar energy utilization by G.D.Rai, Khanna Publishers-Dehli, (1991).
3. Solar energy conversion: The solar cells by Richard C. Neville, Elsevier Scientific Publishing Company, (1978).
4. Solar Cell: from basic to advance systems by Chenming Hu & Richard M. White, McGraw Hill Book company, (1983).

PH-730 Computational Physics

Introduction to symbolic computing (Matlab, Mathematica and Simulink), introduction to computers, errors estimation, methods for roots of nonlinear equations, linear system simulations (Gauss-elimination, Jacobi method, Gauss-Seidel method, LU decomposition), Eigen-value problems; Linear and nonlinear regressions, computational integration and differentiation, Ordinary Differential Equations (Euler method, Improved Euler method, KR-methods), Multi-step methods; Partial differential equations, introduction to Monte Carlo methods, Genetic Algorithms.

Reference Books:

1. S.E. Koonin and D.C. Meredith, Computational Physics, Addison Wesley (2000).
2. J.Kiusaloas, Numerical Methods in Engineering with MATLAB, Cambridge University Press (2010).
3. S.M. Mirza, Computational Physics, AllamaIqbal Open Univ., Press (2002).
4. User's Manual for Matlab, Mathworks Inc., N.Y. (2012).
5. User's Manual for SIMULINK, Mathworks, Inc., N.Y. (2012).

PH-731 Mathematical Modeling& Simulation

Introduction to mathematical modeling, fundamentals of simulation, Introduction to Matlab and Simulink, block model development in Simulink, first order models (examples from fluids, biophysics, physics, electrical systems and mechanical systems), second order systems and models (example on homogeneous and non-homogeneous linear systems coupled or simultaneous systems (examples from fluids and population, electrical and mechanical systems), nonlinear systems and simulation methods; stochastic models and simulation methods (discrete and continuous systems), probability density functions and sampling methods, random walks, introduction to MC techniques.

Reference Books:

1. B.S. Bennett, Simulation fundamentals, Prentice Hall, N. Y. (2000).
2. B.D. Hahn and D.T. Valentine, Essential Matlab for Engineers and Scientists, Elsevier, N.Y. (2007).
3. S.A. Dupree and S. K. Fraley, A Monte Carlo Primer; a Practical Approach (Vol. I) Kluwer Academics/Plenum Publisher, N. Y. (2002).
4. S.A. Dupree and S. K. Fraley, A Monte Carlo Primer; a Practical Approach (Vol. II) Kluwer Academics/Plenum Publisher, N. Y. (2002).
5. User's Manual for Matlab, Mathworks Inc., N.Y. (2012).
6. User's Manual for SIMULINK, Mathworks, Inc., N.Y. (2012).

PH-760 Semiconductor Theory

Introduction/Elementary Properties of Semiconductors: Crystal Structure, Atomic Bonding, Intrinsic and Extrinsic Semiconductors, Energy Bands, Density of States, Nearly Free Electron Model, Kronig-Penny Model, Energy Bands for Intrinsic and Extrinsic Semiconductors. *Semiconductor Statistics:* Fermi-Dirac Statistics, Carrier Concentrations in Thermal Equilibrium in Intrinsic Semiconductors and Semiconductors with Impurity Levels. *Transport Phenomena:* Constant Relaxation Time, Electrical conductivity, the Hall Effect, Transverse Magnetoresistance, Scattering Mechanisms. *The Boltzmann Equation:* The Boltzmann Transport Equation, Conductivity and Magnetoconductivity in Parabolic and Ellipsoidal Bands, Thermoelectric and Thermomagnetic Effects, Quantum Transport.

Excess Carriers in Semiconductors: Diffusion processes, Diffusion and Drift of Carriers, The Continuity Equation, Direct and Indirect Recombination of Electrons and Holes, Steady State Carrier Injection, Optical Absorption, Interband Transitions, Photoconductivity, Luminescence.

Metal- Semiconductor Contacts and PN-Junction Theory: Ohmic, Blocking and Neutral Metal-Semiconductor Contacts, PN-Junction under Equilibrium Conditions, Forward and Reverse-Biased Junctions, Reverse-Bias Breakdown, Deviations from the Simple Theory.

Reference Books:

1. Semiconductors, David K. Ferry, Macmillan Publishing Co. New York, 1991.
2. Semiconductor, R.A. Smith, The Cambridge University Press, Cambridge, 1964.
3. Introduction to Solid State Physics, C. Kittel, 7th Edition, John Wiley & Sons, Inc., New York, 1996,
4. Solid State Electronic Devices, B.G. Streetman, Prentice-Hall International Inc., London, 1980.

PH-761 Physics of magnetic materials

Introduction: magnetism & various magnetic materials with their applications, classical and quantum phenomenology of magnetism.

Origin of Magnetism: orbital motion of a single electron, spin states of a single electron, states of isolated ions, ions in magnetic fields, spectroscopic investigations Quantum Mechanics, Magnetism and Bonding in Metals.

Magnetically Ordered Solids: spontaneous magnetic order, ferromagnetisms in elements, ferromagnetism in alloys, ferromagnetism in non-metallic compounds, ferromagnetism & anti-ferromagnetism, linear and helical magnetism.

Magnetic Anisotropy: magnetocrystalline anisotropy, shape anisotropy and stress anisotropy.

Dia- and Para-Magnetism in Solids: diamagnetism of isolated atoms and ions, diamagnetism of crystalline solids, diamagnetic resonance or cyclotron resonance, the main classes of paramagnetic solids, paramagnetism due to ions of rare-earth and transition elements, paramagnetism of metals, free radicals and molecular paramagnetism, paramagnetic relaxation.

Soft Magnetic Materials: theory and applications.

Amorphous Materials: magnetism and disorder.

Magnetism in Small Structures: exchange coupling and nanocrystals.

Reference Books:

1. Magnetism in Solids –by- D.H. Martin, MIT Press.
2. The Physical Principles of Magnetism –by- A.H. Morrish, John-Wiley & Sons, New York, 2001.
3. Introduction to Magnetic Materials –by- B.D. Cullity, Addison Wesley, 1972.
4. Physics of Magnetism and Magnetic Materials –by- K.H.J. Buschow and F.R. de Boer,

PH-762 Experimental Techniques

Characterization of electromagnetic radiation, and its interaction with matter. Diffraction of x-ray and neutrons by crystalline material. Qualitative and quantitative analysis of the diffraction patterns.

Energy dispersive and wavelength dispersive analysis, thermal analysis, Differential Calorimetric analysis. Thermal Gravimetric analysis (TGA). Molecular spectroscopy techniques, IR spectroscopy, UV-Vis spectroscopy, Transmission Electron Microscopy (TEM), (FTIR), gamma - ray spectroscopy, Mossbauer spectroscopy, Raman spectroscopy and Atomic Force Microscopy (AFM). Understanding of the data analysis qualitatively and quantitatively.

Errors and Data Analysis: Errors of observation: accidental and systematic errors. Errors in compounds quantities, in products, in quotient in sum or difference. Frequency distributions and related terminology, methods of least squares, weighted mean and its standard error, curve fitting and accuracy of co-efficient.

Reference Books:

1. X-ray diffraction: Modern Experimental Techniques. Edited by Oliver H. Seeck, Bridget M. Murphy. CRC Press, Taylor & Francis Group, 10th Feb. 2015.
2. Elements of Modern Physics, Jens Als- Nielsen and Des McMorrow. John Wiley and Sons, Ltd 2001
3. Elements of x-ray diffraction by B.D Cullity, Addison- Wesley Publishing Co. Inc. (1976)
4. Materials Characterization Techniques by Sam Zhang, Lin Li, Ashok Kumar: CRC Press (2008)
5. Materials Characterization: Introduction to Microscopic Methods by Yang Leng, Wiley (2013)
6. Error of Observation and Their Treatment by J. Topping, John Wiley and Sons (1977). It is an old book, but covers the course out lines

PH-763 Surface Physics

An Introduction to Surfaces: The surface as an especially important object for physical investigation. Influence of the surface on physical properties of objects. Clean and covered surfaces. Adsorption and catalysis. What is UHV: Vacuum concepts and UHV hardware. The methods to get clean surfaces. The structure of surfaces. Short overview of modern experimental techniques.

Surface Structures and Reconstructions: Lattice concept. 3 D crystal structures, 2D surface structures. Specific types of surface, fcc, hcp, bcc and stepped surfaces and a discussion of their relative energies. More complex reconstruction, stability, growth mechanisms, adsorption. Desorption and experimental probes of surface structure such as LEED and RHEED. The structure of semi-conductor surfaces. The surface structures of very small metal particles.

Adsorption, Desorption Bonding, Catalysis and Growth Processes: Adsorption mechanisms and kinetics chemisorption vs. physisorption, the kinetics of adsorption, potential energy curves and adsorption energetics. Adsorption mechanisms and kinetics for low coverages Langmuir Isotherms, derivation, adsorbate phase diagrams and phase transitions.

The Structure of Adsorbate Layers: Experimental probes of surface structure such as LEED and RHEED. Growth processes, vibrational spectroscopy, catalysis, Desorption.

The Electronics and Magnetic Structure of Surfaces: Band theory, Free electron theories and the work function. The electronic structure of semiconductor surfaces, Electron emission processes. Magnetic processes at surfaces.

Electron-Surface Interactions: Electron diffraction and quasi – elastic scattering, comparison of particle scattering techniques. Electron spectroscopes, Discussion of the merits of different types of electron energy analysers and electron detectors. Signal processing and spectral analysis. Theory and practice of Auger electron spectroscopy, Quantification of Auger spectra, Auger depth. Profiling.

Atom/ion surface interactions: Comparison of particle scattering techniques, An Introduction to the theory and practice of SIMS, SIMS imaging and depth profiling, Auger depth profiling, theory and practice of Rutherford. Back scattering.

Surface Microscopy: Classification of microscopy techniques, Basic concepts in Surface imaging and localized spectroscopy, Imaging XPS, Optical microscopy, STEM. SEM.SPM. An introduction to the theory and practice of scanning Tunneling Microscopy, Scanning probe microscopy techniques, Atomic Force Microscopy.

Reference Books:

1 Physics at Surfaces, A. Zangwill, Cambridge University Press, 1988.

2. Introduction to Surface Physics, M. Prutton, Oxford University Press, 1994.

3. Surface and Thin Film Analysis: Principles, Instrumentation, Applications / Edited by H. Bubert and H. Jenett. - Wiley-VCH Verlag, 2002.

PH-764 Optical Properties of Solids

Basic Concepts of Optical Response: Maxwell equations, dielectric optical response, refractive index and absorption, Lorentz oscillator model, dispersion relations, Lyddane-Sachs-Teller relation, Drude theory and basic plasma optics, Kramers-Kronig relations, polaritons, dielectric tensor, longitudinal plasma oscillations .

Optical Properties of Phonons: Optical and acoustic phonons, monatomic lattice dispersion relations, diatomic lattice, n -dimensional crystals, effective charges, Bose functions, optical excitation of phonons, infrared absorption, phonon polaritons, light scattering, Raman and Brillouin scattering, coherent Raman spectroscopy.

Linear Optical Properties of Semiconductors: Direct and indirect gap semiconductors, energy and momentum conservation in band-to-band transitions, optical absorption and quantum mechanical time-dependent perturbation theory, dipole-allowed optical transition in the parabolic band approximation, indirect optical transitions, excitons, two-particle Schrodinger equation, selection rules, first -class dipole allowed transitions, second-class dipole allowed transitions, excitonic absorption in first-class dipole allowed transitions, excitonic luminescence, examples of important semiconductors.

Quasi-two-dimensional Semiconductors: Quantum confinement, bandgap offset, quantum wells, envelope function approach, particle-in-box, subbands, superlattices, compositional variations, lattice mismatch, optical transitions and selection rules, excitons in quantum wells.

Overview of Electro-optical Properties of Semiconductors: Franz-Keldysh effect, DC Stark effect, exciton ionization, quantum-confined dc-Stark effect.

Overview of Semiconductor Optical Nonlinearities: Phase-space blocking, screening, bandgap renormalization, thermal nonlinearities, optical Stark effect, two-photon absorption.

Introduction to Basic Concepts of Optoelectronic Devices and Semiconductor Lasers: Basic operation principles of LED's and lasers, doping p-n junctions forward and reverse

bias, I-V curves, semiconductor lasers, and photodetectors.

Reference Books:

1. An introduction to Solid State Physics and its applications, Elliott & Gibson, MacMillan(1976)
2. Optical Properties of Solids, F. Wooten, Academic Press (1972)
3. Semiconductor Opto-Electronics, Moos, Burrell & Ellis, Butterworth (1973)
4. Semiconductor Optics and Transport Phenomena, W. Schäfer and M. Wegener, Springer, Berlin, (2002)

PH-765 Conducting polymers

Basics of conducting polymers: Synthesis, structures and morphology; *Conductivity Properties:* Semiconductor models and conductivity mechanisms in conducting polymers; *Doping reactions:* Composites, copolymers, conductive polymer thin films; Electrochromic and electrochemical properties of conducting polymers; Solubility and processing of conducting polymers; conducting polymer coatings, *Characterization methods:* Electrical, mechanical and electrochemical characterizations; *Application fields of conducting polymers:* Sensor applications, photovoltaic applications; supercapacitor applications, recent activities in the field of conducting polymers.

Reference Books:

1. Conducting Polymers, Fundamentals and Applications: A Practical Approach by Prasanna Chandrasekhar, Springer; 1st edition (August 31, 1999).
2. Conducting Polymers: A New Era in Electrochemistry by GyörgyInzelt, Springer; 1st ed. 2008 edition (November 19, 2010).
3. Up to date a couple of review papers

PH-766 Biophysics

Introduction, Chemical bonding, statistical mechanics, Reaction membranes, Biological energy, Memory, Biological motors.

Reference Books:

1. Biophysics an introduction by Rodney Cotterill (John Wiley and Sons Ltd).
Energies forces and bonds, Energy bands, Thermodynamics and rates, Transport processes, Biological polymers, Biological Movement of organisms, Excitable membranes, Nerve signals, Memory, Biological motors.

PH-770 Environmental Physics

Structure and composition of the Atmosphere: Principal layers, troposphere, stratosphere, mesosphere, thermosphere, Ideal gas model revisited, exponential variation of pressure with height, Escape velocity, Temperature structure and lapse rate.

Radiation: The Sun as the prime source of energy for the earth, Solar energy input, cycles daily and annual, Spectrum of solar radiation reaching the earth, Total radiation and the Stefan Boltzmann, Wien and Kirchoff Laws, Radiation balance at the earth's surface and determination of the surface temperature, Ozone layers and depletion, CO₂, methane, H₂O and the Greenhouse effect.

The hydrosphere: Properties of water, The hydrologic cycle, Measuring the water content of the atmosphere; humidity. Thermodynamics of moist air and cloud formation, Growth of water droplets

in clouds, Rain and thunderstorms.

Winds in the atmosphere: Measuring the wind; the Beaufort scale, Origin of winds; the atmosphere as a heat engine, The principal forces acting on an air parcel, Cyclones and anticyclones, Thermal gradients and winds, Global convection and global wind patterns. *The ground:* Soils and soil types, Water flow through soils and rocks, Soil temperatures. *Energy and the environment:* Energy demands and energy resources, Environmental problems of energy production, Nuclear power, Renewable energy sources; hydro-electric, wave and wind power, biomass, solar, Energy conservation; design of buildings *Atmospheric pollution; acid rain:* Systems approaches to environmental issues, Acid rain as a regional problem.

Sound and noise: Definition of the decibel and A-weighted sound levels, Measures of noise levels; effect of noise levels on hearing, Domestic noise; design of partitions.

Reference Books:

1. Environmental Physics; N.J. Mason and P Hughes – Taylor and Francis (2001).
2. Environmental Science; D.B. Botkin and E.A. Keller, Wiley (1998).
3. Fundamentals of Weather and Climate R. McIlveen, Chapman and Hall (1992).
4. Renewable energy Resources, J. Twidell and T. Weir, E & F.N. Spon (1986).

PH-771 Photovoltaic Technology

Background of Solar Technology: Early attempts at solar, declining costs of PV,

Definition of Gen I, Gen II, and Gen III PV technologies, Solar resources planet-wide, Applications, Utility scale, "Distributed grid" rooftop applications, Current usage of solar PV.

Energy economics: Capacity factor calculations, Comparison of solar PV to other Methods, Daily energy demand variations and peak usage, Energy storage methods and Costs, Differences in economic case for point of use PV versus utility scale power generation.

Types of PV: Monocrystalline Si, Polycrystalline Si, Si thin film, CdTe and CIGS, High performance multijunction cells.

From cell to module: Cell classification, Front side ribbon soldering, Cell interconnects and "stringing", Electrical circuit assembly, Laminate assembly, CPV.

PV systems: Power output, footprint, and cost: Effects of latitude and climate, Tracking Systems, Balance of system (inverters, mounting racks, installation costs).

Thin Film Solar Cell Systems: a-Si, CIGS, CdTe, Exotics.

~~*PV Panel Fabrication:* Discrete cell panels; Construction overview, Stringing, Layout, Wiring, Final Test. Thin Film Panels; Construction overview, Advantages over discrete, Fabrication techniques, Test.~~

PV Related Power Quality Issues: PQ standards & measurements, Case studies.

Reference Books:

1. Solar Photovoltaics – Fundamentals, Technologies and Applications, C. S. Solanki, (PHI Learning).

PH-772 Solar Thermal Power Technology

Solar radiation – Review: Models for radiation analysis and beam radiation calculations, evaluation and estimation of the solar resources.

Thermodynamic and Heat transfer – Review: Thermal conversion of solar radiation, the concentration of solar radiation, overview of solar concentrating technology.

Solar concentrators: Parabolic trough, paraboloidic dish: continuous type and Fresnel type

Tracking mechanisms: single axis and double axis trackings

Solar thermal technologies: Solar Parabolic trough; design considerations, tracking and control systems, thermal design of receivers. Solar parabolic dish; design considerations, Sterling engine, Brayton cycle, tracking and control systems. Solar tower concepts; tower design, heliostat design, receiver types, tracking and control systems.

Material and product/technology overview for the above technologies. *Emerging technologies:* Linear Fresnel reflector, Solar chimney.

Heat transfer fluids and storage systems: Technology overview, design considerations, materials.

Solar thermal power plants: Performance study, site selection and land requirement.

Reference Books:

1. Renewable Energy Engineering and Technology – A Knowledge Compendium, ed. VVN Kishore (TERI Press, 2008).
2. JA Duffie and WA Beckman: Solar Engineering of Thermal Processes, Third Edition (John Wiley & Sons)
3. S Sukhatme and J Nayak: Solar Energy: Principles of Thermal Collection and Storage, Third Edition (Tata McGraw Hill, 2008).

PH-773 Bio-Energy Technology

Course outline, current energy consumption, overview of biofuel/bioenergy and biorefinery concepts.

Fundamental concepts in understanding biofuel/bioenergy production Renewable feedstocks and their production. Feedstocks availability, characterization and attributes for biofuel/bioenergy production Biomass preprocessing: drying, size reduction, and densification. Various biofuels/bioenergy from biomass.

Biomass conversion to heat and power: thermal gasification of biomass, anaerobic Digestion.

Biomass conversion to biofuel: thermochemical conversion, syngas fermentation Biochemical conversion to ethanol: biomass pretreatment.

Different enzymes, enzyme hydrolysis, and their applications in ethanol production Biodiesel production from oil seeds, waste oils and algae. Environmental impacts of biofuel production.

Energy balance and life-cycle analysis of biofuel production. Value-added processing of biofuel residues and co-products.

Reference Books:

1. Biorenewable Resources: Engineering New Products from Agriculture. Robert C. Brown. Wiley-Blackwell Publishing (2003).
2. Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. Samir K. Khanal. Wiley-Blackwell Publishing (2008).

PH-776 Monte Carlo Methods

Introduction to stochastic techniques, random number generation, probability theory, probability distribution functions, discrete and continuous pdfs, direct sampling methods, rejection techniques, importance sampling methods, random walks, diffusion and biased diffusion, Metropolis algorithm and its applications, error estimation and error reduction techniques, multivariate distributions, random walk filters, applications of MC methods (Ising model, Heisenberg model in statistical physics, neutron transport, radiation transport, study cases using large computer codes using MC methods such as GEANT-4, MCNP etc.,)

Reference Books:

1. Monte Carlo methods, M.H. Kalos and P.A. Whitlock, Wiley-CVH Verlag GmbH & Co. (2004)
2. Monte Carlo Methods in Statistical Physics, D.P. Landau and K. Binder, Cambridge University Press (2004).
3. A Monte Carlo Primer; a Practical Approach (Vol. I), S.A. Dupree and S. K. Fraley, Kluwer Academics/Plenum Publisher, N. Y. (2002).
4. A Monte Carlo Primer; a Practical Approach (Vol. II), S.A. Dupree and S. K. Fraley, Kluwer Academics/Plenum Publisher, N. Y. (2002).
5. S.E. Koonin and D.C. Meredith, Computational Physics, Addison Wesley (2000).

PH-777 Non-Linear Dynamics in Physics

Dynamical systems, phase space, Poincare section, spectral analysis, Basin of attraction, bifurcation diagrams; the Logistic map, period doubling, Lyapunov exponents, entropy; Characterization of chaotic attractors; prediction of chaotic states, method of analogues, linear approximation method, modification of chaotic states; spatio-temporal chaos, intermittency; Quantum maps, chaos in non-equilibrium statistical mechanics, driven systems; inter-mode traces in the propagator for particle in the box.

Reference Books:

1. Chaotic Dynamics: An Introduction, G. L. Baker and J. P. Gollub, Cambridge Univ. Press, 1996.
2. Nonlinear Dynamics & Chaos: With Applications to Physics, Biology, Chemistry & Engineering, S. Strogatz, Perseus Books Group, 2001.
3. Nonlinear Dynamics and Computational Physics, V. B. Sheorey, Narosa Pub. House, London, 2005.
4. Mathematica in Action, S. Wagon, Freeman & Co., NY, 2003.

PH-778 Computational Statistical Physics

Review of thermodynamics and Statistical Mechanics. Empirical equation of state. Ideal gas laws.

Van der Waal's equation. Critical Phenomenon. Hugoniot equation. Mie-Gruneisen equation. Semi-empirical theory of Gruneisen ratio. Theoretical calculations of equation of state. Exactly soluble models. Classical ideal gas. Non-interacting Fermi gas. Non-interacting Bose gas. Paramagnets. Ising model. Approximate methods. Thomson-Fermi model. Debye-Huckle theory. Statistical mechanics of Plasmas. Cluster expansions. Computer based calculations of equation of state. Methods of molecular

dynamics and Monte Carlo Techniques.

Reference Books:

1. Statistical Mechanics and Dynamics, H. Eyring, D. Henderson, N. J. Stover and E. M. Eyring, John-Wiley and Sons, 1982.
2. Statistical Mechanics, K. Huang, John-Wiley and Sons, 1987.
3. Statistical Physics, 3rd Edition, L. D. Landau and F. M. Lifshitz, Pergmon, 1980.

PH-779 Computational Condensed Matter Physics

Scattering theory, quantum scattering, calculation of cross-sections; Variational techniques, solution of generalized eigenvalue problems; Hartree-Fock method, the helium atom, many electron system, Slater determinants; Density functional theory, local approximation, exchange and correlation, applications; Molecular dynamics simulations, molecular systems, Langevin dynamics, ensembles and integrators, quantum molecular dynamics; Stochastic techniques;

PhD in Physics

quantum Monte Carlo: variational diffusion, path-integral.

Reference Books:

1. Computational Physics, 2nd Edition, J. M. Thijssen, Cambridge, 2007.
2. Monte Carlo Methods, 2nd Edition, M. H. Kalos, P.A. Whitlock, Wiley-VCH Verlag, 2008.
3. Computational Physics, 2nd Edition, N.J. Giordano, H. Nakanishi, Prentice Hall, 2006.
4. Computational Physics, Problem Solving with Computers, 2nd Edition, R. H. Landau, M. J. Páez, C. C. Bordeiano, Wiley, 2007.
5. Computations in Modern Physics, 3rd Edition, W. R. Gibbs, World Scientific, NY, 2006.
6. Computational Physics, S.E. Koonin and D.C. Meredith, Addison Wesley (2000).

PH-780 Special Topics in Physics-I

This is a course on advances in Physics not already covered in the syllabus. This special paper may be conducted as a lecture course or as an independent study course. The topic and contents of this paper must be approved by the BOS, AU.

PH-781 Special Topics in Physics-II

This is a course on advances in Physics not already covered in the syllabus. This special paper may be conducted as a lecture course or as an independent study course. The topic and contents of this paper must be approved by the BOS, AU.

FACULTY

Core Faculty:

1. Dr. Abdullah Sadiq., Professor/Dean Faculty of Basic & Applied Sciences Education:

Ph.D.	University of Illinois at Urbana-Champaign, Illinois USA	Condensed Matter Physics, Theory & Computations Simulations
MSc	University of Peshawar, Peshawar, Pakistan	Physics

Research Interest: Condensed Matter Physics - Computer Simulations

2. Dr. Muhammad Anwar, Professor/ Chair

department Education:

Ph.D.	University of Durham, UK	Solid State Physics
M-Phil	QAU, Islamabad	Solid State Physics
MSc	University of Punjab, Lahore	Physics

Research Interest: Energy. Renewable energy, energy policy

3. Dr. Asghari Maqsood, Professor

Education:

Ph.D	Göteborg University, Sweden	Physics
M.Sc.	University of Oxford, UK	Physics
M.Phil	Quaid-e-Azam University, Islamabad	Physics
M.Sc	University of the Punjab	Physics

Research Interest: Materials Science, Thermal transport properties, High- T_c superconductors, Thin films, Nano-composites, polymers, Ferrites, Single crystals

4. Dr. Muhammad Atif, Assistant Professor

Education:

Ph.D.	Technical University of Vienna, Austria	Materials Sciences
M-Phil	QAU, Islamabad	Physics
MSc	QAU, Islamabad	Physics

Research Interest: Magnetostrictive materials, Magnetoelectric Composites, Nanomaterials, Ferrites, Materials Synthesis

5. Dr. Rubina Nasir, Assistant Professor

Education:

Ph.D.	Quaid-e-Azam University (QAU), Islamabad	Physics
MS	Pakistan Institute of Engg. And Applied Sciences (PIEAS), Islamabad	Nuclear Engineering
MSc	Quaid-e-Azam University, Islamabad	Physics

Research Interest: Theoretical Condensed Matter Physics, Computational Physics, Radiation Physics, Modeling & Simulations, Nuclear Engineering

6. Dr. Zulquain Ali, Assistant Professor

Education:

Ph.D.	Philips University ,Germany	Materials Science
M-Phil	QAU, Islamabad	Physics
MSc	QAU, Islamabad	Physics

Research Interest: Nanomedicine, Colloidal nanoparticle, Biophotonics

7. Mr. Kashif Ali, Lecturer**Education:**

M-Phil	QAU, Islamabad	Physics
MSc	QAU, Islamabad	Physics

Research Interest: Materials Science

8. Ms Anum Zaid, Lecturer**Education:**

M-Phil	QAU, Islamabad	Physics
BS	University of Wah, Wah	Physics

Research Interest: Solar Energy, Materials Science

8. Mr Ubaid Khan, Lecturer**Education:**

M-Phil	AIOU, Islamabad	Physics
MSc	University of Peshawar, Peshawar	Physics

Research Interest: Nanoparticle physics

Faculty on Leave:

1. Mr. Aamir Minhas Khan (PhD student, China)
*He is expected to join the department in **July 2015**.*
2. Ms. Tayyaba Firdous (PhD student, Canada)
She is expected to join the department in July 2016.
3. Mr. Mozaffar Hussain (PhD student, China)
He is expected to join the department in July 2016.
4. Mr. Muhammad Fakhar Zia (PhD student, Saudi Arabia)
He is expected to join the department in December 2016.
5. Ms. Tashfeen Zehra (PhD student, Netherlands)

She is expected to join the department in December 2016.

Fee Structure

<i>Program</i>	<i>Total Credit Hours</i>	<i>Tution Fee Rate (Per Cr. Hr.)</i>	<i>Estimated Total Cost of Degree Program</i>	<i>Credit Hours 1st Semester</i>	<i>Tution Fee as Per Cr. Hr. for 1st Semester</i>
Ph.D Physics	18+30	RS. 3,360/-	RS. 161,280/-	9	RS. 30,240/-

DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING

The document offers the deep insight of the Department of Electrical & Computer Engineering of AIR University to the reader by detailing out its academic features and accomplishments

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1. Air University Mission, Vision, and Core Values

1.1. Mission

The mission of Air University is to achieve excellence in teaching and research for producing graduates with sound professional knowledge, the integrity of character, a keen sense of social responsibility and a passion for lifelong learning. The University shall stand committed to creating an environment conducive for attracting the best students, faculty and supporting staff for contributing to the development of a prosperous, peaceful and enlightened society.

1.2. Vision

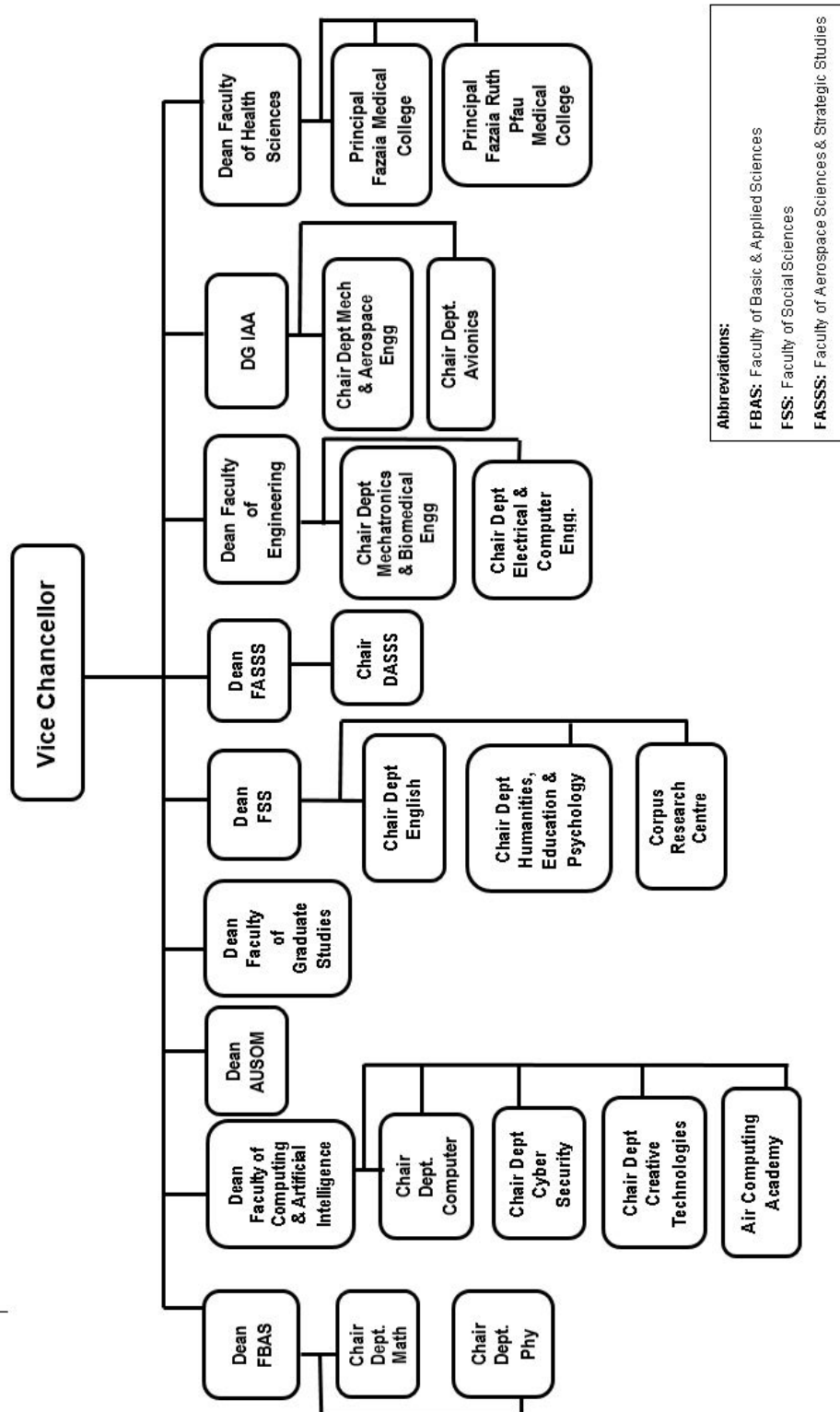
Air University aspires to be among the leading national universities, excelling in teaching, learning, research, innovation and public service.

1.3. Core Values

- Integrity
- Respect
- Academic Freedom
- Open-Mindedness
- Accountability
- Professionalism
- Meritocracy
- Teamwork
- Creativity
- Social Responsibility

2. Air University Organizational Chart

Air University Academic Organogram Main Campus



3. Faculty of Engineering

Faculty of engineering comprises of two departments, namely:

1. Department of Electrical and Computer Engineering (DECE) Established in 2002.
2. Department of Mechatronics and Biomedical Engineering Established in 2003.

The DECE offers both undergraduate and postgraduate programs. At undergraduate level, the dept. offers two programs, Electrical Engineering Program and Computer Engineering Program. Further, three specialization streams exist in EE program which are Power, Electronics and Telecommunications. The dept. has graduated 14 batches of Electrical Engineers. The Computer Engineering (CE) Program was launched in 2017, therefore its first batch of students is yet to be graduated. At postgraduate level, the dept. offers MSEE and PhD EE programs. Our graduates from Electrical department have found their places in society as professionals serving the industry or as academics, training future graduates in institutions both at home and abroad. Faculty development and academic enrichment for forming constructive learning environments remains an ongoing activity.

The faculty at DECE is qualified, experienced and fully in tune with the directions of the university. The hardware in laboratories is also adequate to support a skill level to complement knowledge from the classroom lectures. We thus have a fully operational engineering program at undergraduate and graduate levels. The bachelor's degree is accredited by the Pakistan Engineering Council (Level-II) for batches 2015 and 2016, and by the acceptance our engineering students have found in the industries where they are employed.

The Computer engineering program of the ECE department is a fully operational engineering program at the undergraduate level, with a qualified and experienced team of faculty fully in tune with university standards. Laboratories are equipped with state of the art facilities, both hardware and software to complement the theoretical knowledge gained from classroom lectures. The zero visit of the CE program has been successfully conducted by the PEC and now interim and accreditation visits are scheduled.

4. Message from the Dean, Faculty of Engineering

Air University is in its seventeenth year since being established as a federally chartered public sector university in October 2002. With thirteen batches graduated in Electrical Engineering and twelve in Mechatronics Engineering, the 'products' of the Faculty have found their place in society as professionals serving the industry or as the budding academics of tomorrow being trained in institutions at home and abroad. Yet, the Faculty of Engineering is in its infancy undergoing the usual problems, crises, and challenges that have shaped educational institutions in this stage. Faculty development and academic enrichment remain an ongoing activity.

In engineering, the focus is on electronics, telecommunications, power, and mechatronics, while an undergraduate program in mechanical engineering is in place in the university under the supervision of the Institute of Avionics and Aeronautics also located in the same premises.

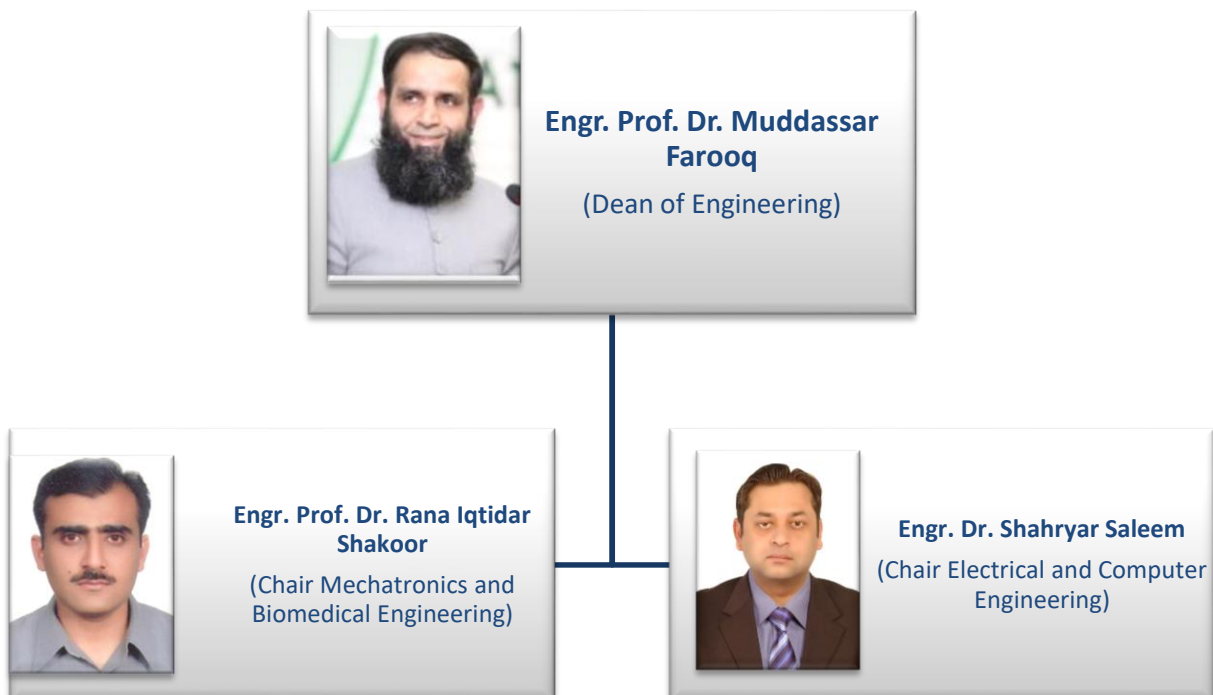
Our faculty is qualified, experienced and fully in tune with the directions of the university. The hardware in laboratories is also adequate to support a skill level to complement knowledge from the classroom lectures. We thus have a fully operational engineering program at undergraduate and graduate levels. These are accredited by the Pakistan Engineering Council and by the acceptance our graduate students have found in the industry where they are employed.

Our undergraduate students have produced several engineering proof-of-concept products and have participated in national and international competitions. Many projects are placed on social media including YouTube for the widest dissemination possible.

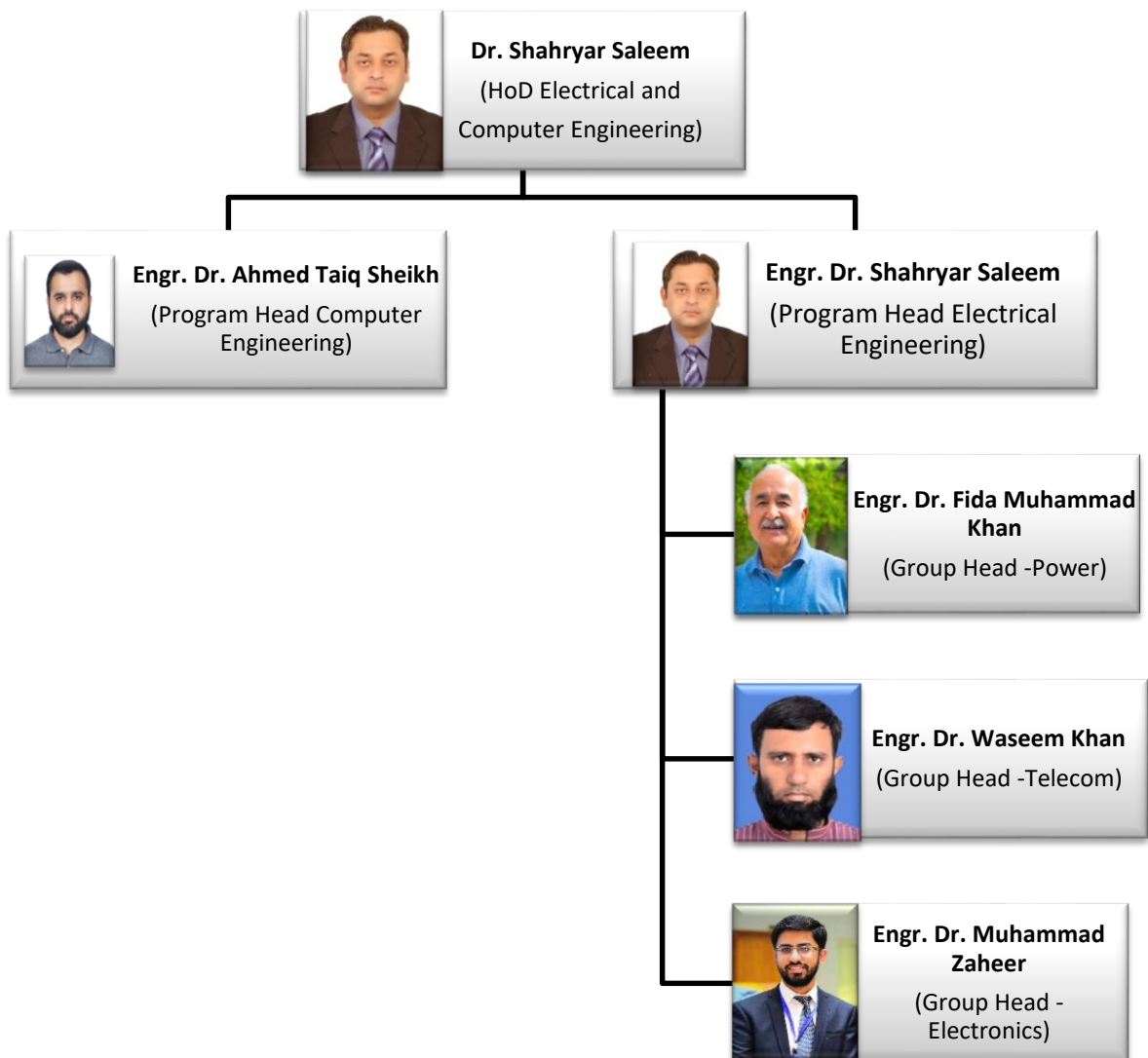
Many of our graduates have proceeded for higher education abroad as well as within Pakistan. They are performing well as the university has done it's all to provide a solid foundation, and they have utilized their time to their own advantage.

I welcome the new students to the Faculty of Engineering assuring them of quality education and full experimental support for their studies. The environment at Air University is conducive for a student to utilize time properly for a promising future in a professional career. With a focused and dedicated approach, and consistent hard-work, a student is bound to find time spent here well rewarded.

5. Faculty of Engineering Management Team



6. ECE Department Organizational Chart



7. Program Coordinators for Bachelor of Engineering

Program Coordinator for a department is answerable to both the Chair Department and the Registrar. He / She acts as a vital link between the department and the administration for transmitting and recording data on students. The program coordinator works in close coordination with the Chair Department and faculty members to help in the smooth functioning of the department. The program coordinators are responsible for course offering, course registration, maintaining class advisory folders, making date sheet of mid semester exams etc. The details of program coordinators for the Electrical & Computer Engineering department are as follows:



Muhammad Nauman Aman
Program Coordinator
Electrical Engineering Department
nauman.aman@mail.au.edu.pk
Ext:457



Amna Shakeel Ghazali
Program Coordinator
Computer Engineering Department
amna.shakeel@mail.au.edu.pk
Ext:457

8. Academic Schedule 2020-2021

 AIR UNIVERSITY PAF Complex, Sector E-6, Islamabad Tel # (051) 9602557-9, (051) 228 1482-4 Fax # (051) 9600158 airweb: http://www.au.edu.pk airweb: info@mail.au.edu.pk																															
Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
SEP 20																															
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DEC 20																															
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MAY 21																															
JUN 21																															
JUL 21																															
AUG 21																															
SEP 21																															

CALENDAR 2020-2021

FALL 2020

SPRING 2021

SUMMER 2021

FALL 2021

*Students must be informed from 1st Aug 2021 to go under test in COVID Contingency / Pre-test
 subject to the signing of consent. *No working day (25-26-27-28-29-30-31)

9. Office Directory

PA to Dean Tel: 051- 9153392	
PA to Chair (Electrical & Computer Engg.) Tel: 051-9153412	PA to Chair (Mechatronics & Biomedical Engg.) Tel: 051-9153472
Program Head (Computer Engg.) Tel:051-9153425 Mail:ahmad.sheikh@mail.au.edu.pk	
Group Head (Electronics) Tel: 051-9153432 Mail: MZaheer@mail.au.edu.pk	Group Head (Power) Tel: 051-9153414 Mail: fida@mail.au.edu.pk
Group Head (Telecom) Tel: 051-9153419 Mail: Waseem.Khan@mail.au.edu.pk	Program Coordinator (Electrical Engg.) Tel: 051-9153457 Mail:nauman.aman@mail.au.edu.pk
Program Coordinator (Computer Engg.) Tel: 051-9153457 Mail:amna.shakeel@mail.au.edu.pk	Program Coordinator (Mechatronics Engg.) Tel: 051-9153499 Mail:neelam@mail.au.edu.pk

10. Brief Profile: Department of Electrical and Computer Engineering (DECE)

10.1. DECE Mission Statement:

“The department aspires to produce outstanding professionals with excellent knowledge of engineering discipline, professional integrity, and ethical values. The graduates should be capable to compete in the contemporary industrial environment and must be intellectually strong enough to undertake the assignment in the fields of higher studies, innovation, and development.”

10.2. Message from Chair Department

This department, which is the oldest and the largest constituent unit of Air University, has a proud history of producing high-quality graduates since its inception in 2002. Our graduates have shown excellent results in the academic field as well as in the industry. They have won laurels for the department by being accepted in some of the most prestigious international universities as graduate students and have won highly sought after scholarships and fellowships all over the world. All the batches we have graduated so far have the accreditation of Pakistan Engineering Council and are

gainfully employed in various public and private sector organizations in the country as well as abroad. From Fall-2009 semester, we have started our M.S. and Ph.D. programs. With the help of highly qualified and experienced faculty members, we are aiming for excellence in graduate studies and research as well. Our faculty members are carrying out in quality research and are regular participants in international conferences and seminars. The field of electrical engineering along with its various areas of specializations is rapidly going through changes and we are acutely aware of the need for constant innovation and rethinking. This feeling is reflected in the periodic review of the curriculum based upon the input from the industry as well as research of our faculty members. We are also constantly upgrading our infrastructure by inducting new equipment and establishing new laboratories. Whether you are a prospective student or wishing to join as a faculty member, or you are interested in establishing linkages with the department, we welcome your interest and would love to answer your queries.

10.3. Introduction:

The Department of Electrical and Computer Engineering of Air University is a renowned and well-established institution having highly qualified faculty, an elegant and modern infrastructure, well-equipped laboratories, and allied academic facilities. It is located in a building with ergonomically organized facilities at an environmentally attractive site. Established in 2002, the department has graduated 14 batches (All PEC accredited) of Electrical Engineering students who are now well established in their careers. There are 33 full-time faculty members serving the department in which 15 are PhDs and 18 have MS degrees (having doctorates from internationally ranked universities in USA, Canada, Australia, Italy, South Korea and others).

The department has fifteen modern laboratories which are equipped with the latest training aids to enhance the learning experience of students. State of the art laboratories are available for digital electronics, electronic systems, analog, digital, RF and optical communication, power electronics and electrical machines, control systems, embedded systems design, digital signal and image processing, telecommunication networks laboratory, power systems laboratory, signal and image processing laboratory, computer systems design lab and projects laboratory. Students also have access to five computer laboratories with the latest computer hardware and software for computer-based courses and fast internet access. For research purposes, students have access to the IEEE digital library as well as other digital libraries provided by HEC.

The department offers state-of-the-art undergraduate and graduate education to prepare engineers to effectively contribute towards social and economic wellbeing of the nation and society at large. In the undergraduate program, the department offers Bachelors of Electrical Engineering (BEE) and Bachelors of Computer Engineering (BCE). Currently, a total of 1011 undergraduate students are enrolled in both programs. Current undergraduate intake of BEE is about 240 students/year and of BCE is about 40 students/year.

In the graduate program, the department offers a Master's of Science in Electrical Engineering (MSEE) and Doctor of Philosophy in Electrical Engineering (Ph.D. EE). Currently, a total of 99 students are enrolled in the MSEE program and 20 are enrolled in Ph.D. EE programs.

10.4. Programs Synopsis:

The Department of Electrical and Computer Engineering offers both undergraduate programs and graduate programs. The details of each of these programs are mentioned below.

10.4.1. Undergraduate Program

10.4.1.1. Bachelors of Electrical Engineering

Bachelor of Electrical Engineering program has the following features

Degree Awarded: B.E.E. (Bachelor of Electrical Engineering)

Duration: 4 Years

Credit Hours: 135

Specialization Streams:

- Electronics
- Telecommunications
- Power Engineering

The BEE program spreads over eight semesters (04 years) and requires successful completion of 135 credit hours for telecom, electronics, and power inclusive of courses, laboratory, and final year project. Keeping in view contemporary industry demands, BEE has adopted the three main aforementioned streams for its BE Electrical Engineering Program. The BEE program has been accredited by the Pakistan Engineering Council (PEC) on Level-II for batches 2015 and 2016. Some of the salient features of the Program are listed below:

- Most of the faculty members hold Doctorate and Master Level Degrees from high ranking and well reputed foreign universities.
- BEE has hosted international conferences and various workshops on topics related to Electrical Engineering with intent to bring awareness among students about the latest technological advancements and engineering innovations.
- BEE students participate and organize competitions at the national level to promote the significance of Electrical engineering.
- BEE has successfully undertaken and completed various projects related to industry and other research organizations.
- BEE Alumni are working at various business enterprises, industries and strategic and defense research institutes throughout the country. Many of them are also working in foreign countries in multi-national companies.
- A large number of BEE alumni are continuing higher education in the top-ranked universities mainly in the USA, Europe, China, and South Korea. Many have selected top-level Pakistani Universities for continuing their education.

10.4.1.2. Bachelors of Computer Engineering (BCE)

Bachelor of Computer engineering program has the following features

Degree Awarded: B.C.E. (Bachelor of Computer Engineering)

Duration: 4 Years

Credit Hours: 136

The BCE program spans over eight semesters (04 years) and requires successful completion of 136 credit hours inclusive of courses, laboratory, and final year project. BCE stresses on the theoretical and practical knowledge of complex digital systems, including general-purpose computers and special-purpose embedded systems. CE establishes the line between hardware and software and partially overlaps computer science and electrical engineering programs. CE students learn how to analyze and design hardware-software systems from transistors to systems software. Microprocessors and microcontrollers are the central topics, and the curriculum includes both analyzing and designing hardware-software systems that contain microprocessors. The zero visit of the BCE program has been successfully carried out by the PEC and now interim and accreditation visits are awaited.

10.4.2. Graduate Programs

The DECE offers two graduate programs:

10.4.2.1. Master of Science in Electrical Engineering MS (EE)

Degree Awarded: MS EE (Master of Science in Electrical Engineering)

Duration: 2 Years

Credit Hours: 30+1 (RM)

Specializations Offered:

- Electromagnetics and Photonics Cluster
- Communication and Signal Processing Cluster
- Power and Control Systems Cluster
- Machine Learning and Image Processing Cluster

Master of Science in Electrical Engineering is a two year, 31 credit-hour programs divided over four semesters. The students have to undertake a compulsory credit hour 'Research Methodology' course. They are further required to complete eight courses, equivalent of 24 credit hours from their chosen area of specialization. They are also required to conduct research and submit their findings in terms of a thesis which is equivalent to 6 credit hours. Satisfactory performance in the course work, as well as the thesis, is must to successfully fulfill the requirements for the award of the Master's degree. As a disclaimer, it must be understood that Air University policy decisions and regulations at the time, take precedence over the requirements.

A comprehensive review of the mathematical concepts and techniques required for subsequent courses and research work is provided in the first two semesters. Core courses are designed to give breadth in Electrical Engineering, as well as give a flavor of all the areas of specialization. The elective

courses provide depth in the chosen area of specialization and lay the foundation for future work during doctoral studies.

Department of Electrical Engineering has fifteen well-equipped laboratories with modern, computer based training systems in Digital Signal Processing, Telecommunication, Antenna, Microwave, Telecomm Networks, and Control Systems. Graduate Research and Computing Labs of Institute of Avionics and Aeronautics at Air University are also available for the thesis work.

A well-endowed library provides free online access to all the resources offered by IEEE and HEC. Students can download any paper with full text from any of the IEEE publications. Air University has also access to the online digital library provided by the Higher Education Commission. AU library has sufficient stock of the most modern books in the field of Electrical Engineering. Special quiet rooms are provided to the researchers in the library to conduct research in the most conducive environment. Wide range of computing facilities is also available to the students.

10.4.2.2. Doctor of Philosophy in Electrical Engineering

Degree Awarded: PhD EE (Doctor of Philosophy in Electrical Engineering)

Duration: Maximum 04 years after MS (Extendable by two years)

Credit Hours: 48 [18 (Course work) + 30 (Dissertation work)]

Specializations Offered:

- Electromagnetics& Photonics
- Communication& Signal Processing
- Power &Control Systems
- Machine learning & Image Processing

Ph.D. in Electrical Engineering is a 48 credit-hour program beyond the Master Degree. The students have to undertake a compulsory one credit hour 'Research Methodology' course if they have not already studied it in their MS studies. If the students have already studied this course or its equivalent, then they are exempted from studying it after formal approval. They are further required to complete a minimum of six courses of 6xx/7xx/8xx level, the equivalent of 18 credit hours from their chosen area of specialization. Students are required to have at least one course with the 8xx course code and at most three courses with 6xx code. They are also required to conduct research and submit their findings in terms of a Ph.D. dissertation equivalent of 30 credit hours. Satisfactory performance in the course work, as well as the Ph.D. dissertation, is a must to successfully fulfill the requirements for the award of the Ph.D. degree. As a disclaimer, it must be understood that Air University policy decisions and regulations at the time, take precedence over the requirements.

Department of Electrical Engineering offers a Ph.D. degree program in following areas of specialization, namely Electromagnetics& Photonics, Communication& Signal Processing, Power & Control Systems, Machine learning & Image Processing. The course work is designed to give in-depth knowledge in the chosen area of specialization. It prepares the students for Doctoral Qualifying Examination and lays the foundation for high-quality research in the selected area.

The Doctoral Qualifying Examination (DQE) is a written examination and is conducted by the Department after the completion of the required course work. In order to be eligible to take DQE, a student must have at least 3.00/4.00 CGPA in the required course work. A student will have two chances to pass DQE. Students failing to clear DQE in two attempts will be separated from the program. A student must pass the written DQE examination of the department with at least 70% aggregate marks in the exam and at least 60% marks in each subject. DQE will consist of two papers, each of three hours duration. The two papers will be from the course work of Ph.D.

After passing the DQE, a student will work on his/her research proposal and request for Proposal Defense Examination (PDE). The student will formally defend his/her proposal in front of the Guidance & Examination Committee (GEC). The student will have to pass PDE in at most two attempts. After successfully passing DQE and PDE, a Ph.D. student will attain the status of the doctoral candidate. The candidate must have at least one article published in an HEC-approved international Journal. Last requirement for Final Defense Examination (FDE) to take place is the reception of two positive reports about his research work from international scholars in the field. The minimum time required for the completion of a Ph.D. degree is three years.

