UNIVERSITY OF
ENGINEERING AND
TECHNOLOGY, PESHAWAR

POSTGRADUATE PROSPECTUS

2020-21

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Vision

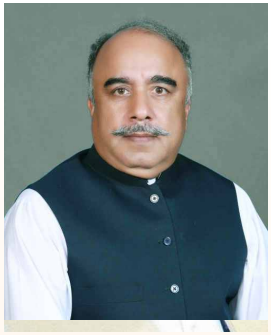
To be among the top ranking universities of the world through Education, Research and Innovation

Mission

To produce highly qualified, well-rounded professionals through education who play a leading role in the society by powering and driving knowledge-based economy and offer research services and innovation for sustainable development.

Message from the **Chancellor**

GOVERNOR



The University of Engineering and Technology Peshawar is the oldest seat of higher learning of Khyber Pakhtunkhwa with a vision to be the top ranked universities of the world through education, research and innovation. Vital to such excellence is its commitment to diversity and inclusiveness, and we all have to cultivate this rich diversity by allowing our core values to keep providing a learning environment where our youth could pursue their dreams.

The comprehensive curriculum in engineering and non-engineering disciplines composed of a wide range of courses are offered within an environment that is conducive to your success and learning abilities. At the same time, you will be challenged to strengthen your skills through vigorous training programs and time bound semesters. That's why, we will expect more from you than any other institution in your academic life thus far.

I am satisfied that UET Peshawar has also worked commendably in coping COVID-19 situation through real-time, interactive and remote online teaching as per its schedule. This has also marked the beginning of a huge transformation in teaching methodology. It is also satisfying that the University also extended its online admission services to the residents of remote areas – the manifestation of which is the intake of students and commencement of academic year 2020-21.

While welcoming you all as the new entrants, we assure you to provide every possible opportunity to achievement. I invite you to explore carefully the information given in this Prospectus 2020-21 and become familiar with UET Peshawar about its offerings. .

I wish you a good fortune, and huge success in all your endeavors.

SHAH FARMAN
Governor, Khyber Pakhtunkhwa

Message from the **Pro-Vice Chancellor**

The University of Engineering and Technology Peshawar has been successfully able to translate the vision over the years of developing responsible future leaders who are capable of facing the daunting realities and global challenges. Towards that end, the university has not only opened new departments but adopted a robust teaching methodology more in line with the requirements of global world. As we know that Pakistan is a signatory of the Washington Accord, UET Peshawar has made special efforts in the last few years to bring the engineering programs upto the International standards. We are able to take a huge shift from conventional to the modern teaching system by getting all our major engineering programs accredited under the Outcome Based Education Program. This achievement, no doubt, is attributed to a strong faculty support. Our robust curriculum also serves as a base for the students to develop interpersonal and leadership skills while acquiring academic knowledge.

The University is promoting a policy of accessible and quality higher education for all the aspirants across Khyber Pakhtunkhwa. Our satellite campuses located in Bannu, Kohat, Jalozai and Abbottabad are a manifestation of this commitment where major engineering programs are taught to the students at their doorsteps. While we are committed to achieve our goals, we strongly believe that the next generation in leadership can only evolve if the students themselves put concerted efforts with their Teachers and parents to build strong career. With such inclusiveness, we are confident that UET Peshawar will turn out to be one of the greatest places of learning in the world.

Join us and be proud of your alma mater!

Prof. Dr. Qaisar Ali
Pro-Vice Chancellor, UET Peshawar

www.uetpeshawar.edu.pk

UET strives to provide admission related information to potential students. The following departments respond to various queries regarding selection of academic disciplines, admission schedule and important dates etc.

Directorate of Postgraduate Studies
The Directorate of Postgraduate Studies (DPGS) deals with admissions of postgraduate students in coordination with Directorate of Admissions. The Directorate also looks after the processing of postgraduate programmes and enforcement of regulations approved by the Academic Council and Syndicate.
Contact: (+92-91) 922 2151, **Email:** khanshahzada@uetpeshawar.edu.pk

Directorate of Admissions
The Directorate of Admissions is responsible for student admissions; provides specific and general information to prospective students round the year.
Contact: (+92-91) 9216784, **E-mail:** admission@uetpeshawar.edu.pk
website: www.enggentrancetest.pk

Directorate of Media and Publications

The Directorate of Media and Publications is responsible for media activities and in-house publications. It runs an extensive admission publicity campaign; circulates admission schedules, important information, announcements, news releases and advertisements.

Contact: (+92-91) 9222147, **E-mail:** dirmedia@uetpeshawar.edu.pk

Campus Management Solutions (CMS) / IT Center

UET Peshawar with its core mandate to provide "quality education" is on a continuous path to bring new technologies in the academic processes. In 2006, UET Peshawar under the auspices of HEC took an initiative and established an advanced network infrastructure through the Campus Management Solutions (CMS) software services. The CMS, a web-based portal was officially launched in 2008 at UET Peshawar with an aim to provide faculty/staff and the students with immediate access to real-time information that helps to streamline the processes, reduce manual handling and building a database that effectively manages student accounts. In 2012, CMS was transformed into Information Technology Center by adding a wide spectrum of services to its domain. These services are offered across the campus which include CMS software services; providing 24/7 internet services on campus and hostels; official email services; VPN to access HEC Digital Library for the students and faculty/staff; video conferencing; issuance of Microsoft licensed softwares to the departments; managing the official website: **www.uetpeshawar.edu.pk** with the latest information on academic and research programs, and IT Help Desk Support. The University also started the Smart Campus (Eduroam), a world-wide education roaming service in 2019 which has further enhanced the internet connectivity for the students and faculty/staff across campus. Over the years, the integration of information technology into academic and administrative processes has completely transformed the learning environment and student lifestyle on campus.

Contact: (+92-91) 9222141, **Email:** cmshelp@uetpeshawar.edu.pk

CENTERS OF EXCELLENCE & SKILL DEVELOPMENT CENTERS

National Institute of Urban Infrastructure Planning (NIUIP)

National Institute of Urban Infrastructure Planning (NIUIP), established in 2008 with Higher Education Commission (HEC) funding, is committed to promote sustainable urban development in Pakistan, and apply research in combating challenges facing rapidly growing urban centers in the country.

Objectives:

- To develop it into a center of excellence for teaching, research and training in urban infrastructure planning in Pakistan.
- To train and educate Maters' and Doctoral level students with hands-on opportunities for research in an applied and problem-solving environment.
- To conduct research in emerging trends in urban planning and development.
- To identify and disseminate global best practices in urban planning and management.
- To develop national and international strategic partnerships for collaborative research.
- To train in-service professionals in government and non-government organizations in urban infrastructure planning.

Continuing Engineering Education Center (CEEC)

CEEC ensures need-based trainings to the engineering community as a part of continuing engineering education to in-serive engineers. The Center has been established with following objectives:

- Capacity building of engineers to engage effectively in the global economy.
- Development of indigenous capacity to ensure effective utilization of international aid.
- Promote quality of teaching and research.
- Improve project management and financial management skills.

Besides serving the engineering community in general, CEEC regularly offers Teachers Training courses in collaboration with HEC for its freshly inducted faculty.

Technology Incubation Center (TIC)

Technology Incubation Center established with the help of HEC is aimed to spur economic development and job creation through technology business incubation. The Center offers support services for start-up entrepreneurs in starting and running their businesses. Besides, it also facilitates the faculty and students in obtaining Intellectual Property Rights as well as

commercialization of their research. The center is fully equipped with allied facilities, offers one roof solutions including, phone, internet connectivity, video conferencing and trainings on IP and legislative matters under the qualified faculty and staff. It also aims to attract young brains to commercialize their innovative ideas and for this purpose the Center incubates small companies, selected through a supervisory committee.