10.5. Outcomes-Based Education (OBE)

In 2014 Pakistan Engineering Council introduced the new accreditation methodology based on OBE / OBA system. PEC has also published the new accreditation manual in 2014. Keeping in view the huge advantages and positive consequences of OBE / OBA system, DECE has embarked upon adopting this methodology. DECE has accepted the challenge and embraced the process to convert to the OBE system since 2016.

10.6. Program Educational Objectives (PEO)

The program educational objectives of the BEE and BCE program are mentioned below.

10.6.1. BEE Program Educational Objectives

A few years after graduation, the graduate of BEE program will be able to:

PEO 1: Undertake and deliver challenging industrial projects in Electrical and related systems by complying with the project engineering requirements of stakeholders.

PEO 2: Carry out research and development projects with minimum supervision in emerging electrical engineering areas that may lead to intellectual property development.

PEO 3: Accept leadership role in organizations or in their own startups by applying out-of-box cognition to invent society-centric sustainable commercial technologies.

Table: Mapping of PEO with the University's Vision and Mission and DECE Mission

Mission / Vision	Vision & Mission Keywords	PEOs		
		PEO1	PEO2	PEO3
AU Vision	Learning ^{PEO2} , Research ^{PEO2} , Innovation ^{PEO3} , Public service ^{PEO3}	✓		
AU Mission	Research ^{PEO2} , Professional knowledge ^{PEO1} , Integrity ^{PEO2} , Social responsibility ^{PEO3} , Prosperous ^{PEO1} , peaceful ^{PEO3} and Enlightened society ^{PEO3}	✓		✓
DECE Mission	Knowledge ^{PEO1} , Integrity ^{PEO2} , Ethics ^{PEO2} , Compete in Industry ^{PEO1} , Undertake development ^{PEO2} , research ^{PEO2} and higher studies ^{PEO2}	✓		

10.6.2. BCE Program Educational Objectives

A few years after graduation, the graduate of BEE program will be able to:

PEO 1: co-designing and co-analyzing hardware/software based computer systems to solve complex societal/industrial problems;

PEO 2: developing innovative technologies or generating new knowledge by applying faculties of mathematical- and design/creative- thinking;

PEO 3: creating impact on society through entrepreneurial startups or intellectual property based inventions.

Mission / Vision	Vision & Mission Keywords	Program Educational Objectives		
		PEO1	PEO2	PEO3
AU Vision	Learning	✓		
	Research		✓	
	Innovation		✓	
	Public service	✓		
AU Mission	Research		✓	
	Professional Knowledge	✓		
	Integrity			✓
	Social Responsibility			✓
	Lifelong Learning		✓	
	Prosperous			✓
	Peaceful			✓
	Competence	✓		
	Professional Integrity			✓
	Ethical Values			✓
	Emerging Computing Systems		✓	
	Smart Industry	✓		
	Research		✓	
	Innovation		✓	
	Technology Development			✓

10.7. Program Learning Outcomes (PLOs)

The graduate attributes defined in Pakistan Engineering Council (PEC) accreditation manual have been adopted as PLOs for the Electrical and Computer engineering program of ECE Department, Air University. The PLOs have been published on the faculty section of the University's website.

10.7.1. BEE PLOs

The following PLOs have been adopted by the BEE program:

- 1. Engineering Knowledge:** An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
- 2. Problem Analysis:** An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
- 3. Design/Development of Solutions:** An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- 4. Investigation:** An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis, and interpretation of experimental data, and synthesis of the information to derive valid conclusions.

5. Modern Tool Usage: An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex Electrical engineering activities, with an understanding of the limitations.

6. The Engineer and Society: An ability to apply to reason informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex Electrical engineering problems.

7. Environment and Sustainability: An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

9. Individual and Team Work: An ability to work effectively, as an individual or in a team, on multifaceted and/or multidisciplinary settings.

10. Communication: An ability to communicate effectively, orally as well as in writing, on complex Electrical engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project Management: An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

12. Lifelong Learning: An ability to recognize the importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

10.7.2. BCE PLOs

The following PLOs have been adopted by the BCE program:

1. Engineering Knowledge: An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex Computer engineering problems.

2. **Problem Analysis:** An ability to identify, formulate, research literature, and analyze complex Computer engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/Development of Solutions:** An ability to design solutions for complex Computer engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4. **Investigation:** An ability to investigate complex Computer engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis, and interpretation of experimental data, and synthesis of the information to derive valid conclusions.
5. **Modern Tool Usage:** An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex Computer engineering activities, with an understanding of the limitations.
6. **The Engineer and Society:** An ability to apply to reason informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex Computer engineering problems.
7. **Environment and Sustainability:** An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and Team Work:** An ability to work effectively, as an individual or in a team, on multifaceted and/or multidisciplinary settings.
10. **Communication:** An ability to communicate effectively, orally as well as in writing, on complex Computer engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management:** An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

12. Lifelong Learning: An ability to recognize the importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

10.8. Academic Staff



Engr. Dr. Muddassar Farooq
Dean Engineering
PhD (TU Dortmund) Germany
Discipline: Computer Engineering
Specialization: Informatik/Computer Science & Engineering



Engr. Dr. Shahryar Saleem
Head of Department
PhD (Victoria University) Australia
Discipline: Electrical Engineering
Specialization: Communication & Sensor Tech.



Engr. Dr. Ijaz M Qureshi
Professor
PhD (University of Toronto) Canada
Discipline: High Energy Physics
Specialization: High Energy Physics



Engr. Dr. Fida Muhammad Khan
Associate Professor
PhD (Michigan State University) USA
Discipline: Electrical Engineering
Specialization: Electrical (Power)



Engr. Dr. Syed Ahmed Pasha
Assistant Professor
PhD (UNSW) Australia
Discipline: Electrical Engineering
Specialization: Systems and Controls



Engr. Dr. Zafar Ali Shah
Associate Professor
PhD (U.E.T) Pakistan
Discipline: Electrical Engineering
Specialization: Electrical (Optics)



Engr. Dr. Waseem Khan
Assistant Professor
PhD (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Radar Signal Processing



Dr. Imran Farid
Assistant Professor
PhD (NWPU) China
Discipline: Info. & Comm. Engineering
Specialization: Image Processing



Engr. Dr. Shahid Hussain Abbasi
Assistant Professor
Ph.D. (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Vehicular Ad. Hoc Networks



Engr. Dr. Sarah Saeed
Assistant Professor
Ph.D. (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Radar Signal Processing



Engr. Dr. M. Habib Mahmood
Assistant Professor
Ph.D. (University of Girona) Spain
Discipline: Computer Engineering
Specialization: Computer Vision



Engr. Dr. Ahmed Tariq Sheikh
Assistant Professor
Ph.D. (KFUPM) KSA
Discipline: Comp. Science and Engineering
Specialization: AI, Computer Architecture



Engr. Dr. Ayesha Khaliq
Assistant Professor
 Ph.D. (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Communications



Engr. Dr. Fiaz Ahmed
Assistant Professor
 Ph.D. (Sabanci University) Turkey
Discipline: Electrical Engineering
Specialization: Controls



Engr. Dr. Saleem Shahid
Assistant Professor
 Ph.D. (Politecnico de Milano) Italy
Discipline: Information Technology
Specialization: Electromagnetics /
 Microwave Imaging



Engr. Dr. Atif Khan
Assistant Professor
 Ph.D. (Sungkyunkwan Uni.) South Korea
Discipline: Electronics & Electrical Eng.
Specialization: Nano/Opto Electronics



Engr. Dr. Muhammad Adil Khan
Assistant Professor
 Ph.D. (Pusan National Uni.) South Korea
Discipline: Electrical Engineering
Specialization: Renewable Energy, Power
 Conservation System



Engr. Dr. Muhammad Zaheer
Assistant Professor
 Ph.D. (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Digital Communication



Engr. Dr. Saad Ullah Khan
Assistant Professor
 Ph.D. (Sungkyunkwan Uni.) South Korea
Discipline: Electrical Engineering
Specialization: Power Distribution
 and Utilization



Engr. Dr. Omar Bin Saeed
Assistant Professor
 P.h.D (KFUPM), Saudi Arabia
Discipline: Electrical Engineering
Specialization: Signal Processing



Engr. Tahir Mahmood Khalid
Assistant Professor
 MS (Boston University) USA
Discipline: Electrical Engineering
Specialization: Signal Processing



Engr. Akram Rashid
Assistant Professor
 MS (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Electronics Engineering



Engr. Shehryar Khan
Lecturer
 MS (Technical Uni. of Munich) Germany
Discipline: Electrical Engineering
Specialization: Communication Electronics



Engr. Amina Asif
Lecturer
 MS (UET Taxila) Pakistan
Discipline: Telecommunication Eng.
Specialization: Comm. & Signal Processing



Engr. Mumajjed Ul Mudassir
Assistant Professor
 MS (UET Taxila) Pakistan
Discipline: Electrical Engineering
Specialization: Telecommunication



Engr. Muhammad Tilal
Lecturer
 MS (Chalmers University of Tech.) Sweden
Discipline: Electrical Engineering
Specialization: Wireless Comm. Systems



Engr. Bahman R. Alyaei
Assistant Professor
 MS (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Telecommunication



Engr. Seema Tahir
Assistant Professor
 MS (INPG Grenoble) France
Discipline: Electrical Engineering
Specialization: Power Engineering



Engr. Madeeha Uzma
Lecturer
 MS (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Electronics



Engr. M. Atique Ur Rehman
Lecturer
 PhD (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Signal Processing & Comm



Engr. Mashood Ahmed
Lecturer
 MS (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Control Systems



Security
Engr. Muhammad Ali Raza
Lecturer
 MS (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Electrical



Engr. Sami Ullah
Lecturer
 MS (Air University) Pakistan
Discipline: Electrical Engineering
Specialization: Electrical



Engr. Ambreen Ali Choudary
Lecturer
 MS (NUST) Pakistan
Discipline: Electrical Engineering
Specialization: RF/Electromagnetics



Engr. Hatif Bin Abdul Majeed
Lecturer
 MS (NUST) Pakistan
Discipline: Energy Systems Engineering
Specialization: Electrical Power



Engr. Muhammad Faizan Munir
Lecturer
 MS (NUST) Pakistan
Discipline: Electrical Engineering
Specialization: Power and Control



Engr. Salman Tariq
Lecturer
 MEng (University of Malaya) Malaysia
Discipline: Power Systems
Specialization: Electrical Power Systems



Engr. Saba Mumtaz
Lecturer
 MS (NUST) Pakistan
Discipline: Electrical Engineering
Specialization: Information Security

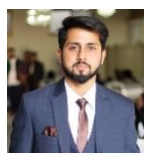


Engr. Usman Hameed
Lecturer
 MS (EME, NUST) Pakistan
Discipline: Computer Engineering
Specialization: Computer systems



Engr. Usman Ghani
Lecturer
 MS (UET Lahore) Pakistan
Discipline: Computer Engineering
Specialization: Computing

10.9. Support Staff



Engr. Wasim Iqbal
Lab Engineer
MS (Air University) Pakistan
Discipline: Electrical Engineering



Engr. Touseef Ur Rehman
Lab Engineer
MS (Air University) Pakistan
Discipline: Electrical Engineering



Engr. Waqar Azam Shami
Lab Engineer
BE (Air University) Pakistan
Discipline: Electronics



Engr. Hiba Hareem
Lab Engineer
BE (Air University) Pakistan
Discipline: Electrical Engineering Power



Engr. Mirza Shujaat Ali
Lab Engineer
BE (CAE-NUST) Pakistan
Discipline: Avionics



Engr. Rabbaya Akhtar
Lab Engineer
BS (COMSATS) Pakistan
Discipline: Electrical Engineering Power



Mr. Zohaib Hassan
Lab Engineer
MS (Air University) Pakistan
Discipline: Electrical Engineering



Engr. Umar Farooq
Lab Engineer
BE (Air University) Pakistan
Discipline: Electrical Engineering



Engr. Rehan Nawaz
Research Assistant
MS (Air University) Pakistan
Discipline: Electrical Engg.



Engr. Hussain Asif
Research Assistant
MS (Air University) Pakistan
Discipline: Electrical Engg.



Engr. Favad Qadir
Research Assistant
MS (Punjab Uni) Pakistan
Discipline: Electrical Engg.



Engr. Awais Shahid
Research Assistant
MS (Air University) Pakistan
Discipline: Electrical Engg.



Engr. Aqib Khan
Research Assistant
MS (Air Uni) Pakistan
Discipline: Electrical Engg.



Engr. Wania Anosh
Research Assistant
BE (Bahria Uni) Pakistan
Discipline: Electrical Engg.



Engr. Hamid Habib Syed
Research Assistant
BS (UET Peshawar) Pakistan
Discipline: Electrical Engg.



Engr. Saud Alam
Lab Engineer
BE (Air Uni) Pakistan
Discipline: Electrical Engg.



Engr. Mughees Ahmed
Research Assistant
MS (Airb Uni) Pakistan
Discipline: Electrical Engg.



Engr. Anum Zulfarnain
Lab Engineer
BE (Air Uni) Pakistan
Discipline: Electrical Engg.



Engr. Ali Raza
Lab Engineer
BS (COMSATS) Pakistan
Discipline: Electrical Engg.



Engr. Faisal Nawaz
Lab Engineer
BS (UET Taxila) Pakistan
Discipline: Electrical Engg.



Engr. Muhammad Uzair
Lab Engineer
BS (COMSATS) Pakistan
Discipline: Electrical Engg.

Engineering Laboratories

Students are provided an opportunity to augment their learning through practical work in the modern laboratories of ECE department. These labs are adaptable, reconfigurable and modular, making them ideally suited for undergraduate teaching in a wide range of fields. Lab experiments are designed in coherence with theory. Students get confirmation of theoretical concepts by performing experimental work in the laboratories. ECE Department has total of fifteen (15) labs with following names and details:

10.9.1. Power Systems Laboratory

Power Systems laboratory is equipped to provide laboratory support for Power Generation Systems, Power Transmission Systems, Power Distribution and Utilization Systems and Power System Analysis. This laboratory is equipped with LabVolt trainers on which a large number of experiments related to these courses can be performed.



10.9.2. Electronic Systems Laboratory

The Electronics System Lab is the Advanced Analog and Digital Electronics Lab. It is equipped with high frequency oscilloscopes, function generators, curve tracers and digital electronics trainers. Function Generators are stable with low distortion, and can generate signal, in the frequency range up to 10 MHz. The Curve Tracer is high performance test equipment. When it is combined with a general purpose scope, characteristic curves of all type of semiconductor can be accurately displayed. The Digital Electronics Trainers are used as a teaching and development tools.



10.9.3. Communications Laboratory

For electrical engineering students especially, for telecommunication engineering students a state of the art laboratory has been established to give practical knowledge of the modern communication systems. All present-day analog and digital communication systems can be modeled practically in this laboratory. Experiments for the curricula of communication systems, digital communication-I, and digital communication-II are conducted in this laboratory. Spectrum analyzers, RF signal generators, network analyzers and latest telecommunication trainers are a part of this lab.



10.9.4. Embedded Systems Laboratory

Embedded System and System on Chip (SoC) are the most advanced fields of engineering discipline. Most of the Electrical and Computer Engineering projects of students are accomplished by utilizing the technologies of our Embedded Systems Laboratory. We emphasis on modern tools usage like Mikro-C programming, Arduino and Raspberry Pi and the modern microcontrollers PIC 18F452 and AVR. This laboratory has full support of training tools and equipment.

This revolutionary lab can support research and development as well in Voice Encryption/Decryption, IP Exchanges., E1/T1 Interfaces, E1 Analysis, VPN Implementations, IP Terminal Development, FPGA and DSP implementation of algorithms.



10.9.5. Control & Instrumentation Laboratory

The Control Engineering Laboratory is equipped with the latest training modules. Concepts in control engineering are experimentally verified on computer based training systems. The trainers assist in enhancing the concepts starting from simulating a simple transfer function, sensing and measuring various quantities, and PID control to complex coupled multivariable nonlinear systems, and such as this Magnetic Levitation System, the Twin-Rotor MIMO System, the Gyro-stable platform and the 3-degree-of-freedom Helicopter Model. The trainers offer maneuverings to both analog and digital systems. Moreover, industrial control is introduced using the Siemens Programmable Logic Controllers. Recently, the laboratory is equipped with K&H ACS 1000 Analog Control System Trainers.



10.9.6. Digital Electronics Laboratory

The Digital electronics lab is designed to provide practical knowledge about the fundamental courses of electronics. The laboratory has the latest equipment to fulfill the requirements of lab work for the courses, such as electron circuit analysis, digital logic design, digital and analog electronics and network analysis etc. The laboratory is equipped with function generators, oscilloscopes, computers and many type of different trainers.



10.9.7. Digital Signal Processing Laboratory

The Digital signal laboratory contains latest DSP kits of Texas Instruments, USA as TMS320C6713, TMS320C6424 and the TMS320C6714. A code composer studio is used to code the Digital Signal Processors. These DSPs are used for a wide range of image and signal processing applications. The general-purpose digital signal processor is dominated by applications in communications like cellular phones and PDA. Embedded digital signal processors are dominated by consumer products. They are found in cellular phones, fax/modems, disk drives, radio, printers, hearing aids, MP3 players, high-definition television (HDTV), digital cameras, and so on. These processors have become the products of choice for a number of consumer applications, since they have become very cost-effective solutions.



10.9.8. Electrical Engineering Project Laboratory

The Project laboratory is equipped with equipment of a multidimensional nature. The purpose of this laboratory is to facilitate students of all semesters from all electrical and computer engineering streams in their respective semester projects as well as in final year design projects.

General project related to design and testing equipment including personal computers, oscilloscopes, function generators and high wattage power supplies have been made available in ample quantity. It also has latest ALL-11 and SmartPro Universal Programmers, which are capable of programming microcontroller ICs like AVR, PIC, EEPROM and UVROM, which makes it the best current programming option in the world.



10.9.9. Power Electronics and Electrical Machines Laboratory

The Electrical Machines and Power Electronics laboratory is used to carry out practical work for Electrical Machines, Power Electronics and Electromagnetic Waves. It is equipped with software controlled LabVolt (Canada) equipment, which is useful to perform experiments related to Single Phase/Three Phase Transformers, A/C Generators/Motors, and D/C Generators/Motors, etc. In order to perform Power Electronics related experiments it has Software Controlled Lab-Volt (Canada), Terco (Sweden), and K&H (Taiwan) equipment to perform experiments related to Power Thyristors, MOSFET, A/C Motor Drives, D/C Motor Drives, and Speed Regulation etc. This Laboratory is also equipped with Oscilloscopes, Function Generators, Multimeters, and D/C Power Supplies.



10.9.10. RF and Optical Communication Laboratory

The RF and optical communication lab is designed with versatile training systems to familiarize students with the practical aspect of microwave and optical phenomenon. Comprehensive lab handouts are designed for all the systems and are provided to the students to facilitate them in the practical work. Students also benefit from planar array antennas constructed using micro-strip

technology. The digital telephony system including digital switching system, telephony training system, and trunk networks is used to practically demonstrate the concepts of telephone networks. The lab is equipped with Rohde & Schwarz and LabVolt equipment like Vector Network Analyzers, Spectrum Analyzer and RF signal generators as well.



10.9.11. Telecommunication Network Laboratory

Telecommunication Networks Lab is designed to provide practical knowledge for the courses of Telecommunication Networks and Computer Networks. The laboratory has Feedback Instruments modern equipment to fulfill the requirements of lab work for these courses. Complete hardware trainers for telephony are provided on which all the signaling and call processing can be monitored by computer integration. Experiments on complex Data Networks are performed on emulation software. However advanced hardware equipment of industrial routers and switches are in procurement phase.



10.10.12 High Voltage Laboratory

High voltage lab is designed to meet the need for power engg. students to perform experiments on high voltage equipment which is essentially present in large scale industries. In this lab, Set of Modular High Voltage Test System Two stages Ac-200KV,10KVA, DC-280KV,10MA, Impulse-280KV 490j / 980j / 1.96KJ is installed.



10.10.13 Signal and Image Processing Laboratory

The signal and image processing laboratory is for computer engineering students to perform labs related to signal processing and image processing. The lab equipment includes 12 Desktop computers, 10 DPS kits, 10 ESP-EYE (Devikit), LPC Express chips and Robot kits.

10.10.14 Computer Systems Design Laboratory

The computer systems design lab is mainly used to perform experiments related to computer systems design and includes equipment such as FPGA Trainer boards, Rtos Kits, Dell Computers, Digital Oscilloscopes etc. This lab is designed to enable students to study the design of computers and be able to interface different components of a system.

11. Undergraduate Engineering Curriculum

11.1. Bachelor of Engineering in Electrical Engineering (Scheme of Studies)



Air University

Department of Electrical and Computer Engineering

Electrical Engineering - Master Course List Fall 2020 Intake and Beyond

Semesters 1 - 4 (Common for all Specializations)

Semester I

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	MA101	Calculus I	---	(3-0-3)
2	PH102	Applied Physics	---	(3-1-4)
3	EE101	Electric Circuit Analysis	---	(3-0-3)
4	EE101L	Electric Circuit Analysis Laboratory	---	(0-1-1)
5	HU115	Pakistan Studies	---	(2-0-2)
6	HU121	Communication Skills	---	(2-0-2)
7	HU118	Islamic Studies	---	(2-0-2)
8	MT171	Engineering Drawing	---	(0-1-1)
No. of Courses= 7		Credit Hours = 18		Labs = 3

Semester II

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	MA105	Multivariable Calculus	MA101	(3-0-3)
2	MA217	Linear Algebra and Differential Equations	MA101	(4-0-4)
3	EE103	Network Analysis	EE101	(3-0-3)
4	EE103L	Network Analysis Laboratory	EE101	(0-1-1)
5	CE112	Computer Programming	---	(2-0-2)
6	CE112L	Computer Programming Laboratory	---	(0-1-1)
7	HUXXX	Social Sciences Elective-I	---	(2-0-2)
8	MT 103	Workshop Practice	---	(0-1-1)
No. of Courses =6		Credit Hours = 17		Labs = 3

Semester III

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EE211	Electricity and Magnetism	---	(3-0-3)
2	CE113	Object Oriented Programming	CE112	(3-0-3)
3	CE113L	Object Oriented Programming Laboratory	CE112	(0-1-1)
4	EE223	Digital Logic Design	---	(3-0-3)
5	EE223L	Digital Logic Design Laboratory	---	(0-1-1)
6	EE208	Analog Electronics	EE101	(3-0-3)
7	EE208L	Analog Electronics Laboratory	EE101	(0-1-1)
8	MA218	Complex Variables and Transforms	---	(4-0-4)
No. of Courses =5		Credit Hours = 19		Labs = 3

Semester IV

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	MA303	Probability and Random Variables	---	(3-0-3)
2	HUXXX	Social Science Elective-II	---	(3-0-3)
3	EE235	Signals and Systems	---	(3-0-3)
4	EE235L	Signals and Systems Laboratory	---	(0-1-1)
5	EE209	Electronic Circuit Design	EE101	(3-0-3)
6	EE209L	Electronic Circuit Design Laboratory	EE101	(0-1-1)
7	EE241	Electrical Machines	EE211	(3-0-3)
8	EE241L	Electrical Machines laboratory	EE211	(0-1-1)
No. of Courses = 5		Credit Hours = 18		Labs = 3

Total credit hours in common semesters= 72**Non Eng: 40 Cr Hrs****Eng: 95 Cr Hrs****Semesters 5 - 8****Telecommunications****Semester V**

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EE361	Computer Networks	---	(3-0-3)
2	EE361L	Computer Networks Laboratory	---	(0-1-1)
3	EE314	Antenna and Wave Propagation	EE211	(3-0-3)
4	EE314L	Antenna and Wave Propagation Laboratory	EE211	(0-1-1)
5	EE328	Microprocessors & Microcontrollers	EE223	(3-0-3)
6	EE328L	Microprocessors & Microcontrollers Laboratory	EE223	(0-1-1)
7	MA200	Numerical Methods	---	(2-0-2)
8	HU114	Technical English	---	(2-0-2)
No. of Courses = 5		Credit Hours = 16		Labs = 3

Semester VI

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EEXXX	Major Based Core Depth Elective I	---	(3-0-3)
2	EEXXXL	Major Based Core Depth Elective I Laboratory	---	(0-1-1)
3	XXX	IDEE	---	(3-0-3)
5	EE383	Electrical Measurements and Instr.	---	(3-0-3)
6	EE383L	Electrical Measurements and Instr. Laboratory	---	(0-1-1)
7	HU307	Technical Report Writing	---	(1-1-2)
8	EM332	Engineering Economics	---	(3-0-3)
9	EE492	Final Year Project I	---	(0-1-1)
No. of Courses = 6		Credit Hours = 17		Labs =4

SUMMER: Internship/Industrial Training**Semester VII**

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EEXXX	Major Based Core Depth Elective II	---	(3-0-3)
2	EEXXXL	Major Based Core Depth Elective II Laboratory	---	(0-1-1)
3	EEXXX	Major Based Core Depth Elective III	---	(3-0-3)
4	EE338	Digital Signal Processing	EE235	(3-0-3)
5	EE338L	Digital Signal Processing Laboratory	EE235	(0-1-1)
6	EE355	Control Systems	---	(3-0-3)
7	EE355L	Control Systems Laboratory	---	(0-1-1)
8	EE493	Final Year Project II	EE492	(0-2-2)
No. of Courses = 5		Credit Hours = 17		Labs = 5

Semester VIII

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EEXXX	Major Based Core Depth Elective IV	---	(3-0-3)
2	EEXXXL	Major Based Core Depth Elective IV Laboratory	---	(0-1-1)
3	EEXXX	Major Based Core Depth Elective V	---	(3-0-3)
4	EEXXXL	Major Based Core Depth Elective V Laboratory	---	(0-1-1)
5	EE494	Final Year Project III	EE493	(0-3-3)
6	EMXXX	Management Elective	---	(2-0-2)
7	HUXXX	Language Elective **	---	(0-0-0)
No. of Courses = 5		Credit Hours = 13		Labs =5

** Non Credit Elective

Total Credit Hours = 72+63=135

Semester V

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EE383	Electrical Measurements and Instr.	---	(3-0-3)
2	EE383L	Electrical Measurements and Instr. Laboratory	---	(0-1-1)
3	EE381	Power Electronics I	---	(3-0-3)
4	EE381L	Power Electronics I Laboratory	---	(0-1-1)
5	EE328	Microprocessors & Microcontrollers	EE223	(3-0-3)
6	EE328L	Microprocessors & Microcontrollers Laboratory	EE223	(0-1-1)
7	EM332	Engineering Economics	---	(3-0-3)
8	HU114	Technical English	---	(2-0-2)
No. of Courses =5		Credit Hours = 17		Labs = 3

Semester VI

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EE338	Digital Signal Processing	EE235	(3-0-3)
2	EE338L	Digital Signal Processing Laboratory	EE235	(0-1-1)
3	EEXX	Major Based Core Depth Elective I	---	(3-0-3)
4	EEXXXL	Major Based Core Depth Elective I Laboratory	---	(0-1-1)
5	HU307	Technical Report Writing	---	(1-1-2)
6	EE355	Control Systems	---	(3-0-3)
7	EE355L	Control Systems Laboratory	---	(0-1-1)
8	EE492	Final Year Project I	---	(0-1-1)
9	MA200	Numerical Methods	---	(2-0-2)
No. of Courses =6		Credit Hours = 17		Labs = 5

SUMMER: Internship/Industrial Training**Semester VII**

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EEXXX	Major Based Core Depth Elective II	---	(3-0-3)
2	EEXXXL	Major Based Core Depth Elective II Laboratory	---	(0-1-1)
3	EE314	Antenna and Wave Propagation	EE211	(3-0-3)
4	EE314L	Antenna and Wave Propagation Laboratory	EE211	(0-1-1)
5	EEXXX	Major Based Core Depth Elective III	---	(3-0-3)
6	EEXXXL	Major Based Core Depth Elective III Laboratory	---	(0-1-1)
7	EMXXX	Management Elective	---	(2-0-2)
8	EE493	Final Year Project II	EE492	(0-2-2)
No. of Courses = 5		Credit Hours = 16		Labs = 5

Semester VIII

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EEXXX	Major Based Core Depth Elective IV	---	(2-0-2)
2	EEXXXL	Major Based Core Depth Elective IV Laboratory	---	(0-1-1)
3	XXX	IDEE	---	(3-0-3)
4	EE475	Analog & Digital Communication	---	(3-0-3)
5	EE475L	Analog & Digital Communication Laboratory	---	(0-1-1)
6	EE494	Final Year Project III	EE493	(0-3-3)
7	HUXXX	Language Elective **	---	(0-0-0)
No. of Courses = 5		Credit Hours = 13		Labs = 5

** Non Credit Elective

Total Credit Hours = 72+63=135**Semester V**

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EE347	Power Distribution & Utilization Systems	---	(3-0-3)
2	EE381	Power Electronics I	---	(3-0-3)
3	EE381L	Power Electronics I Laboratory	---	(0-1-1)
4	EE328	Microprocessors & Microcontrollers	EE223	(3-0-3)
5	EE328L	Microprocessors & Microcontrollers Laboratory	EE223	(0-1-1)
6	HU114	Technical English	---	(2-0-2)
7	EE383	Electrical Measurements and Instr.	---	(3-0-3)
8	EE383L	Electrical Measurements and Instr. Laboratory	---	(0-1-1)
No. of Courses = 5		Credit Hours = 17		Labs =3

Semester VI

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EEXXX	Major Based Core Depth Elective I	---	(3-0-3)
2	EEXXXL	Major Based Core Depth Elective I Laboratory	---	(0-1-1)
2	EE355	Control Systems	---	(3-0-3)
3	EE355L	Control Systems Laboratory	---	(0-1-1)
4	EE338	Digital Signal Processing	EE235	(3-0-3)
5	EE338L	Digital Signal Processing Laboratory	EE235	(0-1-1)
6	HU307	Technical Report Writing	---	(1-1-2)
7	MA200	Numerical Methods	---	(2-0-2)
8	EE492	Final Year Project I	---	(0-1-1)
No. of Courses =6		Credit Hours = 17		Labs =5

SUMMER: Internship/Industrial Training

Semester VII

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	EEXXX	Major Based Core Depth Elective II	---	(3-0-3)
2	EEXXXL	Major Based Core Depth Elective II Laboratory	---	(0-1-1)
3	EEXXX	Major Based Core Depth Elective III	---	(3-0-3)
4	EEXXXL	Major Based Core Depth Elective III Laboratory	---	(0-1-1)
5	EM332	Engineering Economics	---	(3-0-3)
6	EE475	Analog & Digital Communication	---	(3-0-3)
7	EE475L	Analog & Digital Communication Laboratory	---	(0-1-1)
8	EE493	Final Year Project II	EE492	(0-2-2)
No. of Courses = 5		Credit Hours = 17		Labs =5

Semester VIII

S. No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)
1	XXX	IDEE	---	(3-0-3)
2	EMXXX	Management Elective	---	(2-0-2)
3	EEXXX	Major Based Core Depth Elective IV	---	(3-0-3)
4	EEXXXL	Major Based Core Depth Elective IV Laboratory	---	(0-1-1)
5	EE494	Final Year Project III	EE493	(0-3-3)
6	HUXXX	Language Elective **	---	(0-0-0)
No. of Courses = 5		Credit Hours = 12		Labs = 4

Total Credit**Hours =****72+63=135****** Non credit****Elective****List of Major Based Core Depth Electives (Telecommunications)**

S. No	Course Code	Courses	Pre-Requisite	Credit Hours
1	EE374	Analog Communications	---	(3-0-3)
2	EE374L	Analog Communications Laboratory	---	(0-1-1)
3	EE475	Digital Communication I	EE374	(3-0-3)
4	EE475L	Digital Communication I Laboratory	EE374	(0-1-1)
5	EE416	Microwave Theory and Techniques	EE211	(3-0-3)
6	EE416L	Microwave Theory and Techniques Laboratory	EE211	(0-1-1)
7	EE476	Wireless Communications	---	(3-0-3)
8	EE477	Digital Communication II	EE374	(3-0-3)
9	EE477L	Digital Communication II Laboratory	EE374	(0-1-1)
10	EE463	Telecom. Networks	---	(3-0-3)
11	EE463L	Telecom. Networks Laboratory	---	(0-1-1)

12	EE464	Optical Networks	---	(3-0-3)
13	EE478	Satellite Communications	---	(3-0-3)
14	EE479	Navigation and Radar Systems	---	(3-0-3)
15	EE417	Emerging Wireless Tech. and RF Planning	---	(3-0-3)
16	EE418	Telecom Policies and Standards	---	(3-0-3)

List of Major Based Core Depth Electives (Electronics)

S. No	Course Code	Courses	Pre-Requisite	Credit Hours
1	EE304	Digital Electronics	EE101	(3-0-3)
2	EE304L	Digital Electronics Laboratory	EE101	(0-1-1)
3	EE429	FPGA Based Design	---	(3-0-3)
4	EE429L	FPGA Based Design Laboratory	---	(0-1-1)
5	EE406	Linear Integrated Circuit Design	---	(3-0-3)
6	EE406L	Linear Integrated Circuit Design Laboratory	---	(0-1-1)
7	EE407	VLSI Design	EE304	(2-0-2)
8	EE407L	VLSI Design Laboratory	EE304	(0-1-1)
9	EE408	Introduction to Nanotechnology	PH102	(3-0-3)
10	EE409	Solid State Devices	EE209	(3-0-3)

List of Major Based Core Depth Electives (Power)

S. No	Course Code	Courses	Pre-Requisite	Credit Hours
1	EE348	Power Generation Systems	EE241	(3-0-3)
2	EE348L	Power Generation Systems Laboratory	EE241	(0-1-1)
3	EE382	Power Electronics II	EE381	(3-0-3)
4	EE382L	Power Electronics II Laboratory	EE381	(0-1-1)
5	EE444	Power Transmission Systems	EE103	(3-0-3)
6	EE444L	Power Transmission Systems Laboratory	EE103	(0-1-1)
7	EE445	High Voltage Engineering	---	(3-0-3)
8	EE445L	High Voltage Engineering Laboratory	---	(0-1-1)
9	EE446	Power Systems Analysis	---	(3-0-3)
10	EE446L	Power Systems Analysis Laboratory	---	(0-1-1)
11	EE447	Power System Protection	---	(3-0-3)
12	EE447L	Power System Protection Laboratory	---	(0-1-1)
13	EE448	Power System Protection and Control	---	(3-0-3)
14	EE448L	Power System Operation and Control Laboratory	---	(0-1-1)
15	EE449	Renewable Energy Systems	---	(3-0-3)
16	EE450	Smart Grids	---	(3-0-3)

List of Inter Disciplinary Engineering Electives (IDEE)

S. No	Course Code	Courses	Pre-Requisite	Credit Hours
1	CE204	Discrete Structures	---	(3-0-3)
2	MT371	Introduction to Bio-Mechatronics	---	(3-0-3)
3	MT467	Applied Robotics	---	(3-0-3)
4	MT473	Laser and its Applications	---	(3-0-3)
5	MT481	Introduction to Fuzzy Logic	---	(3-0-3)

6	MT485	System Reliability and Safety	---	(3-0-3)
7	BM304	Biomedical Engineering Systems	---	(3-0-3)
8	BM414	DNA Computing	---	(3-0-3)
9	BM434	Medical Robotics	---	(3-0-3)
10	BM435	Bioinformatics	---	(3-0-3)

List of Humanities and Social Sciences Electives

S. No	Course Code	Courses	Credit Hours
1	HU214	Introduction to Sociology	(3-0-3)
2	HU215	Ethics	(2-0-2)
3	HU316	International Relations	(3-0-3)

Language Elective

S. No	Course Code	Courses	Credit Hours
1	HU217	Arabic	(3-0-3)
2	HU218	French	(3-0-3)
3	HU219	Chinese	(3-0-3)

List of Management Science Electives

S. No	Course Code	Courses	Credit Hours
1	EM436	Engineering Management & Entrepreneurship	(2-0-2)
2	EM437	Engineering Procurement & Contract Management	(2-0-2)
3	EM438	Engineering Project Management	(2-0-2)

11.2. Bachelor of Computer Engineering (Scheme of Studies)

Semester I

S.No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)	Knowledge Area
1	CE102	Computing Fundamentals	---	(2-0-2)	Computing
2	CE102L	Computing Fundamentals Laboratory	---	(0-1-1)	Computing
3	CE112	Computer Programming	---	(2-0-2)	Computing
4	CE112L	Computer Programming Laboratory	---	(0-1-1)	Computing
5	EE101	Electric Circuit Analysis	---	(3-0-3)	Engineering Foundation
6	EE101L	Electric Circuit Analysis Laboratory	---	(0-1-1)	Engineering Foundation
7	MT103	Workshop Practice	---	(0-1-1)	Engineering Foundation
8	MA101	Calculus I	---	(3-0-3)	Natural Sciences

9	HU115	Pakistan Studies	---	(2-0-2)	Humanities
10	HU118	Islamic Studies	---	(2-0-2)	Humanities
No. of Courses = 7		Credit Hours = 18		Labs = 4	

Semester II

S.No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)	Knowledge Area
1	CE113	Object Oriented Programming	CE112	(3-0-3)	Engineering Foundation
2	CE113L	Object Oriented Programming Laboratory	CE112	(0-1-1)	Engineering Foundation
3	EE103	Network Analysis	EE101	(3-0-3)	Engineering Foundation
4	EE103L	Network Analysis Laboratory	EE101	(0-1-1)	Engineering Foundation
5	MT171	Engineering Drawing	---	(0-1-1)	Engineering Foundation
6	PH102	Applied Physics	---	(3-1-4)	Natural Sciences
7	MA105	Multivariable Calculus	---	(3-0-3)	Natural Sciences
8	HU121	Communication Skills	---	(2-0-2)	Humanities
No. of Courses = 6		Credit Hours = 18		Labs = 4	

Semester III

S.No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)	Knowledge Area
1	CE214	Data Structures	CE113	(3-0-3)	Engineering Foundation
2	CE214L	Data Structures Laboratory	CE113	(0-1-1)	Engineering Foundation
3	CE223	Digital Logic Design	---	(3-0-3)	Engineering Foundation
4	CE223L	Digital Logic Design Laboratory	---	(0-1-1)	Engineering Foundation
5	CE205	Computer Applications in Engineering Design	---	(2-0-2)	Major (Breadth)
6	CE205L	Computer Applications in Engineering Design Laboratory	---	(0-1-1)	Major (Breadth)
7	CE204	Discrete Structures	---	(3-0-3)	Computing
8	MA217	Linear Algebra and Differential Equations	MA101	(4-0-4)	Natural Sciences
No. of Courses = 5		Credit Hours = 18		Labs = 3	

Semester IV

S.No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)	Knowledge Area
1	CE224	Computer Organization & Assembly Language	CE223	(3-0-3)	Engineering Foundation

2	CE224L	Computer Organization & Assembly Language Laboratory	CE223	(0-1-1)	Engineering Foundation
3	CE231	Computer Networks	---	(3-0-3)	Major (Breadth)
4	CE231L	Computer Networks Laboratory	---	(0-1-1)	Major (Breadth)
5	EE208	Analog Electronics	EE101	(3-0-3)	Engineering Foundation
6	EE208L	Analog Electronics Laboratory	EE101	(0-1-1)	Engineering Foundation
7	MA218	Complex Variables & Transforms	---	(4-0-4)	Natural Sciences
8	HU114	Technical English	HU101	(2-0-2)	Humanities
No. of Courses = 5		Credit Hours = 18		Labs = 3	

Semester V

S.No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)	Knowledge Area
1	CE332	Operating Systems	CE214	(3-0-3)	Major (Breadth)
2	CE332L	Operating Systems Laboratory	CE214	(0-1-1)	Major (Breadth)
3	CE324	Microprocessors and Microcontrollers	---	(3-0-3)	Major (Breadth)
4	CE324L	Microprocessors and Microcontrollers Laboratory	---	(0-1-1)	Major (Breadth)
5	EE235	Signals and Systems	---	(3-0-3)	Engineering Foundation
6	EE235L	Signals and Systems Laboratory	---	(0-1-1)	Engineering Foundation
7	MA200	Numerical Methods	---	(2-0-2)	Natural Sciences
8	MA303	Probability and Random Variables	---	(3-0-3)	Natural Sciences
No. of Courses = 5		Credit Hours = 17		Labs = 3	

Semester VI

S.No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)	Knowledge Area
1	CE325	Digital System Design	CE223	(3-0-3)	Major (Breadth)
2	CE325L	Digital System Design Laboratory	CE223	(0-1-1)	Major (Breadth)
3	EE338	Digital Signal Processing	EE235	(3-0-3)	Major (Breadth)
4	EE338L	Digital Signal Processing Laboratory	EE235	(0-1-1)	Major (Breadth)
5	CEXXX	Elective – I	---	(X-X-3)	Major (Depth)
6	EM332	Engineering Economics	---	(3-0-3)	Management
7	HU307	Technical Report Writing	---	(1-1-2)	Humanities
9	CE497	Final Year Project I	---	(0-1-1)	Senior Design Project
No. of Courses = 6		Credit Hours = 17		Labs = 4+X	

INDUSTRIAL TRAINING / INTERNSHIP (SUMMER)

Semester VII

S.No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)	Knowledge Area
1	CE416	Database Systems	---	(2-0-2)	Major (Breadth)
2	CE416L	Database Systems Laboratory	---	(0-1-1)	Major (Breadth)
3	XXX	IDEE – I	---	(3-0-3)	Interdisciplinary
4	CEXXX	Elective – II	---	(X-X-3)	Major (Depth)
5	CEXXX	Elective-III	---	(3-0-3)	Major (Depth)
6	CEXXXL	Elective-III Laboratory	---	(0-1-1)	Major (Depth)
7	HUXXX	Social Sciences Elective – I	---	(2-0-2)	Humanities
8	CE498	Final Year Project II	CE497	(0-2-2)	Senior Design Project
No. of Courses = 6		Credit Hours = 17		Labs = 4+X	

Semester VIII

S.No	Course Code	Courses	Prerequisites	Credit Hrs. (Theory-Lab-Credits)	Knowledge Area
1	CEXXX	Elective-IV	---	(X-X-3)	Major (Depth)
2	XXX	IDEE – II	---	(3-0-3)	Interdisciplinary
3	EMXXX	Management Elective	---	(2-0-2)	Management
4	HUXXX	Social Sciences Elective – II	---	(2-0-2)	Humanities
5	CE499	Final Year Project III	CE498	(0-3-3)	Senior Design Project
6	HUXXX	Language Elective **	---	(0-0-0)	Humanities
No. of Courses = 6		Credit Hours = 13		Labs = 3+X	
		** Non Credit Elective			

Total Credits = 136

Total C.H:	136	
Engg:	97	72%
Non-Engg:	39	28%

List of Computer Engineering Depth Electives

Area of Specialization	S. No.	Course Code	Courses	Pre-Requisite	Credit Hours
Computing	1	CE411	GPGPU Programming	---	(3-0-3)
	2	CE411L	GPGPU Programming Laboratory	---	(0-1-1)
	3	CE417	Mobile Application Development	---	(3-0-3)
	4	CE417L	Mobile Application Development Laboratory	---	(0-1-1)
	5	CE418	Secure Software Development	---	(3-0-3)

	6	CE419	Quantum Computing	---	(3-0-3)
Digital Design	1	CE426	Computer Architecture	CE224	(3-0-3)
	2	CE426L	Computer Architecture Laboratory	CE224	(0-1-1)
	3	CE427	VLSI Design	---	(3-0-3)
	4	CE427L	VLSI Design Laboratory	---	(0-1-1)
	5	CE428	Embedded Systems	---	(2-0-2)
	6	CE428L	Embedded Systems Laboratory		(0-1-1)
	7	CE429	Hardware Arithmetic for Machine Learning	---	(3-0-3)
	8	CE472	Fault Tolerant Computing	---	(3-0-3)
	9	CE473	Digital instrumentation and Systems	---	(3-0-3)
	10	CE473L	Digital instrumentation and Systems Laboratory	---	(0-1-1)
Algorithms	1	CE333	Design and Analysis of Algorithms	---	(3-0-3)
	2	CE334	System Programming	---	(2-0-2)
	3	CE334L	System Programming Laboratory	---	(0-1-1)
	4	CE335	Parallel and Distributed Computing	---	(2-0-2)
	5	CE335L	Parallel and Distributed Computing Laboratory	---	(0-1-1)
	6	CE437	Cloud Computing	---	(3-0-3)
	7	CE437L	Cloud Computing Laboratory	---	(0-1-1)
	8	CE438	Network and Computer Security	---	(3-0-3)
	9	CE339	Integrated Services over Packet Networks	---	(3-0-3)
	10	CE339L	Integrated Services over Packet Networks Laboratory	---	(0-1-1)
Signal Processing	1	CE344	Digital Image Processing	---	(2-0-2)
	2	CE344L	Digital Image Processing Laboratory	---	(0-1-1)
	3	CE345	Computer Graphics and Animation	---	(2-0-2)
	4	CE345L	Computer Graphics and Animation Laboratory	---	(0-1-1)
	5	CE446	Introduction to Visual Perception	---	(3-0-3)
	6	CE447	Virtual Environment Basics	---	(3-0-3)
Artificial Intelligence	1	CE351	Artificial Intelligence for Engineers	---	(3-0-3)
	2	CE351L	Artificial Intelligence for Engineers Laboratory	---	(0-1-1)
	3	CE352	Machine Learning	---	(3-0-3)
	4	CE453	Data Mining Fundamentals	---	(3-0-3)
	5	CE454	Big Data Analysis	---	(3-0-3)
	6	CE456	Computer System Modeling	---	(3-0-3)
	7	CE456L	Computer System Modeling Laboratory	---	(0-1-1)
Software Engineering	1	CE404	Human-Computer Interface	---	(3-0-3)
	2	CE362	Software Engineering	---	(3-0-3)
	3	CE464	Software Design and Testing	---	(3-0-3)
	4	CE464L	Software Design and Testing Laboratory	---	(0-1-1)
	5	CE465	Computer Engineering Project Management	---	(3-0-3)
	6	CE466	Rapid Prototyping for Computer Systems	---	(2-0-2)
	7	CE466L	Rapid Prototyping for Computer Systems Laboratory	---	(0-1-1)

List of Computer Engineering Inter-Departmental Engineering Electives (IDEE)

S. No.	Course Code	Courses	Pre-Requisite	Credit Hours
1	EE352	Control Systems	---	(3-0-3)
2	EE435	Information Coding Theory	---	(3-0-3)
3	EE476	Wireless Communication	---	(3-0-3)
4	ME131	Thermodynamics I	PH101, MA101	(3-0-3)
5	MT371	Introduction to Bio-Mechatronics	---	(3-0-3)

6	MT467	Applied Robotics	---	(3-0-3)
7	MT473	Laser & Its Applications	---	(3-0-3)
8	MT481	Introduction to Fuzzy Logic	---	(3-0-3)
9	MT485	System Reliability & Safety	---	(3-0-3)
10	BM304	Bio-Medical Engineering System	---	(3-0-3)
11	BM414	DNA Computing	---	(3-0-3)
12	BM434	Medical Robotics	---	(3-0-3)
13	BM435	Bioinformatics	---	(3-0-3)

List of Computer Engineering List of Social Sciences Electives

S. No	Course Code	Courses	Credit Hours
1	HU213	Introduction to Psychology	(2-0-2)
2	HU215	Ethics	(2-0-2)

12. Program Structure for Graduate Studies

12.1. MS EE and PhD EE (Scheme of Studies)

MS & Ph.D. (EE) Program Details for Fall -2020 and Beyond Course List is tabulated below.

S.No	C.Code	General Courses for all Research Clusters	Remarks
1	EE 631	Stochastic Processes	Compulsory for MS/ Elective for PhD
2	EE 651	Linear Systems	Compulsory for MS/ Elective for PhD
3	EE 710	Research Methodology	Compulsory for MS/PhD* Cr. Hrs. (1-0-1)

S.No	C.Code	Electromagnetics and Photonics Cluster	Remarks
1	EE 611	Electromagnetic Fields	Elective for MS/PhD
2	EE 613	Advanced Optics**	Elective for MS/PhD
3	EE 614	Optical Simulation Methods**	Elective for MS/PhD
4	EE 615	Antenna Systems**	Elective for MS/PhD
5	EE 711	Array Signal Processing	Elective for MS/PhD
6	EE 712	Detection and Estimation Theory	Elective for MS/PhD
7	EE 713	Radar Engineering	Elective for MS/PhD

8	EE 714	Electromagnetic Engineering	Elective for MS/PhD
9	EE 715	Computational Methods of Field Theory	Elective for MS/PhD
10	EE 721	Semiconductor Optoelectronic Devices**	Elective for MS/PhD
11	EE 722	Integrated Photonics Circuits Design**	Elective for MS/PhD
12	EE 725	Micro and Nano Fabrication Techniques**	Elective for MS/PhD
13	EE 811	Advanced Array Signal Processing	Elective for MS/PhD
14	EE 813	Advanced Detection and Estimation Theory**	Elective for MS/PhD
15	EE 814	Kalman Filters	Elective for MS/PhD
16	EE 817	Special Topics in Photonics**	Elective for MS/PhD
17	EE 818	Special Topics in Lasers and Optics	Elective for MS/PhD
18	EE 819	Special Topics in Radar Systems Engineering	Elective for MS/PhD

S.No	C.Code	Communication and Signal Processing Cluster	Remarks
1	EE 632	Adaptive Filters	Elective for MS/PhD
2	EE 633	Advanced Digital Communications I	Elective for MS/PhD
3	EE 634	Advanced Coding Theory	Elective for MS/PhD
4	EE 635	Satellite Communications	Elective for MS/PhD
5	EE 636	Advanced Mobile Communication	Elective for MS/PhD
6	EE 637	Lasers and Optical Sources	Elective for MS/PhD
7	EE 638	Photo-detectors	Elective for MS/PhD
8	EE 731	Optimization Techniques	Elective for MS/PhD
9	EE 732	Advanced Digital Communications II	Elective for MS/PhD
10	EE 733	Information Theory**	Elective for MS/PhD
11	EE 734	Multimedia Communications	Elective for MS/PhD

12	EE 735	Optical Waveguide Design	Elective for MS/PhD
13	EE 831	Advanced Wireless Techniques	Elective for MS/PhD
14	EE 832	Space-Time Coding	Elective for MS/PhD
15	EE 833	Adaptive Wireless Transceivers	Elective for MS/PhD
16	EE 834	Statistical Signal Processing**	Elective for MS/PhD
17	EE 838	Special Topics in Signal Processing	Elective for MS/PhD
18	EE 839	Special Topics in Digital Communication Systems	Elective for MS/PhD

S.No	C.Code	Power and Control Systems Cluster	Remarks
1	EE 652	Digital Control Systems	Elective for MS/PhD
2	EE 653	System Identification	Elective for MS/PhD
3	EE 654	Adaptive Control	Elective for MS/PhD
4	EE 655	Real-Time Control	Elective for MS/PhD
5	EE 656	Advanced Power Electronics	Elective for MS/PhD
6	EE 657	Evolutionary Engineering Optimization	Elective for MS/PhD
7	EE 751	Power Electronics for Power Systems	Elective for MS/PhD
8	EE 752	Advanced Neural Networks	Elective for MS/PhD
9	EE 753	Intelligent Control	Elective for MS/PhD
10	EE 754	Advanced Robotics and Control	Elective for MS/PhD
11	EE 755	Optimal Control	Elective for MS/PhD
12	EE 756	Robust Control	Elective for MS/PhD
13	EE 757	Sliding Mode Control	Elective for MS/PhD
14	EE758	Dynamics and Controls of Electrical Machines	Elective for MS/PhD
15	EE 851	Nonlinear Systems & Control	Elective for MS/PhD

16	EE 852	Advanced Process Control	Elective for MS/PhD
17	EE 853	Power System Operation and Protections	Elective for MS/PhD
18	EE 854	Advanced Topics in Nature-Inspired Optimization Techniques	Elective for MS/PhD
19	EE 855	Advanced Topics in Intelligent Systems and Control	Elective for MS/PhD
20	EE 856	Neuro-Fuzzy Control	Elective for MS/PhD
21	EE 857	Stochastic Control	Elective for MS/PhD
22	EE 858	Special Topics in Power and Control	Elective for MS/PhD
23	EE 859	Special Topics in Control Systems	Elective for MS/PhD
24	EE 860	Renewable Power Production and Transportation	Elective for MS/PhD

S.No	C.Code	Machine Learning and Image Processing Cluster	Remarks
1	EE 671	Digital Image Processing	Elective for MS/PhD
2	EE 672	Data Mining	Elective for MS/PhD
3	EE 673	Advanced Digital Image Processing	Elective for MS/PhD
4	EE 771	Pattern Recognition	Elective for MS/PhD
5	EE 772	Machine Learning	Elective for MS/PhD
6	EE 773	Computer Vision	Elective for MS/PhD
7	EE 774	Medical Imaging	Elective for MS/PhD
8	EE 775	Satellite Imaging	Elective for MS/PhD
9	EE 776	Visual Perception	Elective for MS/PhD
10	EE 777	Compressive Sensing	Elective for MS/PhD
11	EE 778	Graphical Models	Elective for MS/PhD
12	EE 871	Special Topics in Pattern Recognition	Elective for MS/PhD
13	EE 872	Special Topics in Signal and Image Processing	Elective for MS/PhD

14	EE 873	Special Topics in Machine Learning	Elective for MS/PhD
15	EE 874	Advanced Computer Vision**	Elective for MS/PhD

S.No	C.Code	Mathematics Courses	Remarks
1	MA 682	Applied Linear Algebra	Elective for MS/PhD
2	MA 689	Probabilistic Methods in Electrical Engineering	Elective for MS/PhD

S.No	C.Code	Other Engineering Courses	Remarks
1	MT 692	Introduction to MEMS Technology**	Elective for MS/PhD
2	MT 794	Design of Microelectromechanical Devices**	Elective for MS/PhD

S.No	C.Code	Compulsory Thesis/Dissertations	Credit Hours
1	EE 799	MS Thesis	(6)
2	EE 700	MS. Thesis in Progress	(0)
3	EE 899	Ph.D. Dissertation	(30)
4	EE 800	Ph.D. Dissertation in Progress	(0)

Note:

1. Single Starred (*) Courses are to be studied only once in MS and PhD
2. All Double Starred (**) Courses are new, with codes not used before.
3. All courses except EE710 are three credit hour courses.
4. Pre-Requisites have been removed.
5. All old courses have been kept with their original codes.

13. Conclusion

The Department of Electrical & Computer Engineering aspires to produce outstanding professionals with excellent knowledge of engineering discipline, professional integrity, and ethical values. The graduates should be well capable of competing in the contemporary industrial environment and must be intellectually strong enough to undertake the assignment in the fields of higher studies, innovation, and development with or even without minimal supervision. The standard of education implemented by the department (accompanied by the lab opportunities) ensures that the graduate must not fall short of capabilities or confidence while competing or working in the multinational environment.

Department of Mechatronics Engineering

Mechatronics is the synergistic integration of sensors, actuators, signal conditioning, Power electronics, decision and control algorithms and computer hardware and software to manage complexity, uncertainty, and communication in engineered systems. In Pakistan, Mechatronics is well-suited to the industry as it provides the right mix of mechanical engineering, electronics, and computer science to enable an engineer to grapple with the essentials of industry. At a graduate level, the department aims to concentrate on instrumentation, sensors and control systems.

Mission of Department of Mechatronics and Biomedical Engineering

The mission of the Department of Mechatronics Engineering is to provide students with the advanced knowledge and nurture them with the positive relationship towards their fellow and in particular towards society. The department aspires to produce graduates who can communicate effectively, seek lifelong learning and become a helping hand in developing a prosperous and enlightened society.

Mechatronics Biomedical Engineering Engineering Program Educational

Objectives

Within a few years of graduation, the students with Bachelors in Mechatronics Engineering are expected to attain the following objectives:

PEO 1: The graduates are analyzing and solving complex engineering problems and proposing solutions to design requirements of the industry.

PEO 2: The graduates are pursuing higher education and are involved in society oriented research.

PEO 3: The graduates are managing projects or working as a team member as a useful member of the society and are demonstrating high professional and morals ethics.

Program Learning Outcomes (PLOs)

Graduates of the Mechatronics Engineering program will be able to:

(1) Engineering Knowledge

An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems

(2) Problem Analysis

An ability to identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

(3) Design / Development of Solutions

An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

(4) Investigation

An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.

(5) Modern Tool Usage

An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations

(6) The Engineer and Society

An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

(7) Environment and Sustainability

An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

(8) Ethics

Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

(9) Individual and Teamwork

An ability to work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings.

(10) Communication

An ability to communicate effectively, orally as well as in writing, on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

(11) Project Management

An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

(12) Lifelong Learning

An ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

Faculty Members

Sr. No.	Name	Details of Qualifications		Specialization
		Degree	Institution	
1	Dr. Zafarullah Koreshi	Ph.D.	University of Cambridge, UK	Nuclear Engineering
		MS	University of Wisconsin, USA	Nuclear Engineering
		BS	University of London, UK	Nuclear Engineering
2	Dr. Zareena Kausar	Ph.D.	University of Auckland, New Zealand	Mechanical Engineering
		MS	UET, Lahore	Mechatronics Engineering
		BS	UET, Lahore	Mechanical Engineering
3	Dr. Shakeel Rehman Shiekh	Ph.D.	BUAA, China	Aircraft Design, Unsteady Fluid Dynamics (CFD)
		MS	University of Texas, Austin Texas	Flight dynamics and Controls
		BE	CAE, NED University, Karachi	Aerospace Engineering
4	Dr. Noman Naseer	Ph.D.	Pusan National University, Korea Busan, Korea	Mechatronics Engineering, Brain Computer Interface
		MS	Air University, Islamabad	Mechatronics Engineering
		BS	E&ME NUST, Rawalpindi	Mechatronics Engineering
5	Dr. Rana Iqtidar Shakoor	Ph.D.	PIEAS, Islamabad	MEMS, Vibrations
		M.S	PIEAS, Islamabad	MEMS, Vibrations
		B.Sc.	UET, Lahore	Mechanical Engineering
6	Dr. M. Habib Mehmood	Ph.D.	Universitat de Girona, Spain	Vision and Robotics
		M.S	Hariot-watt University UK/ Universitat de Girona, Spain/ University of Bourgogne, France	Vision and Robotics
		BE	E&ME NUST, Rawalpindi	Mechatronics
7	Engr. Zahid Husaain	Ph.D.	Air University	Additive Manufacturing
		M.S	UET, Taxila/ Air University	Thermal Systems
		B.S	NUST E&ME, Rawalpindi	Mechanical Engineering
8	Engr Akmal Shah	M.S	MSU, USA	Mechanical Engineering
		BE	CAE, NED University, Karachi	Aerospace Engineering
9	Engr Akhtar Khursheed	MS	NUST, Rawalpindi	Manufacturing
		BS	UET, Lahore	Mechanical Engineering
10	Engr. Neelum Yousuf (on leave)	Ph.D.	Air University	Prosthetic Hand
		M.S	Air University, Islamabad	Mechatronics Engineering
		B.DE	Air University, Islamabad	Mechatronics Engineering
11	Engr. Umer Farooq	M.Sc	LUMS, Lahore	Embedded systems
		B.Sc.	Federal Urdu University, Islamabad	Electronics
12		Ph.D.	Air University	Brain Computer Interfaces
		M.S	NUST, Rawalpindi	

	Engr. Hammad Nazir			Mechatronics Engineering, Machine Vision
		B.E	NUST, Rawalpindi	Mechatronics Engineering
13	Engr. Atiq ur Rehman	Ph.D. MS	Air University SZABIST, Islamabad	Renewable Energy Project Management
		M.Sc	PIEAS, Islamabad	Process Engineering
		B.S	NED University, Karachi	Mechanical Engineering
14	Engr. Imran Shabkhez Sarwar	M.S	NUST, Rawalpindi	Robotics and Intelligent Machines
		B.S	NUST, Rawalpindi	Mechatronics Engineering
15	Engr. Ehtisham Ul Hassan	M.S	NUST, Rawalpindi	Robotics and Intelligent Machines
		B.S	Air University, Islamabad	Mechatronics Engineering
16	Engr. Amna Khan	M.S	Air University, Islamabad	Mechatronics Engineering,
		B.S	Air University, Islamabad	Mechatronics Engineering
17	Engr. Abdullah Siddiqui	M.S	King Fahad University of Petroleum & Minerals (KFUPM)	Mechanical Engineering
		B.E	Air University, Islamabad	Mechatronics Engineering
18	Engr. Samina Jamil	Ph.D.	Bahria University	Electrical Engineering
		M.S	Air University, Islamabad	Mechatronics Engineering
		B.E	NED University, Karachi	Electronics Engineering
19	Engr. Altaf Ur Rahman	M.S	NUST, Islamabad	Robotics and Intelligent Machines
		B.E	UET, Peshawar	Mechatronics Engineering
20	Engr. Amre Eizad	M.S	Air University, Islamabad	Mechatronics Engineering
		B.S	Air University, Islamabad	Mechatronics Engineering
21	Engr. Tallal Saeed	M.S	CASE, UET, Taxila	Control Systems
		B.S	CASE, UET, Taxila	Computer Engineering
22	Engr. Usman Rafique	M.Sc	NUST E&ME, Rawalpindi	Mechatronics Engineering
		B.Sc.	NUST E&ME, Rawalpindi	Mechatronics Engineering

Research Assistants / Lab Engineers

Sr. No.	Name	Designation	Details of Qualifications			Specialization
			Degree	Year	Institution	
1	Engr Umair Aziz	Lab Engineer	Ph.D. MS BE	In Progress 2018	Air University Air University Air University	Mechatronics Mechatronics Mechatronics
2	Engr Ahmad Abdullah	Research Assistant	Ph.D. MS BE	In Progress 2017	Air University Air University Air University	Mechatronics Mechatronics Mechatronics
3	Engr Muhammad Naveed	Research Assistant	Ph.D. MS BE	In Progress 2018	Air University Air University Air University	Mechatronics Mechatronics
4	Engr Fasih ud Din Iqbal	Research Assistant	Ph.D. MS BE	In Progress 2017	Air University Air University Air University	Mechatronics Mechatronics Mechatronics

5	Engr Muzzamil Gaffar	Research Assistant	Ph.D. MS BE	In Progress 2017	Air University Air University Federal Urdu University	Mechatronics Mechatronics Electrical
6	Engr Maheen Firdous	Research Assistant	Ph.D. MS BE	In Progress 2018	Air University Air University Air University	Mechatronics Mechatronics Mechatronics
7	Engr Nauman Ghafoor	Research Assistant	Ph.D. MS BE	In Progress 2018	Air University Air University Air University	Mechatronics Mechatronics Mechatronics
8	Engr Umar Jamil	Research Assistant	Ph.D. MS BE	In Progress 2018	Air University Air University Mirpur University of Science and Technology	Mechatronics Mechatronics Electrical
9	Engr Haroon Khan	Research Assistant	Ph.D. MS BE	In Progress 2018	Air University Air University Air University	Mechatronics Mechatronics Mechatronics
10	Engr. Anam Maqbool	Lab Engineer	MS BS	In Progress 2017	Air University COMSATS University	Electrical Electrical
11	Engr. Bilal Awais	Lab Engineer	BE	2016	Air University	Mechanical
12	Engr. Zargham Raza	Research Assistant	MS BE	In Progress 2017	Air University Air University	Mechatronics Mechatronics
13	Engr. Adil Saeed	Research Assistant	MS BE	In Progress 2018	Air University HITECH Taxila	Mechatronics Electronics
14	Engr. Rabia Saba	Research Assistant	MS BE	In Progress 2018	Air University Air University	Mechatronics Mechatronics

Curriculum Design

MTS program's curriculum breakdown according to HEC curriculum layout.

S. No.	C. Code	Course Title	Pre requisite	Cr. Hrs.		
BEMTS Master course list for the Intake of Fall-2018 and Onwards						
SEM-I						
1	MA-101	Calculus I	-	3	0	3
2	HU-118	Islamic Studies	-	2	0	2
3	HU-107	Communication Skills	-	2	1	3
4	MT-102	Workshop Practice	-	0	2	2
5	MT-142	Electric Circuits Analysis	-	3	0	3
6	MT-142L	Electric Circuits Analysis Lab	-	0	1	1
7	PH-102	Applied Physics	-	3	1	4
Total Semester Cr. Hrs.				13	5	18

SEM-II						
1	MA-108	ODE & Linear Algebra	MA 101	3	0	3
2	CS-157	Computer Programming	-	2	1	3
3	MT-240	Electronics Devices and Circuits	MT-142	3	0	3
4	MT-240L	Electronics Devices and Circuits Lab	MT-142	0	1	1
5	HU-xxx	Social Sciences Electives I	-	2	0	2
6	MT-111	Engineering Statics	-	3	0	3
7	MT-170	Engineering Drawing	-	0	2	2
Total Semester Cr. Hrs.				13	4	17
SEM-III						
1	MA-105	Multivariable Calculus	MA-101	3	0	3
2	MT-247	Electronic Circuits Design	MT-240	3	0	3
3	MT-247L	Electronic Circuits Design Lab	MT-240	0	1	1
4	MT-212	Engineering Dynamics	MT-111	3	0	3
5	MT-272	Solid Modeling and Manufacturing Processes	MT-170	0	1	1
6	MT-225	Materials and Manufacturing Processes	MT-102	3	0	3
7	CS-200	Data Structures and Object Oriented Programming	CS-157	2	1	3
Total Semester Cr. Hrs.				14	3	17
SEM-IV						
1	MA-214	Complex Variables and Transform	MA-105	3	0	3
2	MT-350	Instrumentation and Measurement Systems	-	3	0	3
3	MT-350L	Instrumentation and Measurement Systems Lab	-	0	1	1
4	MT-213	Mechanics of Materials	MT-111	2	0	2
5	MT-213L	Mechanics of Materials Lab	MT-111	0	1	1
6	MT-256	Digital Logic Design	-	3	0	3
7	MT-256L	Digital Logic Design Lab	-	0	1	1
8	MT-260	Actuating Systems	-	3	0	3
9	MT-260L	Actuating Systems Lab	-	0	1	1
Total Semester Cr. Hrs.				14	4	18
SEM-V						

1	MT-252	Signals and Systems	-	2	0	2
2	MT-359	Microcontroller and Embedded Systems	MT-256	2	0	2
3	MT-359L	Microcontroller and Embedded Systems Lab	MT-256	0	2	2
4	MT-317	Theory of Machines	MT-212	2	0	2
5	MT-317L	Theory of Machines Lab	MT-212	0	1	1
6	MT-3xx	Engineering Elective I	-	3	0	3
7	HU-304	Technical Report Writing	-	2	0	2
8	MT-339	Fundamentals of Thermal Sciences	-	3	0	3
9	MT-339L	Fundamentals of Thermal Sciences Lab	-	0	1	1
Total Semester Cr. Hrs.				14	4	18
SEM-VI						
1	MA-301	Probability and Statistics	MA-105	3	0	3
2	MT-368	Mechatronics System Design	MT-256	2	0	2
3	MT-368L	Mechatronics System Design Lab	MT-256	0	2	2
4	MT-462	Robotics	-	3	0	3
5	MT-462L	Robotics Lab	-	0	1	1
6	MT-373	Modeling and Simulation in Mechatronics	MA-108	3	0	3
7	MT-330	Fluid Mechanics	-	2	0	2
8	MT-330L	Fluid Mechanics Lab	-	0	1	1
9	MT- 396	Final Year Project I	-	0	1	1
Total Semester Cr. Hrs.				13	5	18
SEM-VII						
1	MA-202	Numerical Analysis and Computation	MA-105	2	1	3
2	HU-115	Pakistan Studies	-	2	0	2
3	MT-316	Design of Machine Elements	MT-213	2	0	2
4	MT-452	Control Systems	MT-373	3	0	3
5	MT-452L	Control Systems Lab	MT-373	0	1	1
6	MT-3xx	Engineering Elective II (Mechanical Vibrations)	-	2	0	2
7	MT-498	Final Year Project II		0	2	2
8	XX-xxx	Social Sciences Electives II	-	2	0	2

9	CSL-4xx	Community Service Learning	-	0	0	0
Total Semester Cr. Hrs.				13	4	17
SEM-VIII						
1	MT-4xx	Engineering Elective III	-	3	0	3
2	MT-483	Engineering Economics	-	3	0	3
3	MT-451	Manufacturing Automation	MT-225	2	0	2
4	MT-451L	Manufacturing Automation Lab	MT-225	0	1	1
5	BA-xxx	Mngt Sciences Elective	-	3	0	3
6	MT-499	Final Year Project III		0	3	3
Total Semester Cr. Hrs.				11	4	15
Total Program Cr. Hrs.				105	33	138
1	MT-3xx	Engineering Elective I (Path Planning for Mobile Robots)	-	2	1	3
2	MT-319	Engineering Elective II (Mechanical Vibrations)	-	2	0	2
3	MT-447	Engineering Elective III (Power Electronics)	-	3	0	3
4	HU-215	Social Sciences Electives I (Ethics)	-	2	0	2
5	MT-201	Social Sciences Electives II (Energy and Society)	-	2	0	2
6	BA-477	Mngt Sciences Elective (Entrepreneurship & TQM)	-	3	0	3

Courses Description

MT 111 Engineering Statics

Fundamental concepts and principles of mechanics. Important vector quantities. Fundamental units. Moments and couples, wrench, Resultants of forces and couples. Law of equilibrium and applications, Free body diagram, trusses (section method and joint method) and their applications, centre of mass, centre of gravity, friction (static and dynamic) their applications and limitations.

MT 120 Workshop Practice

Safety measures, cutting tools, tools geometry, built up edges, introduction to machine tools, lathe machines, drill press, shapers, milling machines, band saws, grinders, carpentry shop and tools machine tools, type of joints, patterns, welding shop, different type of welding, electric arc welding, oxy acetylene welding, electric shop, series and parallel circuits, wire splicing, switches, switch board.

MT 140 Electric Circuits

Basic circuit elements, ohm's law, KCL and Kvl, node and mesh analysis, series and parallel circuits, linearity and superposition principles, network laws like Thevenin and Norton theorem, maximum power transfer theorem, inductive and capacitive circuits, concepts of circuit reactance and impedance, laplace transform of circuit equations, basic operational

amplifier circuits; inverting non inverting amplifiers, summing and difference amplifiers, integrator and differentiator, poly-phase circuits and phasors.

MT 144 Network Analysis

Time domain and frequency domain analysis of 1st and 2nd order electric circuits with ac and dc forcing function. Frequency response of a circuit through sinusoidal analysis. Topics covered are natural response of 1st order circuits, 1st order circuits with dependent sources, response of 1st order circuits to constant forcing function, response of 1st order circuits to non-constant forcing function, complete response of 2nd order circuits. Solving circuit differential equations using Laplace transform, Laplace transform of special signals, direct transformation of circuits in to S-domain. AC steady state power, concepts of average power, complex power and power factor, frequency response of 1st and 2nd order circuits (passive filters), asymptotic magnitude and phase bode plots.

MT 170 Engineering Drawing

Drafting using both manual and computer aided techniques. Familiarization with orthographic projections, sectional views, auxiliary views, isometric views, pictorial views, assembly and manufacturing drawings. Introduction to electrical drawings.

MT 201 Energy and Society

Understand the nature of energy, its use and its effect on both the individuals and society. Sources of energy: fossil fuels, nuclear energy and renewable energy. Historical patterns of energy use and the factors that shaped them. Social, economic and political implications of energy production and consumption from a local, regional, national and global perspective. A substantial portion of the course examines conservation, energy efficiency and renewable energy sources, with a focus on how these may be incorporated to create a sustainable society.

MT 212 Engineering Dynamics

Dynamics of particles and rigid bodies in one, two and three dimensions. Kinematics of particles; rectilinear motion, plane curvilinear motion, rectangular coordinates, normal and tangential coordinates, polar coordinates, kinetics of particles; kinetic diagrams, rectilinear motion, curvilinear motion. Plane kinematics of rigid bodies; angular motion relations, absolute motion, relative velocity, plane kinetics of rigid bodies; force, mass, and acceleration, equation of motion, translation, fixed axis rotation, general plane motion. Introduction to work and energy relationship, impulse and momentum concepts.

MT 215 Machine Design

Design criteria under static and dynamic loading. Factors of safety and allowances for stress concentration and fatigue. Design of clutches, brakes, belt drives, chain drives, bolts studs, shafts, keys, cotters, riveted joints, welded joints, mechanical springs, tribology and bearings.

MT 224 Materials & Manufacturing Processes

Engineering properties of materials, concept of structures, metals and alloys, ceramics, polymers, composites, materials characterization, scanning probe microscopy, non-destructive testing, and material selection and phase equilibrium diagram. Manufacturing systems, modern casting, conventional machining; turning, milling, tool geometry, chips formation, material removal rate. Non conventional machining; EDM, ECM, water jet machining, laser, EBW etc. Welding processes, heat treatment, electronic fabrication, rapid prototyping.

MT 231 Thermodynamics

Basic concepts of thermodynamics, system, surrounding, work, heat, and different process. Introduction to steady flow and non-steady flow processes and basic steam and gas turbine cycles. The state postulate, energy, processes and thermodynamic systems. Properties of pure substances: property tables, property diagrams, phase change, equations of state (ideal gas) and energy: energy transfer by heat, work and mass. The first law of thermodynamics: control mass

and control volume. The second law of thermodynamics, Carnot cycle, entropy, Clausius inequality, the increase in entropy principle, entropy change of pure substances, the T-S relations for ideal gases: basic concept of exergy, thermodynamic cycles – Rankine steam cycle, gas turbine cycles, and the ideal Otto and Diesel cycles.

MT 242 Digital Logic Design

Foundation of digital computer design. Numbering systems, and Boolean algebra. At the end of introduction of logic gates, design different combinational and sequential circuits leading up to the design of complex digital systems using combinational and sequential logic. An introduction to programmable logic devices with special emphasis on field programmable gate arrays (FPGA's).

MT 243 Analog Electronics

Diodes, terminal characteristics, analysis of diode circuits, small signal model and applications, zener diodes, rectifier circuits, BJT's, analysis of transistor circuits at DC, transistor as an amplifier, small signal model and graphical analysis, single stage amplifier configuration, BJT as a switch, large scale model, BJT logic converter, field effect transistor (FET), Metal Oxide semiconductor FET (MOSFET), MOSFET circuits at DC, MOSFET as an amplifier, MOSFET single stage amplifier configurations, biasing in MOS amplifiers, MOSFET as a switch, Frequency response of amplifiers

MT 247 Power Electronics

Power semiconductor devices, operating characteristics of power semiconductor, devices such as bipolar junction transistors, IGBTs, MOSFETs and thyristors power electronics converters, AC-DC converters, phase controlled rectifiers, AC-AC converters, AC voltage controllers and stabilizers. Cycloconverters, DC-DC converters, buck regulators, boost regulators, DC-AC converters, inverters and its application in uninterruptible power supplies (UPS), introduction to machinery principles, notations, magnetic fields and circuits, magnetic behavior of ferromagnetic materials. AC and DC machinery fundamentals, DC motors, power electronics drives.

MT 253 Microcontroller Based Design

Introduction to microprocessors and microcontrollers, embedded system design, architecture of a modern microcontroller, software/firmware development tools, programming languages; assembly and C, simulation tools like Proteus, implementation of data communication, using peripherals of microcontroller (ADC, PWM, capture/compare etc), interface with external devices like LCD, keypad, motors

MT 262 Electromechanical Systems

Basic principles of electromechanical systems like transformers, generators and motors. Faraday's law and application in rotating machines. Different techniques to analyze the performance of a range of electrical machines. Magnetic circuits, electromagnetic circuits; solenoids, transformers, transformer coupled circuits. Principles of electro-mechanical energy conversion and rotating machines, construction and operation of synchronous generator, construction and operation of synchronous motor, induction machines and their characteristics, applications of AC motors, operating principles of DC machines, performance analysis of the DC machines, modeling of DC motor, brush less DC motor, switched reluctance motor.

MT 314 Mechanics of Materials

Concepts of stress and strain, axial loading, and torsion, pure bending, shear force and bending moment diagrams, beams under transverse loading, transformation of stress and strain, biaxial stress, Mohr's circle, and deflection of beams, beam design and columns.

MT 317 Theory of Machines

Kinematics and kinetics, kinematics fundamentals, degrees of freedom, Grubler's criterion of mobility, the Grashof conditions, classification of the four bar mechanisms, linkages of more than four bars and introduction to working model software is discussed. Inversions and graphical synthesis, linkage transformation, intermittent motion, velocity and acceleration diagrams (graphical methods), instantaneous centre methods for velocity and acceleration of a mechanism, introduction to cams – terminologies, pressure angles, SVAJ diagrams, critical path motion (CPM), sizing the cam, cam manufacturing considerations, introduction to DYNACAM, gear trains – simple, compound, reverted and planetary gear trains are studied. Introduction to power screws, design and applications. Balancing – static and dynamic balancing.

MT 319 Mechanical Vibrations

Fundamentals of vibration, classification of vibration, analysis and elements of vibratory system. Simple harmonic analysis, un-damped and damped free vibration, introduction to forced vibration with harmonic excitation. Forced vibration with viscous and coulomb damping, coordinate coupling, principle coordinates, and multi degrees of freedom system. Numerical techniques used in vibration, and Eigen value problems are studied.

MT 334 Heat Transfer

Basic concepts of heat transfer, conduction, convection, and radiation. Extended surfaces to increase heat transfer and its applications in heat sinks and in heat exchangers. 1-D heat transfer, heat transfer through composite walls, cylinders and spheres. Design and analysis of fins, applications in heat sinks, variable thermal conductivity, heat transfer free and forced convection, thermal boundary layer, flow over plates, flow within pipes, laminar and turbulent flow correlations is studied. Introduction to heat pipes, design of heat exchangers using effectiveness-NTU approach and LMTD approach. Introduction to radiation heat transfer.

MT 337 Fluid Mechanics, Hydraulics and Pneumatics

Preliminary concepts of fluid dynamics, hydraulics, and pneumatics. Particular focus is on application of hydraulics and pneumatics in mechatronics systems. Fluid, properties, equation of state, hydrostatics: manometry, principles of fluid motion: description of fluid flow; continuity equation; Euler and Bernoulli equations, Reynolds number, laminar and turbulent flows: Reynolds demonstration of flow regimes; criterion for laminar/ turbulent flow, Pipe flows: friction factor, friction losses, and other losses. Hydraulic and pneumatic actuating devices, hydraulic valve types, configuration and characteristics responses, pneumatic valve types, configuration and characteristic responses, design and application of hydraulic and pneumatic systems.

MT 351 Instrumentation & Measurement Systems

Measurement processes, errors: its types, causes and removal of errors in measurement systems. Signal and noise in instrumentation, display and recording systems, signal processing, transducers and actuators. Smart sensors, data logging and interfaces, data processing and storage. Measurement of temperature, pressure, flow, humidity in process and other mechatronics systems.

MT 354 Control Engineering

Introduction to control systems, Laplace transformation, block diagrams and signal flow Graphs system modeling and reconstruction. Modeling of electrical, mechanical and electromechanical systems, feedback, Masson's gain formula, state space equation, Routh Hurwitz's stability criteria, root locus analysis, root locus design, continues time system response.

MT 362 Biomechatronics

Theory and design of Mechatronics/Robotic devices related to biomedical engineering including manipulation and mobility devices.

MT 364 Mechatronic Systems Design

Sensors and different sensing techniques are discussed. Signal conditioning of signals provided by sensors. A brief summary of different control techniques of mechatronics systems. A general overview of typical actuators. Different types of motors, including brushed DC motor, brushless DC motor, stepper motor and servo motor, their mathematical models and theory from application perspective. Driver circuits required to provide electric power to these motors, applications of mobile robot.

MT 396 Final Year Project I MT 498 Final Year Project II MT 499 Final Year Project III

Independent, or group work, as prescribed by supervisor and projects committee of concerned department

MT 445 Signals & Systems

Memory, causality, stability, invertibility, linearity and time-invariance linear time invariant systems: impulse response, convolution. Functions of a complex variable, complex series and integrals. Transform methods: Continuous time Fourier series and transform, discrete- time Fourier series and transform, Frequency response. Sampling theory. Laplace and z-transforms, system functions.

MT 446 Digital Signal Processing

Discrete-time signals, sampling theory, interpolation and decimation, causality, stability, convolution of discrete signals, DT Fourier transforms, z-transforms, DFT, FFT algorithms, digital filter design techniques, IIR and FIR Filters, finite word length effects, spectrum analysis, VLSI processors.

MT 454 Advanced Controls and Simulation Techniques

System dynamic response analysis (frequency response) Bode plots, Magnitude and Phase angle plots. Design of state variable feedback systems: controllability, observability. Introduction to optimal control. Material Derivatives, Modeling and Simulation of Sensors & Transducers (Piezo-electric Transducers, Hall Effect Devices) Numerical techniques, time response and digital simulation, stochastic simulation, Monte Carlo methods.

MT 459 FPGA Based Design

Telegraph, scanner, laser printer, advanced hardware, Programmable logic devices like, Programmable array logic (PAL) Programmable logic array (PLA), complex Programming logic device (CPLD), Application Specific Integrated Circuits (ASIC) and Field Programmable Gate Arrays (FPGA), introduction to Verilog/VHDL its applications to different components like Mux Demux, counters, registers etc. Introduction to simple as Programmable computer (SAP-1 and SAP-2).

MT 465 Advanced Robotics

An overview of robots, robot kinematics and dynamics control and sensing systems, robot vision programming and interfacing, basics of robot design and robot testing, applications of robots, forward and backward kinematics, velocity and torque parameters, trajectory generation and PID control for robots.

MT 474 Computer Aided Engineering

Overview to applied problems in fluid flow, thermal and electrical analyses. Introduction to computational techniques (Finite Element method, Variational principles, Galerkin method,

computational fluid dynamics) to solve engineering problems. Codes used in industrial applications. Applications to laminar fluid flow, flow in pipes through bends, pressure drop computations, thermal problems in mixed mode heat transfer.

MT 483 Engineering Economics

The theory of microeconomics makes use engineering economics for the tools of marginal cost-benefit analysis to provide a framework for the economic analysis of decision-making. Money-time relationship: time value of money, simple and compound interest, cash flow, single sums of money, uniform series of cash flows and equivalence. Basic methods: present worth, annual worth, future worth, internal rate of return, and external rate of return methods. Comparing alternative proposals break-even analysis: break-even point, break-even involving income and cost analysis. Benefit-cost analysis: comparing benefits of costs, B/C ratios, and methods for calculating B/C ratios. Depreciation: measuring depreciation, depreciation accounting and standard methods for calculating depreciation.

MT 500 Engineering and Machine Design

Basics of computer aided design tools, machine shop equipment and processes, factors of safety and allowances for stress concentration, design of clutches, brakes, belts, joints, cam design.

MT 501 Applied Mechatronics and Robotics

Introduction to Mechatronics systems, Ac circuits introduction , Diodes , transistors , their types and properties, Introduction to digital circuits, combinational logic and logic classes, Introduction to Boolean algebra, Introduction to sequential logic circuits and flip flops, characteristics of real Op Amps, data acquisition, D/A and A/D conversion, temperature measurement, transformers. Types uses and working of Electric Motors (stepper motors and servo motors). Overview of robots. Robot kinematics and dynamics. Control and sensing systems, robot vision Programming and interfacing. Basics of robot design and robot testing, applications of robots. Forward and Backward kinematics.

MT 502 Applied Mechanical Systems

Modeling of thermal and fluid systems. Kinematics and Dynamics of machinery. CAD tools for mechanical systems.

MT 504 Applied Electrical and Electronics Systems

Electric circuits, amplifiers and their applications, power amplifiers and switches, DC and AC motors, digital systems. Electronic design tools.

MT 506 Microprocessors and Applications

Microprocessor hardware and software modules. Microcontrollers hardware and software architectures, Microcontrollers Programming and interface with real-time mechatronics systems. Data acquisition units, Designing stand-alone embedded systems for mechatronics products. Individual projects.

MT 508 Control Systems

Laplace transformation, block diagrams and signal flow graphs system modeling and reconstruction. Modeling of electrical, mechanical and electromechanical systems, feedback, characteristics of DC generators and servo motors, Masson's gain formula. State space equation, Routh Hurwitz's stability criteria, root locus analysis and design, Bode plots, Magnitude and Phase angle plots. Digital control.

MT 600 Advanced Modeling and Simulation in Mechatronics

Modeling of mechanical systems (springs, dampers, mass, translatory and rotational systems, geared systems). Modeling of electrical systems (capacitor, inductor, resistors, analog electronic devices). Modeling of hydraulic and pneumatic systems. Mechatronics systems (Electro-mechanical, fluid-mechanical and Electro-hydraulic systems), System dynamic

response analysis (frequency response), Numerical techniques, time response and digital simulation, stochastic simulation, Monte Carlo methods. Lagrangian optimization and optimal control strategies in mechatronics.

MT 602 Digital Signal Processing

Signal estimation. Time frequency analysis. DTFT, CTFT, FFT. The z- transform and state-variable methods. Discrete system modeling. Classical compensator design. Pole placement, state estimation, and optimal linear quadratic regulation.

MT 620 Numerical Computing in Engineering

Analysis of linear and nonlinear physical systems equations of motion (ODEs and PDEs). PDEs in Engineering: wave, diffusion, Laplace, Poisson equations. Transform and integral methods for solving boundary and initial value problems. Numerical methods for ordinary and partial differential equations.

MT 622 Embedded Systems for Mechatronics

Examples of embedded systems: Telegraph, scanner, laser printer, advanced hardware, Programmable array logic, Application Specific Integrated Circuits (ASIC) and Field Programmable Gate Arrays (FPGA), architecture, real-time operating systems, embedded software development tools and debugging

MT 634 Control Engineering I

Dynamic analysis of systems involving automatic control of position, speed, power, flow, pressure, temperature, and other physical quantities. Analysis and design of control systems with digital controllers, including PID, finite settling time, state feedback, and minimum variance algorithms. s- transform, z-transform, mathematical modelling of dynamical systems, transfer functions, root-locus, bode plot, Nyquist plot, Nichols chart Computer simulation and analysis using Matlab; laboratory study of feedback systems.

MT 704 Mechatronic Systems Design

Introduction to multi-domain systems. Design methodologies for integrated mechanical, thermal, fluid, electrical, and electronic sensors, actuators and systems used in mechatronics. Optimality modeling for mass-spring- damper robotic arm motion control. Variational lagrangian representation for optimality. Modeling of motion sensors for nonlinear thermal sensors by intergral formulation and Monte Carlo simulation. Emphasis on modeling and simulation of hybrid systems using modern computer-aided tools.

MT 705 Applied Optimal Control

Parameter optimization. Performance measures. Variational approach to open loop optimal control, Pontryagin's minimum principle. Optimal feedback control, dynamical Programming, linear systems with quadratic performance indices, matrix Riccati equation. Numerical solution techniques of optimal control problems. Lab study to apply optimal control techniques to example dynamical systems.

MT 706 Intelligent Control

Uncertainty models and information representation: types of uncertainties and uncertainty measures. Intelligent control methodologies, learning control, fuzzy control, neuro-control, neuro-fuzzy control.

MT 712 Smart Structures

Basic material properties, models, and active and sensory material systems. Health monitoring approaches to detect damage in a structure. Applications of smart materials, primarily for vibration and pointing control. Finite element models with piezoelectric elements used in

sensor selection and actuator. The design of feedback and adaptive feed-forward control algorithms, implementation of sensor, actuator, and control electronics.

MT 716 Advanced Industrial Instrumentation and Control

Field instrumentation. Cabling and grounding. Data acquisition, signal processing and transmission. Smart sensors and sensor diffusion. SCADA systems. Computer based control. Direct digital control. Supervisory control. Programmable logic controllers and industrial controllers. Introduction to distributed control systems.

MT 718 Real-Time Robotic Systems

Computational methods and techniques used in vision-based robotics. Real-time embedded control, Design of modern robotic and industrial control systems, optimization techniques, matrix analysis, and analytic 2D / 3D geometry.

MT 724 Automated Manufacturing Systems

Description and demonstration of automated machine tools and machining cells. Machining center configuration and operation, machine tool controller, machining code generation, in-process sensing and control, cell controllers, and system simulation.

MT 726 Machinery Dynamics and Vibration

Machinery vibration analysis: dimensional analysis, signature analysis in time and frequency domains, spectral analysis, fault detection, diagnosis, and correction; instrumentation; case studies; machine monitoring programmes.

MT 730 Distributed Control Systems

Distributed computer systems architecture. System elements. Data communications links. Software algorithms. Reliability. Applications

MT 732 Artificial Intelligent Systems

Biological and Cognitive Paradigms, Concepts of Machine Intelligence, Intelligent Agents, Vision and Image Analysis, Principles of Decision-Making, Fuzzy Logic, Decision Trees, Case-based Reasoning, Genetic Algorithms, Neural Networks, Expert systems.

MT 738 PC-Based Control

Interfacing of electro-mechanical systems to microcomputers for data acquisition, data analysis and digital control. Using of PC ports and Internet for data acquisition and control purposes. PC architecture. Serial port, parallel port, USB. Programming techniques for serial and parallel communication. ISA and PCI bus specifications. ISA bus interfacing and Programming. Simple ISA card design for data acquisition.

MT 740 Power Electronics and Electrical Drives

Energy conversion and electric power conditioning. DC-DC and DC-AC converters for electrical drives, Analysis of electrical drives. Dynamic models of DC and AC machines. Control principles of variable speed and servo drives. Scalar control of DC-servo motors. Scalar and vector control principles of AC-motors. Practical control examples.

MT 742 Electro-Pneumatic and Hydraulic Systems

Fluids and fluid flows in high-performance actuators and controllers. Power flow and fluid power elements, valve and pump control, linear and rotary motion. State space descriptions. Design of electro-hydraulic position and velocity control servo-mechanisms for high performance with stability.

MT 760 Special Topics

As announced by department. MT 636 Control Engineering II Continuous and discrete-time linear control systems; state variable models; analytical design for deterministic and random inputs; time-varying systems stability. Design of PID control systems, lead compensator, lag

compensator, lead- lag compensator, control systems for disturbance rejection, state-space approach, design of control systems in state-space.

Department of Biomedical Engineering

Biomedical Engineering is the application of engineering principles to the field of biology and health care. Biomedical Engineers work with doctors, therapists and researchers to design and develop medical systems, equipment and devices in order to solve clinical problems.

Biomedical Engineering has brought together the knowledge of diverse fields with a focus of applications in medical sciences. It assisted the healthcare professionals from looking inside the patient's body to rehabilitate the paralyzed ones.

Mission of Department of Biomedical Engineering

To provide students with advanced engineering knowledge and nurture them with the positive relationship towards their fellow and in particular towards society. The Department aspires to produce graduates who can communicate effectively, seek lifelong learning and contribute towards developing a prosperous and enlightened society.

Biomedical Engineering Program Educational Objectives (PEOs)

The program of Biomedical Engineering will achieve the following PEOs;

PEO-1: The graduates are applying Biomedical engineering knowledge to identify and address the technical and societal problems.

PEO-2: The graduates are demonstrating intellectual and analytical abilities in taking initiative and/or developing innovative ideas for technological and professional growth in the field of Biomedical Engineering.

PEO-3: The graduates are working and communicating effectively as a team member or lead multidisciplinary teams while demonstrating the interpersonal and management skills and ethical responsibilities.

PROGRAM LEARNING OUTCOMES (PLOs)

Program learning outcomes are the narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills and attitude that the students acquire while progressing through the program.

The program must demonstrate that by the time of graduation the students have attained a certain set of knowledge, skills and behavioral traits, at least to some acceptable minimum level. Specifically, it is to be demonstrated that the students have acquired the following graduate attributes (PLO 01-12):

PLO-01: Engineering Knowledge: Ability to apply knowledge of mathematics, science and engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PLO-02: Problem Analysis: Ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PLO-03: Design/Development of Solutions: Ability to design solutions for complex engineering problems and design systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO-04: Investigation: Ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.

PLO-05: Modern Tool Usage: Ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

PLO-06: The Engineer and Society: Ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

PLO-07: Environment and Sustainability: Ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

PLO-08: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PLO-09: Individual and Team Work: Ability to work effectively, as an individual or in a team, on multifaceted and/or multidisciplinary settings.

PLO-10: Communication: Ability to communicate effectively, orally as well as in writing on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentations, make effective presentations, and give and receive clear instructions.

PLO-11: Project Management: Ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team to manage projects in a multidisciplinary environment.

PLO-12: Lifelong Learning: Ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

FACULTY MEMBERS

Sr No.	Name	Details of Qualifications		Specialization
		Degree	Institution	
1	Dr. Zareena Kausar	PhD	University of Auckland New Zealand	Mechanical Engineering
		MS	UET, Lahore	Mechatronics Engineering

		BS	UET, Lahore	Mechanical Engineering
2	Dr. Zia Mohy Ud Din	PhD	Kyungpook National University, Daegu, South Korea	Biomedical Engineering
		MS	Kyungpook National University, Daegu, South Korea	Biomedical Engineering
		BS	Sir Syed University of Eng. & Tech. Pakistan.	Biomedical Engineering
3	Dr Jahan Zeb Gul	MS leading to PhD	Jeju National University, South Korea	Mechatronics Engineering (Biomedical)
		BE	University of Engineering and Technology (UET), Taxila, Pakistan (CASE, Islamabad, Pakistan)	Electrical Engineering
4	Aleena Mazhar	MS	Riphah International University	Biomedical Engineering
		BE	Riphah International University	Biomedical Engineering
5	Inam Ur Rehman Junejo	MS	Hanyang University, Ansan, South Korea	Bio-Nano-technology
		BE	Mehran University of Engineering and Technology, Jamshoro	Biomedical Engineering
6	Jamila Akhtar	MS	NED University of Engineering & Technology	Biomedical Engineering
		BE	NED University of Engineering & Technology	Biomedical Engineering
7	Dr. Nauman Naseer	PhD	Pusan National University, Korea	Mechatronics Engineering
		MS	Air University, Islamabad	Mechatronics Engineering
		BE	E&ME NUST, Rawalpindi	Mechatronics Engineering
8	Dr. Sadia Moazzam	FCPS	College of Physicians & Surgeons Pakistan	Physiology
		MBBS	Quaid e Azam Medical College, Bahawalpur	General

9	Dr. Kirn-e-Muneera	M Phil	Army Medical College, (NUST) H-12, Islamabad	Biochemistry
		MBBS	Rawalpindi Medical College	General

LAB ENGINEERS

10	Rida Nisar	BE	Riphah International University	Biomedical Engineering
11	Alina Akhlaq	BE	Riphah International University	Biomedical Engineering
12	Muhammad Usman	BE	Air University, Islamabad	Electrical Engineering

CURRICULUM DESIGN

Semester-wise breakup of the program

Semester I

S. No.	Code	Course Title	Prerequisite	Credit Hours		
1	PH-102	Applied Physics	-	3	1	4
2	CS-156	Introduction to Computing	-	2	1	3
3	BM-120	Basic Electrical Engineering	-	3	0	3
4	BM-120L	Basic Electrical Engineering Lab	-	0	1	1
5	MA-100	Foundational Mathematics OR	-	4	0	4
	BM-110	Basic Biology	-	4	0	4
6	BM-101	Introduction to Biomedical Engineering	-	1	0	1
7	HU-121	Communication Skills	-	2	0	2
Total Semester Credit Hours:				15	3	18

Semester II

S. No.	Code	Course Title	Prerequisite	Credit Hours		
8	MA-111	Calculus & Analytical Geometry	-	4	0	4
9	BM-111	Physiology I	-	2	0	2
10	BM-111L	Physiology I Lab	-	0	1	1
11	BM-121	Circuit Analysis	BM-120	3	0	3
12	BM-121L	Circuit Analysis Lab	BM-120	0	1	1
13	CS-158	Object Oriented Programming	CS-156	2	1	3
14	BM-113	Human Anatomy	-	2	0	2
15	BM-113L	Human Anatomy Lab	-	0	1	1
16	BM-131L	Computer Aided Engineering Drawing	-	0	1	1
Total Semester Credit Hours:				13	5	18

Semester III

S. No.	Code	Course Title	Prerequisite	Credit Hours		
17	MA-218	Complex Variables & Transforms	MA-111	4	0	4
18	BM-211	Physiology II	BM-111	2	0	2
19	BM-211L	Physiology II Lab	BM-111	0	1	1
20	BM-226	Digital Logic Design	-	3	0	3
21	BM-226L	Digital Logic Design Lab	-	0	1	1
22	BM-220	Basic Electronics	BM-121	3	0	3
23	BM-220L	Basic Electronics Lab	BM-121	0	1	1
24	HU-114	Technical English	-	2	0	2
Total Semester Credit Hours:				14	3	17

Semester IV

S. No.	Code	Course Title	Prerequisite	Credit Hours		
25	BM-221	Biomedical Electronics	BM-220	3	0	3
26	BM-221L	Biomedical Electronics Lab	BM-220	0	1	1
27	BM-212	Biochemistry	-	2	0	2
28	BM-212L	Biochemistry Lab	-	0	1	1
29	MA-108	Ordinary Differential Equations & Linear Algebra	MA-111	3	0	3
30	BM-231	Biomedical Instrumentation I	-	3	0	3
31	BM-231L	Biomedical Instrumentation I Lab	-	0	1	1
32	BM-202	Signals & Systems	-	3	0	3
33	BM-202L	Signals & Systems Lab	-	0	1	1
Total Semester Credit Hours:				14	4	18

Semester V

S. No.	Code	Course Title	Prerequisite	Credit Hours		
34	BM-342	Biomechanics	-	3	0	3
35	BM-342L	Biomechanics Lab	-	0	1	1
36	BM-331	Modeling & Simulation	MA-108	2	0	2
37	BM-331L	Modeling & Simulation Lab	MA-108	0	1	1
38	MA-208	Engineering Probability & Statistics	-	3	0	3
39	BM-311	Biomaterials	BM-212	3	0	3
40	BM-311L	Biomaterials Lab	BM-212	0	1	1
41	BM-301	Biomedical Signal Processing	BM-202	3	0	3
42	BM-301L	Biomedical Signal Processing Lab	BM-202	0	1	1
Total Semester Credit Hours:				14	4	18

Semester VI

S. No.	Code	Course Title	Prerequisite	Credit Hours		
43	BM-333	Biomedical Instrumentation II	BM-201	3	0	3
44	BM-333L	Biomedical Instrumentation II Lab	BM-201	0	1	1
45	BM-3XX	Elective I	-	3	0	3
46	BM-332	Biomedical Control Systems	MA-108	3	0	3
47	BM-332L	Biomedical Control Systems Lab	MA-108	0	1	1
48	MA-202	Numerical Analysis and Computation	-	2	1	3
49	BM-325	Microprocessor & Interfacing	BM-226	2	0	2
50	BM-325L	Microprocessor & Interfacing Lab	BM-226	0	1	1
51	BM-396	Final Year Project – I	-	0	1	1
Total Semester Credit Hours:				13	5	18

Semester VII

S. No.	Code	Course Title	Prerequisite	Credit Hours		
52	HU-115	Pakistan Studies	-	2	0	2
53	BM-401	Medical Imaging	PH-102	2	0	2
54	BM-401L	Medical Imaging Lab	PH-102	0	1	1
55	BM-4XX	Elective II	-	3	0	3
56	BM-4XX	Elective III	-	3	0	3
57	HU-307	Technical Report Writing	-	1	1	2
58	BM-498	Final Year Project - II	-	0	2	2
Total Semester Credit Hours:				11	4	15

Semester VIII

S. No.	Code	Course Title	Prerequisite	Credit Hours		
59	HU-118	Islamic Studies	-	2	0	2
60	BM-4XX	Elective IV	-	3	0	3
61	HU-215	Ethics	-	2	0	2
62	BM-4XX	Elective V	-	3	0	3
63	BM-499	Final Year Project - III	-	0	3	3
64	MT-304	Engineering Management and Entrepreneurship	-	2	0	2
Internship			-	0	0	0
Total Semester Credit Hours:				12	3	15
Total Credit Hours:				106	31	137

List of Elective Courses:

Track 1: Instrumentation		Track 2: Tissue Engineering and Molecular Bioengineering		Track 3: Biomedical Computing	
Code	Course Title	Code	Course Title	Code	Course Title
BM-304	Biomedical Engineering Systems	BM-312	Biophysics	BM-431	Telemedicine Systems
BM-402	Medical Device Quality System and Standards	BM-345	Biofluid Mechanics & Bioheat Transfer	BM-432	Medical Data System
BM-433	Medical Device Regulatory Affairs	BM-411	Tissue Engineering	BM-443	Computational Fluid Dynamics
BM-321	Power Electronics	BM-412	Genetic Engineering	BM-434	Artificial Intelligence
BM-434	Medical Robotics	BM-413	Nano Biotechnology	BM-435	Bioinformatics
BM-445	Rehabilitation Engineering	BM-414	DNA Computing	BM-406	Medical Image Processing
BM-322	Bioelectricity	BM-415	Regenerative Medicine	BM-437	Hospital Information Management System
		BM-416	Drug Delivery Systems		
		BM-417	Neuroscience		

COURSE DESCRIPTION**BM-110 Basic Biology**

Cell Structure and Function, Techniques used in Cell Biology, Cell Wall and Plasma Membrane – Biological Molecules in Protoplasm, Importance of Water. Structure of Enzymes, Mechanism of

Enzyme Action, Factors affecting the Rate of Enzymatic Action, Enzyme Inhibition and Classification of Enzymes. Acellular life, Prokaryotes, Diversity among animals, Digestion, Circulation, Immunity, Respiration, Homeostasis, Support and movement, Nervous coordination and Chemical coordination. Reproduction, Development and aging, Inheritance, Chromosome and DNA and Evolution. Gene Cloning, DNA Sequencing, DNA Analysis, Genome Maps, Tissue culture, Transgenic bacteria, plants and animals, Biotechnology and healthcare.

BM-120 Basic Electrical Engineering

Structure of Matter, Conductors, Insulators and Semiconductors, Electric Current, Electromotive Force (Voltage), Resistance, Conductance, Conventional Current, DC and AC, Real and ideal Sources, Ohm's Law Work, Energy and Power, Efficiency, Kirchhoff's voltage and current Laws, Voltage and Current Source Conversion. The Voltage-Divider Rule. The Superposition Theorem, Maximum Power Transfer Theorem, Transients in RC Networks, Electromagnetic Induction Lenz's Law, Faraday's Transformer Action, Self-Inductance, Inductor. Energy Stored in an Inductor, Transients in RL Circuits. Three phase circuits and balanced loads.

BM-101 Introduction to Biomedical Engineering

What is biomedical engineering, Branches of biomedical engineering, Role of biomedical engineer, Biomedical instrumentation fundamental, Critical care devices used in biomedical engineering, Radiological instrumentation, Diagnostic biomedical devices, Therapeutic Biomedical devices, Rehabilitation Engineering, Physiological modeling and simulation, Biomedical signal processing, Clinical Engineering, Biomaterials, Biomechanics, Tissue Engineering and regenerative medicine , Neural engineering, Medical Image Processing.

BM-111 Physiology I

The Cell and its function, protein synthesis and cell reproduction. Metabolism of carbohydrates and formation of ATP. Quantitative issues at the organ and whole body levels of Cardiovascular, Respiratory, Renal and Digestive systems. Nerve and Muscle. Membrane potential, Action potential, Excitation and Rhythmicity. Contraction of Skeletal and cardiac muscles, sliding filament Mechanism, Heart as a pump. Sensory Receptors, Classification and basic mechanism of action. Somatic Sensations, Mechanoreceptive sensations, pain, thermal and visceral pain, headache. Special Senses, Eye, receptor function of the retina, Neurophysiology of Vision, the Chemical Sense-taste and smell.

BM-121 Circuit Analysis

Series & Parallel RLC Circuits, RLC Circuits, LC Circuits, Power Factor Calculations. Nodal, Mesh & loop analysis, Thevenin's, Norton's, Reciprocity & Compensation theorems. Maximum Power Transfer Theorem. First Order Circuits (RL and RC): Transient Response, Steady State Response, Unit Step Response. Introduction to complex frequency, Complex frequency plane, natural response & the S-Plane. Voltage ratio synthesizing, Scaling & Bode Diagrams. General Two Port Networks: Introduction, admittance parameters, some equivalent networks, impedance parameters, hybrid parameters, transmission parameters.

BM-113 Human Anatomy

Anatomy and its branches. Anatomical positions, Planes, Topography, Cell Anatomy, Overview of Cellular Anatomy. Bones, Muscles, Ligaments, Tendons, Bursae, Reticulae, Capsules, Arteries, Veins and Lymphatic system. Vertebrae, Pelvic girdle, Spinal cord and Nervous system. Surface anatomy, Bones surface musculature, Lungs and Heart. Abdomen, Organs location, Structures, Relations and function. Head & Neck, Bones, Muscles and Cranial nerves.

BM-211 Physiology II

Organization of Nervous System, Neuronal Mechanism and circuits for processing information. Spinal cord and the cord reflexes. The cerebral cortex and intellectual functions of the Brain, Motor function of the Brain stem, Vestibular control of postural reflexes, Cerebrum and basal ganglia and Reticular.

Mechanoreceptive sensations, Pain, Thermal and visceral pain and Headache. Limbic System, Role of the Hypothalamus, Control of the vegetative functions of the body, The Autonomic nervous system, The Adrenal Medulla and Electrical Activity from Brain. Introduction to Endocrinology and the pituitary Hormones.

BM-226 Digital Logic Design

Introduction to Digital Electronics, conversion between Binary, Decimal and Hexadecimal. BCD Numbers and The ASCII Code. Boolean operations, Boolean algebra, DeMorgan's theorems. The Map Method. Combinational Logic, Decoders and Encoders, Multiplexers, Read Only Memory, Programmable Logic Array (PLA) and Programmable Array Logic (PAL). Flip-Flops, latches, Triggering of Flip-Flops, Analysis of Clocked Sequential Circuits, State Reduction and Assignment and Design Procedure. Registers, Shift Registers, Ripple Counters, Synchronous Counters, Timing Sequences, Seven-segment Display and Display Driver.

BM-220 Basic Electronics

PN junction, Characteristics, Load Line and dynamic resistance. Half wave and Full wave rectifiers. Clippers and Clampers, Logic gates. Bipolar Junction Transistor Construction, operation and characteristics. Amplifying action and variation in current gain, Common Emitter, Common Collector and Common Base Configurations. Transistor as a switch. BJT Small Signal Analysis, Common Emitter/Base/Collector Amplifier. JFET Construction and Operation, Transfer characteristics and parameters, FET Biasing Circuits, JFET/Depletion MOSFET small-signal model, Loading effects and design of amplifier circuits. Darlington transistor circuit, Circuits of differential amplifiers using BJTs and FETs.

BM-221 Biomedical Electronics

Analysis of OP-AMP action, OP-AMP specifications, characteristics and CMRR. Inverting, non-inverting amplifiers, Voltage follower, Summing amplifiers, Integrator and differentiator. Practical/hands-on experience in performing biomedical-related data processing / computation / analysis with a variety of computer tools, platforms, and applications. Amplifiers in the signal conditioning circuit. Basic Low Pass filters, Butterworth filters, High pass and Bandpass Butterworth filters and Notch filters. A/D and D/A converters, Selected Applications of OP-AMPs.

BM-212 Biochemistry

An introduction to basic concepts of biochemistry. Basic structure, classification and functions of proteins and enzymes. Learn about lipids, vitamins and carbohydrates. Diseases Globular proteins: heme-proteins, hormones & signaling agents. Conformational analysis and forces that determine protein and nucleic acid structure. Molecular Modeling and introduction, classification and structure. Digestion of carbohydrates. Metabolism of carbohydrates. Thermodynamic principles in human body. Thermodynamics of phosphate compounds and role of ATP for biological energy transfer, thermodynamics of life. Digestion, absorption and secretion. Utilization of dietary lipids.

BM-231 Biomedical Instrumentation I

Biomedical signals of the human body, Sensors and transducers for bio-potential measurements. Cardiovascular System Devices, Diagnostic: Electrocardiography, Measurement of Blood pressure, Blood flow, Therapeutic: Cardiac output. Defibrillator, pacemaker, Pulmonary System Devices, Diagnostic: Pulmonary Function Analyzer, Spirometry, Ventilation Monitors, Respiration: Pulse oximetry, Capnography, Therapeutic: Ventilators, Heart lung machine, nebulizer. Musculoskeletal & Nervous System Devices, EMG, EEG, Critical Care Devices. Patient Monitors, central monitoring system, telemetry system, Surgical/Operation Theatre Devices.

BM-202 Signals & Systems

Signal and System Characteristics and Models, Concept of Continuous-Time and Discrete-Time Signals and Systems. Time-Domain Analysis of Continuous-Time Systems. Frequency-Domain Representation of Continuous & Discrete-Time Signals, Amplitude and Phase Spectra of Periodic Signals. Frequency-Domain Analysis of Continuous-Time Systems, System Frequency Response, Amplitude and Phase Responses. Analysis of Continuous-Time Systems using the Laplace Transform and system stability. Study of Filters and their characteristics.

BM-342 Biomechanics

Anthropometry, density, mass and inertial properties, Direct measurement of anthropometric parameters, Muscle anthropometry, Mechanical advantage of muscle, Multipoint muscles. Kinematics of Human Movement, limb-segment angles, joint angle, linear and angular velocities and acceleration, tools for direct/indirect measurement of kinematic quantities. The biomechanics of Human Bone Growth and Development, Composition and Structure of Bone Tissue, Material constituents, structural organization, characteristics of bones. Osteoporosis. Kinetics of Human Movement. Biomechanics of upper & lower extremity, Loading and injuries to the shoulder, elbow, wrist joints. Loading and injuries to the Hip, knee and ankle joints. Gait Biomechanics, Hip, knee and ankle joint kinematics and kinetics and Interpretation of gait data.

BM-331 Modeling & Simulation

Types of Models and its application in Biomedical Engineering, conceptual model of cardiorespiratory system. Electrical and fluidic modeling of the blood flow through the artery, Elementary Vascular Model. Electrical modeling of physiological System, Electrode electrolyte interface model. Modeling of physiological systems. Modeling of human organs using 3D printing, Thermal modeling using Bio heat equations, Application of thermal models on physiological System, Software Implementations.

BM-311 Biomaterials

Introduction to biomaterials science, implantable biomaterials and devices. Properties of Biomaterials, techniques of characterization of Biomaterials, Electron spectroscopy for chemical analysis, 3D structure of biomaterials, Classes of Materials Used in Medicine, physical behavior, synthesis Biological materials, Biomechanics of arthroplasty. Review of clinical cases Sterility and patient safety, Device Failure Mode Analysis, standards and regulatory compliance, Legal aspects of biomaterials, clinical trials and case studies in regulations, Tissue Engineering, gene therapy using viral vector materials for scaffolding. Biomaterial implantation and Acute inflammation, Immune response to biomaterials.

BM-301 Biomedical Signal Processing

Introduction to Digital Signal Processing, ADC/DAC conversions. Realizations of Digital Systems, Time domain Analysis, Digital Convolution, Auto and Cross Correlation, Discrete System Stability. The z-Transforms, Transfer function, pole zero plot, and System Stability, Discrete Time Fourier Transform. Finite Impulse Response Filter Design a. FIR filter design using window method. Infinite Impulse Response Filter Design. IIR filter design using Bilinear Transformation Method, IIR filter design using Pole-Zero placement, and Impulse Invariance methods. Biomedical Applications.

BM-333 Biomedical Instrumentation II

Centrifugation techniques, Electrochemical methods of analysis, Electrophoresis, Blood banking and transfusion, Chromatography, Liquid chromatography, Gas chromatography, High performance liquid chromatography, Clinical chemistry analyser, Automated cell counter, Spectroscopy, Spectrophotometry, Flame photometry, Mass spectrometry, Infrared spectrometry, Nuclear Magnetic

Resonance Spectroscopy, Microscopy, Electron microscopy, Atomic force microscopy, Confocal microscopy.

BM-332 Biomedical Control Systems

Modeling in the Frequency Domain, Electrical/Electronic/Mechanical systems transfer function, State-Space Representation and Analysis. Time Response, Poles, Zeros, and System Response, Transient and steady state response of first and second order systems. Reduction of Multiple Subsystems, Block Diagrams and reduction techniques, Signal-Flow Graphs and Mason's Rule. Control System Stability, Routh-Hurwitz Criterion and Special Cases. Root Locus Techniques, Root Locus and its Properties, Sketching the Root Locus plots. Frequency Response Techniques Bode and Polar Plots, Stability via the Nyquist Diagram, Gain Margin and Phase Margin.

BM-325 Microprocessor & Interfacing

Introduction to Microprocessor and Microcontroller, Simplified CPU / Memory Organization, Addressing modes / Instruction Set Summary, I/O port, pin diagram and functions. Using Assembly Language with C/C++, I/O Programming, Arithmetic and Logical Operations, Program Looping and Subroutine, Serial Port Programming, Interrupts Programming, Data Acquisition Systems, ADC and performance Parameters. Interfacing Microprocessor/Microcontroller, Memory / Basic I/O interface, RAM / ROM interfacing, Keypad, Seven Segment / LED and LCD display, Serial and Parallel ADC, Sensor Interfacing, Relays and Opto-isolators interfacing, Stepper Motor Interfacing, DC motor interfacing and PWM.

BM-401 Medical Imaging

Demonstration of X-rays Equipment, Computed Tomography and Scanners, Attenuation Tomography, Time of Flight Tomography, Reflection Tomography, Diffraction Tomography, Formulation of Attenuation Computed Tomography, Fourier Slice theorem, Physical and physiological principle of MRI, Applications of MRI and fMRI. Generation and detection of ultrasound waves, Physical and physiological principles of Ultrasound, Resolution of Ultrasound imaging, Ultrasound Imaging Modalities, Doppler Ultrasound Imaging, Modes of ultrasound image representation, Ultrasound Image Artifacts. Physical and physiological principles of Positron Emission Tomography (PET), PET Signal Acquisition, PET Image formation, Significance of PET and Applications of PET.

BM-396 Final Year Project – I

BM-498 Final Year Project – II

BM-499 Final Year Project - III

Department of Mechanical & Aerospace Engineering

DMAE MISSION

“The department aspires to produce outstanding professionals with excellent knowledge of engineering discipline, professional integrity and ethical values. The graduates should be capable to compete in the contemporary industrial environment and must be intellectually strong enough to undertake assignment in the fields of higher studies, innovation and development.”

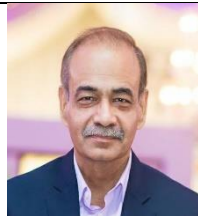
About DMAE

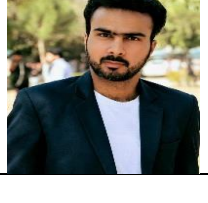
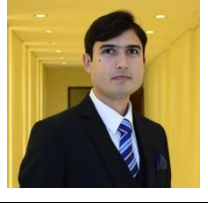
The Department of Mechanical and Aerospace Engineering of Air University is a renowned and well established institution having highly qualified faculty, mostly having doctorates from technically advanced countries of the world, an elegant and modern infrastructure, well-equipped laboratories, and allied academic facilities. The department offers state-of-the-art undergraduate and graduate education in two disciplines (Mechanical and Aerospace Engineering) to prepare engineers for effective contribution towards social and economic wellbeing of the nation and the society at large. The department offers degrees in Bachelors of Mechanical Engineering (BE), MS in Mechanical Engineering, MS in Aerospace Engineering, PhD in Mechanical Engineering, and PhD in Aerospace Engineering. The graduate program offers the ultimate challenge in original research to enable our scholars to address issues at the leading edge of technology. The department has a large number of highly qualified and competent faculty members to guide our MS and PhD scholars effectively to get meaningful thesis work completed successfully within the stipulated period of time. The MS Mechanical Engineering program offers specializations in two streams; Design Engineering and Fluid Power Engineering. The MS Aerospace Engineering program offers specializations in two streams; Solid Mechanics and Fluid Dynamics. The MS degree program requires successful completion of 24 credit hours of course work and 6 credit hours of research work. An MS thesis is aimed at producing work which can meet the criteria for publishing in international journals/conference proceedings. The BE Mechanical

Engineering program spreads over eight semesters (04 years) and requires successful completion of 132 credit hours, inclusive of courses, laboratory, and project work. The department is located in a purpose-built building of Institute of Avionics & Aeronautics (IAA) with ergonomically organized facilities at an environmentally attractive site.

Faculty Members

Department of Mechanical & Aerospace Engineering

1.	Dr. Jehanzeb Masud: Chair Department/DG IAA Education: PhD, Case Western Reserve University, USA Research Interest: Computational and Experimental Fluid Dynamics	
2.	Dr. M Afzaal Malik: Professor Education: PhD, Georgia Institute of Technology, USA Research Interest: Control Systems, Modeling & Simulation, Computational Engineering, Solid Mechanics	
3.	Dr Ibraheem Haneef: Associate Professor/ Director International Cooperation Office Education: PhD, Cambridge University, UK Research Interest: MEMS Sensors	
4.	Dr. Malik Nazir Ahmed: Faculty Member Education: PhD, Cranfield University, UK Research Interest: Solid Mechanics, Composite Structures, Finite Element Analysis, Structural analysis	
5.	Dr. Babar Saeed: Associate Professor Education: PhD, Beijing university of Aeronautics and Astronautics, Beijing, China Research Interest: Composite Materials, Solid Mechanics, Nano Materials, Material Testing and Characterization	
6.	Dr. Hamid Ullah Khan Niazi: Faculty Member Education: PhD, Beijing Institute of Technology, Beijing, China Research Interest: Manufacturing & Automation, Product Design and Development, CAD/CAM, CIM, Additive Manufacturing, Digital and Web based Manufacturing, Engineering/Project Management	
7.	Dr. Mehar Nigar: Assistant Professor Education: PhD, Case Western Reserve University, USA Research Interest: Materials Characterization, Fabrication & Testing of Composite Materials; Recycling of Plastics waste, & Conversion of Waste to Energy, Biofuels	

8.	Dr. Nadeem Shafi: Faculty Member Education: PhD in Mechanical Engineering from Arizona State University, USA Research Interest: Rotorcraft Structural Dynamics, Structural Fatigue.	
9.	Engr. Sijal Ahmed: Lecturer Education: PhD in Progress, Air University Research Interest: Turbo machinery, Large Eddy Simulation, Transition Mechanism, Stall and Surge in Compressors System of Gas Turbine Engines. External Aerodynamics	
10.	Engr. Sohail Iqbal: Lecturer Education: PhD in Progress, Air University Research Interest: Modeling and simulation, Mechanics (Mechanism Design and Analysis)	
11.	Engr. Zulkeefal Dar: Lecturer Education: MSc in Sustainable Energy, Imperial College London, UK Research Interest: Computational Fluid Dynamics, Renewable/Sustainable Energy, Wind/Tidal Turbines,	
12.	Engr. Hassan Ejaz: Lecturer Education: PhD in progress, NUST(SMME) MSc in Mechanical Engineering, NUST(SMME) Research Interest: Structural Optimization, Adhesive Joints, Finite Element Modeling	
13.	Engr. Wajaha Ullah Khant: Lecturer Education: MSc in Mechanical Engineering from Northumbria University, UK Research Interest: CFD, Internal Combustion Engine, Hybrid Technology and Renewable Energy (Biofuels and Biodiesel etc.)	
14.	Engr. Junaid Wazir: Lecturer Education: MS Mechanical Engineering, GIKI Research Interest: CFD	
15.	Engr. Muneeza Azmat: Lecturer Education: MS Computational Science Engineering & Mathematics, The University of Texas at Austin Research Interest: CFD	
16.	Engr. Tauha Irfan Khan: Lecturer Education: MSc in Aerospace Engineering, Air university Research Interest: Fluid Mechanics, CFD, Aero/Hydrodynamics, Bluff-Body Aerodynamics, Multiphase Flow Simulations, Wind/Water Turbines	

17.	Engr. Bilal Mufti: Lecturer Education: MSc in Aerospace Engineering, Air university Research Interest: Fluid Mechanics, CFD, Wind/Water Turbines, Aero/Hydrodynamics, Multiphase Flow Simulations.	
18.	Engr. Zakria Ghazanfar Toor: Lecturer (on study leave) Education: MSc in Aerospace Engineering, Air university Research Interest: Fluid Mechanics, CFD, Aero/Hydrodynamics, Multiphase Flow Simulations, Wind/Water Turbines, Shape Optimization and Cyro-coolers	
19.	Engr. Umar Khan: Lecturer (on study leave) Education: PhD in Progress MS in Mechanical from Air university Research Interest: Computational and Experimental Fluid Dynamics, Heat Transfer	
20.	Engr. Saba Arif: Lecturer (on leave) Education: MS in Renewable Energy Technology, (UET Taxila) Research Interest: Refrigeration and Air conditioning, Energy Conversions, Heat and Mass Transfer, Renewable Energy Technologies	
21.	Engr. Asad Islam: Lecturer (on leave) Education: MS Aerospace Engineering, IST Research Interest: Aerodynamics, CFD, Turbomachinery, Stall & Surge, Compressor Systems of Gas-Turbine Engines, Fluid-Structure Interactions (FSI)	
22.	Engr. Mian Farzan Ul Hassan: Lab Engineer/TA Education: MS Mechanical Engineering in Progress, Air University BE Mechanical Engineering, Air University	
23.	Engr. Bilal Zaman: Lab Engineer Education: MS Mechanical Engineering in Progress, Air University BE Mechanical Engineering, UET Peshawar	
24.	Engr. Zulekha Sohail: Lab Engineer Education: MS Project Management in Progress, Bahria University BE Mechanical Engineering, Air University	
25.	Engr. Iqra: Lab Engineer Education: MS Mechanical Engineering in Progress, Air University BE Mechanical Engineering, BZU	

26.	Engr. Tayyab Jalil: Lab Engineer Education: <i>MS Mechanical Engineering in Progress, NUST(SMME)</i> <i>BE Mechanical Engineering, Air University</i>	
27.	Engr. Muhammad Maaz Akhtar Chishti: Lab Engineer Education: <i>BE Mechanical Engineering, Air University</i>	
28.	Engr. Adeel Iqbal: Lab Engineer Education: <i>MS Mechanical Engineering in Progress, Air University</i> <i>BE Mechanical Engineering, Air University</i>	
29.	Engr. Malik Muhammad Owais: Lab Engineer Education: <i>MS Mechanical Engineering in Progress, Air University</i> <i>BE Mechanical Engineering, Air University</i>	

BE Mechanical Engineering

With a vision for excellence, the faculty at the Department of Mechanical and Aerospace Engineering within IAA is constantly striving for the best. Besides Masters and PhD programs in a wide range of research areas, the department has a vibrant Bachelors program in Mechanical Engineering. The four year BE Mechanical Engineering program is based on rigorous coursework and hands-on practical training that enables creation of the nation's best breed of Mechanical Engineers. During the freshman (first) year, the students are taught basic and supporting courses which pave the foundations of their engineering career. In the sophomore (second) year, introductory level engineering courses are conducted, which are eventually followed by advanced courses in the respective disciplines in the junior (third) and senior (fourth) years. This program prepares the students to work in the industry as knowledgeable professionals conversant with latest trends in technology. Thus, the program is designed to give flexibility to the students to specialize in major areas of Mechanical Engineering. Teaching is accomplished through lectures, problem-solving sessions, tutorials, laboratory work, simulations, design and project work. The final year project, under expert guidance of faculty members, enables the students to apply their knowledge to the problems of practical importance tuned to industrial applications for increasing the job worthiness of the prospective engineers. The BEME program has been accredited under OBE system by the Pakistan Engineering Council (PEC) via their Minutes of 83rd PEC EA&QEC/EAB meeting held on 16-17 Oct, 2017 at PEC HQ Islamabad.

Program Educational Objectives (PEOs)

The DMAE has formulated the following PEOs for its BE Mechanical Engineering Program:

1. Employable graduates with in depth knowledge and sound understanding of principles of Mechanical Engineering with a quest for lifelong learning
2. Graduates demonstrating the capacity to assume social, environmental and ethical responsibility in the national and global perspective.
3. Graduates with capability to be effective team members and take a leadership role in research, design, innovation, implementation and operation of Mechanical and related systems
4. Graduates who can communicate effectively with those inside and outside of Engineering Community and be able to exhibit social and professional responsibility in national and global context

Program Learning Outcomes (PLOS)

The graduate attributes defined in Pakistan Engineering Council (PEC) accreditation manual have been adopted as PLOs for the mechanical engineering program of DMAE, Air University. The following PLOs have been adopted by DMAE:

- 1. Engineering Knowledge:** An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex mechanical engineering problems.
- 2. Problem Analysis:** An ability to identify, formulate, research literature, and analyze complex mechanical engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- 3. Design/Development of Solutions:** An ability to design solutions for complex mechanical engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- 4. Investigation:** An ability to investigate complex mechanical engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.
- 5. Modern Tool Usage:** An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex mechanical engineering activities, with an understanding of the limitations.
- 6. The Engineer and Society:** An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex mechanical engineering problems.
- 7. Environment and Sustainability:** An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
- 8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
- 9. Individual and Team Work:** An ability to work effectively, as an individual or in a team, on multifaceted and/or multidisciplinary settings.
- 10. Communication:** An ability to communicate effectively, orally as well as in writing, on complex mechanical engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. Project Management: An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

12. Lifelong Learning: An ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

Relationship between PLOs and PEOs

Mapping Of PLOs with PEOs					
S. No	Program Learning Outcomes (PLOs)	PEO 1	PEO 2	PEO 3	PEO 4
1	Engineering Knowledge	✓			
2	Problem Analysis:	✓			
3	Design/Development of Solutions			✓	
4	Investigation:			✓	
5	Modern Tool Usage	✓			
6	The Engineer and Society				✓
7	Environment and Sustainability		✓		
8	Ethics		✓		
9	Individual and Team Work		✓		
10	Communication				✓
11	Project Management		✓		
12	Lifelong Learning	✓			

Program Details

BEME SEMESTER # 1

S1	Code	Subject	Pre-Requisite	Course Cr Hrs
1	CH 101	Applied Chemistry	-	2-0-2
2	ME 121	Engineering Statics	-	3-0-3
3	PH 101	Physics	-	2-1-3
4	MA 101	Calculus I	-	3-0-3
5	ME 100	Introduction to Mechanical Engineering	-	1-0-1
6	ME 140	Workshop Practice I	-	0-1-1
7	ME 142	Engineering Drawing and Graphics	-	1-1-2
8	HU 11x	English –I	-	3-0-3
		Total:		15-3-18
8		Commutative hrs		15-3-18

BEME SEMESTER # 2

S1	Code	Subject	Pre-Requisite	Course Credit Hours
1	CS 157	Computer Programming	-	2-1-3
2	MA 105	Multivariable Calculus	MA 101- Calculus I	3-0-3
3	ME 131	Thermodynamics I	-	3-0-3
4	ME 143	Workshop Practice II	-	0-1-1
5	ME 146	Engineering Drawing and Graphics/ AUTO CAD	ME 142 – Engineering Drawing and Graphics	0-1-1
6	ME 222	Engineering Dynamics	-	3-0-3
7	HU 118	Islamic Studies/ Ethics	-	2-0-2
8	HU11X	English –II *		3-0-3*
		Total:		13-3-16
16		Commutative hrs		28-6-34

BEME SEMESTER # 3

S3	Code	Subject	Pre-Requisite	Course Cr Hrs
1	EE 210	Basic Electrical & Electronics Engineering	-	2-1-3
2	MA106	Differential Equations	MA 101- Calculus I	3-0-3
3	ME 223	Mechanics of Materials I	ME 121- Engineering Statics	3-0-3
4	ME 233	Fluid Mechanics I	ME 131- Thermodynamics I	3-0-3
5	ME 234	Thermodynamics II	ME 131- Thermodynamics I	3-0-3
6	ML 222	Engineering Mechanics Lab		0-1-1
7.	ML 234	Thermodynamics Lab		0-1-1
		Total:		14-3-17
23		Commutative hrs		42-9-51

BEME SEMESTER # 4

S4	Code	Subject	Pre-Requisite	Course Credit Hours
1	ME 325	Mechanics of Machines	ME 222- Engineering Dynamics	3-0-3
2	MA 202	Numerical Analysis & Computation	MA 105- Multivariable Calculus	2-1-3
3	ME 224	Mechanics of Materials II	ME 223 – Mechanics of Material I	3-0-3
4	ME 235	Fluid Mechanics II	ME 233 - Fluid Mechanics I	3-0-3
5	ME 247	Manufacturing Process I	-	1-1-2
6	ML-236	Fluid Mechanics Lab		0-1-1
7	ML 224	Mechanics of Materials Lab		0-1-1
8	ME202	Health, Safety and Environment		1-0-1
		Total:		13-4-17
31		Commutative hrs		55-13-68

BEME SEMESTER # 5

S5	Code	Subject	Pre-Requisite	Course Cr Hrs
1	HU XXX	English III	-	3-0-3
2	MA 208	Engineering Probability and Statistics	MA 105- Multivariable Calculus	3-0-3
3	ME 327	Machine Design I		3-0-3
4	ME 311	Control Engineering		3-1-4
5	ME 344	Manufacturing Processes II	ME 247- Manufacturing Processes I	1-1-2
6	ME 312	Instrumentation and Measurement	-	2-0-2
7	ML 312	Instrumentation and Measurement Lab	-	0-1-1
		Total:		15-3-18
38		Commutative hrs		70-16-86

BEME SEMESTER # 6

S6	Code	Subject	Pre-Requisite	Course Credit Hours
1	ME 301	Engineering Materials	-	3-0-3
2	ME329	Mechanical Vibrations	ME222-Engineering Dynamics	3-0-3
3	ME 328	Machine Design II	ME 327- Machine design I	2-0-2
4	ME 336	Heat & Mass Transfer	ME 234 – Thermodynamics I	3-0-3
5	ME 348	Computer Aided Engineering/ FEM		1-2-3
6	ML336	Heat and Mass Transfer Lab		0-1-1
7	ML329	Mechanical Vibrations Lab		0-1-1
8	ME492	Final Year Project I		0-1-1
		Total:		12-5-17
46		Commutative hrs		82-21-103

BEME SEMESTER # 7

S7	Code	Subject	Pre-Requisite	Course Cr Hrs
1	ME451	Engineering Management and Economics	-	2-0-2
2	ME436	Refrigeration and Air Conditioning	ME234-Thermodynamics II	3-0-3
3	ME 460	IC Engines and Propulsion	-	3-0-3
4	ME 481*	Special Topics/ Advancements in Mechanical Engineering (Optional)	-	1-0-1*
5	ME462	Power Plant Engineering		3-0-3
6	HU115	Pakistan Studies	-	2-0-2
7	ME493	Final Year Project II		0-2-2
8	ML460	IC and Power Plant Lab	-	0-1-1
9*	ME xxx*	Technical Elective I*		2-0-2 / 3-0-3*
		Total:		13-3-16
54		Commutative hrs		95-24-119

BEME SEMESTER # 8

S8	Code	Subject	Pre-Requisite	Course Credit Hours
1	EE 300	Electrical Machines	EE-210 Basic Electrical Engineering	2-1-3
2	ME 494	Final Year Project III	-	0-3-3
3	ME45x	Management Elective	-	2-0-2
4	HU3xx	Social Science Elective	-	2-0-2
5	ME446	Entrepreneurship	-	1-0-1
6*	ME xxx*	Technical Elective II*	-	2-0-2 / 3-0-3*
7	ME xxx*	Technical Elective III*	-	2-0-2 / 3-0-3*
	ME 441	Foreign Language	Non Credit But Compulsory	0-0-0
				7-4-11
60		Commutative hrs		102-28-130

Total Courses: 60

Total Cr Hrs.: 130

Course Code Legends

CH = Chemistry

CS = Computer Science

EE = Electrical Engineering

HU = Humanities/Social Sciences

MA = Mathematics

ME = Mechanical Engineering

ML = Mechanical Engineering Laboratories

PH = Physics

Mechanical Course Codes

X0X = Materials

X1X = Instrumentation and Control

X2X = Structural Mechanics/Design

X3X = Thermofluids

X4X = Manufacturing

X5X = Engineering Management

X9X = Final Year Projects

Technical Elective Courses

Course Code	Course Title	Credit Hrs (Theory – Lab – Credits)
ME 426	Machine Design II	3-0-3
ME 428	Finite Element Methods (FEM)	3-0-3
ME 429	Experimental Stress Analysis	3-0-3
ME 438	Computational Fluid Dynamics (CFD)	3-0-3
ME 448	Fundamentals of Automated Manufacturing	3-0-3
ME 449	Automation and Robotics	3-0-3
ME 461	I.C. Engines	3-0-3
ME 462	Power Plant Engineering	3-0-3
ME 463	Energy Resources and Utilization	3-0-3
ME 464	Heating Ventilation & Air conditioning (HVAC)	3-0-3
ME 465	Aerodynamics	3-0-3
ME 466	Tribology	3-0-3

ME 467	Nuclear Engineering	3-0-3
ME 468	Gas Dynamics	3-0-3
ME 482	Introduction to Mechatronics	3-0-3
ME 483	Maintenance Engineering	3-0-3
ME 484	Mechanical Engineering Design Analysis	3-0-3
ME 485	Reliability in Engineering	3-0-3

Management Elective Courses

Course Code	Course Title	Credit Hrs (Theory – Lab – Credits)
ME 452	Total Quality Management	2-0-2
ME 453	Operations Research	2-0-2
ME 454	Health Safety and Environment (HSE)	2-0-2
ME 455	Engineering Law	2-0-2
ME 456	Project Management	2-0-2
ME 457	Business and Entrepreneurship	2-0-2
ME 458	Maintenance Management	2-0-2
ME 459	Techniques of Safety Management	2-0-2

COURSE DESCRIPTIONS

CH 101 - Applied Chemistry (2-0-2)

The emphasis in this course is on basic principles of atomic and molecular electronic structure, periodic trends and chemical thermodynamics. During the course, relevant examples are also introduced in order to develop a better understanding of the practical application of these concepts.

ME 100 - Introduction to Mechanical Engineering (1-0-1)

This course introduces students to the field of mechanical engineering, review of some basic principles from mathematics, and physics applicable in the Mechanical Engineering domain. Ethical considerations and technical communication skills necessary for engineering work; computational and experimental tools necessary for engineers. Application of the concepts learned throughout the course to a small design project that employs mechanical engineering principles.

ME 101 - Engineering Materials (3-0-3)

The course contents of this module include chemical bonding, crystal structures and imperfections and the way they dictate material properties, phase diagrams and their analyses, a review of Ferrous and non-Ferrous alloys and their properties, an introduction to structure and properties of polymeric & composite materials and degradation of materials.

ME 121 - Engineering Statics (3-0-3)

Engineering statics comprises of the following topics;

Force systems: Force, Rectangular components (2D & 3D), Moment and couple (2D & 3D), Resultants (2D & 3D). Equilibrium: Mechanical system isolation and free body diagrams (2D & 3D), Equilibrium conditions. Structures: Plane trusses, Method of joints, Method of sections, Frames. Friction: Types of friction, Dry Friction, Applications of friction.

ME 131 - Thermodynamics I (3-0-3)

Thermodynamics and systems, Energy and 1st law of thermodynamics, Energy balance and analysis, Closed systems and cycles, Evaluating properties, Control volume analysis, Conservation of mass & energy for a control volume (CV), Second law of thermodynamics, Entropy balance for control volume and closed systems.

ME 140 - Workshop Practice I (0-1-1)

Introduction to workshop technology: Safety concept and practices. Engineering materials: Ferrous and non-ferrous alloys. Types of woods, Processing and preservation, Characteristics of a good timber, Plywood and its application, Common tools Types of wood joints. Welding, Soldering and brazing. Sheet metal working: Sheet metal operations. Pattern development. Electrical wiring, Safety practices, Types and uses of cables, Electrical codes, Electric circuits.

ME 142 - Engineering Drawing and Graphics

Line types of s, Lettering, Dimensioning, Use of drawing tools, sheet planning, Orthographic projection (1st angle and 3rd angle) of points, straight lines, oblique, and auxiliary planes. Solids in simple and inclined positions. Traces of lines, section. Loci of points and generation of different types of curves, development of types of solids.

ME 143 - Workshop Practice II (0-1-1)

Machining. Cutting tools. Measurement instruments. Lathe and Milling operations. Drilling and boring. Gas welding. Production of small machine components. Casting and forging. Assembly/disassembly of basic mechanical components.

ME 145 - Engineering Drawing and Graphics/AutoCAD (1-1-2)

Introduction to Computer Aided Drafting. Introduction to software Auto-CAD 2010. Graphical user interface, Drawing and Modifying commands. Developing a sketch in Auto-CAD. Drawing orthographic projections, Dimensioning, Using drawing templates. Introduction to isometric drawings. Introduction and Demonstration of 3-D modeling in different software's.

ME 211 - Control Engineering (2-1-3)

System mathematical modeling and graphical representation in both time and frequency domain for translational, rotational, hydraulic, pneumatic and electrical systems, stability analysis, transient and steady-state analysis, root locus method and root locus based control system design.

ME 222 - Engineering Dynamics (3-0-3)

Kinematics of particles: rectilinear and plane curvilinear motion of particles in rectangular, normal and tangential and polar coordinates, space curvilinear motion. Kinetics of particles: force, mass, acceleration and equation of motion, for rectilinear and curvilinear motion, Work and kinetic energy, impulse momentum relations, conservation of energy and momentum. Plane kinematics of rigid bodies: rotation and absolute motion, relative velocity and acceleration. Plane kinetics of rigid bodies: equations of motion, fixed axes rotation and general plane motions, with application, work and energy relations, impulse-momentum relations.

ME 223 - Mechanics of Materials I (3-0-3)

Stress and strain-Axial loading: Normal & Shearing stress, Stress on oblique plane. Stress-strain diagram, Hooke's law, Modulus of elasticity, Elastic/ plastic behavior, Deformation of members, SI problems & Problems with temp changes, Poisson's ratio, Shearing strain. Torsion: Stresses in a shaft, Deformations in a circular shaft, Stresses and angle of twist in elastic range, shafts. Pure bending: Stresses and deformations. Beams: Shear and BM diagrams, Relations b/w load, shear and BM, Design of beams for bending, Shear stresses in beams & Thin Wall Section.

ME 224 - Mechanics of Materials II (3-0-3)

Transformation of stress and strain: Principal stresses, Max shear stress, Mohr circle 3D state of stress, Criterion for ductile & brittle materials, stresses in TW pressure vessels, transformation of plane strain. Principal stresses: Principal stresses in a beam, Design of transmission shafts, Stresses under CL. Beam deflections: Deformation of beam under Transverse load, Equation of elastic curve, SI beams, Method of superposition, BM diagrams. Columns: Stability of structures, Energy methods: Strain energy, Impact loading.

ME 233 - Fluid Mechanics I (3-0-3)

The course covers evaluation & analysis of Basic properties of fluid (Gas and Liquid) at Rest and in Motion. Hydro static fluid analysis covers Fluid properties, Viscosity and compressibility, Vapor pressure, pressure fields, standard atmosphere, hydrostatic forces, buoyancy, floatation and stability. Fluids in dynamics analysis covers the Bernoulli equation, the velocity fields, control volume and system representation. The analysis techniques cover the Control Volumes and Differential methods techniques.

ME 234 - Thermodynamics II (3-0-3)

Vapor Power Systems: Modeling and analysis, Rankin cycle, Reheat and superheat Regenerative and other Vapor cycles. Gas power systems: Internal combustion engines, Gas turbine power plants. Refrigeration and heat pump systems: Vapor and absorption refrigeration, Heat pump systems, Gas refrigeration systems. Thermodynamic relations: Equation of state and property relations, Entropy and enthalpy changes, P-v-T relation of gas mixture. Ideal gas mixture and psychometric applications.

ME 235 - Fluid Mechanics II (3-0-3)

The course deals with the behavior of fluid when subjected to practical common models. It is designed to attain knowledge of fluid (liquid and gases) behavior in pipe/ducts, flow over bodies, open channel flows and compressible flows. The knowledge gained is also applied to compression, expansion and power devices.

ME 245 - Manufacturing Processes I (3-0-3)

Introduction to manufacturing engineering, engineering properties of materials, Casting: processes and equipment, Bulk forming processes, Sheet metal forming, Joining and Assembly Processes, Powder metallurgy, Forming and shaping of plastics and composite materials.

ME 312 - Instrumentation and Measurement (2-0-2)

Significance of measurements, design of experiments, measurement systems, calibration, static and dynamic measurements, sensitivity, range, precision, repeatability, uncertainty and errors in the measurement of length, force, torque, frequency, pressure, flow and temperature, analogue and digital conversion

ME 325 - Mechanics of Machines (3-03)

Friction: bearings, screw threads, clutches, belts, brakes, rope drives; Chain and sprockets; Governors: effort, power, sensitivity, stability; Gyroscopic couple; Gears: simple and compound, gear-trains, epi-cyclic trains; Dynamometers; Linkage analysis; Balancing of rotating masses.

ME 327 - Machine Design I (3-0-3)

Design philosophy: static, dynamic, fatigue loading; Concept of: load, stress, deflection, stiffness; Design of non-permanent joints: screws, fasteners; Design of permanent joints: welding, bonding; Design of: springs, bearings, gears; Fatigue failure; Flexible machine elements; Design standards.

ME 328 - Machine Design II (2-0-2)

Kinematics, force analysis and design of spur, helical, bevel and worm gears; Design of rolling contact bearings, journal bearings, springs, belts, ropes, chains, shafts; Hydrodynamic theory of lubrication; Introduction to: experimental stress analysis, FEA, CAD (3D modeling, 2D drawing).

ME 329 - Mechanical Vibrations (3-0-3)

Motion: oscillatory, periodic, harmonic; Natural frequency by Rayleigh method, SDOF system solution through Newton and energy methods; Un-damped, damped, free and forced systems; Two DOF systems: modes, coordinate coupling, vibration isolation and absorption, orthogonality; Critical speeds.

ME 336 - Heat and Mass Transfer (3-0-3)

This is an elementary course introducing various mechanisms and modes of energy transfer (Heat and Mass) , supplement the Laws of Thermodynamics by providing additional rules

governing energy transfer rates and modes: Conduction, Convection and Radiation. The knowledge gained in this course is widely used in analysis as well as designing products in various engineering disciplines, including Mechanical, Mechatronics, Electric, Electronics and Aerospace etc.

Conduction: Heat equation, Fourier's Law, Steady / transient / multidimensional conduction, Boundary conditions, One-dimensional steady heat conduction in plane and composite walls, cylinders and spheres with and without heat generation, Critical thickness of insulation, Heat transfer through extended surfaces, etc. **Convection:** Newton's law of cooling, Boundary layers, Effects of flows on convection, Convection for flow over flat plates and through pipes and ducts, Fluid friction and heat transfer, Free and forced convections with its coefficients etc. **Radiation:** Stefan's Boltzman Law, Blackbody radiation, Radiation shape factor & its application, Kirchoff's Law, Radiation shields etc. **Heat exchangers:** Classification, Heat exchanger effectiveness – LMTD & NTU methods, Design considerations etc. **Mass Transfer:** Fick's law and its application, Mass transfer Coefficient, Water vapor migration in buildings, analogy between momentum heat and mass transfer etc.

ME 346 - Manufacturing Processes II (2-1-3)

Conventional machining processes, Machining processes for producing various shapes, Abrasive machining and finishing operations, on-conventional machining, Control of machine tools, Jigs and fixtures, Computer integrated manufacturing systems, Metrology and precision measurements, Process planning.

ME 348 - Computer Aided Engineering (CAE) (1-2-3)

Fundamentals of Finite Element Method, Computational Fluid Dynamics, Solid Modeling and Multi-body Dynamics, Implementation of engineering design concepts using codes and industry standard software packages.

ME 437 - Refrigeration and Air Conditioning (2-0-2)

The course aims at providing essential knowledge on various refrigeration cycles, system components, refrigerants and air conditioning systems, including basic analysis of common cycles including Vapor compression cycle, air cycle refrigeration and vapor absorption systems. The basic design aspects of Refrigeration & Air Conditioning Systems including HVAC essentials are also covered

ME 451 - Engineering Management and Economics (3-0-3)

This course aims to focus on important concepts in relations to both engineering management and economics. Engineering management module comprises: Plant management, Management systems, Productivity, Role of work study and other plant management parameters. Inventory management and PERT-CPM. Engineering economics module comprises of: Types of costs, Equivalence, Types of investments, Depreciation accounting, Inflation and economic considerations, Project management.

ME 492 - Final Year Project I (0-1-1)

Final Year Project I require Independent, or group work, as prescribed by supervisor and projects committee of concerned department.

ME 493 - Final Year Project II (0-2-2)

Final Year Project II requires Independent, or group work, as prescribed by supervisor and projects committee of concerned department

ME 494 - Final Year Project III (0-3-3)

Final Year Project I require Independent, or group work, as prescribed by supervisor and projects committee of concerned department

ML XXX - Mechanical Engineering Labs

Mechanical Engineering lab consists of practical and experimental work relating to following subjects: Statics, Dynamics, Thermodynamics, Fluid Mechanics, Mechanics of Materials,

Manufacturing Process, Mechanics of Machines, Heat and Mass Transfer, Stress Analysis and Mechanical Vibrations

Course Description for Technical Electives

ME 426 - Machine Design II (3-0-3)

This course includes Techniques of mechanical design, Describing mechanical design problems and process, the human element in design, finite element method of stress analysis, application of method to plane strain and axisymmetric problems, techniques for non-linear analysis, study of loads, “ life, reliability and reliability relationship” for various mechanical components. Techniques of the mechanical design process, computer aided design methods, and design for mass production and batch production.

ME 428 - Finite Element Methods (FEM) (3-0-3)

Introduction to FEM. Stress analysis by FEM, Energy, Variation principles and Ritz's methods, Coordinate Transformation. Isoperimetric formulation. Solution of Eigen value, Boundary value and Initial value problems.

ME 429 - Experimental Stress Analysis (3-0-3)

Stress strain transformation, Strain measurement methods, Grids, Electrical resistance gauges: Rosettes and their principle of operation, Strain gauge bridges for measurements of forces, moments and structural members. Instrumentation for stress analysis work. Photo elasticity methods stress optics, Fringe patterns in polar scope. Calibration and compensation techniques for stress measurements on optical models, Brittle coating technique, Birefringent Coatings.

ME 438 - Computational Fluid Dynamics (CFD) (3-0-3)

Types of ordinary and partial differential equations, Solution of equation sets, Boundary value and initial value problems, Control volume approach, Time stepping, Accuracy, Stability, Consistency, Linearization, Diffusion, Dispersion, Vorticity stream function and primitive variable formulations. Turbulence modeling. Examples of external flow across various configurations, Internal flows through pipes, ducts and valves.

ME 448 - Fundamentals of Automated Manufacturing (3-0-3)

Introduction to manufacturing automation, numerically controlled machines, Integration of NC and robotics. Machine tool controls, CNC, Programming for CNC Lathe, CAM.

ME 449 - Automation and Robotics (3-0-3)

Robotics: Basic concepts, Classification, Drive and control system, Coordinate transformation, Kinematics dynamic, interpolation, interfacing, Applications. Automated Guided Vehicles. motion, programming, PLCs, Ladder diagram, Relay sequencing, Processor modules. Microcontroller. Basic elements of micro controller: Types, Micro processor and PLC, Assembly, machine and high level programming languages for microcontroller. Actuators, Sensor, Input signals, Output signals, Signal conditioning. Automations: Introduction to automations: Automation strategies, Economics of automations, Partial automations, Group technology and flexible manufacturing. Use of sensors and actuators in automations.

ME 461 - I.C. Engines (3-0-3)

Basic: Engine classifications, Engine components, Basic terminology, Working principles of SI and CI engines etc. Testing and performance: Design, performance and testing parameters, knocking characteristics, engines emissions and their control etc. Thermo-Chemistry: Characterization of flames, Composition of air and fuels, Alternative fuels, Combustion stoichiometry, Enthalpies of combustion, Self-ignition and Octane Number, Unburned / burned mixture composition, Thermodynamics charts etc. Air Standard Cycles and Their Analysis: Otto, Diesel, Dual, and Brayton cycles etc. Combustion: Combustion phases in SI and CI engines, ignition advance and retard, Combustion chamber design etc. Carburetion: Factors

affecting carburetion, Mixture requirements, Simple carburetor, Calculation of the air-fuel ratio etc.

ME 462 - Power Plant Engineering (3-0-3)

Economics of Power Generation: load curve, Incremental heat rate, Economic scheduling principle etc. Thermodynamics Review & Rankine Cycle: Ideal and externally / internally irreversible Rankine cycle, Superheat, Regeneration, Supercritical-pressure cycle etc. Fossil-Fuel Steam Generators: Classification, Water-Tube boiler, Water circulation, Super-heaters, Fans, Stack etc. Fuels and Combustion: Coal analysis, Coal firing, Fluidized bed combustion etc. Condensate-Feed water System: Direct-contact / Surface condensers, Desorption, Heat transfer surface area, Circulating water flow and pressure drop etc. Gas-Turbine and Combined Cycles: Turbine losses, Gas-turbine cycles, Ideal / non-ideal Brayton cycle and modifications, Combined

ME 463 - Energy Resources and Utilization (3-0-3)

Introduction to types of renewable energy: Solar energy, Wind energy, geothermal energy, Ocean thermal energy, Tidal wave and geothermal energy, Biomass energy. Fuel cell and heat pump systems, energy efficiency issues and energy storage. Potential of using renewable Energy resources as supplement of conventional energy resources. Renewable and nonrenewable energies used as hybrid energy systems, Modern renewable energy plants. Wind energy, Wind turbine design specifications, Compatible electric generators and major operational issues of the wind mill for electric power generation. Wind mills design usage for pumping water. Biomass energy conversion methods, detailed description of biomass energy conversion plant, Operational and maintenance problems and their remedies.

ME 464 - Heating Ventilation & Air Conditioning (HVAC) (3-0-3)

Refrigeration cycles: Vapor compression cycle, Pressure- enthalpy chart, Types of refrigerants, Air cycle refrigeration and vapor absorption system. Air conditioning: Indoor and outdoor air conditions, Comfort conditions and comfort zone, Indoor air quality. Psychometric, Central air-conditioning system, Essential components of central air-conditioning plant, Water chiller and water heater, Air handling unit, Chilled water and hot water recirculation system, CFM rating and tons of air-conditioning of a central air-conditioning plant. Cooling load and heating load calculation procedures, Duct sizing and piping design, Pumps and fans selection. Air ventilation: Calculation of fresh air supply of a multi story building, Air handling unit for untreated fresh air, Dust and bacteria removal systems, Forced convection based air ventilator design.

ME 465 - Aerodynamics (3-0-3)

Introduction, Aerodynamics of incompressible flow, Ideal potential flows, Aerofoil theory, 3D lifting surfaces, Lift and Drag estimation, Effect of geometric features of wing. Introduction to high speed aerodynamics. Introduction to dynamics of flight including stability and control.

ME 466 - Tribology (3-0-3)

Friction, Wear mechanism, Wear debris classification, Surface roughness, Friction and wear measurement techniques, Lubrication of sliding and rolling parts. Types of lubricants, Grades and their properties, Theories of lubrication, Oil whirl, Hydrodynamic and elasto-hydrodynamics lubrication of journal bearing, Solid lubricants, Self lubricating fuel. Tribology in manufacturing. Tribology in automobiles.

ME 467 - Nuclear Engineering (3-0-3)

Review of nuclear physics, Reactor physics, and Reactor heat transport. Types of enrichment and reprocessing; Handling of fuels .Safety aspects.

ME 468 - Gas Dynamics (3-0-3)

Basic governing laws of conservation of mass, Momentum and energy, Limitations. Sub-sonic and supersonic gas flow. Mach number and Mach angle. Isentropic Flow and Applications; Operation of nozzles under varying pressure ratios. Normal and oblique shocks, Prandtl- Meyer

compression and expansion with applications. Rayleigh flow and Fanno flow, Busemann's shock polar diagram.

ME 482 - Introduction to Mechatronics (3-0-3)

Introduction to Mechatronics. Sensors and transducers: Transducer characteristics, Sensors for measuring displacement, Strain, Force, Pressure, Temperature and Motion. Encoders. Motors and their types. Stepper motors. Permanent magnetic motors. Servo Systems. Interfacing. Ports, Input/output, Analog to Digital converter, Sampling theory, Digital to Analog converter. Sample and hold, Multiplexer. Interfacing switches, LEDs, Stepper motors and DC motors to micro-controllers.

ME 483 - Maintenance Engineering (3-0-3)

Introduction and types of maintenance: Preventive maintenance, Its objectives, Benefits and economics, Inspection and implementation. Routine maintenance and monitoring of fault indicators, Main concepts and implementation. Proper assembly/ disassembly, Alignment aspects, Machine handling. Record keeping and maintenance scheduling, Stocking spares and cost effectiveness, Safety in maintenance. Introduction to 1st, 2nd and depot level maintenance.

ME 484 - Mechanical Engineering Design Analysis (3-0-3)

Philosophy and concept of engineering design. Engineering creativity, Phases and procedure in design. Management of engineering project. Computer aided design. Modeling and simulation, Optimization and reliability. Application of industrial design codes. Design for service, Manufacturing, cost. Philosophy of design software and analysis.

ME 485 - Reliability in Engineering (3-0-3)

Quality control and reliability, Reliability prediction and calculations, Reliability enhancing techniques. Hazard function. Poisson process. Weibull distribution. Series and parallel systems, Non series-parallel systems, Time- dependent systems, Life-testing, Sequential probability ratio test.

MS Mechanical Engineering

The Master of Science in Mechanical Engineering is offered by the Department of Mechanical and Aerospace Engineering (DMAE). This program develops competence and offers specialization in the fields of Design Engineering and Fluid Power Engineering. The minimum time required for the degree completion is 4 semesters (02 Years). The award of MS degree requires successful completion of 24 credit hours of graded post- graduate level courses including at least one Mathematics course and successful defense of 6 credits hours of thesis research. The specialty wise requirements for the MS degree are as follows.

Program Details

Degree	MS. Mechanical Engineering (Specialization: Design Engineering)	MS. Mechanical Engineering (Specialization: Fluid Power Engineering)
Core Courses	6 courses (total 18 Credit Hrs.)	6 courses (total 18 Credit Hrs.)
Elective Courses	2 courses (total 6 Credit Hrs.)	2 courses (total 06 Credit Hrs.)
Research Work	MS Thesis (06 Credit Hrs.)	MS Thesis (06 Credit Hrs.)
Total Credit Hrs.	30	30

Core Courses for MSME

At least six core courses approved by the department from the following list need to be taken, including MA 644 as the mandatory requirement, for the degree program

Course Code	Course Title	Credit Hours
MA-644	Advanced Engineering Mathematics	3-0-3

MA-645	Advanced Numerical Techniques	3-0-3
ME-732	Theory of Elasticity	3-0-3
AE -645	Advanced Materials in Engineering	3-0-3
ME-765	Product and Process Design	3-0-3
ME-602	Finite Element Methods	3-0-3
AE-723	Advanced Mechanics of Composites	3-0-3
ME-742	Advanced Theory of Vibrations	3-0-3
ME-739	Elastic Stability of Structures	3-0-3
ME-733	Theory of Plasticity	3-0-3
AE-721	Mechanics of Composites	3-0-3
AE-724	Theory of Plates and Shells	3-0-3
AE-610	Advanced Incompressible Fluid Dynamics	3-0-3
ME-712	Computational Heat Transfer	3-0-3
AE-611	Advanced Compressible Fluid Dynamics	3-0-3
ME-601	Computational Fluid Dynamics I	3-0-3
ME-711	Computational Fluid Dynamics – II	3-0-3
AE-711	Computational Gas Dynamics	3-0-3
AE-716	Waves and Compressible Flow	3-0-3
ME-773	Turbo Machinery	3-0-3
ME-713	Engineering Tribology	3-0-3
ME -761	Advanced CAD/ CAM	3-0-3
ME-731	Advanced Mechanics of Materials	3-0-3
ME -762	Computer Integrated Manufacturing	3-0-3
ME-758	Control Systems for Mechanical Applications	3-0-3
AE- 753	Advanced Heat Transfer	3-0-3
ME-738	Advanced Manufacturing	3-0-3
ME-740	Structural dynamics	3-0-3
ME-XXX(s)	Other courses including those in HEC approved curriculum list, and offered by faculty as and when required	3-0-3

Elective Courses

Maximum of two elective courses can be taken from the list given below. However, any of the core courses can be taken as an elective course. Selection of these electives will be done with the consent of Chair Department / Advisor.

Course Code	Course Title	Credit Hours
MA 630	Partial Differential Equations I	3-0-3
ME-714	Combustion	3-0-3
ME-715	Flow Induced Vibrations	3-0-3
ME-721	Modeling and Simulation of Dynamic Systems	3-0-3
ME-722	Modeling and Simulation with Bond Graph-1	3-0-3
ME-723	Modeling and Simulation with Bond Graph-2	3-0-3
ME-724	Mechatronics System Design	3-0-3
ME-734	Computational Fatigue Mechanics	3-0-3
ME-735	Computational Fracture Mechanics	3-0-3
ME-736	Computational Thermo Mechanics	3-0-3
ME-737	Computational Weld Mechanics	3-0-3
ME-751	Linear Control Theory	3-0-3

ME-752	Digital Control Systems	3-0-3
ME-753	Adaptive Controls	3-0-3
ME-754	Robust Controls	3-0-3
ME-755	Non-Linear Controls	3-0-3
ME-756	Fuzzy Logic and Controls	3-0-3
ME-757	Advanced Process Control	3-0-3
ME-763	MEMS Devices and Applications	3-0-3
ME-781	MEMS Sensors and Actuators	3-0-3
ME-782	Mechanics of MEMS	3-0-3
ME-XXX(s)	Other courses including those in HEC approved curriculum list, and offered by faculty as and when required	

PhD in Mechanical Engineering

PhD in Mechanical Engineering is a 48 credit hour program beyond Masters, which includes a PhD dissertation equivalent to 30 credit hours and 18 credit hours of course work in the student's chosen area of specialization. These courses can be of any combination of the advanced level courses that are outlined in the MS course list. The requirement for obtaining a PhD degree includes:

- Maintaining a CGPA of at least 3.5/4.0 in the course work as per university policy
- Passing of a PhD qualifying exam.
- Acceptance for publication of at least one paper in a peer reviewed journal listed in the ISI citation index.
- Two positive reports about the student's research work from international scholars in the field from technologically advanced countries.
- Successful oral defense of the PhD thesis.

Currently, the following specializations can be pursued in the course of the doctorate degree.

- Structural Analysis
- Structural Dynamics
- Mechanics of Composite materials and failure trends
- Multidisciplinary Design and Optimization
- Micro Electro Mechanical Systems
- Turbulence Modeling
- Flow induced Acoustics
- Computational Fluid Dynamics
- Fluid Structure Interaction
- Turbo-machinery
- Two-Phase Flows
- Fluid dynamics and Heat Transfer in Material Processing

The PhD degree is expected to be completed in four years. The maximum and minimum time allowed for completion of the PhD program is six and three years, respectively.

MS Aerospace Engineering

The Master of Science in Aerospace Engineering is offered by the Department of Mechanical and Aerospace Engineering (DMAE). This program develops competence and offers specialty in the fields of Solid Mechanics and Fluid Dynamics. The minimum time required for the degree completion is 4 semesters (2 Years). The award of MS degree requires successful completion of 24 credit hours of graded post-graduate level courses including at least one Mathematics course and successful defense of 6 credits hours of thesis research. The specialty wise requirements for the MS degree are as follows:

Program Details

Degree	MS. Aerospace Engineering (Specialization: Solid Mechanics)	MS. Aerospace Engineering (Specialization: Fluid Dynamics)
Core Courses	4 courses (total 12 Credit Hrs.)	4 courses (total 12 Credit Hrs.)
Elective Courses	4 courses (total 12 Credit Hrs.)	4 courses (total 12 Credit Hrs.)
Research Work	MS Thesis (6 Credit Hrs.)	MS Thesis (6 Credit Hrs.)
Total Credit Hrs.	30	30

MS Aerospace Engineering (Solid Mechanics)

Core Courses

At least four of the following core courses need to be taken, including MA 644 as mandatory requirement, for the degree program.

Elective
At least
elective
need to
with any

Course No.	Course Title	Credit Hrs.
MA644	Advanced Engineering Mathematics	3-0-3
AE 601	Theory of Elasticity	3-0-3
AE 721	Advanced Theory of Vibrations	3-0-3
AE 723	Advanced Mechanics of Composites	3-0-3
AE 640	Finite Element Methods	3-0-3

Courses
four
courses
be chosen

combination of the following listed courses and the core/elective courses of Fluid Dynamics. Selection of these electives will be done with the consent of Chair Department / Advisor.

Course No.	Course Title	Credit Hrs.
MA 645	Advanced Numerical Techniques	3-0-3
AE705	Advanced Aircraft Structural Analysis	3-0-3
AE607	Fundamental of Adhesives, sealants, and coatings	3-0-3
AE638	Polymer Engineering	3-0-3
AE618	Product and Process Design	3-0-3
AE641	Behavior of Materials under Impact Loading	3-0-3
AE724	Theory of Plates and Shells	3-0-3
AE644	Thin Walled Structures	3-0-3
AE645	Advanced Materials in Engineering	3-0-3
AE728	Aero-Elasticity	3-0-3
AE747	Theory of Plasticity	3-0-3
AE748	Fracture Mechanics	3-0-3
AE760	Surface Engineering	3-0-3

AE661	Degradation of Materials	3-0-3
AE725	Mechanical Behavior of Engineering Materials	3-0-3
AE726	Failure Mechanisms in Engineering Materials	3-0-3
AE 606	Impact Engineering	3-0-3
AE 740	Finite Element Methods -II	3-0-3
AE 726	Failure Mechanism in Engineering Materials	3-0-3
AE 811	Experimental Techniques in Solid Mechanics	3-0-3
AE 703	Advanced Strength of Materials	3-0-3
AE 615	Aircraft Engine Design	3-0-3
AE 720	Advanced Stress Analysis	3-0-3

MS Aerospace Engineering (Fluid Dynamics)

Core Courses

At least four of the following core courses need to be taken, including MA 630 as the mandatory requirement, for the degree program.

Course No.	Course Title	Credit Hrs.
MA630	Partial Differential Equations I	3-0-3
MA644	Advanced Engineering Mathematics	3-0-3
AE 610	Advanced Incompressible Fluid Dynamics	3-0-3
AE 611	Advanced Compressible Fluid Dynamics	3-0-3
AE 630	Computational Fluid Dynamics I	3-0-3
AE 753	Advanced Heat Transfer	3-0-3

Elective Courses

At least four elective courses need to be chosen with any combination of the following listed courses and the core/elective courses of Solid Mechanics. Selection of these electives will be done with the consent of Chair Department / Advisor.

Course No.	Course Title	Credit Hrs.
MA 645	Advanced Numerical Techniques	3-0-3
AE 712	Gas Turbine Theory and Performance	3-0-3
AE 613	Mechanics and Thermodynamics of A/C Propulsion	3-0-3
AE 614	Combustion Phenomena	3-0-3
AE 615	Aircraft Engine Design	3-0-3
AE 616	Advanced Thermodynamics	3-0-3
AE 629	Flight Dynamics & Control	3-0-3
AE 618	Product and Process Design	3-0-3
AE 645	Advanced Materials in Engineering	3-0-3
AE731	Gas Turbine Combustion	3-0-3
AE 732	Propulsion System Performance & Integration	3-0-3
AE 718	Potential Flow and Panel Method	3-0-3
AE 634	Applied Computational Fluid Dynamics	3-0-3
AE 735	Advanced Aerospace Propulsion	3-0-3

AE 650	Turbo Machinery	3-0-3
AE 710	Experimental Techniques in Fluids and Thermal Sciences	2-1-3
AE 730	Computational Fluid Dynamics II	3-0-3
AE 736	Hypersonic/High Temperature Gas Dynamics	3-0-3
AE 754	Conduction Heat Transfer	3-0-3
AE 755	Convective Heat Transfer	3-0-3
AE 756	Radiation Heat Transfer	3-0-3
AE 857	Hydrodynamic Stability	3-0-3
AE 858	Rarefied Gas Dynamics/Kinetic Theory	3-0-3
AE 859	Turbulent Fluid Flow	3-0-3
AE 732	Propulsion System Performance and Integration	3-0-3
AE 637	Rheology	3-0-3
AE 613	Mechanics and thermodynamics of Aerospace Propulsion	3-0-3
AE 731	Gas Turbine Combustion	3-0-3
AE 612	Gas Turbine Theory and Performance	3-0-3
AE 860	Computational Fluid Turbulence	3-0-3

PhD in Aerospace Engineering

PhD in Aerospace Engineering is a 48 credit hour program beyond Masters, which includes a PhD dissertation equivalent to 30 credit hours and 18 credit hours of course work in the student's chosen area of specialization. These courses can be any combination of the advanced level courses that are outlined in the MS course list. The requirement for obtaining a PhD degree includes:

- Maintaining a CGPA of at least 3.5/4.0 in the course work as per university policy
- Passing of the PhD qualifying exam.
- Acceptance for publication of at least one paper in a peer reviewed journal listed in the ISI citation index.
- Two positive reports about the student's research work from international scholars in the field from technologically advanced countries.
- Successful defense of the PhD thesis.

Currently the following specializations can be pursued in the course of the doctorate degree.

- Structural Analysis
- Structural Dynamics & Aero-elasticity
- Mechanics of Composite materials and failure trends
- Multidisciplinary Design and Optimization
- Micro Electro Mechanical Systems
- Turbulence Modeling
- Aero-acoustics
- Computational Fluid Dynamics
- Fluid Structure Interaction
- Turbo-machinery
- Configurationally Aero/Hydro dynamics

The PhD degree is expected to be completed in four years. The maximum and minimum time allowed for completion of the PhD program is six and three years, respectively.

Course Descriptions

The course descriptions of the core courses and the pertinent elective courses are as follows:-

AE601/ME732 - Theory of Elasticity (3-0-3)

This course aims to make a study on the following topics such as: Development of TOE equations; rectangular and polar coordinates; Airy's stress function; problem solving; plane stress and strain, through polynomials, rotationally symmetric stress distributions; super positioning; bending of bars, thermal stresses; disks; rotating, inside / outside pressure, diametric load.

AE 645 - Advanced Materials in Engineering (3-0-3)

This module gives understanding of both conventional and advanced materials in engineering applications and its applications in aerospace. Course include; internal atomic/ crystal structures and imperfections and dictation in material properties, phase diagrams, analysis & review of Ferrous and non-Ferrous alloys/properties. property modifications & treatments, TTT diagrams, introduction to structure and properties of polymeric materials, composite materials, ceramics and engineering ceramics, failure analysis and degradation of materials.

ME765 - Product and Process Design

This is an advanced course on design methodologies, Conceptualization, preliminary design, detail design, and manufacturing. Failure analysis, materials selection, methods of design optimization, and current approaches in computer-aided design, Application of computer methods to engineering design, Optimization and automated design methods, the use of linear and non-linear programming methods for engineering design and related problems, Unconstrained minimization, penalty functions and feasible directions.

ME-761 ADVANCED CAD/CAM

Overview of existing CAE systems. Fundamental of CAD: Introduction, Design Process, Creating manufacturing database. CAD/CAM System Hardware Structure, Configuration, Mini, Micro, Interactive display devices, Peripherals, Storage, Display and operating system. Geometric Modal and Technique, Solid Modeling, Graphics in CAD. Conventional numerical control, NC part programming, computer numerical control, NC programming with interactive graphics, The role of group technology in CAD/CAM, The role of process planning in CAD/CAM, Process planning system.

ME 762 Computer Integrated Manufacturing

CIM Introduction, Product Development Through CIM, Principles of Computer Graphics, Geometric Modeling Techniques, CIM Data Base and data base Management Systems, Computer Aided Process Planning, Planning of Resources for manufacturing Through Information Systems. Manufacturing Automation, CNC Machine Tools, Robots in Computer Integrated Manufacturing, Computer Aided Quality Control, Collaborative Engineering, FMS, Shop Floor Data Collection Systems, Simulation In Manufacturing, Auxiliary devices supporting manufacturing automation (vision system, RFID)

ME 602/AE640 - Finite Element Methods (3-0-3)

The course covers theory of FEM as applied to 1 & 2D problems of solid mechanics. Displacement method approach is used to develop the stiffness matrices of various elements. Hands on Projects using PATRAN / NASTRAN are undertaken by students to enhance practical ability in using the commercially available software. Students are also required to give a detailed presentation at the end of the course depicting their theoretical / software knowledge gained during the course.

ME742 - Advanced Theory of Vibrations

It begins with an introduction to some basic concepts, discussion about spring, mass and damper elements, and introduction to harmonic motion and its analysis. The course then covers Free and Forced vibration of single degree of freedom (SDOF) system, damped and un-damped system. After thoroughly covering SDOF system two and multi degrees of freedom system are covered. Special additional topics are covered at the end of the course.

AE723 - Advanced Mechanics of Composites

The objective of this course is to introduce composite materials to graduate students. It begins with an introduction to the composite material and their constituents. The course then covers unidirectional composites, in which various mechanical properties of unidirectional composite are discussed. The course also covers behavior of laminated composite plates under various loading conditions in detail. Special additional topics are covered at the end of the course.

ME 731 - Advanced Mechanics of Materials

Introduction, Theory of Stress and Strain, Linear Stress-Strain-Temperature Relations, Inelastic Material Behavior, Applications of Energy Methods, Torsion, Bending of Straight Beams, Shear Center for Thin-Wall Beam Cross Sections, Curved Beams, Beam on Elastic Foundations, The Thick-Wall Cylinder, Elastic and Inelastic Stability of Columns, Flat Plates, Stress Concentration, Fracture Mechanics, Fatigue: Progressive Fracture, Contact Stresses, Creep: Time-Dependent Deformation.

ME 733/AE747 - Theory of plasticity

Stresses and Strains, Foundations of Plasticity, Elastoplastic Bending and Torsion, Plastic Analysis of Beams and Frames, Further Solutions of Elastoplastic Problems, Theory of the Slip line Field, Steady Problems in Plane Strain, Non steady Problems in Plane Strains, Computational Methods.

ME734 - Computational Fatigue Mechanics

Fatigue phenomenon; constant and variable loads; stress concentration, stress intensity factors; residual stresses; fatigue crack; growth and analysis; fatigue testing, interpretation, corrosion due to fatigue, fretting, high and low temperature, fatigue of joints and structures; design for fatigue; fiber-metal laminates.

ME 735 - Computational Fracture Mechanics

Introduction, Linear Elastic Fracture Mechanics, The Elastic Stress Field Approach, Crack Tip Plasticity, The Energy Balance Approach, LEFM Testing, Elastic-Plastic Fracture Mechanics, Basic Aspects of Elastic-Plastic Fracture Mechanics, EPFM Testing, Failure Assessment Using EPFM, Fracture Mechanics Concepts for Crack Growth, Fatigue Crack Growth, Sustained Load Fracture, Dynamic Crack Growth and Arrest, Mechanism of Fracture in Actual Material, Mechanisms of Fracture in Metallic Materials, Influence of Material Behavior on Fracture Mechanics Property.

ME 736 - Computational Thermo-mechanics

Tensor Notation, Some Basic Equations of Continuum Mechanics, Creep Behavior of Isotropic and Anisotropic Material; Constitutive Equations, Creep Behavior of Thick-Walled Tubes, The Creep Potential Hypothesis in Comparison with the Tensor Function Theory, Damage Mechanics, Tensorial Generalization of Uniaxial Creep Laws to Multi-axial State of Stress, Viscous Fluids, Memory Fluids, Viscoelastic Materials, Visco-plastic Materials, Creep and Damage Experiments, Creep Curve.

ME 737 - Computational Weld Mechanics

Introduction, Computer Simulation of Welding Processes, Thermal Analysis of Welds, Evolution of Microstructure Depending On Temperature, Evolution of Microstructure Depending On Deformations, Carburized and Hydrogen Diffusion Analysis, Welded Structure and Applications of Welding in Industrial Fields, Fracture Mechanics, Input Data for Computational Welding Mechanics.

AE 644 - Thin Walled Structures

Mechanics of Solids, Thin Plates and Shells, Non-Linear Static Analysis, Vibrations of Structures, Non-Linear Dynamics, Stability of Structures, Dynamic Stability.

AE646– Aero-Elasticity

Introduction, Deformation of Airplane Structures under Static Loads, Deformation of Airplane Structures under Dynamic Loads, Approximate Methods for Computing Natural Mode Shapes and Frequencies, Aerodynamic Tools, Wings and Bodies in 3-D Unsteady Flow, Static Aeroelastic Phenomena, Flutter, Dynamic Response Phenomena, Aeroelastic Model Theory, Model Design and Construction, Testing Techniques.

AE 724 - Theory of Plates and Shells

Simple Elastic Shells, Geometric Boundary Layers, FEM and Time Stepping Procedures in Non-Linear Dynamics of Flexible Branched Shell Structures, Dynamic Stiffness Vibration Analysis for Higher Order Plate Models, Anisotropic Thermo-Creep-Damage in 3D Thick Plate vs. Reissner's Approach,

AE 705 - Advanced Aircraft Structural Analysis

Fundamentals of Structural Analysis, Elasticity, Virtual Work, Energy and Matrix Method, Thin Plate Theory, Structural Instability, Vibrations of Structures, Analysis of Aircraft Structures, Principles of Skinned Structures, Airworthiness and Airframe Loads, Bending, Shear and Torsion of Thin-Walled Beams, Stress Analysis of Aircraft Components, Structural and Loading Discontinuities.

AE 857 - Hydrodynamic Stability

Introduction, Thermal Instability, Centrifugal Instability, Parallel Shear Flows, Uniform Asymptotic Approximations, Additional Topics in Linear Stability Theory, Non-Linear Stability.

AE 610 - Advanced Incompressible Fluid Dynamics

Incompressible flows, aerodynamics and their analysis under "in viscid" and "viscous" flows. In viscous incompressible flows, further subdivisions on the basis of flow Reynolds number (Re) i.e. Laminar boundary layer (High Re), Stokes flow (low Re) and turbulent flow (Very high Re). The basic governing equations of fluid/aerodynamics i.e. Navier Stokes equations are introduced and their various analytical solution techniques are explained in detail. Two dimensional incompressible and in viscid flows are solved using complex analysis treatment.

AE 611 - Advanced Compressible Fluid Dynamics

The main focus of this course is on compressible flow. Compressible flows form a major part of aerodynamics and their analysis is broadly classified under "in viscid" and "viscous" flows. In viscid compressible flows include analysis of properties across shocks/expansion waves, variable area flows, linearized 2 D flow, part of hypersonic flow and unsteady wave motion. Viscous compressible flows involve solution of the complete system of governing equations including Navier Stokes equations. Various examples of viscous compressible flow are illustrated.

ME 601/AE630 - Computational Fluid Dynamics I

This course introduces CFD to postgraduate students. The major topics include classification, implicit & explicit methods, iterative & time/space marching schemes, grids, boundary conditions, aerospace applications. Various techniques like Finite difference; finite volume methods for solutions of Navier Stokes & Euler equations are introduced.

AE753 - Advanced Heat Transfer

This graduate level course in heat transfer is designed to cover material beyond the undergraduate level. Different modes of heat transfer, i.e. conduction, Convection and Radiation are broadly discussed. The main focus of this course is on Conduction and Convection with some introductory material on Radiation towards the end of the course. In Conduction 2 D steady and 1 D unsteady problems are introduced and their solution methods discussed. In Convection the equations of motion, energy and mass conservation are reviewed and problems involving forced and free convection are discussed with reference to various flow regimes.

ME 712 - Computational Heat Transfer

Introduction to Heat Transfer, Mathematical Background, Governing Equations, Finite Difference Review, Finite Element, Simulation of Transport Processes, and Numerical Method for Conduction Heat Transfer, Numerical Method for Convection Heat Transfer, Numerical Method for Radiation Heat transfer, Combined Modes and Process Application.

ME 711/AE730 - Computational Fluid Dynamics II

Review of Finite Difference Solution of Partial Differential Equations, Transformations of the Fluid equations of Fluid Motion from Physical space to Computational Space, Euler Equations, Parabolized Navier Stokes Equations, Navier Stokes Equations, Boundary Conditions, Introduction to High Temperature Gases, Grid Generation: Unstructured Grids, Finite Volume Method, Finite Element Method.

ME 713 - Engineering Tribology

Concept of Lubrication and Wear, Hydrodynamic Lubrication, Hydrodynamic Lubrication in Non-Newtonian Fluids, Computational Hydrodynamics, Elasto-hydrodynamic Lubrication, Micro-Elasto-hydrodynamic Lubrication, Deposition methods of solid Lubricants, Applications, Tribology of Polymers, Tribology of Polymers Composites, Wear and Friction of Ceramics, Nano-Tribology, Bio-Tribology.

ME 714 - Combustion

Fundamentals, Experimental Investigation, Mathematical Description of Premixed Laminar Flat Flames, Thermodynamics of Combustion Processes, Ignition Process, Engine Knock, Navier-Stokes-Equations for Three-Dimensional Reacting Flow, Turbulent Reacting Flows, Turbulent Non-premixed Flames, Turbulent Premixed Flames, Combustion of Liquid and Solid Fuels, Effects of Combustion Processes on the Atmosphere

ME 715 - Flow Induced Vibrations

Introduction, General Overview, Modeling Approaches, Fundamental Mechanism of FIV, Vibration Induced by Cross-Flow, Single circular cylinder, Two circular cylinder in cross-flow, Multiple Circular Cylinder, Bodies of rectangular and other cross-section shapes, Acoustic Resonance in tube bundles, Prevention of FIV, Vibration Induced by External Axial Flow, Single cylinder/multiple cylinders, Vibration of elastic plates and shells, ,Vibration induced by leakage flow, Vibrations Induced by Internal Fluid Flow, Vibration of Straight and Curved pipes conveying fluid, Vibration related to bellows, Collapsible Tubes,

AE 711 - Computational Gas Dynamics

Gas Dynamics Review, Governing Equations of Gas Dynamics, Waves, Scalar Conservation Laws, Computational Review, And Numerical Error. Numerical Calculus, Basic Principles of Computational Gas Dynamics, Conservation and other Basic Principles, CFL Condition, Upwind and Adaptive Stencils, Artificial Viscosity, Linear Stability. Basic Numerical Methods for the Euler Equations, Boundary Treatments, Advanced Methods of Computational Gas Dynamics, Flux-Limited Methods, Flux-Corrected Methods, Self-Adjusting Hybrid Methods,

AE 629 -Advanced Aircraft Dynamics and Controls

Airframe and Atmospheric Modeling, Control and Guidance System Modeling, Root Locus, s-Plane, z-Plane, Transient Response, Flight-Path calculation, Covariance Propagation, Utility Sub-Routines.

AE 735 - Advanced Aircraft Propulsion

Fundamentals, Fundamental Equations, Isentropic Equations, Polytropic Process, Rockets, Performance of Ideal Rocket, Solid Rocket Motors, Liquid Rocket Motors, Hybrid Rockets, Construction of Rockets, Multi-staging, Design Methodology, Piston Aerodynamic Engines, Engine Type, Thrust, Combustion, Propeller Design, Propeller Performance, Gas Turbine Engines, Ideal Gas Dynamics, Engine Cycle , Performance, Component Performance, Engine Performance Analysis, Design Point Optimization, Component Design, Engine Controls, Ramjet and Scramjet Engines.

AE 615 - Aircraft Engine Design

Engine Cycle Design, the Design Process, Constraint Analysis, Mission Analysis, Engine Selection, Parametric Cycle Analysis, Engine Selection: Performance Cycle Analysis, Sizing the Engine, Engine Component Design, Global and Interface Quantities, Rotating Turbo-Machinery, Combustion Systems, Inlets and Exhaust Nozzles.

AE 716 - Waves and Compressible Flow

Equations of inviscid compressible flow including flow relative to rotating axes, Models for linear wave propagation including Stokes' waves, Inertial waves, Rossby waves and simple solutions, Fourier Series, Fourier integrals, Method of stationary phase, Dispersion and group velocity, Flow past thin wings, Simple wave flows applied to one-dimensional unsteady gas flow and shallow water theory, Shock waves, Weak solutions, Rankine-Hugniot relations, Oblique shocks, Bores, Hydraulic pump.

AE 633 - Potential Flow and Panel Method

Introduction, Different forms of fluid dynamics equations, Fundamentals of inviscid, incompressible flows, General Solution of the incompressible, Potential flow equations, Exact solution with complex variables,

Numerical (Panel) Methods, Singularity elements and Influence coefficients, Two-dimensional numerical solutions, Three dimensional numerical solutions, Enhancement of Potential Flow Models.

ME 773/AE650 - Turbo-machinery

Overview of Basic Concepts, Hydraulic Pumps, Hydraulic Turbine, Centrifugal Compressors and fans, Axial Flow Compressors and Fans, Steam Turbine, Axial Flow and Radial Flow Gas Turbine, Cavitations in Hydraulic Machinery.

AE 859 - Turbulent Fluid Flow

Classical Picture of Turbulence, Ubiquitous Nature of turbulence, Equations of Fluid Mechanics, Origin and Nature of Turbulence, Turbulence Shear Flows and Simple Closure Models, Phenomenology of Taylor, Richardson and Kalmogorov, Freely Decaying, Homogeneous Turbulence, Isotropic Turbulence, Role of Numerical Simulation, Isotropic Turbulence, Role of Rotation, Stratification and Magnetic Field on Turbulence, Two Dimensional Turbulence.

ME 79X – MS Thesis

ME89X – PhD Thesis

ME9XX – PhD Thesis

Faculty of Social Science

The faculty of Social Sciences department of Humanities offers courses in English, Islamic Studies, Sociology, International Relations and Pakistan Studies to undergraduate students in other disciplines. The progressive introduction of courses in anthropology, career management, strategic studies, environmental studies and training for ELT teachers is envisaged for the near future. Proposals for these courses are in an advanced stage of preparation. For its language courses, the faculty prides itself on remaining abreast of latest developments. Classroom teaching is enriched with audio-visual aids, computer programs and controlled and free practice in the University's well-equipped language laboratory, together with exposure to outside interests through seminars, workshops and guest speakers.

The Department of Humanities started its MS/MPhil degree program in Linguistics and Literature in the Spring Semester 2010. Some students of these disciplines have already completed their work and have qualified for their degrees. The course, which is spread over four semesters, is designed with some minor changes round the Higher Education Commission's recommendations. Students are encouraged to join the ELL (English Linguistics and Literature) group that holds seminars whenever possible to bridge the gap between theory and practice. Admissions to these program is open for selected candidates once a year, in the Fall Semester.

In addition to the foregoing, a popular, 3-month, certificate/diploma level program for the development of basic language, writing and conversational skills in English is offered every semester in the evening. Teaching is provided by native or near-native speakers of the language with a full range of back-up material and enrichment through audio-visual accessories, computers and language laboratory facilities.

Department of Humanities

Welcome to the Department of Humanities at Air University. Becoming part of this dynamic department means that you are a part of vibrant community of students and faculty, and that you wish to develop yourself through the departments' carefully planned post- and undergraduate courses. These courses of humanities and languages are interspersed with projects and activities that stimulate and challenge students' intellectual curiosity and generate social capital.

The department offers three types of courses in its morning and evening programs. The postgraduate MS/M. Phil in Linguistics and Literature program initiated in 2010 is based on coursework of two semesters that facilitates research in areas of English studies. The course is supported by intensive training in areas of theoretical linguistics, applied linguistics and literary studies. Students are encouraged to be part of the university's research group ELL (English Language and Linguistics) that holds regular seminars and research group meetings to meet gaps between theory and research in this field. Our PhD program is also on offer in addition to these three.

The undergraduate courses of ESP (English for Specific Purposes) are designed to address students' weak areas to meet the professional demands of their fields of specialization which are taught and examined in English. The focal aim is to bridge the gap between college and university requirements. The courses of Pakistan Studies, Islamiyat and Sociology help students to become culturally sensitive participants in democratic dialogue and inspire them to become ethically responsible citizens.

The faculty members of the department are either PhDs, or involved in their postgraduate research degree. Our particular areas of interests are sociolinguistics, psycholinguistics, language variation, language and technology, comparative religions, discourse analysis, gender and resource development.

Faculty Details

1. Prof. Dr. Wasima Shehzad,

Dean Faculty of Social Sciences, Chair Department of Humanities

Fulbright Alumna, University of Michigan, USA

Education: PhD Linguistics, MPhil TESOL (Edinburgh, UK), MA English Literature and Language, Punjab University; DIP TEIL

Research Interests: Corpus Linguistics, Genre Studies, Discourse Studies, Academic/Technical Writing, Quality Assurance in Education, Curriculum Development and Syllabus Design, Language Planning and Policy.

2. Dr. Farzana Masroor (Assistant Professor)

Education: PhD Applied Linguistics, University Technology Malaysia

Research Interests: Genre Analysis, Argumentative Texts, EAP/ESP, Cross-Cultural Discourse.

3. Dr. Uzma Anjum (Assistant Professor)

Education: PhD Linguistics (NUML)

Research Interest: Language Documentation, Sociolinguistics, Language Shift and Language Death, Pragmatics, Morphology, Phonology & Phonetics

4. Dr. Inayat Ullah (Asstt Prof)

Education: PhD Ling and Literature

Research Interest: Trauma Studies, Postcolonial Scholarship, Perpetrators studies, Feminism, eco criticism, critical theories.

5. Dr. Sham Haider (Asstt Professor)

Education: PhD in Education, University of Rochester

Research Interest: TESOL

6. Dr. Afia Kanwal (Asstt Prof)

Education: PhD Linguistics (NUML), MA English Linguistics and Literature (NUML), MA English Language Teaching (Gold Medalist)(NUML)

Research Interests: Cognitive Science and Language Learning; Learning Styles; Modern Literature; ELT in Pakistan

7. Dr. Syeda Tehseen Zehra

Education: PhD Linguistics NUML. M. Phil Linguistics BZU

Research Interests: CDA, DA. Sociolinguistics, Corpus Linguistics, Pragmatics, English Language Teaching

8. Dr. Sohaib Sultan

Date of Joining: March, 2018

Education: PhD in Education (NUML ISB)

9. Dr. Aziz Khan (Asstt Prof)

Education: PhD Linguistics (University of Auckland)

Research Interest: Language Policy and Planning, Language Policy and Planning; language and academic culture, social and cultural contexts of language learning and teaching

10. Air Cdr (Retd) Tariq Qureshi

Education: MA English Language and Literature

Research Interest: American Drama

11. Mr. Akhtar Abbas (Lecturer)

Education: PhD Scholar AU (Thesis near Completion), M. Phil in Linguistics and Literature

(Air University)

Research Interests: Genre Studies, Academic Writing, Discourse Studies, Corpus Studies Discourse, Language and Identity, Language Planning and Policy.

12. Ms Afroz Ilyas (Lecturer)

Education: MPhil Linguistics and Literature (Air University), MA TEFL (AIOU)

Research Interests: English Language Teaching Through Literature, Effective Teaching, Role of Lexis in Developing And Writing Skill in Academically Weak Students, Improving Reading Skills Through Cognitive And Meta Cognitive Skills

13. Ms Humera Faraz (Lecturer)

Education: PhD Scholar NUML(Course Work Completed) MPhil Linguistics & Literature (Air University), MA English, (BZU Multan)

Research Interest: Sociolinguistics, Critical Discourse English Analysis, Language Teaching and Learning

14. Fizza Farrukh (Lecturer)

Education: MPhil Linguistics and Literature

Research Interests: Discourse Studies, Pragmatics, Sociolinguistics, Language in Media, Politeness in Language, English Language Teaching

15. Mr. Ayaz M Shah (Lecturer)

Education: PhD Scholar IIUI, MPhil Linguistics

Research Interest: Stylistics and Film Studies

16. Mr Naveed Iqbal, Assistant Professor

Education: MA International Relations, California, USA

Research interest: International regions, Transnational Societies, Ethno-linguistic Fractionalization, Separatist Movements

17. Mr Hafiz Tariq Ejaz, Lecturer.

Education: PhD Scholar. M.Phil, MA Islamic Studies, MA Arabic, MA English,

Research interests: Seerah, Mysticism & Orientalism, Interfaith.

18. Ms. Sameena Batool Shah (Lecturer)

Education: MPhil Islamic Studies

19. Ms. Hafsa Ali (Lecturer)

Education: PhD Scholar QAU. MPhil Pakistan Studies QAU

Research Interest: Electoral Politics in Pakistan, Media Studies, Qualitative Research Methods

20. Mr. Arsalan Ahmed (Lecturer)

Education: PhD Scholar QAU, MPhil IR

Research Interest: Sectarianism and Suni Islam in South Asia, Islamic History, Pakistan History, Salafi Movement in Pakistan

21. Mr. Yasir Khan (Lecturer)

Education: MPhil Islamic Studies

MS/MPhil in Linguistics and Literature

Brief introduction of program

The MS/MPhil course is currently confined to studies in Linguistics and Literature. The program is specially designed to facilitate candidates with interests in the field of Language, General and Applied Linguistics, and literary theory and literature. These areas of specialization are supported by intensive courses of research

Exact title of program that will appear on the degree

MS/MPhil in Linguistics and Literature

Objective to offer program

To offer opportunities in critical thinking through comparative analysis and application of theory in a social context where contemporary issues are discussed and evaluated to develop confidence, analytical thought and creativity. This is in line with the vision of the Higher Education Commission in Pakistan to promote informed decision-making, effective citizenship and leadership.

Entry requirement of program

People with interests in research areas related to language, literature and language teaching

Master in English or Four years Bachelor degree in English with minimum 45% marks or equivalent from HEC recognized Institute.

For award of MS degree HEC requires GRE General/

GAT-General test (at least 50% score), that must be taken before admission or commencement of classes

Admission Test and Selection Interview

Scope regarding market, social and employment perspective of program

This course prepares individuals to be employed at various places in the society with a wide range of employment opportunities that are for those with a background in English language teaching, linguistics and literature.

The individuals would be critical thinkers who study literature and linguistics for aesthetic purposes, compare and apply theories in social context where contemporary issues are evaluated to develop confidence, analytical thought and creativity.

The individuals would be more informed, decision-makers, effective citizens with leadership qualities.

Duration of the program

The duration of the course is 24 months with 4 semesters including 2 semesters for thesis. There are three Core courses in the first semester whereas in the second semester one core course is offered along with elective courses in order to complete a total of 12 credit hours per semester. Two extensions (each of a semester length) may be taken by research students. Third and the forth semester is for dissertation.

Course content of program and semester-wise workload

Core courses

No.	Course Code	Course Title	Total Credit Hrs
1	HU 617	Discourse Analysis (Core Course)	3-0-3
2	HU 602	General Linguistics (Core Course)	3-0-3
3	HU 603	Critical Theories & Research (Core Course)	3-0-3
4	HU 622	Research Methodologies (Core Course)	3-0-3
		Total	12

Elective Courses

Students may choose four elective courses to complete a total of 12 credit hours.

No.	Course Code	Course Title	Total Credit Hrs
1.	HU618	Pragmatics	Elective 3
2.	HU619	Corpus Linguistics	Elective 3
3.	HU 620	Phonetics & Phonology of English language	Elective 3
4.	HU621	Critical Discourse Analysis	Elective 3
5.	HU 623	Modern Literature	Elective 3
6.	HU 624	Language Teaching: Theory, Research and Practice	Elective 3
7.	HU 625	Systemic Functional Linguistics	Elective 3
8.	HU 626	Stylistics	Elective 3
9.	HU 627	Sociolinguistics	Elective 3
10	HU 628	Psycholinguistics	Elective 3
11	HU 629	Language and Identity	Elective 3
12	HU 630	Grammatical Models	Elective 3
13	HU 631	Pakistani English	Elective 3
14	HU 632	Postcolonial Studies	Elective 3
		Total	12

Course Work 24 Cr Hrs (12cr Hrs per semester)

Research/Thesis 6 Cr Hrs

Total: 30 Cr Hrs

Areas of specialization

This program contributes to three major areas of study: Applied Linguistics, General Linguistics and Literature.

1. A dissertation in Applied Linguistics is supported by courses of Linguistics that encompass schools of thought of Language, Sociolinguistics, Psycholinguistics, Translation Studies, Language Planning, Multilingualism, Variation in Language, and Contemporary Theories.
2. A Theoretical Linguistics dissertation is supported by courses of Structural and Functional Linguistics, Systemic Functional Grammar, Stylistics, Lexicology, levels of language and fundamental concepts and theories.
3. An enquiry into literature is supported by courses of Literary and Critical Theory, Discourse Studies of contemporary literature and Classic and Modern Textual Analysis.

Course Descriptions

HU 620 Phonetics and Phonology

This course covers human sounds in language with special reference to English; the history of phonetics; influences from other languages; reconstructions of earlier forms of English – n Old, Middle, Early Modern, Modern; sound shifts, oscillation between related consonants/ between voiced and unvoiced consonants, stress shifts, recent American influence; traditional British RP; the IPA ; supra segmental, stress, intonation, duration, pause, elision.

HU 602 General Linguistics

An overview of the origins and functions of language is made in this course. It covers topics like language families, language and thought, factors in communication and the development of alphabetic and writing systems, it includes introductions to the main branches of Theoretical Linguistics, Phonology (covered in detail in HU 601), Morphology, Syntax and Semantics/Pragmatics, Sociolinguistics and Psycholinguistics (covered in depth in HU 610 and HU 611).

HU 603 Critical Theories and Research

The focus of this course is on modern theories and criticism. It explores relationships and representations and distinguishes between theory and criticism. Theoretical developments since the beginning of the twentieth century are included; Russian Formalism, Anglo-American New Criticism, French Structuralism, Poststructuralism and Deconstruction are discussed in the context of their application to various aspects of research in the humanities and social sciences.

HU 622 Research Methodologies

This course addresses the needs of novice researchers in the social sciences, with particular focus on linguistic and literary studies; it facilitates student learning through lectures, seminars and a strong practical components. Students are encouraged to participate, present their ideas and think their way through the processes and paradigms of modern research. They are also provided with the hand on practice to develop research skills.

HU 621 Introduction to Critical Discourse Analysis

This interdisciplinary course covers discourse studies, critical discourse and discourse analysis. Various theories and methods relevant to linguistic and sociological analysis are studied; with its strong practical component, this course is designed to facilitate students of linguistic and literary studies to a deeper understanding of the historical background, concepts and methodological approaches of critical discourse analysis

HU 623 Modern Literature

Students who wish to pursue research in literature and literary studies are encouraged to opt for this course. Tracing the various trends in literature over the centuries, this course aims to discuss the themes and issues emerging in modern world literature. Various genres of literature emanating from different parts of the world are included with special focus on literatures written in English.

HU 624 Language teaching; theory, research and practice

This course includes teaching approaches, methods and practices, and implications for research in Pakistan. General and language learning theories are discussed, together with related interests in classroom techniques, curriculum development, course/syllabus design, study material development and assessment and evaluation procedures relevant to language learning.

HU 625 Systemic Functional Linguistics

This course facilitates discussions in Theoretical Linguistics. It is designed to enable advanced students of linguistic research to become fully conversant with the notions of Systemic Functional Linguistics which lies in the mainstream of British linguistics, in contrast to Chomskian Linguistics and other structuralist approaches of the American school.

HU 626 Stylistics

A branch of Linguistics which builds bridges to literature. Stylistics applies the insights of linguistics to the study and interpretation of literature. Stylistics can provide workable approaches for the comprehension of literature. This course covers the essentials of linguistics in phonology, morphology, syntax, semantics/pragmatics, selection restriction rules, the elements of style, historical and contemporary ideas and the analysis of text for students of stylistics.

HU 627 Sociolinguistics

The study of language enhances one's understanding of the social, political and ethical dimensions of society. This course explores the development of language standards, dialects, registers, pidgins, creoles and the effects of language planning and official policy; topics like language accommodation of groups in contact, bilingualism, lingua francas and the changing status of English are covered.

HU 628 Psycholinguistics

This course covers essential elements in the study of the relationship between linguistics and psychology. Both disciplines are extensive, touching upon most areas of human thinking, feeling and acting. The observations of writers such as de Saussure, Bloomfield, Boas, Sapir, Whorf and Chomsky are discussed. This course includes questions of origin, animal communication, speech centers in the brain, child language acquisition, receptive and productive skills, speech act theory, aphasia, dyslexia, therapy, the relation between language, personality and thinking and possibilities in experimentation and laboratory work.

HU 629 Language and Identity

This course is designed to facilitate students who are curious about the formation of identity through linguistic dispositions. Language lies at the center of social organization at different levels. It helps humans to cooperate, plan and remember things; language can also create wide gaps between groups and communities; issues like language choice, social mobility, economic advantage, prestige, esteem and the construction of group, regional and national identities are included in this course.

HU 630 Grammatical Models

This course provides students an understanding of traditional ideas of grammatical models including early and Latinate models. Also covered are separate language grammars, English grammar, synthetic and analytic languages, linguistic descriptive models, transformational generative models, a systemic grammatical model, Firthian grammar, contextualization and functional grammar. These models are explored and compared with current usage

HU 631 Pakistani English

The development of non-native varieties; historical overview, world 'English's,' **chaos theory**, the introduction of English to this region; early incentives and compulsions; the situation today; the effects of first language interference--transference and the development of Pakistani dialects of English; phonological, morphological, syntactic and semantic deviations; questions of acceptability at national and international levels, standardization, indigenization and reverse influence are discussed.

HU 632 Postcolonial studies

This course is designed to assist students interested in Post-Structural and Postcolonial Studies. The political and cultural structures of the postcolonial societies are studied in relation to the language use and literature written in and about postcolonial countries. The course includes an overview of the main contributors to postcolonial writing, theory and criticism.

BS English Program

Total Cr Hrs	133
Cr Hrs First Semester	17
Program Duration	04 Years(Normal) and extension onwards as per AU Policy
Timing	Morning (08:30-04:30)

BS ENGLISH

Program Description

Introduction

Department of Humanities' BS English Program is a 04 Years Degree Program that will cover core areas of linguistics, literature and English language. In addition, the program will help the students to connect their knowledge of English language, linguistics and literature with other areas of social sciences such as psychology, Islamic studies, sociology, Pakistan studies, international relations, communication, business studies, etc. to bring innovation in their educational and professional life thereby making them confident, independent, innovative and research-oriented.

Course of Study

The BS program in English is based on four years of education after higher secondary school. In the first two years, students will be offered compulsory and general courses from humanities and social sciences along with some foundational courses from the field of Linguistics and Literature. After two years, students will take advance courses from Linguistics and Literature.

While designing the curriculum for this proposed program, the guidelines of Higher Education Commission (HEC) and the curriculum of BS English of some leading national universities have been taken into account.

Title of the Degree:

Bachelors of Science in English

Target Audience: The target audience of this program will be the students interested in arts and humanities. They will represent Air University nationally as well as internationally in the field of arts and humanities particularly in English Language, Linguistics and Literature through their knowledge and research work.

Duration: 04 Years Full Time

Teaching System: Semester System

Sessions: Morning

Admission Requirement: As per AU policy, i.e., the candidates seeking admission in BS English should have qualified the Intermediate examination from any Board of Intermediate and Secondary Education in Pakistan 'OR' An examination equivalent to the Intermediate for which such candidates must submit an Equivalence Certificate issued by the Inter-Board Chairman Committee, Islamabad before the semester starts. Applicants must have scored 50% or more marks with at least 55 % marks in the subject of English.

a. Admission Criteria: The admission criteria will be based on the following:

SSC	20%
HSSC	30%
Admission Test	30 %
Interview	20%

b. Intermediate (12 years of education) with a minimum of 50% marks

Structure of Program:

Total Credit Hours: 133 CR (15-18 credit hours per semester)

Division of Credit Hours

- Compulsory Courses : 25 CR
- General Courses : 24 CR
- Foundational Courses: 24 CR
- Major Courses (Linguistics and Literature) : 30 CR
- Core courses : 15 CR
- Electives from Literature or Linguistics: 12 CR
- Research Project each for Literature or Linguistics: 03 CR

Major courses are designed to provide knowledge and ideology that are essential to take up further studies in both specialized areas of Linguistics and Literature.

**Semester Wise Breakdown of Courses and Credit Hours
Subjects and Credit Hours**

Semester 1:

S.No	Course Code	Course Title	Cr Hrs	Pre Req
1	EN101	English 1: Language in Use	2-1-3	-
2	HU115	Pak Studies	2-0-2	-
3	EN111	Geography	3-0-3	-
4	EN112	Environment and Society	3-0-3	-
5	EN121	Introduction to English Literature 1 (poetry drama)	3-0-3	-
6	EN131	Introduction to English Linguistics 1 (phonology phonetics, syntax and morphology)	3-0-3	-
		Total	17	-

Semester 2

S.No	Course Code	Course Title	Cr Hrs	Pre Req
1	EN102	English II: Academic Reading and Writing	3-0-3	-
2	HU118	Islamic Studies	2-0-2	-
3	EN113	Liberal Arts	3-0-3	-
4	EN114	Gender Studies	3-0-3	-
5	EN122	History of English Literature (Medieval to Romantic I)	3-0-3	-
6	EN132	History of English Language	3-0-3	-
		Total	17	

Semester 3

S.No	Course Code	Course Title	Cr Hrs	Pre Req
1	EN201	English III: Communication Skills	2-1-3	-
2	CS100	Introduction to Computers	2-1-3	-
3	EN212	Foreign Language: French/ Chinese /Urdu	3-0-3	-
4	EN211	Philosophy and Iqbalayat	3-0-3	-
5	EN221	Introduction to English Literature-II (Novel, Story & Prose)	3-0-3	-
6	EN231	Introduction to Linguistics II (Semantics Pragmatics)	3-0-3	-
		Total	18	

Semester 4

S.No	Course Code	Course Title	Cr Hrs	Pre Req
1	EN202	Advance Academic Reading and Writing	3-0-3	EN 102
2	EN201	Human Rights & Citizenship	3-0-3	
3	MA200	Introduction to Statistics	3-0-3	
4	EN213	Introduction to Law	3-0-3	
5	EN222	History of English Literature II (19th Century Realism up to Contemporary Times)	3-0-3	EN122
6	EN361	Research Methodology	3-0-3	
		Total	18	

Semester 5

S.No	Course Code	Course Title	Cr Hrs	Pre Req
1	EN301	Visionary Discourse	3-0-3	
2	EN321	Literary Criticism	3-0-3	
3	EN322	Poetry (14th to 18th Century)	3-0-3	EN 121
4	EN323	Novel (18th & 19th Century)	3-0-3	EN 221
5	EN331	Morphology & Syntax II	3-0-3	EN 131
6	EN332	Sociolinguistics	3-0-3	
		Total	18	

Semester 6

S.No	Course Code	Course Title	Cr Hrs	Pre Req
1	EN324	Literary theory	3-0-3	
2	EN325	Classics in Drama	3-0-3	EN 121
3	EN326	19th Century Poetry	3-0-3	EN 322
4	EN333	Lexical Studies	3-0-3	
5	EN334	Psycholinguistics	3-0-3	
		Total	15	

Note: From semester 7 onwards, students will either opt for Literature or Linguistics. In both semester 7 & 8, two streams of literature and linguistics will be studied separately.

LITERATURE STREAM (7 & 8 SEMESTER)**Semester 7 Literature**

S.No	Course Code	Course Title	Cr Hrs	Pre Req
1	EN441	20th Century Literature (Poetry & Drama)	3-0-3	EN 221
2	EN442	American Literature	3-0-3	
3	EN443	Translation Theory & Literary Studies	3-0-3	
4		Elective I	3-0-3	
5		Elective II	3-0-3	
		Total	15	

Electives to be selected from semester 7

EN471 Chinese Literature

EN472 Folk Literature

EN473 Continental Literature

EN474 Pakistani Literature

EN 475 South Asian Literature

Semester 8 Literature

S.No	Course Code	Course Title	Cr Hrs	Pre Req
1	EN 444	20th Century Fiction and Non Fiction	3-0-3	EN 221
2	EN445	Literary Stylistics	3-0-3	EN 121 & EN 221
3	EN498	Research Project	3-0-3	EN 361
4		Elective I	3-0-3	
5		Elective II	3-0-3	
		Total	15	

Electives to be selected from semester 8:

EN476 Science Fiction & Fantasy (3)

EN477 Emerging Forms of Literature (3)

EN478 Literary Discourse & Journalistic Writing (3)

EN479 Teaching of Literature (3)

Semester 7 Linguistics

S.No	Course Code	Course Title	Cr Hrs	Pre Req
1	EN451	Language Learning theories	3-0-3	
2	EN452	Pragmatics	3-0-3	EN231
3	EN453	Pedagogical Grammar	3-0-3	
4		Elective I	3-0-3	
5		Elective II	3-0-3	
		Total	15	

Electives to be selected in 7 Semesters:

EN480 Syllabus Designing

EN481 Discourse Analysis

EN482 Applied Linguistics (Forensic, clinical, legal, eco Linguistics)

EN483 World Englishes

EN484 Corpus Linguistics

Semester 8 Linguistics

S.No	Course Code	Course Title	Cr Hrs	Pre Req
1	EN454	Genre Analysis	3	
2	EN456	Stylistics	3	
3	EN499	Research Project	3	EN 361
4		Elective I	3	
5		Elective II	3	
		Total	15	

Electives to be selected in 8 semester:

EN485 Testing and Evaluation

EN486 Language in Education

EN487 English for Specific Purposes

EN488 Translation Studies

EN489 Language, Culture & Identity

MS/MPHIL IN LINGUISTICS**Rationale**

The demands of globalization have a direct and pressing impact on education sector and, consequently, an up gradation of education and research standards is inevitable. Currently, Department of Humanities at Air University, Islamabad is offering a combined Linguistics and Literature (MS/MPhil) Program. However, with the recent increase in the knowledge and research base of the Department after the successful conduct of International conferences in 2015 & 2016 and inauguration of Corpus Research Centre, the onus is on the Faculty and

Department to offer its benefits to the community and generate improvement and transformation in the research environment of the country. Hence, in order to deliver its research and teaching expertise to the society, the MS/MPhil in Linguistics is proposed herewith. Already offered MS/MPhil Linguistics and Literature degree would continue.

Introduction

The MS/ MPhil Program is a full time (morning) degree program, which focuses on the core areas of Linguistics as well as covers the emerging areas. The program is specially designed to facilitate candidates with interests in the field of Linguistics and Applied Linguistics. These areas of specialization are supported by intensive research based projects.

Exact title of program that will appear on the degree

MS/MPhil in Linguistics

Objectives of the Program

This program offers opportunities in critical thinking through comparative analysis and application of theory in a social context where contemporary issues are discussed and evaluated to develop confidence, analytical thought and creativity. These objectives are in line with the vision of the Higher Education Commission in Pakistan to promote informed decision-making, effective citizenship and leadership.

Entry Requirement of the Program

1. Master in English/Linguistics/Applied Linguistics/ELT or Four years Bachelor Degree in English/Linguistics/Applied Linguistics/ELT with minimum 45% marks/ CGPA 2.50/4.00 from HEC recognized institutions.
2. GAT-General Test (at least 50% score)/ Admission Test (at least 60% score). This must be passed before the date of admission in MS Program.
3. Candidates will appear for an interview for the purpose of final selection.

(Note: the University reserves the right to accept or reject applications for admission)

Scope regarding market, social and employment perspective of program

This course prepares individuals to be employed at various places in the society with a wide range of employment opportunities that are for those with a background in English language teaching, linguistics.

The individuals would be critical thinkers who study general linguistics theories and its applied aspects. They would compare and apply theories in social context where contemporary issues are evaluated to develop confidence, analytical thought and creativity. Students would demonstrate knowledge and understanding of linguistic diversity and variability within and across societies and describe how a linguistic theory would interpret relevant data, or how that data is problematic for the theory. In addition, they would analyze data from language structures and relate it to language function.

The individuals would be more informed, decision-makers, effective citizens with leadership qualities.

Some of them could be English language teachers, language software developers, professional writers, lexicographers, publishing copy-editor/proofreaders, speech and language therapists, and translators.

Duration of the Program

Full time (24 months) with 4 semesters including two semesters for course work and two semesters for thesis extendable by two more semesters by Dean of the faculty on the recommendation of Chair Department. This duration can be extended to two regular semesters on the recommendations of Guidance and Evaluation Committee (GEC) and approval by Faculty Board of Graduate Studies (FBGS) if the student fails complete the degree in three academic years, and only if the student is able to successfully justify the extension to FBGS through GEC.

Assessment

1. Internal Assessments (Mid Semester Exam, Projects, Assignments, Presentations, Quizzes, Term/Semester Paper etc.)
2. End of Semester Examinations
3. Synopsis Defense based on the proposal submitted and evaluated by GEC comprising of Research Supervisor, one Internal and one External examiners
4. Quarterly submission of progress report as per AU policy
5. Final Thesis (25,000 to 35,000 words) passed by a panel of examiners (including Supervisor, one Internal and one External evaluator)
6. Final Thesis Defense in accordance with the University's procedures

Letter Grade and Grade Point

The award to the student based on academic performance is called a Grade or Letter Grade. With each letter grade a Grade Point is associated. A student may be awarded one of the following letter grades as shown in the table below.

Subject Letter Grade	Grade Points
A	4
A-	3.67
B+	3.33
B	3.00
B-	2.67
C+	2.33
C	2.00

Utilizing the information from the table above, student's total grade points earned in a semester can be calculated by multiplying grade point associated with the letter grade earned with Cr Hrs of each subject, and then totaling all the grade points of the subject studied in the semester. For example, a student studies three subjects in a semester of 4, 2, and 3 Cr Hrs, and earned A-, B+ and B grades respectively. His/her Grade points for the semester are: $4 \times 3.67 + 2 \times 3.33 + 3 \times 3.00 = 30.34$

Program Break up Semester Wise
Semester I

No.	Course Code	Course Title	Credit Hrs
1	HU ---	Course 1(Elective/Core Course)	3-0-3
2	HU---	Course 2(Elective/Core Course)	3-0-3
3	HU---	Course 3(Elective/Core Course)	3-0-3
4	HU---	Course 4(Elective/Core Course)	3-0-3
Total			12

Second Semester

No	Course Code	Course Title	Total Credit Hrs
1	HU ---	Course 5(Elective/Core Course)	3-0-3
2	HU ---	Course 6(Elective/Core Course)	3-0-3
3	HU ---	Course 7(Elective/Core Course)	3-0-3
4	HU ---	Course 8(Elective/Core Course)	3-0-3
Total			12

Third Semester:

No	Course Code	Course Title	Total Credit Hrs
1	HU799	Thesis	06

Break Down of the Program:

Course Work **24 Cr Hrs(12 Cr Hrs Per Semester)**

Research/Thesis **06 Cr Hrs**

Total: **30 Cr Hrs**

Core Courses

No.	Course Code	Course Title	Credit Hrs
1	HU 620	Phonetics and Phonology	3-0-3
2	HU 639	Semantics and Pragmatics	3-0-3
3	HU 640	Morphology and Syntax	3-0-3
4	HU 622	Research Methodologies	3-0-3
5	HU 602	General Linguistics	3-0-3

Elective Courses

No	Course Code	Course Title	Total Credit Hrs
1	HU 617	Discourse Analysis	3-0-3
2	HU 619	Corpus Linguistics	3-0-3
3	HU 624	Language Teaching: Theory, Research and Practice	3-0-3
4	HU 625	Systematic Functional Linguistics	3-0-3
5	HU 626	Stylistics	3-0-3
6	HU 627	Sociolinguistics	3-0-3
7	HU 628	Psycholinguistics	3-0-3
8	HU 629	Language and Identity	3-0-3
9	HU 631	Pakistani English	3-0-3
10	HU 633	Historical Linguistics	3-0-3
11	HU 634	Genre Studies	3-0-3
12	HU 635	Applied Linguistics	3-0-3
13	HU 636	Second Language Acquisition	3-0-3
14	HU 637	Academic Writing	3-0-3
15	HU 638	Linguistic Typology	3-0-3

*** IF NEED BE, Additional course/s can be prescribed to the students on the advice of supervisor and approval by the Chair/Dean.**

Areas of specialization

This program contributes to two major areas of study: Applied Linguistics and General Linguistics.

1. A dissertation in Applied Linguistics is supported by courses of Linguistics that encompass schools of thought of Language, Sociolinguistics, Psycholinguistics, Translation Studies, Language Planning, Multilingualism, Variation in Language, and Contemporary Theories, language teaching theory, research and practice.
2. A Theoretical Linguistics dissertation is supported by courses of Structural and Functional Linguistics, Systemic Functional Grammar, Stylistics, Lexicology, levels of language and fundamental concepts and theories.

Course Descriptions

HU 620 Phonetics and Phonology

This course covers human sounds in language with special reference to English; the history of phonetics; influences from other languages; reconstructions of earlier forms of English – Old, Middle, Early Modern, Modern; sound shifts, oscillation between related consonants/ between voiced and unvoiced consonants, stress shifts, recent American influence; traditional British RP; the IPA ; supra segmental, stress, intonation, duration, pause, elision.

HU639 Semantics and Pragmatics

This course is designed to familiarize the students with basic concepts of how context contributes to studying language use. In particular this course aims to analyse what speakers mean in terms of implicit and explicit meanings, how context determines meanings and how listeners interpret meanings according to context. This course focuses on major aspect of linguistic pragmatics like presupposition, deixis, speech acts, cooperative principle, politeness theories and different aspects of language related to meaning making in the context.

HU640 Morphology and Syntax

The course focuses on the interplay between morphology and syntax in the functioning of languages, and how it is brought to bear on the complex and often confusing task of describing a language. Working through the course, the major morphological and syntactic, categories will be highlighted and their intra-sentential interrelationships will be demonstrated. The value of descriptive linguistic research in general will be emphasized and the relevance of the morphosyntactic approach in the description of Languages will be shown.

HU 622 Research Methodologies

This course addresses the needs of novice researchers in the social sciences, with particular focus on linguistic and literary studies; it facilitates student learning through lectures, seminars and a strong practical component. Students are encouraged to participate, present their ideas and think their way through the processes and paradigms of modern research. They are also provided with the hands on practice to develop research skills.

HU 617 Discourse Analysis

This interdisciplinary course covers discourse studies, critical discourse and discourse analysis. Various theories and methods relevant to linguistic and sociological analysis are studied; with its strong practical component, this course is designed to facilitate students of linguistic and literary studies to a deeper understanding of the historical background, concepts and methodological approaches of critical discourse analysis.

HU 602 General Linguistics

An overview of the origins and functions of language is made in this course. It covers topics like language families, language and thought, factors in communication and the development of alphabetic and writing systems, it includes introductions to the main branches of Theoretical Linguistics, Phonology (covered in detail in HU 601), Morphology, Syntax and Semantics/Pragmatics, Sociolinguistics and Psycholinguistics (covered in depth in HU 610 and HU 611).

HU 619 Corpus Linguistics

This course is an introduction to the fast growing field of corpus linguistics. It aims to familiarize students with key concepts and common methods used in the construction and analysis of language corpora, as well as tools that have been developed for searching and using major corpora such as the British National Corpus. Students will be given hands-on experience in analyzing their own corpora through software. Criteria and methods used for evaluating corpora and analytical tools will also be discussed with updated references of research materials and viewpoints of renowned corpus linguists.

HU 624 Language Teaching; Theory, Research and Practice

This course includes teaching approaches, methods and practices, and implications for research in Pakistan. General and language learning theories are discussed, together with related interests in classroom techniques, curriculum development, course/syllabus design, study material development and assessment and evaluation procedures relevant to language learning.

HU 625 Systemic Functional Linguistics

This course facilitates discussions in Theoretical Linguistics. It is designed to enable advanced students of linguistic research to become fully conversant with the notions of Systemic Functional Linguistics which lies in the mainstream of British linguistics, in contrast to Chomskian Linguistics and other Structuralist approaches of the American school.

HU 626 Stylistics

Stylistics is a branch of Linguistics acting as a bridge between Linguistics and Literature. Stylistics applies the insights of linguistics to the study and interpretation of literature. Stylistics can provide workable approaches for the comprehension of literature. This course covers the essentials of linguistics in phonology, morphology, syntax, semantics/pragmatics, selection restriction rules, the elements of style, historical and contemporary ideas and the analysis of text for students of stylistics.

HU 627 Sociolinguistics

The study of language enhances one's understanding of the social, political and ethical dimensions of society. This course explores the development of language standards, dialects, registers, pidgins, creoles and the effects of language planning and official policy; topics like language accommodation of groups in contact, bilingualism, lingua francas and the changing status of English are covered.

HU 628 Psycholinguistics

This course covers essential elements in the study of the relationship between linguistics and psychology. Both disciplines are extensive, touching upon most areas of human thinking, feeling and acting. The observations of writers such as de Saussure, Bloomfield, Boas, Sapir, Whorf and Chomsky are discussed. This course includes questions of origin, animal communication, speech centers in the brain, child language acquisition, receptive and productive skills, speech act theory, aphasias, dyslexia, therapy, the relation between language, personality and thinking and possibilities in experimentation and laboratory work.

HU 629 Language and Identity

This course is designed to facilitate students who are curious about the formation of identity through linguistic dispositions. Language lies at the center of social organization at different levels. It helps humans to cooperate, plan and remember things; language can also create wide gaps between groups and communities; issues like language choice, social mobility, economic advantage, prestige, esteem and the construction of group, regional and national identities are included in this course.

HU 631 Pakistani English

The development of non-native varieties; historical overview, world 'English's,' chaos theory, the introduction of English to this region; early incentives and compulsions; the situation today; the effects of first language interference--transference and the development of Pakistani dialects of English; phonological, morphological, syntactic and semantic deviations; questions of acceptability at national and international levels, standardization, indigenization and reverse influence are discussed.

HU633 Historical Linguistics

All languages are constantly in a process of change and over time related languages can diverge and become different from one another. Linguists have developed techniques for studying language change and for comparing languages in order to group them into families and reconstruct their parent forms. The aim of this course is to familiarise students with the techniques of language comparison and reconstruction, based on materials from the study of Indo-European languages, but also illustrating the methods with data from a range of other language families. At the conclusion of the course, students will be familiar with reconstruction and comparison methods for any set of language data.

HU634 Genre Studies

This course explores the role of genre in shaping society and the everyday actions of individuals. Students will explore the following questions: What constitutes a genre, and what functions does it accomplish in the world? How does a genre work to stabilize knowledge and particular realities in various contexts? How can the use of genre promote social change? What happens when genre expectations are not met, that is, when the genre conventions accepted by a particular community are flouted either intentionally or by mistake? As students formulate answers to these questions, they will come to understand genres not as static categories but as dynamic ways of processing information that shape the world we inhabit.

HU635 Applied Linguistics

Applied Linguistics is the application of research-based linguistic theory, practice, and methodology to language-related tasks or problems. The primary focus is on language teaching and learning, particularly with regard to foreign languages. Applied Linguistics also covers the topics of pragmatics, forensics, language planning, linguistics, literacy, multilingualism, discourse analysis, and computer mediated communication.

HU636 Second Language Acquisition

This course provides an introduction and overview to research on second language acquisition. We will examine major theories of second language acquisition (SLA) as well as the developmental stages and individual

differences among language learners. A field experience component of the course will allow you to observe some aspects of the language acquisition and development process.

HU637 Academic Writing

This course aims to help you improve your academic writing. It emphasizes the interrelatedness of critical reading, writing, and thinking. It asks you to locate and closely examine published research articles on a topic in your field to use as you develop the conventions of academic writing. In a workshop setting, you will learn and practice concrete strategies for composing and revising texts and you will develop greater metacognitive awareness of your writing processes.

HU638 Linguistic Typology

This course is an introduction to the principles and practices of linguistic typology, i.e. the cross-linguistic comparison of formal features of languages independent of their historical and geographical connections. Typologists examine variation between languages in terms of their structural characteristics, attempt to account for the distribution of the variation encountered and provide explanations for the patterns uncovered. At the conclusion of the course students will be familiar with the main trends in 20th and 21st century language typology in terms of phonology, morphology and syntax. They will understand the key methodological principles of typology and have a greater understanding of the ways in which languages are similar (linguistic universals) and different (linguistic diversity).

(Note: Courses may be modified, added or dropped in accordance with the University's policies. Courses may not be available in a given semester if minimal conditions are not met).

PhD in Linguistics and Literature

Introduction

The PhD program is designed round studies in English Literature and Linguistics for candidates interested in pursuing advanced research in these fields. The current focus is on Linguistics and Literature. Essentially a continuation of the MS/M.Phil program offered by the Department of Humanities, this program provides students with a wide background in literature and in theoretical and applied linguistics through research-oriented courses.

Aim

This program provides opportunities for critical thinking through analysis and the application of theory to issues in language and literature relevant to Pakistan. The objectives of the program are in line with the vision of the Higher Education Commission of Pakistan to promote informed decision-making, effective citizenship and leadership.

Title of the program

PhD in Linguistics and Literature

Program Length: Full time attendance for two semesters of 18 Credit Hours followed by research work of 30 credit hours. The minimum duration of PhD Program is three years. It can be extended to a maximum of four years on recommendation of GEC and subsequent approval of FBGS.

A student with CGPA of 3.0/4 or more may take leave of up to one semester after the completion of his/her course work. Such leave will not be counted towards the duration of PhD studies.

1. **Entry requirements:**

- i. M.Phil/MS in English or equivalent with thesis with a minimum 3.0/4 CGPA from an institution recognized by HEC/AU:
- ii. GRE/GAT Subject successful completion of an examination prescribed by the National Testing Service, other requirements as stipulated by the Higher Education Commission and successful completion of Air University's admission procedures.
- iii. Research Proposal to be submitted

(Note: the University reserves the right to accept or reject applications for admission)

Qualifying Examination

A PhD student shall be required to pass Comprehensive Examination and Subject Examination.

10. **Comprehensive Examination (CE)** is based on PhD/MS level courses approved in the plan of study of the student. The mode of examination is comprehensive written test and grading is pass or fail. The paper for the CE will be prepared and checked by the concerned department.
11. **Subject Examination (SE):** After passing CE, the students appear in SE which is meant to assess the approach of tackling research problems. The mode of examination is presentation of proposed research before the committee appointed by HOD comprising three examiners including the supervisor. The supervisor will be the chair of that committee.

Assessment:

- Internal Assessments (Projects, Assignments, Presentations etc)
- End of semester examinations:
- Dissertation passed by a panel of examiners (including two internal and one external evaluators)
- Viva-voce in accordance with the University's procedures:
- At least one research paper published in a journal recognized by Higher Education Commission

Program of studies

Semester I

Course Code	Course Title	Cr. Hrs
HU---	Elective Course I	3-0-3
HU---	Elective Course II	3-0-3
HU---	Elective Course III	3-0-3
Total		9 Cr Hrs

Semester II

Course Code	Course Title	Cr. Hrs
HU---	Elective Course IV	3-0-3
HU---	Elective Course V	3-0-3
HU---	Elective Course VI	3-0-3
Total		9 Cr Hrs

Semester III

Course Code	Course Title	Credit hours
HU799	Thesis (Core Course)	30

Total Cr Hrs: - 48 Crs

List of Electives

No.	Course Code	Course Title	Total Credit Hrs
1	HU 701	Postcolonial Discourse	Elective 3
2	HU 702	Advanced Stylistics	Elective 3
3	HU 703	World Literatures/ Literature in Translation	Elective 3
4	HU 704	Research in Humanities and Social Sciences	Elective 3
5	HU 705	Shakespearean Studies	Elective 3
6	HU 706	Literary theory and its Applications	Elective 3
7	HU 707	Pakistani Literature in English	Elective 3
8	HU 708	Literature of North America	Elective 3
9	HU 709	Translation Studies	Elective 3
10	HU 715	Corpus Linguistics	Elective 3
11	HU 716	Computational Linguistics	Elective 3
12	HU 717	Feminist Linguistics	Elective 3
13	HU 718	Language Planning and Education	Elective 3
14	HU 719	Language and Power	Elective 3
15	HU 720	Advanced Grammatical Models	Elective 3
16	HU 721	Philosophy of Language	Elective 3
17	HU 722	Language Learning & Teaching Paradigms	Elective 3
18	HU 723	Cognitive Linguistics	Elective 3
19	HU 724	Genre Studies/Analysis	Elective 3
20	HU725	Corpus Linguistics and Research	Elective 3
21	HU726	South Asian Literature in English	Elective 3

Detailed Course Contents

HU 701 Postcolonial Discourse

This course is designed to assist students who are interested in Post-Structural and Postcolonial Studies; Orientalism both traditional and modern is included. Political, linguistic and cultural structures of postcolonial societies are also studied in the context of Language use and Literature written in and about postcolonial countries. The course includes an overview of the main contributors to postcolonial writing, theory and criticism.

HU 702 Advanced Stylistics

Literary critics sometimes complain that stylistics does not help with the appreciation of literary texts, while linguists complain that literary criticism does not help with the appreciation of linguistic interests. Going beyond basic Stylistics, Advanced Stylistics seeks to explicate texts within a wider context while still maintaining its primary bearings in the functions, forms and usage of language; practicum with selected literary works.

HU 703 World Literatures/ Literature in Translation

This course provides perspectives outside the dominant Anglo-Saxon tradition and stream-- an overview of major works in translation from non-English speaking writers; selected Russian fiction writers of the nineteenth and twentieth century; Magic Realism, selected South American fiction writers; South Asian literature in translation; selected Pakistani poets and writers.

HU 704 Research in Humanities and Social Sciences

This course is designed for researchers taking up PhD research work in the social sciences with a particular focus on linguistic and literary studies. This course facilitates student learning through lectures, seminars and a strong practical component where the students have to do a small project. Students are encouraged to participate, present their ideas and think their way through the processes and paradigms of modern research. Students practice reviewing the previous literature, writing the introduction and the purpose statement, asking the right research questions, stating the research hypotheses, using a linguistic theory to analyze research data, defining the major terms used in the study, setting in clear terms the limits of the research being conducted, stating the significance of carrying the research., and using varied sources useful to the topic of research. The students also explore different types of research methods and their procedures, including the use of statistical tests to determine the significance of their research results.

HU 705 Shakespearean Studies

Shakespeare is studied as a poet and dramatist through selected works in the context (a) of the Elizabethan age and (b) of his continuing relevance to English speakers today. Challenges to his authorship are discussed; his contribution to the English language is noted in this course. Two tragedies and two comedies form the core material of this course

HU 706 Literary Theory and its Applications

This course focuses on the explication, evaluation and contextualization of theory and practice of literary criticism. Students are introduced to the working concepts of the critical tradition within a broader intellectual history. Modern movements in criticism and the ideas of individual theorists are presented as part of an ongoing conversation with critical and aesthetic precursors going back as far as Plato

HU 707 Pakistani Literature in English

Selected writings in English by Pakistani authors in full-length fiction and poetry are studied. Questions of themes, the choice of language, the appropriation of language, the purpose or purposes of writing in English, local and foreign readers of Pakistani writings, code-mixing, multiculturalism and deviant usage are discussed. The diasporas and Pakistani writings abroad are also covered. Selections from three novelists (two based in Pakistan and one abroad) and three poets form the core material of this course.

HU 708 Literature of North America

North America has the largest group of speakers of English in the world today; therefore, from this region short history, early European influences, independence, expansion of frontiers, industrial and political development, new themes and interests; linguistic influences and development; selected writings; short stories, longer fiction, prose, drama and poetry; the American contribution and influence; criticism, theory and practice are studied in depth.

HU 709 Translation Studies

This course discusses the primary implications of translation such as historical reportage of spoken forms, old texts, interpretive constraints, changes in meaning, absence of situational, gestural and non-verbal reinforcement, cultural implications, crusts of meaning, connotation and denotation, situations, contexts, differences in language, differences in perception and understanding, meanings and effects generated by non-representative features of language. Theories of translation and practical approaches are also included in this course.

HU 715 Corpus Linguistics

Corpus Linguistics is a methodology whereby large collections of electronically transcribed texts are used in conjunction with computer tools to investigate language. This course aims to provide a general introduction to corpus based language study. The course is centered round three main parts—different types of corpora; methods of analysis to explore linguistic variation (concordances, collocations, frequency lists, Keynes); and applications of corpus linguistics in language teaching.

HU 716 Computational Linguistics

Language and Machines; Artificial Intelligence, Linguistic Machines, Robotics, Machine Translation and related interests are discussed in this course. It includes sociological, national and international dimensions, advantages and disadvantages and linguistic change. This course also discusses implications, for present assumptions about literacy and numeracy as linguistic and educational tools and offers insight to psychology of the individual and for society as a whole

HU 717 Feminist Linguistics

Feminism in some form or the other is probably as old as the human race itself. The primary interests here are the writings of feminists in the second half of the twentieth century. These showed how deeply-etched attitudes embedded in many major world languages perpetuated and reinforced negative perceptions of women. Feminist writings contributed to what is known as 'political correctness,' greater care is taken in the use of language in order to avoid exacerbating gender and social sensitivities in discourse

HU 718 Language Planning and Education

Language is the primary tool for the acquisition of knowledge. Status and Corpus planning, the link between language and education in general, a brief overview of official policy in Pakistan since its inception ideology, early planning, changing emphases for Urdu, English and the regional languages, language policy, successes, partial successes and failures in implementation, the present position and implications for education in the country are also discovered in this course.

HU 719 Language and Power

This course includes Advanced Sociolinguistics: language as an important component of organization; power structures in institutions and groups: governance and language; manipulation; analyses of selected political speeches; analyses of advertising and commercial propaganda; the language of untruth, linguistic smokescreens; ambiguity, the language of negation, innuendo and suggestion, suggestio falsi, suppressio veri; language as an individual or social construct rather than as a reliable reflection of reality; the rhetoric of power; how language uses people--guiding pathways of thinking, suggestibility, subliminal influence; the force of linguistic labels, linguistic categorization and the psychology of power; softening and demonizing things through language, cultural sensitivities, euphemisms, dysphemisms

HU 720 Advanced Grammatical Models

Traditional ideas are discussed in this course, starting from old prescriptive, Latinate models; grammar as a tool of language learning; kinds of languages (synthetic, analytic, agglutinative, etc), Linguistic Descriptive Grammar, Transformational-Generative Grammar, Systemic Grammar, Firthian Models, Functional Grammar and contextualization are included. The potential of these models for teaching/learning languages is explored and compared with approaches in vogue in Pakistan today;

HU 721 Philosophy of Language

The writings of philosophers over the centuries; the ancient Greeks and Romans; traditional logic; rhetoric in the classical age; in the middle ages; German thinkers, Novalis, the Schlegels, Herder, others; British thinkers, Locke, Hume, Berkeley, others; logical positivism, Wittgenstein, Russell, others; human thinking and language; logical fallacies generated by language; language and theories of knowledge; language as the primary tool of knowledge are explored in this extensive course.

HU 722 Language Learning & Teaching Paradigms

The purpose of this course is to provide a sequence of readings and learning experiences that will enable the consistent application of theories of learning, in designing classroom learning experiences, developing a classroom learning community, and assessing progress towards desired outcomes. Primary theories and perspectives related to learning, including behavioral, developmental, cognitive, social cognitive, socio-cultural, and constructivist learning theories will be covered. In addition, we examine how these different theories address student assessment, motivation, self-regulation, and classroom management

HU 723 Cognitive Linguistics

Cognitive Linguistics is the study of the mind through language and the study of language as a cognitive function. The course focuses on studying how cognitive mechanisms like memory, categorization, attention, and imagery are used during language behavior, and on understanding psychologically viable models of language that cover broad ranges of linguistic phenomena, including idioms and figurative language. Research in Cognitive

Linguistics is multidisciplinary. Evidence is drawn from text analysis, language acquisition, language change, psycholinguistic experimentation, and brain imaging, among other sources.

HU 724 Genre Studies/ Analysis

The course focuses on developing an understanding of rhetorical strategies for accomplishing intentions as writers, methods of communicating effectively with the intended audience, and the genre approach for analyzing conventional features of discourse. Raising critical consciousness of rhetorical purposes and ideological effects of generic forms, the ability to act and contribute in relevant ways in a specific discourse community will be developed amongst the students. Course offerings include but are not limited to areas such as Genre Theory, Rhetorical Situation, Discourse Community, Academic Genres, Research Genres, Cyber Genres, Professional Genres, Popular Genres, and Literary Genres. Class discussions would also include media and films.

The attributes of academic audiences, the strategies academic writers employ to achieve their intentions and the conventional genre features of academic discourse will be examined. Along with the analysis of other genres, the students will be asked to analyze a small sample of academic articles for rhetorical and genre features as a way of helping them become familiar with the conventions of academic discourse and the expectations of academic audiences.

(Note: Courses may be modified, added or dropped in accordance with the University's policies. Courses may not be available in a given semester if minimal conditions are not met)

PhD in Linguistics

Department of Humanities

Rationale

As an advancement to the foundational knowledge of linguistics, there is a need for launching PhD in Linguistics program in a bid to enable PhD students to demonstrate an advanced understanding of important topics and theories, as well as familiarity with the nature of data and the methods of research, in the domains of linguistic analysis in a wide range of areas. The PhD in Linguistics program draws upon the foundational knowledge from linguistics to develop a broad-based understanding of a range of scholarly domains within the field. The diversity of emphasis that characterizes the linguistics scholarship is reflected in the wide range of research and teaching areas being offered as a package of the program at Air University. The graduates of PhD in Linguistics program will demonstrate a commitment to professional engagement and will be recognized for excellence in their specific areas of the field, including participation in professional events, dissemination of research in various forums, and contributions that enhance scholarly exchange and practical application of their scholarly work.

Introduction

The PhD program is a full time (morning) degree program, which is designed around courses in Linguistics for candidates interested in pursuing advanced research in these fields. The current focus is on Linguistics. Essentially a continuation of the MS/M.Phil Linguistics offered by the Department of Humanities, this program provides students with a wide background in Linguistics in theoretical and applied areas through research-oriented courses.

Exact title of program that will appear on the degree

PhD in Linguistics

Objectives of the Program

This program provides opportunities for critical thinking through analysis and the application of theory to issues in language and linguistics in Pakistan as well as across the globe. The objectives of the program are in line with the vision of the Higher Education Commission of Pakistan to promote informed decision-making, effective citizenship and leadership.

Scope regarding market, social and employment perspective of program

Employment opportunities at national and international level in government, private sector, multinational companies, educational sector, in a range of positions that are related to English, ESP, linguistics and a number of its sub branches e.g., linguistic experts, writers, analysts, public relation and communication officers, curriculum planners, translator, Research expert, teacher, journalist, social workers etc.

Entry Requirement of Program:

1. M.Phil/MS in English/Linguistics/Applied Linguistics/ELT or equivalent (24 credit hours course work along with 6 credit hours for thesis) with minimum CGPA 3.00/4.00 or equivalent from an institution recognized by the Higher Education Commission.
2. The candidate must have cleared GAT Subject Test (minimum 60% cumulative score) or a GRE Subject Test (at least 60th percentile)/Admission test (at least 70% score) before the date of admission to the PhD Program.
3. Other requirements as stipulated by the Higher Education Commission.
4. Successful completion of the University's admission procedure.
5. Candidates who qualify the Admission Test will be required to submit Research Proposal as a pre-requisite to appear for an interview for final selection.

(Note: the University reserves the right to accept or reject applications for admission)

Duration of the Program

Full time attendance for two semesters of 18 Credit Hours (Course Work **09** Cr Hrs per semester) followed by research work of 30 credit hours. The minimum duration of PhD Program is three academic years, extendable by three more academic years by Dean of the Faculty on the recommendation of Chair Department, and extendable to one further semester depending on the approval of the Faculty Board of Graduate Studies (FBGS).

A student with CGPA of 3.00/4.00 or more may take leave of up to one semester after the completion of his/her course work with valid justification as per AU policy. Such leave will not be counted towards the duration of PhD studies.

Assessment:

1. Internal Assessments (Mid Semester Exam, Projects, Assignments, Presentations, Quizzes, Term/Semester Paper etc)
2. End of semester examinations
3. Comprehensive Examination after the successful completion of course work

4. Synopsis Defense based on the proposal submitted and evaluated by Guidance and Evaluation committee (GEC) comprising of Research Supervisor, two Internal and two External Examiners
5. Quarterly submission of progress report as per AU policy.
6. Final Thesis passed by a panel of examiners (including Supervisor, two Internal, two External and two Foreign Evaluators)
7. Final Thesis Defense (75,000 to 90,000 words) in accordance with the University's procedures
8. At least one research paper published in a journal recognized by Higher Education Commission for the award of PhD degree

Letter Grade and Grade Point

The award to the student based on academic performance is called a Grade or Letter Grade. With each letter grade a Grade Point is associated. A student may be awarded one of the following letter grades as shown in the table below.

Subject Letter Grade	Grade Points
A	4
A-	3.67
B+	3.33
B	3.00
B-	2.67
C+	2.33
C	2.00

Utilizing the information from the table above, student's total grade points earned in a semester can be calculated by multiplying grade point associated with the letter grade earned with Cr Hrs of each subject, and then totaling all the grade points of the subject studied in the semester. For example, a student studies three subjects in a semester of 4, 2, and 3 Cr Hrs, and earned A-, B+ and B grades respectively. His/her Grade points for the semester are: $4 \times 3.67 + 2 \times 3.33 + 3 \times 3.00 = 30.34$

Program Break up Semester Wise

First Semester: Students may choose either of the elective courses to complete a total of 09 credit Hours.

No.	Course Code	Course Title	Total Credit Hrs
1	HU ---	Elective Subject I	3-0-3
2	HU ---	Elective Subject II	3-0-3
3	HU ---	Elective Subject III	3-0-3
		Total	09

Second Semester

Students may choose either of the elective courses to complete a total of 09 credit Hours.

No	Course Code	Course Title	Total Credit Hrs
1	HU ---	Elective Subject IV	3-0-3
2	HU ---	Elective Subject V	3-0-3
3	HU ---	Elective Subject VI	3-0-3
		Total	09

Third Semester:

No	Course Code	Course Title	Total Credit Hrs
1	HU799	Thesis	30

Course Work 18 Cr Hrs (9cr Hrs per semester)
Research/Thesis 30 Cr Hrs

Total: 48 Cr Hrs

List of Courses (All Elective Courses)

No.	Course Code	Course Title		Total Credit Hrs
1	HU 702	Advanced Stylistics		3-0-3
2	HU 704	Research in Humanities and Social Sciences		3-0-3
3	HU 709	Translation Studies		3-0-3
4	HU 716	Computational Linguistics		3-0-3
5	HU 717	Feminist Linguistics		3-0-3
6	HU 718	Language Planning and Education		3-0-3
7	HU 719	Language and Power		3-0-3
8	HU 720	Advanced Grammatical Models		3-0-3
9	HU 721	Philosophy of Language		3-0-3
10	HU 722	Language Learning & Teaching Paradigms		3-0-3
11	HU 723	Cognitive Linguistics		3-0-3
12	HU 728	Corpus Linguistics and Research		3-0-3
13	HU 729	Genre Studies and Research		3-0-3
14	HU 730	Languages and Globalization		3-0-3
15	HU 731	Second Language Acquisition and Bilingualism		3-0-3
16	HU 732	*Field Research Methods in Linguistics		3-0-3
17	HU 733	*Qualitative Research Methods in Linguistics		3-0-3
18	HU 734	*Quantitative Research Methods in Linguistics		3-0-3

19	HU 735	Advanced Morphology and Syntax		3-0-3
20	HU 736	Advanced Phonetics and Phonology		3-0-3
21	HU 737	Language and Gender		3-0-3
22	HU 715	Corpus Linguistics		3-0-3
23	HU 724	Genre Studies/Analysis		3-0-3

*** IF NEED BE, Additional course/s can be prescribed for these and/or other courses to the students on the advice of supervisor and approval by the Chair/Dean.**

Areas of specialization

This program contributes to two major areas of study: Applied Linguistics and General Linguistics.

3. A dissertation in Applied Linguistics is supported by courses of Linguistics that encompass schools of thought of Language, Sociolinguistics, Psycholinguistics, Translation Studies, Language Planning, Multilingualism, Variation in Language, and Contemporary Theories, language teaching theory, research and practice.
4. A Theoretical Linguistics dissertation is supported by courses of Structural and Functional Linguistics, Systemic Functional Grammar, Stylistics, Lexicology, levels of language and fundamental concepts and theories.

Curriculum Details All Elective Courses

HU 702 Advanced Stylistics

Literary critics sometimes complain that stylistics does not help with the appreciation of literary texts, while linguists complain that literary criticism does not help with the appreciation of linguistic interests. Going beyond basic Stylistics, Advanced Stylistics seeks to explicate texts within a wider context while still maintaining its primary bearings in the functions, forms and usage of language; practicum with selected literary works.

HU 704 Research in Humanities and Social Sciences

This course is designed for researchers taking up PhD research work in the social sciences with a particular focus on linguistic and literary studies. This course facilitates student learning through lectures, seminars and a strong practical component where the students have to do a small project. Students are encouraged to participate, present their ideas and think their way through the processes and paradigms of modern research. Students practice reviewing the previous literature, writing the introduction and the purpose statement, asking the right research questions, stating the research hypotheses, using a linguistic theory to analyze research data, defining the major terms used in the study, setting in clear terms the limits of the research being conducted, stating the significance of carrying the research., and using varied sources useful to the topic of research. The students also explore different types of research methods and their procedures, including the use of statistical tests to determine the significance of their research results.

HU 709 Translation Studies

This course discusses the primary implications of translation such as historical reportage of spoken forms, old texts, interpretive constraints, changes in meaning, absence of situational, gestural and non-verbal reinforcement, cultural implications, crusts of meaning, connotation and denotation, situations, contexts, differences in language, differences in perception and understanding, meanings and effects generated by non-representative features of language. Theories of translation and practical approaches are also included in this course.

HU 716 Computational Linguistics

Language and Machines; Artificial Intelligence, Linguistic Machines, Robotics, Machine Translation and related interests are discussed in this course. It includes sociological, national and international dimensions, advantages and disadvantages and linguistic change. This course also discusses implications, for present assumptions about literacy and numeracy as linguistic and educational tools and offers insight to psychology of the individual and for society as a whole.

HU 717 Feminist Linguistics

Feminism in some form or the other is probably as old as the human race itself. The primary interests here are the writings of feminists in the second half of the twentieth century. These showed how deeply-etched attitudes embedded in many major world languages perpetuated and reinforced negative perceptions of women. Feminist writings contributed to what is known as 'political correctness,' greater care is. Status and Corpus planning, the link between language and education in general, a brief taken in the use of language in order to avoid exacerbating gender and social sensitivities in discourse.

HU 718 Language Planning and Education

Language is the primary tool for the acquisition of knowledge overview of official policy in Pakistan since its inception ideology, early planning, changing emphases for Urdu, English and the regional languages, language policy, successes, partial successes and failures in implementation, the present position and implications for education in the country are also discovered in this course.

HU 719 Language and Power

This course includes Advanced Sociolinguistics: language as an important component of organization; power structures in institutions and groups: governance and language; manipulation; analyses of selected political speeches; analyses of advertising and commercial propaganda; the language of untruth, linguistic smokescreens; ambiguity, the language of negation, innuendo and suggestion, suggestiofalsi, suppressioveri; language as an individual or social construct rather than as a reliable reflection of reality; the rhetoric of power; how language uses people--guiding pathways of thinking, suggestibility, subliminal influence; the force of linguistic labels, linguistic categorization and the psychology of power; softening and demonizing things through language, cultural sensitivities, euphemisms, dysphemisms.

HU 720 Advanced Grammatical Models

Traditional ideas are discussed in this course, starting from old prescriptive, Latinate models; grammar as a tool of language learning; kinds of languages (synthetic, analytic, agglutinative, etc), Linguistic Descriptive Grammar, Transformational-Generative Grammar, Systemic Grammar, Firthian Models, Functional Grammar and contextualization are included. The potential of these models for teaching/learning languages is explored and compared with approaches in vogue in Pakistan today.

HU 721 Philosophy of Language

The writings of philosophers over the centuries; the ancient Greeks and Romans; traditional logic; rhetoric in the classical age; in the middle ages; German thinkers, Novalis, the Schlegels, Herder, others; British thinkers, Locke, Hume, Berkeley, others; logical positivism, Wittgenstein, Russell, others; human thinking and language; logical

fallacies generated by language; language and theories of knowledge; language as the primary tool of knowledge are explored in this extensive course.

HU 722 Language Learning & Teaching Paradigms

The purpose of this course is to provide a sequence of readings and learning experiences that will enable the consistent application of theories of learning, in designing classroom learning experiences, developing a classroom learning community, and assessing progress towards desired outcomes. Primary theories and perspectives related to learning, including behavioral, developmental, cognitive, social cognitive, socio-cultural, and constructivist learning theories will be covered. In addition, we examine how these different theories address student assessment, motivation, self-regulation, and classroom management.

HU 723 Cognitive Linguistics

Cognitive Linguistics is the study of the mind through language and the study of language as a cognitive function. The course focuses on studying how cognitive mechanisms like memory, categorization, attention, and imagery are used during language behavior, and on understanding psychologically viable models of language that cover broad ranges of linguistic phenomena, including idioms and figurative language. Research in Cognitive Linguistics is multidisciplinary. Evidence is drawn from text analysis, language acquisition, language change, psycholinguistic experimentation, and brain imaging, among other sources.

HU 728 Corpus Linguistics and Research

Corpus Linguistics is a methodology whereby large collections of electronically transcribed texts are used in conjunction with computer tools to investigate language. This course provides an indepth exposure to the fast growing field of corpus linguistics. It aims to familiarise students with key concepts and common methods used in the construction of language corpora, as well as tools that have been developed for searching and using major corpora such as the British National Corpus. Students will be given hands-on experience in pre-editing, annotating, and searching corpora. Criteria and methods used for evaluating corpora and analytical tools will also be discussed. The main aim of this module is to master the uses of text corpora in linguistics research and applications.

HU 729 Genre Studies and Research

The course focuses on developing an understanding of rhetorical strategies for accomplishing intentions as writers, methods of communicating effectively with the intended audience, and the genre approach for analyzing conventional features of discourse with the aim of practical application. This course aims to provide students with an opportunity to explore various genres produced in academic, workplace, and transitional (academic-to-workplace) and/or literary contexts. Students will be asked to choose and research particular social situations, analyze texts produced in the contexts of these situations, and present the results of these explorations in written assignments and oral presentations. Students will be asked to go through drafting and peer review and revision processes while working on the course assignments. In-class time will be provided for peer review sessions. Social contexts and genres to be explored will be negotiated among students and the instructor.

HU 730 Languages and Globalization

This advanced doctoral course will consider the role of language in the processes of globalization, with a particular focus on English and education. We will take as our starting point the inextricable relationship between language and power to explore the ways in which English has become a global force and how other languages are faring in a globalized world. The course will aim to map ethnographic studies of language and education against our developing understandings of globalization, aided by the work of theorists of language and power. Exploring ethnographic studies against the work of these theorists (and vice versa) will help illuminate the important ways in which language and literacy constitute key stages on which struggles for power and access to social resources are played out—here, taking into consideration the processes of globalization. Engaging with a range of theories and ethnographic studies should help students consider directions for their own scholarly projects. Students will design their own final projects in keeping with the approaches to the study of language and power explored in the course.

HU 731 Second Language Acquisition and Bilingualism

This course provides an introduction and overview to research on second language acquisition and bilingualism. We will examine major theories of bilingualism and second language acquisition (SLA) as well as the developmental stages and individual differences among language learners. A field experience component of the course will allow you to observe some aspects of the language acquisition and development process. The course will also introduce research areas related to second language acquisition and bilingualism and the techniques used for research in the area.

HU 732 Field Research Methods in Linguistics

This course will draw upon all aspects of students' linguistic training – phonology, phonetics, morphology, syntax, semantics and the success of the course will depend partly on the ability of students with complementary skill sets to work collaboratively and cooperatively.

HU 733 Qualitative Research Methods in Linguistics

This required doctoral research methods course will introduce PhD students to qualitative research in education. The course will offer students an opportunity to explore the theoretical and philosophical foundations of qualitative inquiry while applying these principles in a research project. This course provides an overview of advanced quantitative methods that are widely used by researchers in educational, social science, and public health settings. Through active participation in this course, students will be able to understand and use more sophisticated statistical techniques to: (1) formulate and test relevant research hypotheses; (2) conduct rigorous data analysis; (3) interpret results; (4) report and present research findings; and (5) evaluate existing quantitative research.

HU 734 Quantitative Research Methods in Linguistics

This course provides students with an introduction to the quantitative methods that are commonly used in education research. It covers basic concepts underlying statistical and quantitative reasoning, including descriptive statistics, probability, statistical inference, hypothesis testing, analysis of variance, correlation, and bivariate and multivariate regression analysis. Students are expected to engage in computer-based analyses of

education-related problems using SPSS. This course is designed to provide advanced doctoral students with the opportunity to investigate and authentically use qualitative research methods. Authentic in this case means that the research project should further the student's dissertation research. In other words, the research completed will be "real" and not simply a course assignment. Readings and class discussion will focus on rigorous qualitative study design.

HU 735 Advanced Morphology and Syntax

This consists of detailed studies of new trend and various aspects of the grammar. The different models of grammar, with emphasis on the nature of the semantic component and transformations should be examined. Morphophonemics and an advanced study of the word form, lexeme and the morphological processes of English should also receive emphasis.

HU 736 Advanced Phonetics and Phonology

The purpose of this course is to give the student advanced knowledge concerning the analysis of speech sounds. In addition, it presents the most prominent and recent theories in acoustic composition analysis and perception. The course provides the student also with the practical skills in conducting phonological experiments that deal with the principles of the composition of speech sounds and the different transformations they might undergo during their production both segmentally and nonsegmentally.

HU 737 Language and Gender

This course provides an in depth knowledge of the large body of literature on Language and Gender within Sociolinguistics and within studies of language in social context more generally. Students will investigate how language in use mediates, and is mediated by, social constructions of gender and sexuality. An emphasis on the history of research in language and gender, which contains distinct phases and movements in the field, will culminate in a current description of the state of language and gender research today. Particular attention will be paid to the evolution of feminist theory, ideology, hegemony, performativity, and the "borders" of gender identities. Students will read scholarly articles and write critical reflection papers, and complete a final paper on a topic related to language and gender.

HU 715 Corpus Linguistics

Corpus Linguistics is a methodology whereby large collections of electronically transcribed texts are used in conjunction with computer tools to investigate language. This course aims to provide a general introduction to corpus based language study. The course is centered round three main parts—different types of corpora; methods of analysis to explore linguistic variation (concordances, collocations, frequency lists, Keynes); and applications of corpus linguistics in language teaching.

HU 724 Genre Studies/ Analysis

The course focuses on developing an understanding of rhetorical strategies for accomplishing intentions as writers, methods of communicating effectively with the intended audience, and the genre approach for analyzing conventional features of discourse. Raising critical consciousness of rhetorical purposes and ideological effects of generic forms, the ability to act and contribute in relevant ways in a specific discourse community will be developed amongst the students. Course offerings include but are not limited to areas such as Genre Theory,

Rhetorical Situation, Discourse Community, Academic Genres, Research Genres, Cyber Genres, Professional Genres, Popular Genres, and Literary Genres. Class discussions would also include media and films.

The attributes of academic audiences, the strategies academic writers employ to achieve their intentions and the conventional genre features of academic discourse will be examined. Along with the analysis of other genres, the students will be asked to analyze a small sample of academic articles for rhetorical and genre features as a way of helping them become familiar with the conventions of academic discourse and the expectations of academic audiences.

(Note: Courses may be modified, added or dropped in accordance with the University's policies. Courses may not be available in a given semester if minimal conditions are not met).

M.Phil. in Education

Rationale:

The demands of globalization have a direct and pressing impact on education sector and, consequently, an up gradation of education and research standards is inevitable. Currently, Faculty of Social Sciences at Air University, Islamabad is offering the following Programs:

1. BS in English
2. MPhil in Linguistics
3. MPhil in Linguistics and Literature
4. PhD in Linguistics
5. PhD in Linguistics and Literature

Now Faculty of Social Sciences is to launch MPhil in Education Program from Semester Fall 2018 onwards to provide in-service and pre-service teachers, professional development opportunities.

Introduction:

The MPhil in Education Program is a full time degree program, which focuses on the core areas of Education as well as covers the emerging areas. The program is specially designed to facilitate candidates with interests in the field of Education. These areas of specialization are supported by intensive research based projects.

Date of Commencement

September, 2018

Entry Requirement of the Program:

- B.Ed four Years/ BS in Education/ B.Ed 1.5 with MA/ B.Ed 2.5 with BA/ M.Ed/ MA Education/ MA EPM
- GAT-General Test (at least 50% score)/Admission Test (at least 60% score). This must be passed before admission.
- Candidates will appear for an interview for the purpose of final selection.

SEMESTER DISTRIBUTION

- Full time (24 months) = 4 semesters

- 2 semesters = course work
- 2 semesters = thesis
- extendable by 2 more semesters (by Dean of the faculty on the recommendation of Chair Department)
- Extendable to two regular semesters only if the student fails to complete the degree in three academic years (on the recommendations of Guidance and Evaluation Committee (GEC) and approval by Faculty Board of Graduate Studies (FBGS)) as per AU Policy.

SIGNIFICANCE OF THE PROGRAM

The MPhil program in Education is a specialized program of studies in education. There are very few institutes in Pakistan that offer such program in the field of education. Preparation of innovative educational leaders, who are able to bring positive educational reforms, is more than important and critical for future of Pakistan. Improvements in education system should be based on sound research, the application of the theory as it relates to effective practice, policy development, and collaboration with practitioners. Educational Leadership can be used to improve the quality of teaching and learning research and scholarship. Graduate programs such as Educational Leadership are significantly important to bring a positive change in young leaders and by virtue of that, educational reforms and change would come in the institutions, communities and then at the national level.

Conceptual Framework of Mphil.Education

VISION

The vision of Educational Program is to bring a positive change in lives of educators and students through innovative and contemporary educational leadership. The program embraces the mission and aims at Air University, and develop competent educational leaders of faith, intellect, and character who have a vision and a compelling sense of purpose for the continuous improvement of educational system, and enhancement of learning for all. Air University, being a leading educational institute of higher education in Pakistan, produces intellectually mature educational leaders who provide innovative solutions of challenging educational problems of 21st century through their learning experiences and skills that they develop during their stay at Air University.

MISSION STATEMENT (M.Phil. Education)

This program is envisioned as a distinct program at the Air University, dedicated to educate tomorrow's educational leaders through its innovative academic excellence. Students are prepared for leadership roles in educational experience, engaging students through effective teaching and practical experiences involving inquiry, discussion, research, creative activities, and experiential learning. The acute educational problems facing Pakistan need researchers who can ask critical questions, design innovative methods of inquiry to find answers and convert those answers into usable knowledge for scholars, education practitioners and policy makers. The MPhil in Education will develop the understanding of educational problems and research needs in the developing world. It will provide the skills and knowledge required for leadership roles within research and education. Graduation of this program will leave equipped with knowledge from multiple disciplines of education so they can solve problems that we are facing in the world now, and will face in the future.

GOALS OF THE PROGRAM (M.Phil. Education)

Graduates of the program will be the agents of change in Pakistan. Educational leadership careers can involve all kind of learning environments, from pre-kindergarten to graduate programs, and from public schools to private institutions. Success in educational leadership requires a detailed understanding of the educational process, empathy with instructors and their challenges, and insight into the need of students. An education degree in educational leadership program fosters leadership skills for all kind of educational reforms. Successful educational leaders understand their environment. They

know how to create a vision and implement programs that move toward that vision. Having been teachers themselves, they recognize the challenges that teachers face in an increasingly diverse and complex society. There is a huge potential market for educational leaders all over Pakistan, and the graduates of Air University MPhil program in Education can assume positions in all kinds of educational institutions.

OBJECTIVES

1. To prepare educational leaders recognized for the quality and significance of their teaching, research, scholarship, service, outreach, and leadership.
2. To provide widely recognized leadership in the improvement of teaching, learning, and the assessment of educational outcomes across the life span through research, scholarship, and technology.
3. To provide leadership in the development of collaborative, professional relationships with organizations and educational institutions focused on the improvement of education in schools, communities, and workplace settings.
4. To develop knowledge and understanding of practical approaches to educational reforms.
5. To develop a range of learning and transferable skills which integrate current research and best practice in the areas of educational leadership.
6. Be prepared for employment in research/faculty positions at top-tier research institutions.
7. Contribute to the interdisciplinary public discourse on education.
8. Engage in and promote evidence-based practices through the application of rigorous methodology.
9. Link education research to policy and practice.
10. Provide leadership in the field by developing an independent line of ethical and culturally responsive research.
11. Contribute to development of the next generation of scholars.

PROGRAM DESCRIPTION

Conducive environment to the students to master the required skills and competencies in the field of education.

Compulsory courses (each comprises three credit hours):

- ED-601 Professional Development of Teachers
- ED-602 Educational Change and Development
- ED- 671 Qualitative Research Methods in Education
- ED- 672 Quantitative Research Methods in Education

Elective courses (each comprises three credit hours):

- ED- 641 Curriculum Studies
- ED- 642 Education and Development
- ED- 644 Educational Technology
- ED-646 Teacher Education

Optional courses (each comprises three credit hours):

- ED-645 Educational Testing and Development
- ED-647 Monitoring & Evaluation
- ED- 643 Academic Writing

Teaching Faculty:

- Faculty requirement by HEC:
 - 2 (PhDs)
- Available Faculty: Two Ph.D.
 - 1 (permanent): Dr. Sohaib Sultan
 - 1 (New Regular Appointment): Dr. Sadaf Zamir

Scope regarding market, social and employment perspective of program

The MPhil program in Education is a specialized program of studies in education. There are very few institutes in Pakistan that offer such program in the field of education. Preparation of innovative educational leaders, who are able to bring positive educational reforms, is more than important and critical for future of Pakistan. Improvements in education system should be based on sound research, the application of the theory as it relates to effective practice, policy development, and collaboration with practitioners. Educational Leadership can be used to improve the quality of teaching and learning research and scholarship. Graduate programs such as Educational Leadership are significantly important to bring a positive change in young leaders and by virtue of that, educational reforms and change would come in the institutions, communities and then at the national level.

Duration of the Program

Full time (24 months) with 4 semesters including two semesters for course work and two semesters for thesis extendable by two more semesters by Dean of the faculty on the recommendation of Chair Department. This duration can be extended to two regular semesters on the recommendations of Guidance and Evaluation Committee (GEC) and approval by Faculty Board of Graduate Studies (FBGS) if the student fails complete the degree in three academic years, and only if the student is able to successfully justify the extension to FBGS through GEC.

Assessment

7. Internal Assessments (Mid Semester Exam, Projects, Assignments, Presentations, Quizzes, Term/Semester Paper etc)
8. End of Semester Examinations
9. Synopsis Defense based on the proposal submitted and evaluated by GEC comprising of Research Supervisor, one Internal and one External examiners
10. Quarterly submission of progress report as per AU policy
11. Final Thesis (25,000 to 35,000 words) passed by a panel of examiners (including Supervisor, one Internal and one External evaluator)
12. Final Thesis Defense in accordance with the University's procedures

Letter Grade and Grade Point

The award to the student based on academic performance is called a Grade or Letter Grade. With each letter grade a Grade Point is associated. A student may be awarded one of the following letter grades as shown in the table below.

Subject Letter Grade	Grade Points
A	4
A-	3.67
B+	3.33
B	3.00
B-	2.67
C+	2.33
C	2.00

Utilizing the information from the table above, student's total grade points earned in a semester can be calculated by multiplying grade point associated with the letter grade earned with Cr Hrs of each subject, and then totaling all the grade points of the subject studied in the semester. For example, a student studies three subjects in a semester of 4, 2, and 3 Cr Hrs, and earned A-, B+ and B grades respectively. His/her Grade points for the semester are: $4 \times 3.67 + 2 \times 3.33 + 3 \times 3.00 = 30.34$

Program Break up Semester Wise

Semester I

No.	Course Code	Course Title	Credit Hrs
1	ED-601	Professional Development of Teachers	3-0-3
2	ED-602	Educational Change and Development	3-0-3
3	ED- 671	Qualitative Research Methods in Education	3-0-3
4	ED- 672	Quantitative Research Methods in Education	3-0-3
		Total	12

Second Semester

No	Course Code	Course Title	Total Credit Hrs
1	ED ---	Elective I Course	3-0-3
2	ED ---	Elective II Course	3-0-3
3	ED ---	Elective III Course	3-0-3
4	ED ---	Elective IV Course	3-0-3
		Total	12

Third Semester:

No	Course Code	Course Title	Total Credit Hrs
1	ED699	Thesis	06

Break Down of the Program:

Course Work 24 Cr Hrs(12 Cr Hrs Per Semester)

Research/Thesis 06 Cr Hrs

Total: 30 Cr Hr

Core Courses

No.	Course Code	Course Title	Credit Hrs
1	ED-601	Professional Development of Teachers	3-0-3
2	ED-602	Educational Change and Development	3-0-3
3	ED- 671	Qualitative Research Methods in Education	3-0-3
4	ED- 672	Quantitative Research Methods in Education	3-0-3

Elective Courses

No	Course Code	Course Title	Total Credit Hrs
1	ED- 641	Curriculum Studies	3-0-3
2	ED- 642	Education and Development	3-0-3
3	ED- 643	Academic Writing	3-0-3
4	ED- 644	Educational Technology	3-0-3
5	ED- 645	Educational Testing and Development	3-0-3
6	ED- 646	Teacher Education	3-0-3
7	ED- 647	Monitoring & Evaluation	3-0-3

*** IF NEED BE, Additional course/s can be prescribed to the students on the advice of supervisor and approval by the Chair/Dean.**

Faculty Details

22. Dr. Sohaib Sultan

Assistant Professor

Date of Joining: 4 June, 2018

Education: PhD in Education (NUML Islamabad)

23. Dr. Sadaf Zamir

Assistant Professor (New Regular Appointment)

Date of Joining: ???, 2020

Education: PhD in Education (International Islamic University Islamabad)

Instructional Tools and Evaluation Methods:

The instructor will assess student's performance through a number of evaluation methods that include class participation, Group discussion, Question-Answer sessions, presentations, assignments, and project, mid-term and final examinations.

Attendance Record:

- Mandatory 75 %

Course Assessment and Evaluation:

- Class participation+ Assignments +Project + Presentation 25 %
- Mid Term Examination 30 %
- Final Examination 45 %

Details:

Assessment Task	Due	Weighting
Quiz	Every week	10 %
Assignments 1 + 2	Week 4 & 9	10%
Mid Term Examination	Week 8	30 %
Project & Presentations	Week 16	5 %
Final Examination	Week 17 & 18	45 %

Final Grades:

Absolute marking:

S.No.	Marks in %age	Grades	GPA
1	80 – 100	A	4.00
2	75 – 79.99	A ⁻	3.67
3	70 – 74.99	B ⁺	3.33
4	65 – 69.99	B	3.00
5	60 – 64.99	B ⁻	2.67
6	55 – 59.99	C ⁺	2.33
7	50 – 54.99	C	2.00
8	Below 50	F	0.00

i) Course Outlines for Elective**Courses****ED-641 Curriculum Studies**

Credit Hours – 03

Fall Semester – Academic Year 2018-19

Course Description:

In *Curriculum Design* scholars would examine and be practically exposed to fundamental components of a Curriculum Design i.e., Curriculum, its role, scope and characteristics, Foundations of Curriculum, Process of Curriculum Development, Curriculum Evaluation and Assessment, Curriculum Change, Revision Process, Curriculum Implementation and Global Trends in curriculum development. Once

equipped with this knowledge, participants would be able to conduct research under supervision in an area of their choice in Curriculum Design.

Course Objectives:

The primary objective of this course is to develop an orientation for curriculum design among the scholars and to acquaint them with fundamentals of curriculum design. Specifically, the course aims at introducing them to the fundamental concepts used in curriculum design. This Course Focuses on

- To develop understanding of foundations of curriculum design.
- To understand process of curriculum development in various educational settings.
- To learn process of curriculum implementation in different tiers of education.

Learning Outcomes:

After studying course the students will be able to:

- To apply knowledge practically in the process of Curriculum Development.
- To differentiate between foundations of curriculum in diverse needs.
- To identify and use multiple designs of curriculum for addressing various situations.

Topics Covered:

Module	Topics	Week
1.	Introduction to Curriculum Design	1,2
	1.1. Components of curriculum	
	1.2. Scope of curriculum	
	1.3. Role of curriculum in national framework	
	1.4. Characteristics of curriculum	
	Foundations of Curriculum	3
	2.1 Philosophical foundation	
	2.2 Psychological foundation	
	2.3 Sociological foundation	
2.	Process of Curriculum Development I	4
	3.1. Situational analysis	
	3.2. Selection of goals, aims and objectives	
	3.3. Principle of goal setting	
	3.4. Taylor's model	
3.	Process of Curriculum Development II	5
	4.1. Selection of contents	
	4.2. Organization of contents	
	4.3. Selection of learning experiences	

- 4.4. Organization of learning experiences
- 4.5. Wheeler's model

4.	Curriculum Designs I	6
	5.1. Need of curriculum design	
	5.2. Design based on individual needs and interests	
	5.3. Hidden curriculum	
	5.4. Hilda Taba model	
5.	Curriculum Design II	7
	MID-TERM EXAMINATION	8
6.	Stakeholders Role in Curriculum Design	9
	7.1. Role of Teachers and parents	
	7.2. Role of administrators and community	
	7.3. Role of political activists and media	
	7.4. Role of pressure groups	
7.	Curriculum Implementation I	10
	8.1. Curriculum Evaluation	
	8.2. Curriculum Assessment	
	8.3. Curriculum Change process	
	8.4. Curriculum Revision process	
8.	Curriculum Implementation II	11
	9.1 Design syllabus	
	9.2 Design text books	
	9.3 Step wise process in implementation	
	9.4 Curriculum Process in Pakistan	
10.	Global Trends	12
	11.1 Comparisons in education systems	
	11.2 Trends in developed countries	
11.	Curriculum Evaluation	13
	12.1 Need and Role of Evaluation	
	12.2 Functions of Evaluation	
	12.3 Types of Evaluation	
	12.4 Approaches of Evaluation	
12.	Assignments/Presentations/Quiz	14
	12.1 Highlight role of curriculum development in national framework	
	12.2 Elaborate principle of goal settings in process of curriculum development	
	12.3 Analyze role of Philosophical foundation of curriculum	
	12.4 Explore psychological foundation of curriculum	
	12.5 How role of parents is important in curriculum development?	

12.6 What is role of evaluation in the process of curriculum implementation?

12.7 Differentiate between learners centered design and subject centered?

13. Projects

15

13.1 Textbook analysis (Science book Class: 8)

13.2 Evaluate BS Education program with reference to national needs

13.3 Effects of Pre-Service Teachers' Training in curriculum implementation

14.

Presentations

16

15.

FINAL EXAMINATION

17- 18

Instructional Tools and Evaluation Methods:

The instructor will assess student's performance through a number of evaluation methods that include class participation, Group discussion, Question-Answer sessions, presentations, assignments, and project, mid-term and final examinations.

Attendance Record:

- Mandatory 75 %

Course Assessment and Evaluation:

- Class participation+ Assignments
+Project + Presentation 25 %
- Mid Term Examination 30 %
- Final Examination 45 %

Details:

Assessment Task	Due	Weighting
Quiz	Every week	10 %
Assignments 1 + 2	Week 4 & 9	10%
Mid Term Examination	Week 8	30 %
Project & Presentations	Week 16	5 %
Final Examination	Week 17 & 18	45 %

Final Grades:

Absolute marking:

S.No.	Marks in %age	Grades	GPA
1	80 – 100	A	4.00
2	75 – 79.99	A ⁻	3.67
3	70 – 74.99	B ⁺	3.33
4	65 – 69.99	B	3.00
5	60 – 64.99	B ⁻	2.67
6	55 – 59.99	C ⁺	2.33
7	50 – 54.99	C	2.00
8	Below 50	F	0.00

ED-642 Education and Development

Credit Hours – 03

Semester – Academic Year 2017-18

Course Description:

Education and Development is a hands-on course designed to impart education in the foundational methods and techniques of academic research in social sciences. Scholars would examine and be practically exposed to the main components of education and development i.e., Gender and Population education, Education for Sustainable Development, Right based education, poverty alleviation and peace education. Once equipped with this knowledge, participants would be able to conduct research under supervision in an area of their choice in education and development.

Course Objectives:

The course aims to

The primary objective of this course is to develop orientation for education and development among the scholars and to acquaint them with fundamentals of education and development. Specifically, the course aims at introducing them to the basic concepts used in education and development. This Course Focuses on

- To identify barriers in achieving universal literacy and steps to remove these in education.
- To generate environmental awareness among learners at schools.
- To explore gaps in different sectors of mainstream education.

Learning Outcomes:

After studying course the students will be able to:

- To apply knowledge practically in the process of universal literacy.
- To aware effectively new learners about environment.
- To identify taboos in local educational settings.

Topics Covered:

Module	Topics	Week
1.	Education as Development and Change	1,2
	1.1. Aims and Approaches in Education	
	1.2. Philosophical Approaches in Education	
	1.3. Education in Different Periods and Societies	
	1.4. Diversity in Education	
2.	Universal Literacy	3
	2.1 Literacy and individual rights	
	2.2 Factors of universal literacy	
	2.3 Medium of instruction	
	2.4 Formal and non-formal education	

3.	Gender Disparity	4
	3.1. Concept of Gender equality	
	3.2. Factors affecting status and role of women in society	
	3.3. Steps towards reducing Gender Disparity	
4.	Population Education	5
	4.1. Factors affecting Population education	
	4.2. Impact of Population growth on national development	
	4.3. Roles of family, school and community	
	4.4. Steps towards population planning and welfare	
5.	Environmental Awareness I	6
	5.1. Need and scope of environmental awareness	
	5.2. Types and causes of pollution	
	5.3. Waste management	
6.	Environmental Awareness II	7
	6.1. Forests and land use	
	6.2. Environmental health	
	6.3. Environmental policy	
	MID-TERM EXAMINATION	8
7.	Stake holders role in education	9
	7.1. Contemporary education systems	
	7.2. Role of media	
	7.3. Role of madrassah	
	7.4. Role of NGOs	
8.	Privatization of Education	10
	8.1. Government resources and multiple demands	
	8.2. Need and scope of education in private sector	
	8.3. Challenges of quality education	
	8.4. Factors enhancing quality in education	
9.	Information in Education	11
	9.1 Information explosion in education	
	9.2 Expanding learning resources	
	9.3 Information and communication technology	
	9.4 Technology in education	
10.	Global Trends	12
	Comparisons in education systems between developed and developing countries across the world	

11.	Researches in Teacher Education/Assignments/Presentations/Quiz	13
11.1	Compare and Contrast formal and non-formal education in Pakistan	
11.2	Elaborate advantages and disadvantages of NGO's role in Pakistan	
11.3	Highlight strategies to motivate public for following Population Education	
11.4	How role of madrassah education is important in local settings?	
11.5	What are types of causes of pollution in megacities of Pakistan?	
11.6	Why deforestation is becoming very dangerous in Pakistan?	
12.	Projects	14
12.1	Assess the impact of medium of instruction in career development	
12.2	Estimate effect of Environmental Policy in Pakistan	
13.		15
13.1	Summary of all Lessons Taught	
13.2	REVISION WEEK	
14.	Revision and Practice	16
15.	FINAL EXAMINATION	17- 18

Instructional Tools and Evaluation Methods:

The instructor will assess student's performance through a number of evaluation methods that include class participation, Group discussion, Question-Answer sessions, presentations, assignments, and project, mid-term and final examinations.

Attendance Record:

- Mandatory 75 %

Course Assessment and Evaluation:

- Class participation+ Assignments
+Project + Presentation 25 %
- Mid Term Examination 30 %
- Final Examination 45 %

Details:

Assessment Task	Due	Weighting
Quiz	Every week	10 %
Assignments 1 + 2	Week 4 & 9	10%
Mid Term Examination	Week 8	30 %
Project & Presentations	Week 16	5 %
Final Examination	Week 17 & 18	45 %

Final Grades:

Absolute marking:

S.No.	Marks in %age	Grades	GPA
1	80 – 100	A	4.00
2	75 – 79.99	A ⁻	3.67
3	70 – 74.99	B ⁺	3.33
4	65 – 69.99	B	3.00
5	60 – 64.99	B ⁻	2.67
6	55 – 59.99	C ⁺	2.33
7	50 – 54.99	C	2.00
8	Below 50	F	0.00

ED-644 Educational Technology**Credit Hours – 03**

Spring Semester – Academic Year 2018-19

Course Description:

In *Educational Technology* scholars would examine and be practically exposed to fundamental components of a Educational Technology i.e., e-learning skills, the teacher of yesterday and today, the Psychology of using Teaching Aids, Asynchronous and Synchronous communication, Fitting Technology into Practice, The Educational Technology Movement, Virtual Teamwork, e-learning around the globe and the Digital Divide. Once equipped with this knowledge, participants would be able to conduct research under supervision in an area of their choice in Educational Technology.

Course Objectives:

The primary objective of this course is to develop an orientation for curriculum design among the scholars and to acquaint them with fundamentals of curriculum design. Specifically, the course aims at introducing them to the fundamental concepts used in curriculum design. This Course Focuses on

- To develop understanding of applications of Educational Technology.
- To understand process of implementation Educational Technology in various educational settings.
- To learn learning process through Educational Technology in different tiers of education.

Learning Outcomes:

After studying course the students will be able to:

- To use applications of Educational Technology.
- To differentiate among various modes of e-learning.
- To identify and use multiple teaching strategies apropos of Educational Technology.

Topics Covered:

Module	Topics	Week
10.	Introduction to Educational Technology	1,2

- 1.5. Comparison of Traditional and e Learning Skills
- 1.6. Parameters for a Successful e-Learner
- 1.7. Blogs, Wikis and Social Networking
- 1.8. Mobile Learning (m-learning)

11. Education – Then (in past) and Now (in present) 3

- 2.1 The Teacher of Yesterday and Today
- 2.2 An Outline of the Teaching Methods Used (Then and Now)
- 2.3 Teacher Competency Factors

12. Traditional Skills and e-Learning Skills 4

- 3.4. Notes, Reading, Writing, Self-Assessment, Research Skills
- 3.5. Learning in Face to Face Group
- 3.6. Acceptance of Responsibility
- 3.7. Mendley, J-Store and Library Software

13. Learning and Educational Technology 5

- 4.5. Sense of Sight: Value of One Sense Over Another
- 4.6. The Psychology of Using Teaching Aids
- 4.7. Media and Methods of Teaching Aids
- 4.8. Integrated Use of Teaching Aids

14. Communication and Interaction Skills 6

15. Non Projected and Projected Aids 7

- 6.4. Graphic Aids Charts/Display Boards/ Models)
- 6.5. Dioramas Noets and Acrylic Materials for Model Making
- 6.6. Projectors: Slides/Filmstrips/Overhead
- 6.7. Microfilm and Microfiche: Holography

MID-TERM EXAMINATION 8

16. The Effectiveness of Educational Technology 9

- 7.5. Nanotechnology Instructional Practices
- 7.6. Educational Technology in Mathematics
- 7.7. Educational Technology in Science
- 7.8. Educational Technology in Social Sciences

17. The Pros and Cons of Educational Technology 10

- 8.5. Fitting Technology into Practice
- 8.6. The Standard Movements in Education
- 8.7. The Educational Technology Movement

8.8. The Movement for Improving Teacher Quality

18.	A Framework for Globalization	11
	9.5 Virtual Teamwork	
	9.6 Learning in a Distance Education Settings	
	9.7 Online Remedial Effects in Education	
	9.8 Accelerating Learning Through Technology	
10.	Global Trends	12
	10.1 Preparing Students for Twenty First Century	
	10.2 The Digital Divide	
11.	Mastery in Educational Technology	13
	11.1 E Demand Around the Globe	
	11.2 MIT in Every Home	
	11.3 U Learning	
	11.4 Making a Contribution	
12.	Researches in Teacher Education/Assignments/Presentations/Quiz	14
	12.1 Draw comparison between traditional and e-learning skills	
	12.2 Elaborate advantages and disadvantages of using A.V. aids in classroom	
	12.3 Highlight strategies to promote virtual teamwork	
	12.4 How teacher of yesterday and today can be explained?	
	12.5 What are teaching methods used then and now?	
	12.6 When Educational Technology movement get started?	
13.	Projects	15
	13.1 Observe the impacts of Technology in Teachers' Training Programs in Distance Education Centers	
	13.2 Assess the acceleration of learning through technology in the classroom	
	13.3 Generate Blog, Vlog and infographics on Educational Themes	
14.	Presentations	16
15.	FINAL EXAMINATION	17- 18

Instructional Tools and Evaluation Methods:

The instructor will assess student's performance through a number of evaluation methods that include class participation, Group discussion, Question-Answer sessions, presentations, assignments, and project, mid-term and final examinations.

Attendance Record:

- Mandatory 75 %

Course Assessment and Evaluation:

- Class participation+ Assignments
+Project + Presentation 25 %
- Mid Term Examination 30 %
- Final Examination 45 %

Details:

Assessment Task	Due	Weighting
Quiz	Every week	10 %
Assignments 1 + 2	Week 4 & 9	10%
Mid Term Examination	Week 8	30 %
Project & Presentations	Week 16	5 %
Final Examination	Week 17 & 18	45 %

Final Grades:

Absolute marking:

S.No.	Marks in %age	Grades	GPA
1	80 – 100	A	4.00
2	75 – 79.99	A ⁻	3.67
3	70 – 74.99	B ⁺	3.33
4	65 – 69.99	B	3.00
5	60 – 64.99	B ⁻	2.67
6	55 – 59.99	C ⁺	2.33
7	50 – 54.99	C	2.00
8	Below 50	F	0.00

ED-602 Educational Change and Development**Credit Hours – 03**

Fall Semester – Academic Year 2018-19

Course Description:**Course Objectives:**

The primary objective of this course is to develop orientation for educational change and development among the scholars and to acquaint them with fundamentals of educational change and development. Specifically, the course aims at introducing them to the basic concepts used in the subject. This Course Focuses on

- To develop understanding of the basic framework of social learning process.
- To understand process of role playing and learning through thinking.
- To comprehend inductive and deductive thinking approaches.

Learning Outcomes:

After studying course the students will be able to:

- To apply cognitive learning skills in multiple educational settings.
- To differentiate between applications of deductive and inductive approaches.
- To identify and use diverse patterns of behaviours of learners in classroom settings.

Topics Covered:

Module	Topics	Week
19.	Community of Learners	1,2
	1.9. Introduction	
	1.10. Self esteem and self actualization	
	1.11. Academic learning	
	1.12. Cooperative learning	
20.	Partners in Learning	3
	2.1 Group investigation	
	2.2 Social norms and personal identity	
	2.3 Social & religious studies	
21.	Adapting to Individual Differences	4
	3.8. Productivity and development	
	3.9. Conceptual systems theory	
	3.10. Information processing and social families	
22.	Cognitive Learning Skills	5
	4.9. Models of teaching	
	4.10. Skills of thinking	
	4.11. Curriculum designs	
	4.12. One's development and social milieu	
23.	Thinking Inductively	6
	5.4. Higher order thinking	
	5.5. Analytic and synthetic skills	
	5.6. Hilda Taba model	
24.	The Developing Intellect	7
	6.8. Intellectual development	
	6.9. Conceptual activities	
	6.10. Information processing models	
	6.11. Peaks of personal development	
	MID-TERM EXAMINATION	8
25.	Deductive Approach	9,10
	7.9. Identification of problem	
	7.10. Formulation of objectives	
	7.11. Synthesis of the identified problem	
	7.12. Analysis of the problem	

26.	The Professional Learning Community	11
	8.9. Professional skill	
	8.10. Organizing personally and professionally	
	8.11. Expected effects on learning	
	8.12. Making discomfort productive	
27.	Learning from Basic Skills to Exploration of Space	12
	9.9 Learning in educational settings	
	9.10 Learning in Industry	
	9.11 Learning in Recreation	
	9.12 Learning in workplace	
10.	Self-Control	13
	11.3 Patterns of Behavior	
	11.4 How to modify behavior?	
11.	Researches in Educational Change & Development	13
	12.5 Search/Inquire & Discussion	
12.	Discussion on Final Projects	14
	13.1 Group Project to explore Educational Settings	
13.	Revision and Practice	15
	14.1 Summary of all Lessons Taught	
	14.2 REVISION WEEK	
14.	Presentations	16

15.	FINAL EXAMINATION	17- 18

Instructional Tools and Evaluation Methods:

The instructor will assess student's performance through a number of evaluation methods that include class participation, Group discussion, Question-Answer sessions, presentations, assignments, and project, mid-term and final examinations.

Attendance Record:

- Mandatory 75 %

Course Assessment and Evaluation:

- Class participation+ Assignments 25 %
+Project + Presentation
- Mid Term Examination 30 %
- Final Examination 45 %

Details:

Assessment Task	Due	Weighting
Quiz	Every week	10 %
Assignments 1 + 2	Week 4 & 9	10%
Mid Term Examination	Week 8	30 %
Project & Presentations	Week 16	5 %
Final Examination	Week 17 & 18	45 %

Final Grades:

Absolute marking:

S.No.	Marks in %age	Grades	GPA
1	80 – 100	A	4.00
2	75 – 79.99	A ⁻	3.67
3	70 – 74.99	B ⁺	3.33
4	65 – 69.99	B	3.00
5	60 – 64.99	B ⁻	2.67
6	55 – 59.99	C ⁺	2.33
7	50 – 54.99	C	2.00
8	Below 50	F	0.00

ED- 601 Professional Development of Teachers

Credit Hours – 03

Fall Semester – Academic Year 2018-19

Course Description:

Professional Development of Teachers is a hands-on course designed to instruct fundamental methods of professional development among teachers in education. Scholars would examine and be practically exposed to the main components of professional development of teachers i.e., problem oriented classroom, constructivism, social aspects of learning, discovery learning, taxonomic categories and innovations in teacher development. Once equipped with this knowledge, participants would be able to conduct research under supervision particularly in an area of their choice in professional development of teachers.

Course Objectives:

The primary objective of this course is to develop orientation for professional development among the teachers and to acquaint them with fundamentals of professional development. Specifically, the course aims at introducing them to the basic concepts used in professional development of teachers. This Course Focuses on

- To discuss the meaning and concept of professional development of teachers.
- To study various learning theories used in professional development of teachers.
- To comprehend multiple teaching strategies.

Learning Outcomes:

After studying course the students will be able to:

- To apply skills in personality development of students.

- To solve issues in developing professional skills of teachers.
- To identify and use difference between direct methods and concept teaching.

Topics Covered:

Module	Topics	Week
28.	Introduction	1,2
	1.13. Concept of professional development in Education	
	1.14. Silent features of professional development	
	1.15. Memory development and understanding	
	1.16. Reflective thinking	
29.	Planning in Professional Development	3
	2.1 Task analysis	
	2.2 Content analysis	
	2.3 Taxonomic categories	
	2.4 Determining behavioral objectives	
30.	Collaborative Approach	4
	3.11. Cultural diversity	
	3.12. Excellence in education	
	3.13. School integration	
31.	Problem Solving Approach	5
	4.13. Dewey and problem oriented classroom	
	4.14. Piaget and Constructivism	
	4.15. Bruner and Discovery learning	
	4.16. Vygotsky social aspects of learning	
32.	Presentation Teaching	6
	5.7. Kinds of knowledge	
	5.8. Structure and organization of knowledge	
	5.9. Planning and Conducting presentation lessons	
33.	Direct Instruction	7
	6.12. Relationship between teacher behavior and student achievement	
	6.13. Behavioral theory	
	6.14. Social learning theory	

	MID-TERM EXAMINATION	8
34.	Concept Teaching	9,10
	7.13. Specific concepts	
	7.14. Nature of concepts	
	7.15. Logical reasoning and higher level thinking	
	7.16. Communication	
35.	Classroom Discussion	11
	8.13. Advantages and disadvantages	
	8.14. Adapting discussions for diverse learners	
	8.15. Broaden participation	
	8.16. Interpersonal regard and understanding	
36.	Innovations in Teacher Development	12
	9.13 Micro Teaching	
	9.14 Modular approach	
	9.15 System approach	
	9.16 Personalized system of instruction	
11.	Modern Trends	13
	Comparisons among various teaching methods and strategies	
12.	Researches in Professional Development of Teachers	13
	12.6 Searc/Inquiry & Discussion	
13.	Discussion on Final Projects	14
	13.1 Group Project in Modern Approaches of Teaching	
14.	Revision and Practice	15
	14.3 Summary of all Lessons Taught	
	14.4 REVISION WEEK	
15.	Presentations	16
16.	FINAL EXAMINATION	17- 18

Instructional Tools and Evaluation Methods:

The instructor will assess student's performance through a number of evaluation methods that include class participation, Group discussion, Question-Answer sessions, presentations, assignments and project, mid-term and final examinations.

Attendance Record:

- Mandatory 75 %

Course Assessment and Evaluation:

- Class participation+ Assignments +Project + Presentation 25 %
- Mid Term Examination 30 %
- Final Examination 45 %

Details:

Assessment Task	Due	Weighting
Quiz	Every week	10 %
Assignments 1 + 2	Week 4 & 9	10%
Mid Term Examination	Week 8	30 %
Project & Presentations	Week 16	5 %
Final Examination	Week 17 & 18	45 %

Final Grades:

Absolute marking:

S.No.	Marks in %age	Grades	GPA
1	80 – 100	A	4.00
2	75 – 79.99	A ⁻	3.67
3	70 – 74.99	B ⁺	3.33
4	65 – 69.99	B	3.00
5	60 – 64.99	B ⁻	2.67
6	55 – 59.99	C ⁺	2.33
7	50 – 54.99	C	2.00
8	Below 50	F	0.00

ED-646 Teacher Education

Credit Hours – 03

Semester – Academic Year 2017-18

Course Description:

Teacher Education is a hands-on course designed to impart education in the foundational methods and techniques of academic research in social sciences. Scholars would examine and be practically exposed to the main components of a Teacher Education i.e., Curriculum, its role, scope and characteristics, strategies in teacher education, lesson planning, pedagogy by level, teaching methodologies etc. Once equipped with this knowledge, participants would be able to conduct research under supervision in an area of their choice in teacher education.

Course Objectives:

The course aims to

The primary objective of this course is to develop a orientation for teacher education among the scholars and to acquaint them with fundamentals of teacher education. Specifically, the course aims at introducing them to the basic concepts used in teacher education. This Course Focuses on

- To develop understanding of the basic framework of teacher education.
- To understand process of teacher education in educational settings.
- To identify dimensions of teacher education and evaluation process.

Learning Outcomes:

After studying course the students will be able to:

- To apply knowledge practically in the process of teachers' training programs.
- To use fresh teaching strategies in classroom settings.
- To inculcate prospective teachers through research oriented approach.

Topics Covered:

Module	Topics	Week
37.	Introduction to Teacher Education	1,2
	1.17. Definitions of teaching	
	1.18. The concept of effective teaching	
	1.19. Role of teacher for conducive learning environment	
	1.20. Personal characteristics of effective teaching	
38.	Strategies in Teacher Education	3
	2.1 The concept of teaching methods	
	2.2 Teaching strategies and techniques	
	2.3 Professional characteristics of an effective teacher	
39.	Lesson Planning in Teaching	4
	3.14. Need for lesson planning	
	3.15. Approaches to lesson planning	
	3.16. Weekly/Daily/Unit/Course planning	
40.	Steps in Lesson Planning	5
	4.17. Introduction	
	4.18. Presentation & Generalization	
	4.19. Application & Recapitulation	
	4.20. The lesson plan format	
41.	Pedagogy by Level	6
	5.10. Pedagogy of early childhood education	
	5.11. Pedagogy for elementary education	
	5.12. Pedagogy for secondary education	

42.	Inquiry Method	7
6.15.	The inductive method of inquiry	
6.16.	The deductive method of inquiry	
6.17.	The scientific method	
6.18.	The problem solving approach	
MID-TERM EXAMINATION		8
43.	Individual & Group Learning	9,10
7.17.	Individual project & group project	
7.18.	Research projects & cooperative learning	
7.19.	Techniques of cooperative learning	
7.20.	Advantages and limitations of activity & cooperative method	
44.	Demonstration Method	11
8.17.	Planning & organizing classroom discussion	
8.18.	Practicing in asking & answering questions in classroom	
8.19.	Assessing the discussion	
8.20.	Advantages & limitations of discussion method	
45.	Motivation	12
9.17	Motivation and its implications	
9.18	Intrinsic & extrinsic motivation	
9.19	Theories of motivation	
9.20	Strategies to motivate students	
11.	Developing Teaching Skills	13
11.5	Set induction & presentation	
11.6	Lesson preparation according to individual needs	
11.7	Identify learning difficulties & students' evaluation	
12.	Researches in Teacher Education/Assignments/Presentations/Quiz	13
12.7	Compare and Contrast Individual Learning and Group Learning Project	
12.8	Elaborate advantages and disadvantages of Discussion Method	
12.9	Highlight strategies to motivate students in classroom settings	
12.10	How role of teacher for conducive learning is important?	
12.11	What are personal characteristics of effective teaching?	
12.12	Which approaches to lesson planning are important in class?	
13.	Projects	14
13.1	Importance of Pre Service Teachers' Training programs	
13.2	Importance of In Service Teachers' Training programs	
14.		15
14.5	Summary of all Lessons Taught	
14.6	REVISION WEEK	

Instructional Tools and Evaluation Methods:

The instructor will assess student's performance through a number of evaluation methods that include class participation, Group discussion, Question-Answer sessions, presentations, assignments, and project, mid-term and final examinations.

Attendance Record:

- Mandatory 75 %

Course Assessment and Evaluation:

- Class participation+ Assignments +Project + Presentation 25 %
- Mid Term Examination 30 %
- Final Examination 45 %

Details:

Assessment Task	Due	Weighting
Quiz	Every week	10 %
Assignments 1 + 2	Week 4 & 9	10%
Mid Term Examination	Week 8	30 %
Project & Presentations	Week 16	5 %
Final Examination	Week 17 & 18	45 %

Final Grades:

Absolute marking:

S.No.	Marks in %age	Grades	GPA
1	80 – 100	A	4.00
2	75 – 79.99	A ⁻	3.67
3	70 – 74.99	B ⁺	3.33
4	65 – 69.99	B	3.00
5	60 – 64.99	B ⁻	2.67
6	55 – 59.99	C ⁺	2.33
7	50 – 54.99	C	2.00
8	Below 50	F	0.00

ED-671 Course Title: Qualitative Research Methods

Credit Hours: 3

Course Description:

Qualitative Research Methods is a hands-on course designed to impart education in the foundational methods and techniques of academic research in social sciences. Scholars would examine and be practically exposed to the main components of a research framework i.e., problem definition, literature Review, research design, data collection, ethical issues in research, Proposal Writing, Research Paper Writing and presentation of Research work. Once equipped with this knowledge, participants would be well-placed to conduct disciplined independent

research under supervision in an area of their choice. In addition to their application in an academic setting, many of the methodologies discussed in this course would be similar to those deployed in professional research environments.

Learning Outcomes:

This research methods course will introduce students to qualitative research in education. The course will offer students an opportunity to explore the theoretical and philosophical foundations of qualitative inquiry while applying these principles in a research project.

- To develop understanding of the basic framework of research process.
- To develop an understanding of various research designs and techniques.
- To identify various sources of information for literature review and data collection.
- To develop an understanding of the ethical dimensions of conducting applied research.

Course Outline

Unit 01 Introduction to Research Methodologies/ Paradigms, Perspectives

- 1.1. Introduction to Research
- 1.2. Research Theory and Research Theory Building
- 1.3. Problem Statement and Research Questions
- 1.4. Research Design
- 1.5. Classification of research by Method
- 1.6. Exploring epistemologies

Unit 02 Introducing Qualitative Research

- 2.1 Introduction to Qualitative Research
- 2.2 Ethnographic Research

Unit 03 Different types of qualitative research

- 3.1. Case Study Research
- 3.2. The Qualitative Research Process
- 3.3. Ethnography
- 3.4. Phenomenological research

Unit 04 Data collection in qualitative research

- 4.1. Observations
- 4.2. Interviews
- 4.3. Focus group
- 4.4. Documents analysis

Unit 05 Referencing and Citations

- 5.1. APA Referencing Style
- 5.2. In-text Citation
- 5.3. Practice & Assignment

Unit 06 Qualitative Research and Quantitative Research II

- 6.1. Selection of Topic
- 6.2. Literature Review
- 6.3. Selection of Method and Tool
- 6.4. Population and Sample
- 6.5. Data Analysis

Unit 07 Data Analysis

- 7.1. Grounded theory
- 7.2. Understanding Data Analysis: Coding and analyzing
- 7.3. Coding
- 7.4. Memos
- 7.5. Categories development
- 7.6. Themes

Unit 08 Writing qualitative data

Unit 09 Use of Software

- 11.1 Introduction to NVIVO
- 11.2 Data entry in NVIVO
- 11.3 Data Analysis in NVIVO

Unit 10 How to Write Research Paper

- 12.1 Practice & Discussion

ED-672 Course Title: Quantitative Research Methods

Credit Hours: 3

Course Description:

This course provides students with an introduction to the quantitative methods that are commonly used in education research. It covers basic concepts underlying statistical and quantitative reasoning, including descriptive statistics, probability, statistical inference, hypothesis testing, analysis of variance, correlation, and bivariate and multivariate regression analysis. Students are expected to engage in computer-based analyses of education-related problems using SPSS.

Learning Outcomes:

- 1. Provide students with a solid understanding of (and appreciation for) basic quantitative methods.
- 2. Equip students with the ability to comprehend and critically evaluate quantitative research studies.
- 3. Provide students with the knowledge to conduct their own quantitative study.
- 4. Improve students' ability to manipulate and interpret data using SPSS.

Course Outline

Unit 01 Introduction to the course

- 1.1. Introduction to Research
- 1.2. Overview of Course, Review of Syllabus
- 1.3. Research and the Use of Quantitative Methods
- 1.4. Types of Variables and Scales of Measurement
- 1.5. Overview of Datasets

Unit 02 SPSS

- 2.1 Introduction to SPSS
- 2.2 Data entry in SPSS
- 2.3 Data Analysis in SPSS

Unit 03 Different types of quantitative research

- 3.1. Survey Research
- 3.2. Correlational Research
- 3.3. Casual-Comparative Research
- 3.4. Experimental Research

Unit 04 Data Exploration Using Descriptive Statistics: Part I

- 4.1. Measures of Central Tendency – Mean, Median, and Mode
- 4.2. Measures of Dispersion – Range, Standard Deviation, Variance
- 4.3. Frequency Distributions
- 4.4. Measures of Relative Position – Percentiles, z-scores
- 4.5. Probability
- 4.6. The Normal (or Bell-Shaped) Curve
- 4.7. The Normal Distribution and z-scores

Unit 05 Introduction to Inferential Statistics

- 5.1. Discussion of Fry (2003) paper
- 5.2. What is statistical inference?
- 5.3. Sampling
- 5.4. Estimation
- 5.5. Confidence Intervals
- 5.6. Distribution of Sample Means

Unit 06 Hypothesis Testing

- 6.1. What is a hypothesis?
- 6.2. Type I versus Type II error
- 6.3. Understanding p-values
- 6.4. Statistical significance versus practical significance

Unit 07 Test Statistics

- 7.1. z-test
- 7.2. t-tests
- 7.3. - One sample
- 7.4. - Independent samples
- 7.5. - Related samples

Unit 08 Analysis of Variance

- 8.1 One-Way ANOVA
- 8.2 Post Hoc tests
- 9.3 Two-Factor ANOVA

Unit 09 Chi-square (χ^2) Tests

- 9.1 Chi-square tests
- 9.2 Goodness of Fit
- 9.3 Test for Independence

Unit 10 Correlation and Regression

- 10.1 Correlations
- 10.2 Scatterplots
- 10.3 Experimental versus Non-Experimental Research Designs
- 10.4 Bivariate Linear Regression
- 10.5 Assumptions of Linear Regression Models
- 10.6 Estimating a Regression Model
- 10.7 Interpreting Regression Coefficients

ED-645 Course Title: Educational Testing and Development

Credit Hours: 3

Course Description:

Educational Testing and Development is designed to train future teachers for the purpose of appropriate knowledge of the concept of various forms of tests' construction and evaluation during the course of study at any level. The teacher will develop skills to construct classroom based tests to evaluate students learning outcomes. The learner will also be able to report the result to different stake holders in a professional manner.

Learning Outcomes:

After the end of the course the prospective teachers will be able to:

- Understand the concept of evaluation and testing
- Determine the qualities of a good test.
- Plan and construct appropriate classroom test to evaluate student's performance.
- Make report of the test results to different stake holders.

Course Outline

Unit 01 Test, Testing and Evaluation

- 1.1 Meaning of test, testing and Evaluation
- 1.2 Purpose, principles and scope of test and evaluation
- 1.3 School evaluation program
- 1.4 Cooperative learning through evaluation

Unit 02 Type of Tests I

- 2.1 Essay types tests
- 2.2 Objective type tests
- 2.3 Verbal tests

Unit 03 Type of Tests II

- 3.1 Recognition type items
- 3.2 Recall type items
- 3.3 Information processing items

Unit 04 Types of Evaluation

- 4.1 Placement Evaluation
- 4.2 Diagnostic Evaluation
- 4.3 Formative Evaluation
- 4.4 Summative Evaluation

Unit 05 Test Construction

- 5.1 Planning test
- 5.2 Preparing test items
- 5.3 Assembling test items

Unit 06 Test Administration and Analysis

- 6.1 Administration of test
- 6.2 Conduction of test
- 6.3 Analysis of test items
- 6.4 Modification of test items

Unit 07 Qualities of a Good Test

- 7.1 Reliability
- 7.2 Validity
- 7.3 Adequacy
- 7.4 Objectivity
- 7.5 Differentiability

Unit 08 Interpretation of Test Scores

- 8.1 Percentage
- 8.2 Ordering and ranking

- 8.3 Frequency distribution
- 8.4 Measure central tendency (Mean, Mode and Median)
- 8.5 Pictorial form (Graph, polygon, histogram)

Unit 09 Declaration/Reporting the Test Results

- 9.1 Students
- 9.2 Parents
- 9.3 Management
- 9.4 Administration

Unit 10 Counseling

- 10.1 Counseling after results

ED-647 Course Title: Monitoring & Evaluation

Credit Hours: 3

Course Description:

Monitoring & Evaluation is a hands-on course designed to impart education in the foundational methods and techniques of academic research in social sciences. Scholars would examine and be practically exposed to the main components of a monitoring & evaluation i.e., Curriculum, role of monitoring & evaluation, preparing instructional objectives, validity & reliability, constructing objective & subjective type items, assembling cum administering tests. Once equipped with this knowledge, participants would be able to conduct research under supervision in an area of their choice in monitoring & evaluation.

Learning Outcomes:

The primary objective of this course is to develop a orientation for monitoring & evaluation among the scholars and to acquaint them with fundamentals of monitoring & evaluation. Specifically, the course aims at introducing them to the basic concepts used in monitoring & evaluation. This Course Focuses on

- To develop understanding of the basic framework of monitoring & evaluation.
- To understand process of developing instructional objectives.
- To identify dimensions of evaluation procedures in educational settings.

Course Outline

Unit 01 Introduction to Monitoring & Evaluation

- 1.1. Concept of monitoring & evaluation
- 1.2. Objectives of monitoring & evaluation
- 1.3. Aspects of monitoring & evaluation
- 1.4. Scope and significance of monitoring & evaluation

Unit 02 Role of Monitoring & Evaluation in Teaching

- 2.1 Instructional decisions requiring evaluation
- 2.2 General principles of evaluation
- 2.3 Types of testing & evaluation procedures

Unit 03 Preparing Instructional Objectives

- 3.1. Instructional objectives as learning outcomes
- 3.2. Selection of instructional objectives
- 3.3. Methods of stating instructional objectives

Unit 04 Validity & Reliability

- 4.1 Approaches to test validation
- 4.2 Factors influencing validity

4.3 Nature of reliability and its measures

4.5 Factors influencing reliability measures

Unit 05 Constructing Classroom Tests

- 5.1. Planning & preparing the classroom tests
- 5.2. Selection & organization of appropriate test items
- 5.3. Considerations in relevant test items

Unit 06 Constructing Objective Test Items

- 6.1. Short-answers/true-false/matching items
- 6.2. Multiple choice items
- 6.3. Advantages and limitations of objective type items
- 6.4. Scoring of objective type items

Unit 07 Constructing Subjective Test Items

- 7.1 Forms and uses of essay type questions
- 7.2 Constructing interpretive exercises
- 7.3 Advantages and limitations of subjective type items
- 7.4 Scoring of subjective type items

Unit 08 Assembling, Administering and Appraising Tests

- 8.1. Assembling test items for particular setting
- 8.2. Administering test in classroom
- 8.3. Appraising test items in specific educational setting
- 8.4. Preparing records

Unit 09 Selecting and Using Kinds of Tests

- 9.21 Achievement tests
- 9.22 Aptitude tests
- 9.23 Interpreting test scores
- 9.5 Advantages and limitations in different tests

Unit 10 Evaluating procedures

- 10.1 Evaluating and learning development
- 10.2 Developmental & observational techniques
- 10.3 Peer appraisal

Unit 11 Researches in curriculum designs

- 11.1 Practice & Discussion

ED-643 Course Title: Academic Writing

Credit Hours: 3

Course Description:

This course aims to help you improve your academic writing. **It is not a remedial course.** Rather, it emphasizes the interrelatedness of critical reading, writing, and thinking. It asks you to locate and closely examine published research articles on a topic in your field to use as you develop the conventions of academic writing. In a workshop setting, you will learn and practice concrete strategies for composing and revising texts and you will develop greater metacognitive awareness of your writing processes.

Learning Outcomes:

The course is grounded in a view of literacy as a social practice, which means that we will explore how academic genres are implicated in the professional practices of educational research and publishing communities. Academic discourse

conventions such as critical summary, argumentation, and citation are presented as ways by which researchers—and you as emergent professionals—negotiate membership in various academic communities of practice. Through a series of peer editing experiences, you will also develop skills as thoughtful readers of your colleagues' writing, an ability that is useful for professionals as well as students.

Course Outline

Unit 01 Introductions & Overview

- 1.1. Why do we need a writing class in graduate school?
- 1.2. What makes writing challenging?

Unit 02 Metanarratives about Writing

- 2.1 What are the "stories" we have gleaned about writing from our context?
- 2.2 What personal "stories" do we hold about our own writing?
- 2.3 What "meta-phors" shape our thinking about writing?
- 2.4 Doing library research (**field trip to Library**)

Unit 03 Literacy as Social Practice, Genre and communities of practice, Academic Discourse

- 3.1 Defining key terms
- 3.2 Introduction to academic writing as discourse, genre, and jargon.

Unit 04 Critical Reading

- 4.1. Summary (descriptive and critical)
- 4.2. Annotated Bibliography
- 4.3. Positioning
- 4.4. Mapping

Unit 05 Literature Reviews: Purposes

- 5.13. Difference between annotated bibliography and literature review

Unit 06 Argumentation & Structure

- 6.1. Claims
- 6.2. Evidence
- 6.3. Core Paragraph Structure

Unit 07 Cohesion

Unit 08 Point of View, Voice & Authority

Unit 09 Positioning

- 9.1 Social purposes of citation/conventions
- 9.2 Citing, Referencing, and Footnotes, APA conventions

Unit 10 Conclusions Abstracts

Unit 11 Revision & Editing, Peer review vs. peer editing

Course Objectives of Each Course

ED-641 Curriculum Studies

- To develop understanding of foundations of curriculum design.
- To understand process of curriculum development in various educational settings.
- To learn process of curriculum implementation in different tiers of education.

ED-642 Education and Development

- To identify barriers in achieving universal literacy and steps to remove these in education.
- To generate environmental awareness among learners at schools.
- To explore gaps in different sectors of mainstream education.

ED-644 Educational Technology

- To develop understanding of applications of Educational Technology.

- To understand process of implementation Educational Technology in various educational settings.
- To learn learning process through Educational Technology in different tiers of education.

ED-602 Educational Change and Development

- To develop understanding of the basic framework of social learning process.
- To understand process of role playing and learning through thinking.
- To comprehend inductive and deductive thinking approaches.

ED-601 Professional Development of Teachers

- To discuss the meaning and concept of professional development of teachers.
- To study various learning theories used in professional development of teachers.
- To comprehend multiple teaching strategies.

ED-646 Teacher Education

- To develop understanding of the basic framework of teacher education.
- To understand process of teacher education in educational settings.
- To identify dimensions of teacher education and evaluation process.

ED-671 Qualitative Research Methods

- To develop understanding of the basic framework of research process.
- To develop an understanding of various research designs and techniques.
- To identify various sources of information for literature review and data collection.
- To develop an understanding of the ethical dimensions of conducting applied research.

ED-672 Quantitative Research Methods

- Provide students with a solid understanding of (and appreciation for) basic quantitative methods.
- Equip students with the ability to comprehend and critically evaluate quantitative research studies.
- Provide students with the knowledge to conduct their own quantitative study.
- Improve students' ability to manipulate and interpret data using SPSS.

ED-645 Educational Testing and Development

- Understand the concept of evaluation and testing
- Determine the qualities of a good test.
- Plan and construct appropriate classroom test to evaluate student's performance.
- Make report of the test results to different stake holders.

ED-647 Monitoring and Evaluation

- To develop understanding of the basic framework of monitoring & evaluation.
- To understand process of developing instructional objectives.
- To identify dimensions of evaluation procedures in educational settings.

ED-643 Academic Writing

The course is grounded in a view of literacy as a social practice, which means that we will explore how academic genres are implicated in the professional practices of educational research and publishing communities. Academic discourse conventions such as critical summary, argumentation, and citation are presented as ways by which researchers—and you as emergent professionals—negotiate membership in various academic communities of practice. Through a series of peer editing experiences, you will also develop skills as thoughtful readers of your colleagues' writing, an ability that is useful for professionals as well as students.

Suggested Teaching Approaches

- Lecture Method
- Discussion Method
- Project Method
- Assignment Method
- Collaborative Learning Method
- Demonstration Method

Institute of Avionics & Aeronautics (IAA)

The Institute of Avionics and Aeronautics at the Air University was established in 2006 as a Centre of excellence for education, research and development in multi-disciplinary engineering fields. The institute has been mandated with supporting the nascent aeronautical and associated high-tech industries in Pakistan through research in avionics, aeronautics and mechanical engineering. Currently, the IAA comprises two major departments, namely, the Department of Avionics Engineering and the Department of Mechanical and Aerospace Engineering. The Department of Avionics Engineering offers MS and PhD degrees in Avionics Engineering and Information Security. The Department of Mechanical and Aerospace Engineering offers BE, MS and PhD degrees in Mechanical Engineering, and MS and PhD degrees in Aerospace Engineering.

At the Department of Avionics Engineering, research is carried out in the areas of navigation systems, guidance and control systems, active and passive surveillance systems, signal processing, microwave circuit design, communication systems, micro-electro-mechanical systems (MEMS) and system integration. There is lot of emphasis on applied / result-oriented research in this department and, by the grace of Allah Almighty, the department has already made huge strides in this direction by delivering industry standard turn-key solutions and consultancy services to a number of private and public sector organizations of Pakistan.

The Department of Mechanical and Aerospace Engineering specializes in two focal areas, namely, mechanical engineering and aerospace engineering. Mechanical engineering, being the mother of all engineering disciplines, deals with diverse engineering problems and hence encompasses a number of multi-disciplinary activities. It deals with the generation, conversion, transmission, and, utilization of thermal and mechanical energy; the design and production of tools, machines and their products; the consideration of fundamental characteristics of materials as applied to design; and the synthesis, analysis and automation of mechanical, thermal and fluid systems. The functional aspects of mechanical engineering include design, production, manufacturing, operation, administration, economics and research related activities. The BE qualification in mechanical engineering at Department of Mechanical and Aerospace Engineering prepares the students to effectively and confidently handle the diverse challenges related to mechanical engineering discipline in their professional life. The MS and PhD programs of the department are more research oriented for human resource development to take on the challenges of R&D activities. The aerospace engineering specifically focuses on areas such as aerodynamics, propulsion, aerospace structures, structural analysis, structural dynamics, aero-elasticity, composite materials, computational & experimental fluid dynamics, turbulence modeling, fluid-structure interaction, aero-acoustics, and MEMS sensors for aerospace applications.

At IAA, the expertise of the relevant professionals has been combined with the invigorating academic setup of the Air University in the heart of Islamabad making IAA a unique setup for exploring new perspectives and research directions. In addition to the requisite resident faculty, an appropriate number of PhD qualified engineers with rich practical experience in relevant fields are also associated with IAA as adjunct faculty members.

Department of Avionics Engineering

Introduction

The word Avionics is a combination of Aviation and Electronics. In recent years, the aircraft industry has experienced an exponential increase in the application of digital communications, controls and navigation systems. On-board computers now control vital flight functions of large aerial vehicles from takeoff to automatically controlled landings while on-board sensors observe physical phenomena as diverse as weather, ground vehicles, crop densities and other aerial targets. The field of avionics is thus multi-disciplinary and challenging. The Avionics Engineering Department of IAA offers **MS and PhD degrees in Avionics Engineering** and **MS in Information Security**. The program offered provides an opportunity of pursuing a rigorous course of studies reflecting the challenges of today's high-tech electronics and aviation industry. The students are allowed to select courses from a variety of specializations which are covered in depth and which probe the frontiers of engineering and scientific knowledge. Special-study courses are available to explore emerging technologies and their applications for solving problems. Advanced concepts and applications are emphasized throughout the program and the thesis research. The aim is to provide the required knowledge and substantial depth so that the alumni can continue to pursue lifelong multidisciplinary learning as professional engineers.



“The experience I had in Avionics Engg Deptt, AU provided me with a strong foundation and opened up many opportunities for my career ahead. As a result of technical knowledge I gained through coursework and research I felt well prepared to face challenges in professional life.”

Ammar Saleem
Faculty Member at CAE (NUST)
MS-AvE-F11
(Currently pursuing PhD at Turkey)



“Satisfaction is what I got from Avionics Engineering Department. The department helped me to broaden my horizon and expose my talent.”

Bilal Khan
MS-IS-F17



“Avionics Engg Deptt has provided me chances to fully explore my potential and boost my skills. The faculty is highly qualified and co-operative. State-of-the-art labs are available for research. It is my pride, privilege and pleasure to be a student of Avionics Engg Deptt.”

Salman Liaquat
MS-AvE-S17

	“The faculty, staff and students of the department of Avionics Engg altogether make the department vibrant and conducive to learning and research. An exclusive aspect of the department is that represents the impartial merge of both theoretical and practical knowledge.” Imran Aziz Faculty Member at CAE (NUST) MS-AvE-F15
	“It’s been a steep learning curve for me at Avionics Engg Deptt. Today, after a year at the department, I find myself way tuned to engineering and research with an inquisitive and analytical approach. And I still find a lot more ice to break!” Sohaib Fakhar MS-AvE-S17
	“I am very proud to be a part of Avionics Engg Deptt, AU. It’s a place where you can explore and polish your abilities to meet the challenges of the modern world.” Mobeen ur Rehman MS-AvE-F17
	“The student teacher interaction is worth praising. This department taught me a lot and overall groomed my personality.” Salman Akhtar MS-AvE-S16
	“The best aspect of Avionics Engineering Department, in my opinion, is its efforts for Industry-academia linkage which is rarely seen in any other university or department in Pakistan. The research thesis on which I worked was funded by Industry.” Atif Shahzad Faculty Member at CAE (NUST) MS-AvE-F15
	“In a very short time at the department, I developed the ability to design solutions for complex engineering problems and design systems and the ability to conduct investigation into complex problems using research based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.” Zohaib Zafar MS-AvE-S17

Mission Statement

To offer graduate students an opportunity to pursue rigorous course of studies and engage in solution oriented original research work, by providing the best faculty and state of the art laboratories with a view to bridging the gap between academia and industry. Special emphasis laid on inculcating strong ethical practices thus providing graduates with sound professional knowledge, integrity of character, a keen sense of social responsibility and a passion for lifelong learning.

Message of Chair Department

Welcome to the Avionics Engineering department, at The Institute of Avionics and Aeronautics (IAA), Air University. Our goal for graduate students is to give them a high-quality engineering education that includes hands-on experience. Each of our faculty members is ready and willing to work in their research specialty with capable students on individual projects. Our faculty has two major areas of research: Avionics systems and Information security.

Our master's and doctoral students give numerous technical presentations in courses and on their research. All graduate students are also expected to publish their research in relevant peer reviewed engineering journals.

Whether you are a current or former student, a potential student, or a visitor, please feel free to contact or visit us.



Dr. Israr Hussain

Chair Avionics Department

PhD, University of Manchester, UK

Teaching & Research Faculty



Dr. Israr Hussain

Chair, Department of Avionics

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Education:

- **B.E. Avionics (1986-1991)**
College of Aeronautical Engineering, Pakistan
- **MS Avionics Engineering (2002-2004):**
National University of Sciences & Technology, (NUST) Pakistan
- **PhD Electrical Engineering (2004-2008)**
University of Manchester, UK

	Dr. Ammar Masood Faculty Member E-mail: ammarmas@yahoo.com Education: PhD Electrical Engineering Purdue University, West Lafayette, IN Specialty: Information Security & Software Engineering MS Electrical Engineering Purdue University, West Lafayette, IN Specialty: Communications & Signal Processing BE Avionics Engineering College of Aeronautical Engg Risalpur, Pakistan PhD, Purdue University, USA
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	Dr. Muhammad Adnan Visiting Faculty Member Education: PhD in Avionics Systems - University of Toulouse, France Research Interests: Digital & Embedded System, DSP, Avionics Integration E-mail: avionion@gmail.com
	Engr. Naveed Ahmad Abbasi Lecturer (pursuing his PhD from Turkey, On Study Leave) E-mail: abbasinvd@hotmail.com Education: MS. Northwestern Polytechnical University, Xi'an, China Research Interests: Information Coding Theory, Digital Signal and Image Processing
	Dr Muhammad Zakwan Faculty Member E-mail: mohammadzakwan@gmail.com Education: PhD ELECTRONIC & ELECTRICAL ENGG.; KOÇ UNIVERSITY; ISTANBUL; TURKEY MS. Northwestern Polytechnical University, Xi'an, China



Engr. Adnan Fazil; Research Associate

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Education: BE Avionics Engineering (CAE, NUST)

Research Interests: Wireless Communications, Instrumentation



Engr. Khurram Khan Jadoon;

Research Associate(pursuing his PhD from South Korea, On Study Leave)

Education:

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Engr. Zain-ul-Abideen

Lab Engineer

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Education: Bachelor in Telecom Engineering, Muhammad Ali Jinnah University Islamabad.

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Education:

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M.S Avionics Engineering (IAA, AU)



Dr Shahzad Arshad

Visiting Faculty Member

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Ext: 500

Education:

Qualification	Major Field of Specialization	Univ/Inst
BE	Avionics	CAE, PAF Academy, Risalnur
MS	Microwave Engineering	CAE, NUST, Risalpur
PhD	RF and Microwave Engineering	University of Manchester, UK



Dr Azhar Hasan

Visiting Faculty Member

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Education:

PHD EE

GEORGIA INSTITUTE OF TECHNOLOGY,, USA ((FALL 2007 — MAY 2012))

MS EE

National University of Sciences and Technology, Islamabad ,

MBA

Institute of Business Administration, Karachi



Dr Aamer Iqbal Bhatti

Visiting Faculty Member

Email: aamer987@gmail.com

Education:

Leicester University, UK

1997-1999

Post-doctoral research

Leicester Univeristy, UK

1994-1997

PhD in Control Systems

Imperial College of Science Technology and Medicine, London

1993-1994

MSc Control Systems

Research Interests:

Control Systems, Radar Signal Processing



Dr Muhammad Mukaram

Visiting Faculty Member

Email: mukise3@yahoo.com

Education:

BE Software Engineering, NUST

MS Informatics (Mobile Transaction Security)

PhD in Computer System Engineering from University of Manchester, UK



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Education

Bachelor of Engineering (Avionics), 1999

College of Aeronautical Engineering,

National University of Sciences and Technology, Islamabad

Master of Science, Information Security, 2009

Military College of Signals,

National University of Sciences and Technology, Islamabad

Thesis: Security Analysis of e-Passport System

Ph.D, Information Security, 2014

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Research Laboratories

1. Avionics Integration Lab (AIL)

The aim of this lab is to provide the-state-of-the-art hybrid avionics equipment integration and systems development platform supporting multiple busses, multiple platforms and unified operations. Demonstration of implementing multiple gateways will be possible through most modern reconfigurable and programmable Hard Ware. This complete instrumentation ready lab is the key strength of avionics integration research facilities at IAA. It is bifurcated into two parts. The avionics Integration test-bed which aims at the integration of one specific aircraft and the research test-bed which aims at providing a toolset for simulating the environment for any research purpose in the area of avionics integration and aerospace sensors & systems simulation.

The instrumentation platform chosen for these test beds is PXI for seamless integration of signal conditioning, data acquisition and switching mechanisms. AIL's main strength is that the addition of cards can help the instrumentation equipment to morph into the desired research test bed for avionics integration. AIL is equipped to support research in the following areas:

- Real-time fault tolerant Protocols design, implementation and analysis
- Aerospace Sensor and Systems Research
- Distributed Controls Systems Design and Evaluation Platforms
- Embedded Systems Design and Implementation
- Reconfigurable Hardware Applications
- ASIC Design Testing and Validation
- FPGA Algorithms Optimization and Basic Support Facility for ASIC Design
- Instrumentation and Measurement
- Design Validations Facilities
- Automated Test Equipment
- Production Validation and Quality Assurance



2. Electro Optics Lab (EOL)

This lab aims at providing the-state-of-the-art thermal imaging, optical and image processing and tracking ,

multiple sensors fusion FLIR/CCD, robust image registration techniques, optical measurement and testing using spectrometry, fiber optic sensors calibration, linearization and testing facility. Also included in the scope of this lab are fault diagnostics using multiple vision sensors, laser applications, light source, monochrome and color LEDs testing. EOL will be equipped to support research in the following areas:

- Image Processing and Image Based Tracking Control
- Multiple Sensors Fusion FLIR/CCD
- Robust Image Restoration Techniques
- Optical Measurement and Testing Using Spectrometry
- Fiber Optic Sensors Calibration, Linearization and Testing Facility
- Fault Diagnostics Using Multiple Vision Sensors
- Lasers Target Designation and Ranging and Precise Motion Measurement

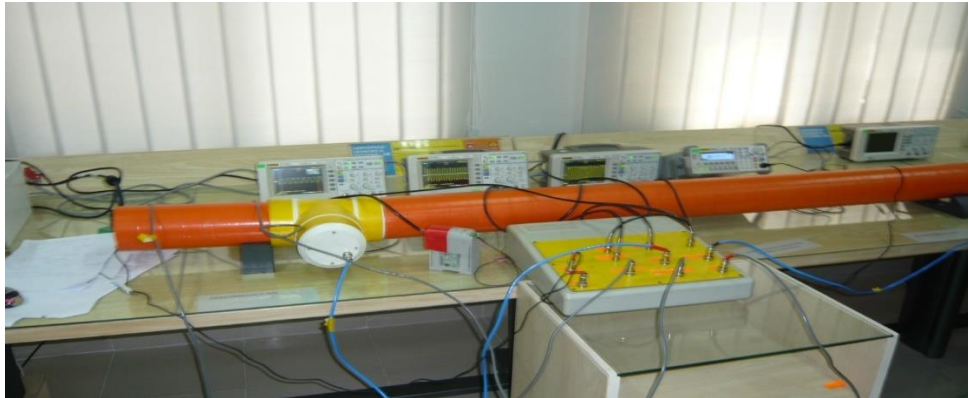


3. Aerospace Sensors & Systems Lab (ASSL)

Aerospace sensors and systems lab aims at providing the research facility for advanced topics in aerospace sensors such as sensors modeling, linearization, sensor failure detection, complimentary filtering, and multiple sensor fusion. This lab uses a modular test and measurement system platform extended in SCXI signal conditioning interfaces that allow programmable filtering and signal conditioning of sensors signal as well as sensor activation. This lab when used in conjunction with avionics system integration will become a unique aircraft instrumentation and avionics integration test-bed for research purposes. ASSL will be equipped to support research in the following areas:

- Aerospace Sensors and Systems Research
- Vibrations
- Adaptive Control
- Aerospace Vehicle Autopilot Design
- Fault Tolerant and Robust Controls
- Optimization and H-infinity Controls
- Fault Detection and Isolation

- Sensors and System Identification
- Data Fusion
- Neuro-Fuzzy Techniques in Instrumentation and Measurement



4. Communication Security & Embedded Systems Lab

This state-of-the-art lab can support research and development in Voice Encryption / Decryption, IP Exchanges., E1 / T1 Interfaces, E1 Analysis, VPN Implementations, IP Terminal Development, FPGA and DSP implementation of algorithms.

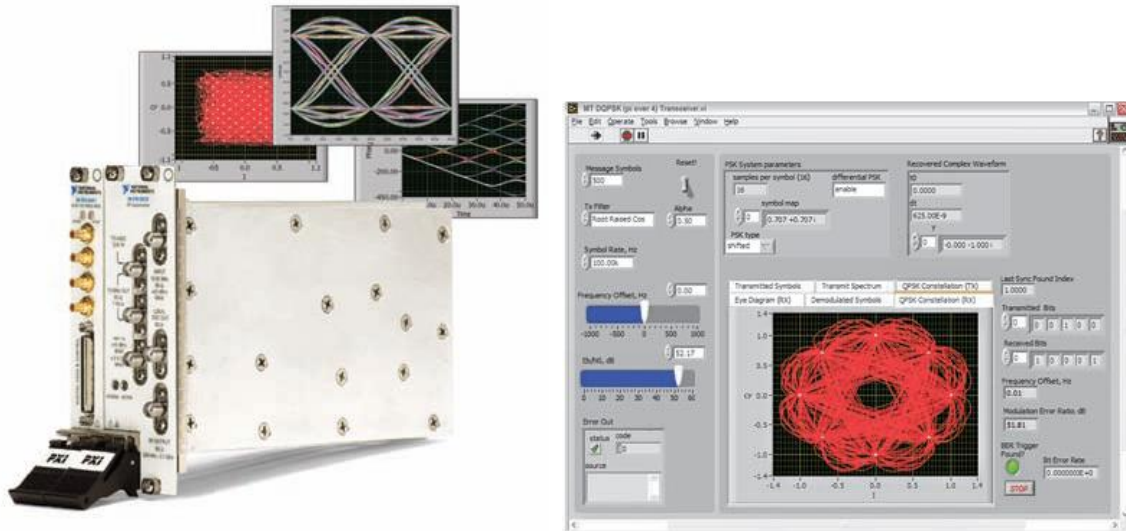


5. ECM & Radar Lab

The aim of this lab is to provide complete test facility in the range of the software defined radios, frequency hopping radios and systems, wireless adhoc networks, HF, UHF, VHF spectrum monitoring and selective jamming including the concepts of OFDM implementation and testing services. This Lab is equipped to support research in the following areas:

- Software Defined Radios
- Hopping Radios Analysis and Testing

- Jammer Design, Self-Protection Jammer, Friend Aware Jamming
- Wireless Adhoc Networks
- WiMAX and Emerging Standards Analysis in Commercial Range
- HF/UHF/VHF Spectrum Monitoring and Selective Jamming
- Orthogonal Frequency Division Multiplexing (OFDM)



6. Micro Electro-Mechanical Systems Lab

Micro-Electro-Mechanical-Systems (MEMS) is an emerging technology that has found abundant use in aerospace systems. Miniaturized sensors on silicon chips have replaced bulky sensors saving volume, weight and power all of which are at a premium in aerospace vehicles. The lab adds a highly sought-after dimension to the in-country indigenous capabilities in the area of MEMS. At present it has facilities for characterization of MEMS devices but work is in hand to expand the available facilities to fabrication of micro and nano sensors and devices for aerospace as well as electronics, automotive and medical applications etc.

Programs Offered

Master of Science in Avionics Engineering with following streams:

- Control Systems
- Communications
- Microwave
- Signal & Image Processing

***Note:** subject to adequate student enrolment in a particular specialty

PhD in Avionics Engineering

Master of Science in Information Security

Admission Eligibility

Master of Science in Avionics Engineering

1. BE / B.Sc. Engineering (Electrical / Electronics / Avionics), with minimum CGPA 2.00/4.00 or equivalent. For the Communications and Signal & Image Processing streams candidates with BE (Computer / Telecom) are also eligible to apply and for the Control Systems stream candidates with BE (Computer / Telecom / Aerospace / Mechanical / Mechatronics) are also eligible to apply.
2. For award of MS degree HEC requires GRE General / GAT-General test (at least 50% score), that must be taken before.
3. Candidates will appear in an interview for final selection.

PhD Avionics Engineering

1. Master degree in the relevant area of engineering (with at least 24 credit-hours course work plus 6 credit hours thesis) with a CGPA of at least 3.0/4.00 or equivalent.
2. Subject GRE (International) 60 percentile/GAT subject test with minimum of 60% marks / equivalent University Test with above 60% score in the given order / as per prevailing university policy.
3. Candidates will appear in an interview for final selection.

Master of Science in Information Security

1. BE / B.Sc. Engineering (Electrical / Computer), BE Software Engineering, B.Sc. Computer Science, BIT (4 years) with minimum CGPA 2.00/4.00 or equivalent.
2. GRE (General) / NTS GAT-General with minimum 50% score.
3. Candidates will appear in an interview for final selection.

MS Avionics Engineering

The avionics engineering department at IAA offers MS in four (04) specialties subject to adequate student enrolment in a particular specialty. The award of MS degree requires successful completion of 24 credit hours of graded post-graduate level courses and successful defense of 6 credits hours of thesis research.

Course Requirements

Core Courses: At least three courses of relevant stream from the following core courses:

Course No.	Course Title
AV-610	Linear Systems Theory
AV-611	Linear Multivariable Feedback Control Systems
AV-620	Random Processes
AV-621	Digital Signal Processing
AV-626	Digital Communications
AV-630	Wireless Communications-I
AV-640	Electromagnetic Field Theory
AV-641	Transmission Lines and Waveguides
AV-712	Optimal Control
AV-713	Non-Linear Systems
AV-714	Flight Dynamics & Control
AV-716	Adaptive Control
AV-723	Detection & Estimation
AV-725	Communication Networks
AV-726	Array Signal Processing
AV-727	Radar Signal Processing
AV-735	Design & Analysis of Algorithms
AV-737	Image Processing
AV-742	RF and Microwave Circuit Design
AV-743	Microwave Engineering
AV-744	Microwave Electronic Devices
AV-829	Information Theory
MA-644	Advanced Engineering Mathematics
AV-799 ¹	MS thesis research

¹Compulsory

Elective Courses:

Course No.	Course Title
AV-632	Software Engineering
AV-715	Robust Control
AV-717	Soft Computing Systems
AV-718	System Identification
AV-719	Neural Networks
AV-720	Avionics Systems Integration
AV-722	Stochastic Systems
AV-724	Embedded System Design
AV-731	Wireless Communications II
AV-734	Principles of Real-Time Computing
AV-736	Optimization

AV-738	Adaptive Filter Theory
AV-739	Introduction to Chaos
AV-740	Multimedia Signal Processing
AV-741	Digital Video Processing
AV-745	Analog IC Design (Bipolar)
AV-747	Semiconductor Device Technology
AV-749	Analog IC Design (MOS)
AV-760	Power Electronics
AV-819	Instrumentation & Measurement for Aerospace Applications
AV-827	Navigation Systems
AV-828	Missile Guidance
AV-831	Computer Vision
AV-833	Model based Software Testing
AV-846	Advanced Antenna Engineering
AV-848	Microwave Design
AV-880	Advanced Topics in Control Engineering
AV-881	Advanced Topics in Communications
AV-882	Advanced Topics in Microwave Engineering

PhD Avionics Engineering

PhD in Avionics is a 48 credit hour program beyond Masters which includes a PhD dissertation equivalent to 30 credit hours and 18 credit hours of course work in the student's chosen area of specialization. Requirement for obtaining a PhD degree includes:

1. Maintaining a CGPA in the course work as per university policy.
2. Passing of the PhD qualifying exam.
3. Acceptance for publication of at least one paper in a peer reviewed journal listed in the ISI citation index.
4. Two positive reports about the student's research work from international scholars in the field.
5. Successful defense of the PhD thesis.

The PhD degree is expected to be completed in four years. The maximum time allowed for the PhD program is six years, while the minimum time required for completion of PhD degree requirement is three years.

Course Requirements

A PhD student is required to take six of the following courses:

Course No.	Course Title
AV-610	Linear Systems Theory
AV-611	Linear Multivariable Feedback Control Systems
AV-620	Random Processes
AV-621	Digital Signal Processing
AV-626	Digital Communications

AV-630	Wireless Communications I
AV-632	Software Engineering
AV-640	Electromagnetic Field Theory
AV-641	Transmission Lines and Waveguides
AV-712	Optimal Control
AV-713	Non-Linear Systems
AV-714	Flight Dynamics & Control
AV-715	Robust Control
AV-716	Adaptive Control
AV-717	Soft Computing Systems
AV-718	System Identification
AV-719	Neural Networks
AV-720	Avionics Systems Integration
AV-722	Stochastic Systems
AV-723	Detection & Estimation
AV-724	Embedded System Design
AV-725	Communication Networks
AV-726	Array Signal Processing
AV-727	Radar Signal Processing
AV-731	Wireless Communications II
AV-734	Principles of Real-Time Computing
AV-735	Design and Analysis of Algorithms
AV-736	Optimization
AV-737	Image Processing
AV-738	Adaptive Filter Theory
AV-739	Introduction to Chaos
AV-740	Multimedia Signal Processing
AV-741	Digital Video Processing
AV-742	RF and Microwave Circuit Design
AV-743	Microwave Engineering
AV-744	Microwave Electronic Devices
AV-745	Analog IC Design (Bipolar)
AV-747	Semiconductor Device Technology
AV-749	Analog IC Design (MOS)
AV-760	Power Electronics
AV-819	Instrumentation & Measurement for Aerospace Applications
AV-827	Navigation Systems
AV-828	Missile Guidance
AV-829	Information Theory
AV-831	Computer Vision
AV-833	Model based Software Testing
AV-846	Advanced Antenna Engineering
AV-848	Microwave Design
AV-880	Advanced Topics in Control Engineering

AV-881	Advanced Topics in Communications
AV-882	Advanced Topics in Microwave Engineering
MA-644	Advanced Engineering Mathematics
AV-899 ¹	PhD Thesis

¹Compulsory

MS Information Security

The avionics engineering department at IAA also offers MS in Information Security subject to adequate student enrolment. The award of MS degree requires successful completion of 24 credit hours of graded post-graduate level courses and successful defense of 6 credits hours of thesis research. The specific requirements for the MS-IS degree is as follows:

Core Courses: At least three of the following core courses:

Course No.	Course Title
IS-650	Number Theory
IS-750	Applied Cryptography
IS-660	Computer Networks
IS-661	Computer Security
IS-751	Cryptanalysis
IS-762	Information Security Management
IS-799 ¹	MS thesis

¹Compulsory

Elective Courses: Selection can be made from following courses:

Course No.	Course Title
IS-620	Random Processes
IS-710	Design and Analysis of Algorithms
IS-711	Neural Networks
IS-715	Optimization
IS-720	Digital Signal Processing
IS-725	Image Processing
IS-730	Software Engineering
IS-731	Soft Computing Systems
IS-732	Principles of Real-Time Computing
IS-735	Model based Software Testing
IS-740	Introduction to Chaos
IS-745	Information Theory
IS-766	Operating System Security
IS-770	Cloud Computing

IS-771	Parallel and Distributed Processing
IS-781	Wireless Network Security
IS-791	Digital Forensics

Courses Description MS and PhD Avionics Engineering

AV-610 Linear Systems Theory

The course covers following topics. Linear spaces and linear operators. Bases, subspaces, eigenvalues and eigenvectors, canonical forms. Linear differential and difference equations. Mathematical representations: state equations, transfer functions, impulse response, matrix fraction and polynomial descriptions. System-theoretic concepts: causality, controllability, observability, realizations, canonical decomposition, stability, introduction to optimal control and the Kalman filter.

AV-611 Linear Multivariable Feedback Control Systems

Control design concepts for linear multivariable systems, System Modeling, Design of feedback controllers, Full Order Observer design, Internal Stability, Transfer functions and closed loop stability, Closed Loop Design Specifications, Sensitivity to Plant Model Uncertainty, The Bode Loop Shaping, Multivariable (MIMO) Closed Loop system representations, Observer Based Compensator, Multivariable Integral Control, Feasibility for MIMO systems, Bias Estimation & Integral Control, LQR Controller, Kalman filter as an optimal estimator, Time Domain Design Limitations, Frequency Domain Design Specifications, Robust Stability, MIMO Generalization of the Stability Robustness, Singular Values and Feedback Control, Classical properties of LQ regulators, The MIMO Root Locus

AV-620 Random Processes

Topics include probability axioms, sigma algebras, random vectors, expectation, probability distributions and densities, Poisson and Wiener processes, stationary processes, autocorrelation, spectral density, effects of filtering, linear least-squares estimation, and convergence of random sequences.

AV-621 Digital Signal Processing

Introduction to digital signal processing of continuous and discrete signals. The family of Fourier Transforms including the Discrete Fourier Transform (DFT). Development of the Fast Fourier Transform (FFT). Signal sampling and reconstruction. Design and analysis of digital filters. Correlation and spectral estimation. Estimators of second order properties of random processes: nonparametric and model-based techniques of spectral estimation

AV-626 Digital Communications

This course covers Sampling, Pulse Code Modulation, Pulse Amplitude Modulation, Pulse Position Modulation, Time Division Multiplexing, Digital Pass band Modulation: Gram Schmidt Orthogonalization Procedure, Geometric representation of signals, Noise: Additive Gaussian white and colored noise, multiplicative noise, Receivers: Optimal Receiver in AWGN (ML Receiver), sub-optimal Receivers, Matched Filter Receiver, Receiver Performance, Performance comparison of modulation schemes, Probability of Error, Coherent modulation schemes: BFSK, BPSK, Binary Amplitude shift keying: BASK, M-ary modulation schemes, Performance comparison of modulation schemes in AWGN, Non-Coherent Digital Modulation Schemes, Non-

Coherent ML Receiver, Non-Coherent BPSK, Non-Coherent BFSK, Non-Coherent BASK, Synchronization and Symbol Timing Recovery, Digital Communication through band limited channels: ISI, Optimum receiver with ISI, Equalization

AV-630 Wireless Communications I

This course covers Overview of wireless communication, Cellular concepts & cellular standards, Channel Modeling - Path loss & Large-scale propagation, Channel Modeling – Small Scale Fading, Modulation techniques, Error Correction Coding, Multiple Access (MA) Techniques , Spread spectrum (SS), Direct Sequence Spread spectrum (DSSS), Frequency Hopping Spread spectrum (FHSS), Direct Sequence Code Division Multiple Access (DS-CDMA)

AV-632 Software Engineering

The goal of software engineering is to control the quality of software by following engineering principles during development. In the practical aspect of this course, the use of object-oriented programming, design patterns, refactoring and extreme programming will be discussed. As a graduate level course, the other aspect of this course focuses on automatic techniques that analyze software artifacts and thus facilitate the engineering process. Through course projects, students will acquire hands-on experience on analyzing software.

AV-640 Electromagnetic Field Theory

The course covers following topics. Vectors, Coulomb's Law, Electric Field, Gauss's Law, Scalar Potential, Conductors in Electrostatic Fields, Electrostatic Energy, Electric Multipoles, Boundary Conditions at Surface Discontinuity, Electrostatics in the presence of Matter, Special Methods in Electrostatics, Electric Currents, Ampere's Law, Magnetic Induction, Integral form of ampere's law, Vector Potential, faraday's Law of Induction, Magnetic Energy, Magnetic Multipoles, magnetism in the presence of matter, Maxwell's Equations, and Scalar and Vector Potentials.

AV-641 Transmission Lines and Waveguides

The course covers following topics. Plane waves, Polarization, Laws of Reflection and Refraction, Energy Relations, Waveguides (Fields in Bounded Regions), Circuits and Transmission Lines.

AV-712 Optimal Control

The course covers following topics. Euler-Lagrange formulation; Hamilton-Jacobi approach; Pontryagin's minimum principle; Systems with quadratic performance index; Second variation and neighboring extremals; Singular solutions; numerical solution techniques.

AV-713 Non-Linear Systems

The course covers following topics. Introduction to the analysis and design of nonlinear systems and nonlinear control systems. Stability analysis using Lyapunov, input-output and asymptotic methods. Design of stabilizing controllers using a variety of methods: linearization, absolute stability theory, vibrational control, sliding modes and feedback linearization.

AV-714 Flight Dynamics & Control

This course covers Vector Kinematics, Quaternion and Matrix Analysis of Kinematics, Geodesy & Rigid Body Dynamics, Review of Aerodynamics, Static Stability Analysis, Review of Classical and Modern Control Theory, Nonlinear Aircraft Model, Linear Models and Stability Derivatives, Simulation of Aircraft Dynamics, Trim point, Calculations & Numerical Linearization, Aircraft Rigid Body Modes, Handling Qualities, Stability Augmentation, Control Augmentation, Autopilots

AV-715 Robust Control

Introduction to Lebesgue and Hardy functional spaces, linear operators and norms; time and frequency domain representations of linear systems, internal stability, performance measures and their limitations; model reduction and approximation by balanced realization; classical method of robustness in frequency domain, Bode's gain and phase relations, sensitivity functions; different explicit models of system uncertainty, unstructured uncertainty and small gain theorem, robust stability and robust performance; structured uncertainty and μ -synthesis; H_2 and H_∞ optimal control; H_∞ loop shaping; Gap metrics, nu-gap metrics and extended loop-shaping design;

AV-716 Adaptive Control

Dynamic System Models, Signal Measures, Lyapunov Stability, I/O stability, Adaptive parameter Estimation, Adaptive state feedback control, Continuous time MRAC, discrete-time MRAC, Indirect Adaptive Control, Multivariable Adaptive Control

AV-717 Soft Computing Systems

Fuzzy Sets, Fuzzy rules and reasoning, Fuzzy inference systems, least squares methods for system ID, derivative based optimization, derivative free optimization, Adaptive Networks, Supervised learning NN's, Learning from reinforcement, unsupervised learning, Neuro fuzzy interfaces, data clustering algorithms, neurofuzzy control.

AV-718 System Identification

Introduction to System ID, Models, Review of linear systems, Review of probability, random variables, Stochastic processes, Response of linear systems to random inputs, Propagation of statistics, Introduction to Kalman Filtering, Least Sq Estimation method, Time domain methods, Freq. domain methods, Introduction to PEM, Regression analysis, Application of PEM to aircraft system ID, Experiment design, Maximum Likelihood Estimation methods, Maximum Likelihood Estimation methods, Subspace methods

AV-719 Neural Networks

This course will be an introduction to the basic neural network architectures and learning rules. Emphasis will be placed on the mathematical analysis of networks and learning rules, and on the application of neural networks to certain engineering problems in pattern recognition, signal processing and control systems. The course will incorporate necessary background material (such as linear algebra, optimization and stability), while including extensive coverage of performance learning, like the Widrow-Hoff rule and backpropagation. Several enhancements of backpropagation, such as the conjugate gradient and Levenberg-Marquardt variations, will be discussed. Simple building blocks will be used to explain associative and competitive networks, including feature

maps, learning vector quantization, and adaptive resonance theory. Recurrent associative memory networks, such as the Hopfield network, will also be presented.

AV-720 Avionics Systems Integration

This course we covers Microprocessors (DSP/controllers), Real time operating systems Vx-works, Android and RT-Linux), Multi-thread programming , Scheduling schemes, Programming Communication buses (MLT-ST-1553, ARINC 429, CAN and MODBUS) , general design considerations /techniques and simulation of test systems via Hardware-In-The-Loop methodology, Embedded systems / Avionics system Components Communication Buses / Direct link, Real time operating systems User requirement generation. Design and development considerations.

AV-722 Stochastic Systems

Review of Random Prtocesess & Linear Systems, Modeling of physical systems by stochastic differential & difference equations, Analysis of systems whose inputsd are stochastic processes, Spectral factorization, parametric optimization,. Minimum variance control, State estimation of continous-time and discrete-time systems, Linear stochastic control theory

AV-723 Detection & Estimation

Brief Review Of Probability& Statistics, Detection Theory: Hypothesis Testing, Decision Criteria, Basic Concept Of Estimation: Maximum Likelihood, Maximum A Posteriori Estimator, Linear Estimation In Static Systems, Method Of Least Squares, Recursive Least Squares, Linear Dynamic System With Random Inputs, State Estimation In Discrete Time Linear Dynamic Systems, Estimation For Kinematic Model, Kalman Filter Applications, Extended Kalman Filter And Applications, Adaptive Estimation And Manoeuvring Target Tracking, Input Estimation And Manoeuvre Detection, Variable State Dimension Approach, Multiple Model Algorithms, Interacting Multiple Model Algorithms For Manoeuvring Targets, Multiple Sensor Data Fusion

AV-724 Embedded System Design

Embedded system design fundamentals as well as reconfigurable logic design and implementation using a hardware description language are covered in this course. Experiencing various micro-controllers and microprocessors, participants discover hardware, software and firmware design trade-offs, tool chains, and best practices in current embedded systems development. Real-time operating system topics will be considered to further emphasize embedded hardware-software impacts. Numerous hands-on laboratory projects are provided to reinforce lecture concepts. A final project will integrate course topics into an embedded system design based on an intellectual property (IP) core implemented in a reconfigurable logic package and driven by application code loaded from either the development platform or on-board firmware.

AV-725 Communication Networks

This course covers physical layer communications, Link layer protocols, Introduction to queuing theory, Higher layer protocols: TCP, IP and ATM, Routing algorithms, Flow control, Local Area Networks and multiple access, High performance switches and routers, Wireless Networks, Optical Networks and WDM

AV-726 Array Signal Processing

Array signal processing belongs to the general domain of space-time processing as it uses multiple sensors, arranged in a specific geometric arrangement, to acquire multiple versions of a signal. These multiple versions of the signal are processed jointly to estimate the location of the signal source. For multiple signal sources, we can determine and track the locations of these sources. This course covers Basics of Array Signal Processing: Wavefields in Open Space, Spatial Signal Processing, Transmit Beamforming Arrays, Receiver Antenna Arrays, Uniform Linear Arrays: Theory of Array Signal Processing, Source Localization using Frequency Wave-number Spectrum, Narrowband and Wideband, Subspace Methods, Mutual Coupling and Correlation, Beam-forming and Main Beam Steering, Null Placement; Implementation of Array Signal Processing Systems: Signal Processing Errors, Array Element Failure, Ill-conditioned Matrices; Applications of Array Signal Processing, Arrays for RADAR Applications, Arrays for SONAR Applications, Arrays for Biomedical Applications, Arrays for Wireless Communications

AV-727 Radar Signal Processing

This course will be an introduction to radar signal processing covering full range of basic signal processing techniques on which all radar systems rely, including topics such as target interference models, matched filtering, waveform design, Doppler processing, and threshold detection, CFAR and target tracking. In addition, introductions are provided to the advanced topics of synthetic aperture imaging and space-time adaptive array processing.

AV-731 Wireless Communications II

Capacity of fading channels, Wireless Channel Modeling, Performance of Communication systems in Fading Channels, Diversity (both receive and transmit), Multiple Antennas and Space Time Coding, MIMO, Adaptive modulation and Coding, Adaptive modulation and Coding, Multicarrier modulation, Capacity regions for different Multiple Access Systems (TDMA, FDMA, SSMA), Multiuser Diversity, Ad hoc and mesh networks: physical layer view and capacity

AV-734 Principles of Real-Time Computing

The primary purpose of this course is to present an overview of real-time computing. Basic concepts, terminology, and problems of real-time computing are introduced. The constraints of real-time computing are used to contrast real-time applications from applications that are not real-time. The course focuses on software solutions to real-time problems. Issues that are addressed include scheduling, specification of system requirements and design, real-time software architectures, languages and operating systems for real-time computing, real-time problems in a distributed processing system, and hardware-software interfaces.

AV-735 Design and Analysis of Algorithms

The course covers following topics. Computational models and techniques for analyzing the time and space complexity of algorithms. The design and analysis of recursive and non-recursive algorithms for searching, sorting, set operations, graph algorithms, matrix multiplication, etc. NP-Complete problems.

AV-736 Optimization

An introduction to various methods of obtaining the extremum (minimum or maximum) of a non-dynamical system and the use of these methods in real-life applications. Computational methods for nonlinear optimization; unconstrained optimization. Constrained optimization; linear programming; simplex method for solving linear programs; Lagrange's conditions, the Karush-Kuhn-Tucker (KKT) conditions, Least squares, Penalty methods, Practical aspects of optimization.

AV-737 Image Processing

The course is presented in three units. Foundations: the review of continuous-time and discrete-time signals, and spectral analysis; design of finite impulse response and infinite impulse response digital filters; processing of random signals. Speech processing: vocal tract models and characteristics of the speech waveform; short-time spectral analysis and synthesis ; linear predictive coding. Image processing: two dimensional signals, systems, and spectral analysis; image enhancement; image coding; image reconstruction. The laboratory experiments are closely coordinated with each unit. Throughout the course, the integration of digital signal processing concepts in a design environment is emphasized.

AV-738 Adaptive Filter Theory

Theory and applications of adaptive filtering in systems and signal processing. Iterative methods of optimization and their convergence properties: transversal filters; LMS (gradient) algorithms. Adaptive Kalman filtering and least-squares algorithms. Specialized structures for implementation: e.g., least-squares lattice filters, systolic arrays. Applications to detection, noise cancelling, speech processing, and beam forming.

AV-739 Introduction to Chaos

This is a course on bifurcations, chaos, fractals and their applications in diverse fields such as price fluctuations in the stock market, flow of data traffic on the Internet, biological rhythms, and superconducting circuits with particular emphasis on applications in automatic control and telecommunications. The theory is developed systematically, starting with first-order differential equations and their bifurcations, followed by phase plane analysis, limit cycles and their bifurcations, and culminating with the Lorenz equations, chaos, iterated maps, period doubling, renormalization, fractals, and strange attractors.

AV-740 Multimedia Signal Processing

Characteristics of speech and image signals; important analysis and synthesis tools for multimedia signal processing including subspace methods, Bayesian networks, hidden Markov models, and factor graphs; applications to biometrics (person identification), human-computer interaction (face and gesture recognition and synthesis), and audio-visual databases (indexing and retrieval). Emphasis on a set of MATLAB machine problems providing hands-on experience.

AV-741 Digital Video Processing

This course introduces fundamental theory and techniques for efficient representation and processing of video signals. Topics to be covered include: introduction to video systems, Fourier analysis of video signals, properties of the human visual system, motion estimation, basic video compression techniques, video communication standards, and stereo video processing. A term-project is required in the second half of the semester.

AV-742 RF and Microwave Circuit Design

Topics include resonators, filters, detectors, mixers, amplifiers, and microwave systems. There are student design projects for a micro-strip resonator, micro-strip low pass filter, and a high dielectric constant coaxial resonator bandpass filter based upon the Microwave Office software package and use of MathCad at student's option. LEC

AV-743 Microwave Engineering

Properties of waveguides, striplines, and micro-strips. Scattering parameters. Butterworth and Chebyshev impedance transformers. Microwave couplers, cavities, and Fabry-Perot resonators. Periodic structures. Microwave filter design. Faraday rotation and non-reciprocal devices.

AV-744 Microwave Electronic Devices

The course covers following topics. Theory and design of passive and active microwave components and monolithic integrated circuits including: microstrip, lumped inductors and capacitors, GaAs FETs, varactor and mixer diodes, monolithic phase shifters, attenuators, amplifiers and oscillators. Experimental characterization of the above components using network analyzer, spectrum analyzer, power and noise meter

AV-745 Analog IC Design (Bipolar)

This course is devoted to the study of analog circuits realized in bipolar technology, with a focus on applications such as transimpedance amplifiers, and broadband amplifiers for networking and communications. The course begins with a consideration of device operation and the modeling needed to support both the hand analysis and computer simulation needed for design. Basic circuit building blocks and cascaded multistage amplifiers will be analyzed. The analysis and design of feedback circuits is a key component of the course.

AV-747 Semiconductor Device Technology

The principle of operation, device physics, and analytical numerical, and circuit device models for semiconductor devices, such as bipolar junction transistors, metal-semiconductor junctions and transistors, heterostructure junctions and transistors. Selected advanced semiconductor devices, such as novel microwave devices, are also introduced. Prerequisite: SDM-I or equivalent.

AV-749 Analog IC Design (MOS)

Analysis, design and applications of modern analog circuits using integrated bipolar and field-effect transistor technologies. Provides the student with a working knowledge of the basic circuits used in modern analog integrated circuits and techniques for analysis and design.

AV-760 Power Electronics

Introduction to the fundamental operating principles of power conditioning circuits that are currently being used to effect power flow from ac to dc and vice versa. Emphasis is on the relationship between form and function of these circuits. Circuits discussed will include ac/dc line-commutated converters, dc/dc converters, dc/variable frequency converters, resonant converters, and ac/ac converters. Computer simulations will be used as a part of the course work.

AV-819 Instrumentation & Measurement for Aerospace Applications

Principles and Elements of Instrumentation and Measurement Systems, Review of Random Processes, Inertial Force Sensors, Inertial Rotation Sensors, Applications of rate gyros, Coriolis Angular rate sensors, Fibre optics gyros, Ring Laser Gyros, Filtering Estimation and Aiding

AV-827 Navigation Systems

Introduction to navigation science, coordinate frames and transformations, review of relevant concepts from systems theory and random processes, discrete linear and nonlinear Kalman filtering techniques, the global positioning system, inertial navigation, navigation examples and case studies

AV-828 Missile Guidance

Tactical Missile Guidance: Proportional navigation; Important closed-form solutions and their utility; Method of Adjoints: Analysis of missile guidance systems using adjoints; Noise Analysis: Simulating noise, stochastic adjoints; Monte Carlo results; Proportional Navigation and Miss Distance: Useful design relationships for rapid guidance system sizing; Digital Noise Filters: Digital noise filter properties and system performance; Advanced Guidance Laws: Deriving optimal guidance laws without optimal control theory; Kalman Filters and the Homing Loop: Combining Kalman filtering and optimal guidance and optimal guidance techniques; Endoatmospheric Ballistic Targets: Speed, Re-entry angle, Ballistic coefficient; Extended Kalman Filtering: Performance comparison of linear, linearized, and extended Kalman filters; Other Forms of Tactical Guidance and Tactical Zones: Beam rider, command to line-of-sight guidance plus drag and acceleration factors; Strategic Considerations: Gravitation and its impact on performance; Boosters: Using the rocket equation and an introduction to gravity turn steering; Lambert Guidance; Miscellaneous Topics and T4 Guidance: Gravity compensation, pulsed and burnout guidance; predictor-corrector method; Radome Slope Estimation: Dither signals and bandpass filtering.

AV-829 Information Theory

The course covers, Entropy rates of stochastic processes. Maximum entropy and Burg's Theorem. Kolmogorov complexity. Information theory and statistics. Stein's Lemma. AEP. Network information theory. Slepian-Wolf Theorem. Broadcast channel. Multiple access channel capacity. Optimal investment and information theory. Universal portfolios and universal data compression.

AV-831 Computer Vision

Course will explore current techniques for the analysis of visual data (primarily color images). In the first part of the course we will examine the physics and geometry of image formation, including the design of cameras and the study of color sensing in the human eye. In each case we will look at the underlying mathematical models for these phenomena. In the second part of the course we will focus on algorithms to extract useful information from images. This includes detection of reliable interest points for applications such as image alignment, stereo and instance recognition; robust representations of images for recognition; and principles for grouping and segmentation. Time permitting we will look at some additional topics at the end of the course.

AV-833 Model based Software Testing

The course covers following topics. Fundamentals of software testing; Test generation using finite state models, Statecharts, Timed automata, Constraint Logic, Petri nets, Z, Combinatorial design, and others; Test adequacy assessment using black box and white box criteria; Industrial applications of model based testing. Students will be required to form small teams of two or three, preferably interdisciplinary, and make in-class presentations based on a selected topic in model based testing. The work of each team will be reviewed by the instructor and other teams.

AV-846 Advanced Antenna Engineering

Antenna concepts, linear wire antennas, linear arrays, aperture and horn antennas, printed-circuit radiators, frequency-independent antennas, and measurement techniques.

AV-848 Microwave Design

This course presents advanced techniques applicable to the design of RF amplifiers and oscillators and emphasizes advanced theory and design techniques. Considerable emphasis is placed on microstrip implementation of UHF and microwave circuits. In the latter part of the course, commercially available computer-aided design and analysis software packages are introduced and used to complete the second design problem.

AV-880 Advanced Topics in Control Engineering

Current topics of interest in control systems. This course may be repeated for credit.

AV-881 Advanced Topics in Communications

Current topics of interest in communications. This course may be repeated for credit.

AV-882 Advanced Topics in Microwave Engineering

Current topics of interest in microwave engineering. This course may be repeated for credit.

MA-644 Advanced Engineering Mathematics

Theory of linear algebra, Eigen values, Eigen vectors, orthogonality. Vector calculus, Gauss's divergence theorem, Stokes's theorem, Cartesian tensors, Variational calculus, Linear programming, Constrained and unconstrained Optimization, Integral Transforms (Laplace, Fourier, Mellin, Hankel, Z-Transform), Numerical Integration are introduced.

Courses Description MS Information Security

IS-620 Random Processes

Topics include probability axioms, sigma algebras, random vectors, expectation, probability distributions and densities, Poisson and Wiener processes, stationary processes, autocorrelation, spectral density, effects of filtering, linear least-squares estimation, and convergence of random sequences.

IS-720 Digital Signal Processing

Introduction to digital signal processing of continuous and discrete signals. The family of Fourier Transforms including the Discrete Fourier Transform (DFT). Development of the Fast Fourier Transform (FFT). Signal

sampling and reconstruction. Design and analysis of digital filters. Correlation and spectral estimation. Estimators of second order properties of random processes: nonparametric and model-based techniques of spectral estimation

IS-730 Software Engineering

The goal of software engineering is to control the quality of software by following engineering principles during development. In the practical aspect of this course, the use of object-oriented programming, design patterns, refactoring and extreme programming will be discussed. As a graduate level course, the other aspect of this course focuses on automatic techniques that analyze software artifacts and thus facilitate the engineering process. Through course projects, students will acquire hands-on experience on analyzing software.

IS-731 Soft Computing Systems

Fuzzy Sets, Fuzzy rules and reasoning, Fuzzy inference systems, least squares methods for system ID, derivative based optimization, derivative free optimization, Adaptive Networks, Supervised learning NN's, Learning from reinforcement, unsupervised learning, Neuro fuzzy interfaces, data clustering algorithms, neurofuzzy control.

IS-711 Neural Networks

This course will be an introduction to the basic neural network architectures and learning rules. Emphasis will be placed on the mathematical analysis of networks and learning rules, and on the application of neural networks to certain engineering problems in pattern recognition, signal processing and control systems. The course will incorporate necessary background material (such as linear algebra, optimization and stability), while including extensive coverage of performance learning, like the Widrow-Hoff rule and backpropagation. Several enhancements of backpropagation, such as the conjugate gradient and Levenberg-Marquardt variations, will be discussed. Simple building blocks will be used to explain associative and competitive networks, including feature maps, learning vector quantization, and adaptive resonance theory. Recurrent associative memory networks, such as the Hopfield network, will also be presented.

IS-732 Principles of Real-Time Computing

The primary purpose of this course is to present an overview of real-time computing. Basic concepts, terminology, and problems of real-time computing are introduced. The constraints of real-time computing are used to contrast real-time applications from applications that are not real-time. The course focuses on software solutions to real-time problems. Issues that are addressed include scheduling, specification of system requirements and design, real-time software architectures, languages and operating systems for real-time computing, real-time problems in a distributed processing system, and hardware-software interfaces.

IS-710 Design and Analysis of Algorithms

The course covers following topics. Computational models and techniques for analyzing the time and space complexity of algorithms. The design and analysis of recursive and non-recursive algorithms for searching, sorting, set operations, graph algorithms, matrix multiplication, etc. NP-Complete problems.

IS-715 Optimization

An introduction to various methods of obtaining the extremum (minimum or maximum) of a non-dynamical system and the use of these methods in real-life applications. Computational methods for nonlinear optimization; unconstrained optimization. Constrained optimization; linear programming; simplex method for solving linear programs; Lagrange's conditions, the Karush-Kuhn-Tucker (KKT) conditions, Least squares, Penalty methods, Practical aspects of optimization.

IS-720 Image Processing

The course is presented in three units. Foundations: the review of continuous-time and discrete-time signals, and spectral analysis; design of finite impulse response and infinite impulse response digital filters; processing of random signals. Speech processing: vocal tract models and characteristics of the speech waveform; short-time spectral analysis and synthesis ; linear predictive coding. Image processing: two dimensional signals, systems, and spectral analysis; image enhancement; image coding; image reconstruction. The laboratory experiments are closely coordinated with each unit. Throughout the course, the integration of digital signal processing concepts in a design environment is emphasized.

IS-740 Introduction to Chaos

This is a course on bifurcations, chaos, fractals and their applications in diverse fields such as price fluctuations in the stock market, flow of data traffic on the Internet, biological rhythms, and superconducting circuits with particular emphasis on applications in automatic control and telecommunications. The theory is developed systematically, starting with first-order differential equations and their bifurcations, followed by phase plane analysis, limit cycles and their bifurcations, and culminating with the Lorenz equations, chaos, iterated maps, period doubling, renormalization, fractals, and strange attractors.

IS-745 Information Theory

The course covers, Entropy rates of stochastic processes. Maximum entropy and Burg's Theorem. Kolmogorov complexity. Information theory and statistics. Stein's Lemma. AEP. Network information theory. Slepian-Wolf Theorem. Broadcast channel. Multiple access channel capacity. Optimal investment and information theory. Universal portfolios and universal data compression.

IS-735 Model based Software Testing

The course covers following topics. Fundamentals of software testing; Test generation using finite state models, Statecharts, Timed automata, Constraint Logic, Petri nets, Z, Combinatorial design, and others; Test adequacy assessment using black box and white box criteria; Industrial applications of model based testing. Students will be required to form small teams of two or three, preferably interdisciplinary, and make in-class presentations based on a selected topic in model based testing. The work of each team will be reviewed by the instructor and other teams.

IS-650 Number Theory

Introduce the concept of numbers and their properties with specific emphasis to their use in cryptology. This course is intended to serve as prerequisite for more advanced courses in cryptography and cryptanalysis.

IS-660 Computer Networks

The course will cover classical concepts such as network architecture, switching, routing, congestion control, and quality-of-service, and discuss recent developments in these areas. The course will also cover new developments in networking such as network measurements, network management, overlay networking and peer-to-peer systems, network security, and new network architectures. The course will emphasize a system-oriented and empirical view of Internet architecture.

IS- 661 Computer Security

Introduction of the basic notions of confidentiality, integrity, availability; authentication models; protection models; security kernels; secure programming; audit; intrusion detection and response; operational security issues; physical security issues; personnel security; policy formation and enforcement; access controls; information flow; legal and social issues; identification and authentication in local and distributed systems; classification and trust modeling; risk assessment.

IS-750 Applied Cryptography

Introduce the concept of Applied Cryptography along with mathematical details/description and practical systems. The course is intended to make the student understand the role of cryptography in information security and give them background knowledge for further studies and research in the field of cryptology. The course will serve as a prerequisite course for Cryptanalysis.

IS-751 Cryptanalysis

The course is intended to discuss general concepts, methods and algorithms used for cryptanalysis. The construction of classical, stream, block and number theoretic ciphers are discussed from cryptanalysis point of view. During course established practices used in cryptanalysis will be discussed in detail and latest research in the cryptanalysis field will be introduced for extending research if any. The outcome of the course is intended to familiarize students with algorithmic and implementation weakness of cryptographic algorithms which may lead to exploitation and their countermeasures.

IS-762 Information Security Management

This course is concerned with fundamental principles of computer security as applied to management. It covers privacy concerns, secrecy issues, operational security, physical security, hardware security, software security, communications security, and data security. This course is designed and developed to cover the 10 domains in the Information Security Common Body of Knowledge. They include: Security Management Practices, Security Architecture and Models, Business Continuity Planning (BCP) and Disaster Recovery Planning (DRP), Law, Investigations, and Ethics, Physical Security, Operations Security, Access Control Systems and Methodology, Cryptography, Telecommunications, Network, and Internet Security.

IS-766 Operating System Security

This course covers both fundamentals and advanced topics in operating system (OS) security. We will study OS level mechanisms and policies and how they relate to mitigating and defending against real-world attacks on computer systems, including self-propagating worms, large-scale botnets, and advanced malware. Basic OS

security techniques such as logging, system call auditing, address space randomization, memory protection, virtual machine introspection (VMI) will be discussed. Recent advanced techniques such as host-based intrusion detections, system randomization, vulnerability fingerprinting, and virtualization will also be introduced.

IS-770 Cloud Computing

This course will begin by first establishing the definition of cloud computing, then describing the various service delivery models of a cloud computing architecture, and the ways in which clouds can be deployed as public, private, hybrid, and community clouds, followed by a much deeper review of the security and privacy issues related to cloud computing environments. We will examine cloud computing models, look into the threat model and security issues related to data and computation outsourcing, and explore practical applications of secure cloud computing. Using the confidentiality, integrity, and availability of data (CIA) model we will examine the threats and security implications to befall poorly established and maintained cloud computing environment. Audit approaches and methodologies for assessing internal control exposures within cloud computing environments will also be fully discussed and examined.

IS-771 Parallel and Distributed Processing

This course covers a broad range of topics related to parallel and distributed computing, including parallel and distributed architectures and systems, parallel and distributed programming paradigms, parallel algorithms, and scientific and other applications of parallel and distributed computing. In lecture/discussion sections, students examine both classic results as well as recent research in the field. The lab portion of the course includes programming projects using different programming paradigms, and students will have the opportunity to examine one course topic in depth through an open-ended project of their own choosing. Course topics may include: multi-core, SMP, MMP, client-server, clusters, clouds, grids, peer-to-peer systems, GPU computing, scheduling, scalability, resource discovery and allocation, fault tolerance, security, parallel I/O, sockets, threads, message passing, MPI, RPC, distributed shared memory, data parallel languages, MapReduce, parallel debugging, and applications of parallel and distributed computing.

IS-781 Wireless Network Security

This course covers security and privacy issues in wireless networks and systems, such as cellular networks, wireless LANs, wireless PANs, mobile ad hoc networks, vehicular networks, satellite networks, wireless mesh networks, sensor networks and RFID systems. Security problems of MAC and especially upper layers will be emphasized. Attacks and proposed solutions at several layers, authentication, key distribution and key management, secure routing, selfish and malicious behaviors, and secure group communication are analyzed for applicable wireless network types. A short overview of cryptography and wireless networking principles will be given at the beginning of the course.

IS-791 Digital Forensics

The knowledge of computer and network forensics has become essential in securing today's network-centric computing environment. This new course will give the students both the fundamental knowledge and hands-on practice on computer and network forensics. The added exposure to forensics will enhance the marketability of our students and serve the students who carry the skills and knowledge forward into their future careers.

FACULTY OF AEROSPACE SCIENCES AND STRATEGIC STUDIES

Department of Aerospace Sciences and Strategic Studies

Air University, Islamabad

The discipline of Strategic Studies is a subset of international relations and political science. Strategy concerns itself with the use of elements of national power as instrument of policy to achieve nation's geo-political, economic and other interests. Strategy is the overall plan for utilizing the capacity for coercion, in conjunction with political, economic, diplomatic social and psychological instrument of power-to achieve intended outcomes.

The Department of Aerospace Sciences is starting MS Strategic Studies programme for fresh graduates, Officers of Pakistan Air Force and other Services, Intelligence/Security community, civil society and government. The Department offers variety of courses that cover full spectrum of strategic studies, taught by highly qualified faculty with unique combination of academic and practitioner's experience.

Objectives

The programme objectives are train scholars and practitioners in the field of strategic studies by imparting knowledge through a multi-disciplinary approach. Combination of aerospace and cyber space studies, besides traditional and non-traditional aspects of security, would equip DASSS scholars in better understanding of strategic and security challenges of the 21st Century. The DASSS scholars would be exposed to policy making elite of the country through visits and interactions with various military and government departments, besides inviting senior practitioners and prominent academics as guest speakers in the seminars and lectures. Seminars and conferences would form important constituent that would enable DASSS scholars to develop their research and communication skills and understanding of the contemporary issues.

Scope Regarding Market, Social and Employment Perspective

DASSS graduates would find better job prospects in the government and non-government sectors. Their prospective employers include: security establishment; government agencies and NGOs dealing with non-traditional aspects of security such as environment, climate change, human rights and disaster management; international non-government organizations including United Nations and its various organisations including International Atomic Energy Agency (IAEA). DASSS graduates would also find increasing job opportunities in the print and electronic media, research organisations and academia.

Admission and Eligibility Criteria

The Department would enroll candidates possessing specialization or previous degree in Defence & Strategic Studies, International Relations, Political Science, Defence & Diplomatic Studies, Peace & Conflict Studies, Government and Public Policy Studies, Security Studies, War Studies, Pakistan Studies, Gender Studies, Energy, Environment and Climate Change Studies, and Area or Regional Studies. The minimum CGPA should be 2.5 or First Division in 16 years BS/M.Sc or equivalent degree from a recognized University. The Candidate would have to pass GRE (International) or GAT General with 50% score or GAT equivalent test by the Department based on HEC guidelines with 60% score. An Applicant would be required to appear for an admission interview by the Department before admission is offered.

Master of Science in Strategic Studies Curriculum (MS SS)

Core Courses

SS-601 Advanced Research Methods in Strategic Studies	3 CH
SS-602 Evolution of Strategic Thought	3 CH
SS-603 Theory & Dimensions of Contemporary Strategy	3 CH

Elective Courses

SS-604 Seminar on Global Strategic Issues	3 CH
SS-605 Seminar on Strategic Policies of Great Powers	3 CH
SS-606 Evolution & Development of Nuclear Strategy	3 CH
SS-607 National Security Policy and Strategy	3 CH
SS-608 Dynamics of Strategic Stability in South Asia	3 CH
SS-609 Air & Space Power Employment in 21 st Century	3 CH
SS-610 Economics of Defence and Conflict	3 CH
SS-611 Security and Conflict Analysis	3 CH
SS-612 Conflict & Cooperation in Global Commons	3 CH
SS-613 Conflict & Cooperation in South Asia	3 CH
SS-614 Conflict & Cooperation in West Asia	3 CH
SS-615 Conflict and Cooperation in Asia-Pacific	3 CH
SS-616 Conflict & Cooperation in Central Asia	3 CH
SS-617 Civil-Military Relations: Theory and Practice	3 CH
SS-618 Dynamics of Conflict Resolution	3 CH
SS-621 Security, Leadership and Society	3 CH
SS-622 Environment Politics and Globalization	3 CH
SS-623 WMD Proliferation and Nuclear Security	3 CH
SS-624 Geopolitics, Territory and Security	3 CH
SS-625 Politics and Economics of Energy	3 CH
SS-626 Politics of Space and Cyber Security	3 CH
SS-627 International Law	3 CH
SS-628 Diplomacy	3 CH
SS-699 MS Thesis	6 CH

Scheme of Studies for MS in Strategic Studies

Semester	Subject	Credits
First	SS-601 Advanced Research Methods in Strategic Studies	3 CH
	SS-602 Evaluation of Strategic Thought	3 CH
	SS-603 Theory & Dimensions of Contemporary Strategy	3 CH
	SS-604 Seminar on Global Security Issues	3 CH

		Total 12CH
Second	Elective-II	3 CH
	Elective-III	3 CH
	Elective-IV	3 CH
	Elective-V	3 CH
		Total 12CH
Third and Fourth	Thesis	6 CH
Total 30 Credit Hours		

Course Duration and Degree Requirements

As per Air University Academic Regulations, **the normal duration of MS in Strategic Studies would be two years/four semesters**; extendable by two semesters by Dean of Faculty on recommendation of HoD. FBGS may grant extension, beyond three years, for maximum of two regular semesters on semester by semester basis.

Student would need to complete and pass 24 CH course work with CGPA of 2.5 and pass MPhil Dissertation within the period prescribed above, and be recommended by FBGS for award of the degree.



Acting Dean, FASS & Officiating Chair Department, DASSS

Welcome to the Department of Aerospace Sciences And Strategic Studies (DASSS)

I heartily welcome you to Department of Aerospace Sciences and Strategic Studies (DASS) of Air University, Islamabad. The Department is dedicated to train scholars and practitioners in strategic studies by imparting knowledge through a multi-disciplinary approach. Combination of aerospace and cyberspace studies, Pakistan's power potentials, national interests, traditional and non-traditional aspects of security and regional/international power dynamics are studied to equip DASSS students to devise strategies to meet the national security challenges of 21st Century. DASSS students are exposed to meet the strategic community of the country through visits and interactions with military and government departments, besides interacting with practitioners and academics as guest speakers. Seminars and conferences would form important constituent of the studies, enabling DASSS students to develop their research and communication skills and understanding of the contemporary issues.

DASSS graduates are likely to find better job prospects in government and non-government sectors. Their prospective employers include: security establishment; government agencies; NGOs dealing with non-traditional aspects of security such as extremism, environment, climate change, human rights and disaster management; international non-government organizations including United Nations and its various organisations like International Atomic Energy Agency (IAEA). DASSS graduates would also find increasing job opportunities in the print and electronic media, research organisations and academia.

Join the Programme and be part of the strategic community of Pakistan.

Dr. Ghulam Mujaddid,
Air Commodore (Retired),
Actg Dean, FASSS &
Officiating HoD, DASSS,
Air University, Islamabad.

TEACHING FACULTY:



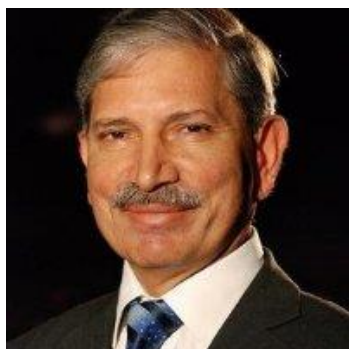
Dr. Ghulam Mujaddid
Air Commodore (Retired)
Actg. Dean, FASSS &
Officiating HoD, DASSS
PhD, QAU



Dr. Adil Sultan
Air Commodore
Assistant Professor
HoD, DASS,
PhD, QAU
Masters' in Mass Communication, AIOU



Brig. (R), Dr. Naeem Salik,
Assistant Professor
Adjunct Faculty,
PhD



Air Marshal Masood Akhtar (Retired)
Visiting Faculty



Dr. Ahmad Rashid Malik
Assistant Professor
Visiting Faculty
PhD

Programs Offered

The Department of FASSS offers Programme:

- **MS Strategic Studies (MSSS)**
- **Degree Awarded: MS in Strategic Studies**
Credit Hrs: 30 Credit Hours (24 Credit Hours Coursework+ 06 Credit Hours Research)
Eligibility:

- 16 years of education, preferably in Defence & Strategic Studies, Political Science, Defence & Diplomatic Studies, Peace & Conflict Studies, Government & Public Policy Studies, Security Studies, War Studies, Pakistan Studies, Gender Studies, Energy, Environment, Climate Change Studies and Area or Regional Studies with at least 2.50/4.00 CGPA or 60 % marks in last-earned degree from HEC recognized University/Institute. The Candidate would have to pass GRE International with 70th Percentile or GAT General with 50% score or GAT equivalent Test by the Department based on HEC guidelines with 60% score. Applicant would be required to appear for an admission Interview by the Department before grant of admission.

Courses Description

SS-601 Advanced Research Methods in Strategic Studies

The purpose of this course is to equip the students with advance practice of research in Strategic Studies. It would develop the skills to review the literature and also help the students in data collection, analysing and evaluating research. This course would enable MPhil scholars to apply qualitative and quantitative methods in their area of work. Research methods and various instruments of gathering qualitative/quantitative data in systematic, scientific and ethical ways will be discussed. In addition, the student will be guided for tools of data collection, data analysis and data interpretation. Software for qualitative/quantitative data analysis and generating references will be briefly discussed.

SS-602 Evolution of Strategic Thought

This course would enable students to understand the evolution of strategic thought from the times of Thucydides, Sun Tzu, Koteliya all the way to the modern theorists of war like Clausewitz, Liddlehart, Bernard Bordie, Andre Beaufre and Collins Gray. Students would learn about profound technological changes in the military technology, communication systems and social media that have affected strategic thought. The nature of war, competition and cooperation would also be examined, and students would be able to appreciate and explore the evolving nature of strategic.

SS-603 Theory & Dimensions of Contemporary Strategy

This course would enable students to understand the evolution of strategic theory and its contemporary connotations. Students would learn the revolution in the strategic affairs brought about by profound technological changes in the military technology, communication systems and social media that have affected strategic theory and its practice. The nature of war, competition and cooperation would be examined, and students would be able to appreciate and explore the evolving nature of strategic thought and practice in contemporary times.

SS-604 Seminar on Global Strategic Issues

The principal purpose of this course is to examine and analyze the contemporary global issues. An interactive approach involving interplay of international, systemic and natural phenomenon would be used to understand the dynamics of strategic issues facing the world and Pakistan. This would equip the students with necessary knowledge to secure and safeguard Pakistan's national interests with regards to the strategic issues, and also help the students to choose their respective area of research.

SS-605 Seminar on Strategic Policies of Great Powers

The principal purpose of this course is to examine patterns of change and continuity in the policy behavior of the United States, Soviet/Russia, China, Japan and EU. An interactive approach involving interplay of domestic context, regional factors and systemic forces will be used to understand the dynamics of their strategic behavior. Students would learn about the nature of great powers and their strategic policies. They would appreciate that structure and nature of international system is determined by the concentration of power in states called the great powers; whose strategic policies need to be studied and analyzed. This would equip the students with necessary knowledge to secure and safeguard their own state in the prevailing international order.

SS-606 Evolution & Development of Nuclear Strategy

The students would understand the development of nuclear doctrine and strategy during the period of continuing political struggle between the United States and the former USSR. The concept of nuclear deterrence became importance in creating an impression that the adversary would have no chance of victory in war as there would be no victors in a nuclear holocaust. The students would understand the doctrines of massive retaliation; flexible response; nuclear retaliation; surprise attack and 'Second Strike' capability along with the concept of mutually assured destruction.

SS-607 National Security Policy and Strategy

This course examines national security policy and strategy as developed and pursued by governments and the civilian sector. The students would understand policy development, monitoring and evaluation role of government departments and agencies, concept of national interests and process of strategy formulation. The students would also be exposed to continuity of government and private sector approaches to risk and contingency planning aspects of internal security with focus on disaster resilience and crisis response, and external security with focus of dynamics of international system.

SS-608 Dynamics of Strategic Stability in South Asia

South Asia has three nuclear-armed powers, each with its own strategic objectives and nuclear philosophies, making definition and practice of deterrence a tall order. In this backdrop, the students would be exposed to the significant transformation in the strategic force postures of the three principal states of South Asia. The students would understand that in case of China and India, the growth of nuclear capabilities is accompanied by the development of ballistic missile defense systems. The students would examine the future of deterrence stability and the security relationships among the three countries, and its linkage with global strategic balance.

SS-609 Air & Space Power Employment in 21st Century

The students would develop recognition of value of air and space assets for handling contingencies from disaster relief to war and increasing demand for such assets. They would understand that such developments have created both challenges and opportunities for the Air and Space Forces in supporting nation's interests in a challenging technological and security environment. The students would be enabled to examine the changing roles of air and space forces in national security strategy; implications of new systems and technologies for military operations, and the role of space in security strategy.

SS-610 Economics of Defence and Conflict

The student would explore relationship between conflict and defence from an economic perspective. They would be introduced to economics of conflict and peace, and explore relationship between defence spending and conflict and questions about the impact of rising weapons costs and costs of conflict. The students would be guided on issues of conflict economics, and of defence input and outputs.

SS-611 Security and Conflict Analysis

Students would learn the concept of security and conflict. They would be able to analyze conflict by recognizing its causes, context, actors, interests, incompatibilities, resources and motivations inherent in the conflict. The purpose of security and conflict analysis is to assist the students in understanding the structure of conflict and contemplate strategies to manage, resolve or transform the same.

SS-612 Conflict and Cooperation in Global Commons

In this course students would learn the concept, definition and types of global commons: the high oceans, the atmosphere, outer space and the Antarctic. They would understand importance of the global commons for security and development of nations. Study of international regimes governing the commons, and politics of access and exploitation would be a special area of interest. The students would understand how Pakistan should endeavour to optimally use the global commons for economy and security.

SS-613 Conflict and Cooperation in South Asia

The students would learn the geopolitical dynamics of South Asian region; its resources, political landscape and environment. The interstate security cooperation, competition, economic integration and patterns of regional cooperation would be explored by the students. The interests of global powers in the region and its linkage with the dominant state structure would also be examined by the students.

SS-614 Conflict and Cooperation in West Asia

The students would learn the geopolitical dynamics of West Asian region; its resources, political landscape and environment. The interstate security cooperation, competition, economic integration and patterns of regional cooperation would be explored by the students. The interests of global powers in the region and its linkage with the dominant state structure would also be examined by the students.

SS-615 Conflict and Cooperation in Asia-Pacific

The students would learn the geopolitical dynamics of South Asian region; its resources, political landscape and environment. The interstate security cooperation, competition, economic integration and patterns of regional cooperation would be explored by the students. The interests of global powers in the region and its linkage with the dominant state structure would also be examined by the students.

SS-616 Conflict and Cooperation in Central Asia

The students would learn the geopolitical dynamics of Central Asian region; its resources, political landscape and environment. The interstate security cooperation, competition, economic integration and patterns of regional

cooperation would be explored by the students. The interests of global powers in the region and its linkage with the dominant state structure would also be examined by the students.

SS-617 Civil-Military Relations: Theory and Practice

The students would be introduced to assumptions of military sociology theory. They would learn the peculiar characteristics of military profession and its relationship with civil society. Various models of civil-military relations would be examined in case-study format. The students would be encouraged to form their own views on the concept and practice of civil-military relations.

SS-618 Dynamics of Conflict Resolution

In order to resolve conflict effectively, it is imperative to have a full understanding of conflict dynamics. In this course, the students would be exposed to drawing lessons from a variety of disciplines, including psychology, sociology and communication to get a wholesome view of the nature and dynamics of conflict and conflict resolution. With a robust understanding of nature of conflict, students would be equipped to attempt to resolve intra-society or international conflict.

SS-621 Security, Leadership and Society

It provides innovative approach to the interdisciplinary study of leadership regarding peace and security. The security challenges in the 21st century needs comprehensive understanding of the nature of threat emanating from state as well as non-state actors, from within the society, and the role of leadership in dealing different challenges through graded approach. the students shall be able to Understand the role of society in defining factors behind securitization and desecuritization of a state, and the role of leadership; Identify various security constructs that are created within the society, influenced by historical experiences, or artificially created by various interests groups; and role of leadership that could change the security constructs, both positive and negative.

SS-622 Environment, Politics and Globalization

The students will learn about global environmental changes caused by globalization, and politics guiding national choices of major powers and the emerging industrial states. Reluctance by major industrial states to acknowledge the harmful impact of environment degradation and its impact on global climate change has emerged as a major security challenge that could only be dealt through combined efforts of all countries.

SS-623 WMD Proliferation and Nuclear Security

This course is designed to help students to understand proliferation dynamics, theoretical and practical aspects of global nonproliferation regime, and its implications for international security. The students would understand the evolution and development of global nonproliferation regime, shaped by several variables, and its likely future. They would understand the political and technical drivers that led to global nuclear proliferation and the efforts towards nonproliferation; familiarize themselves with states' motivations to acquire nuclear weapons; learn technical aspects of major arms control arrangements; understand current efforts towards nuclear nonproliferation and nuclear security.

SS-624 Geopolitics, Territory and Security

It is a unique multidisciplinary course that focuses on the territorial aspect of inter-state relations. Students will be able to explore geopolitical and political geographic analysis – contextualized within the wider social sciences – and the relevant aspects of international law to understand the creation and maintenance of international boundaries. After completing this course, the students shall be able to understand emerging trends of geopolitics shaped by different factors; and identify different patterns of enmity and amity shaped by convergence and divergence of interests, and also by geostrategic locations of major actors.

SS-625 Politics and Economics of Energy

The control of natural resources has been one of the major determinants of global conflicts, and has shaped political priorities of major powers. The students in this course will be taught the economics of energy that continue to shape interests of major powers.

SS-626 Politics of Space and Cyber Security

Space is emerging as the new frontier of global competition. Major powers are exploiting space for their commercial as well as military needs, while denying the benefits to the developing countries. The students shall be taught ongoing efforts by some of the states to militarize the space, and their reluctance to negotiate global treaty or arrangement to prevent monopoly of the few. Likewise cyber domain has emerged as the new challenge. Both state as well as non-state actors are using cyber warfare as an effective tool to launch offensive without attribution. Cyber security has emerged as a necessity for state entities as well as multinational companies, especially the IT sector. The students will get a better understanding about this new form of warfare and the need to take collective measures to deal with this new threat.

SS-627 International Law

Objectives of this course are to generate awareness among the students regarding the nature, evolution, development and application of International Law, upon the members of international community such as states, international institutions and individuals. This course also addresses the issue of practicability of International Law.

SS-628 Diplomacy

Diplomacy is an important means by which states execute policies. It is largely designed to enable states to secure the objective of their foreign policies by interacting with the other states preferably without a resort to force in war. The main purpose of this course is to acquaint the students not only about the linkage between foreign policy and diplomacy of a country but also to teach them about the means and methods of achieving the aims and objectives of foreign policy through various kinds of diplomacy. In addition, important matters related to diplomacy will be covered in the course in its theoretical and applied dimensions.

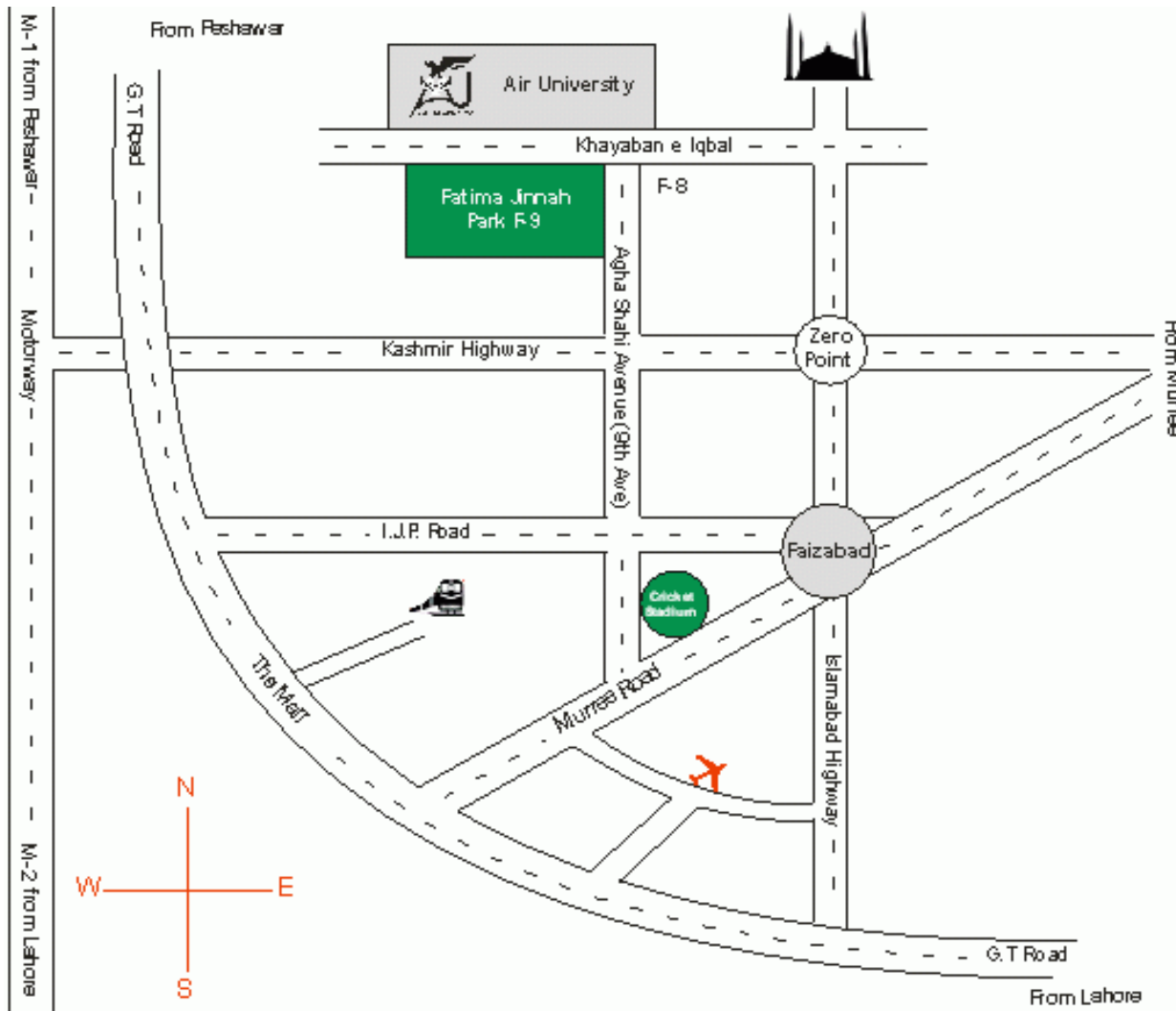
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Direction



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