Gems and Jewelry Center of Excellence (GJCoE)

The Gems and Jewelry Center of Excellence Center is a state-of-the-art facility in gem cutting and polishing. The center with its qualified teaching faculty and laboratories offers five month diploma in gemology and lapidary. The Center has been upgraded to Gems and Jewelry Center of Excellence that will not only provide training in gemology and lapidary, but value gems and precious stones.

Earthquake Engineering Center (EEC)

UET Earthquake Engineering Center is a multi-disciplinary research and education Center, established with the aim to mitigate the seismic disaster risk in the province in particular and country, in general. The center has made tremendous progress so far in the last few years. It has been upgraded to the National Institute of Earthquake Engineering with the funding of Rs. 487.219 million by HEC. The center has developed research collaborations with renowned international organizations, research centers and universities for human resource development, research and development activities.

Quality Enhancement Cell (QEC)

The Quality Enhancement Cell (QEC), is aimed to assist the university in improving the student learning by continuously enhancing and maintaining the academic standards under the HEC guidelines. At present, the QEC efforts are mainly focused on coordination between the university and HEC, and implementation of the HEC quality assessment procedures.

Since its establishment in February 2007, QEC has focused on gathering information and data about the facilities, finances, research, students, and faculty of each department and, has incorporated the collected information in the HEC ranking performa as per HEC requirements.

Office of Research, Innovation & Commercialization (ORIC)

UET Peshawar has developed the Office of Research Innovation & Commercialization (ORIC). This office is aimed at transforming pure knowledge into products and services with the perspective of ultimate community welfare. Its main role is to strengthen University's research and knowledge creation process by providing strategic and operational support through promoting entrepreneurship, technology-transfer and commercialization activities to energize local and national economy. It also aims at strengthening University-Industry relationships by enhancing cross-cutting and multi-disciplinary research initiatives for the up gradation of local and national industries. In general it aspires to achieve sustainable development by translation of research into public benefit through ensuring research relevance in terms of social, economic and environmental aspects.

National Center for Robotics and Automation
The Advanced Robotics and Automation Lab (ARAL), located at the Department of Mechatronics Engineering, UET Peshawar, was established in 2018 and is part of the National Center of Robotics and Automation (NCRA), Pakistan. As part of a response to our national challenges such as lack of agriculture technology and productive automation, the lab is actively involved in research and prototype development pertaining to all aspects of precision agriculture, industrial automation and biomedical devices. The lab is headed by Prof. Dr. Muhammad Tahir Khan who leads a team of established researchers having Ph.D. degrees from countries; Canada and UK. Several research associates, assistants, and Master/PhD students are also engaged in research on different funded projects.

National Center for Big Data & Cloud Computing (NCBC)
The vision of NCBC is to effectively utilize cloud computing for Big Data applicationsfor solution to problems of national importance. Keeping in view the advantages of cloud computing in provisioning and processing of big data and its suitability for the emerging trend in mobile devices and Pakistani R&D environment having limited hardware resources, the utility of the cloud computing is plausible. In NCBC, our focus is on the following key sub-domains, which are R&D problems of National importance.

- Multimedia streaming and analytics
- Remote sensing big data analytics
- Traffic characterization and analytics
- Cloud integration and analytics for mass data platform

National Center for Cyber Security
National Centre for Cyber Security (NCCS) shall play a leading role in securing Pakistan's Cyberspace and making Pakistan world's premier nation in Cyber Security.

Center of Intelligence Systems and Network Research
The Center of Intelligence Systems and Network Research (CSINR) was launched at Electrical Engineering Department. The Center presents an example of industry-academia linkage, established with the active participation of faculty of Electrical Engineering Department.

National Center for Artificial Intelligence (AI)
National Center of Artificial Intelligence (NCAI) was inaugurated at the main campus of National University of Sciences & Technology (NUST) at NUST on 16th of March, 2018. NCAI is the latest technological initiative of Government of Pakistan under the government's Vision 2025 where leading universities are its partners. The center at UET Peshawar is designed to become the leading hub of innovation, scientific research, knowledge transfer to the local economy, and training in the area of Artificial Intelligence (AI) and its closely affiliated fields. The central aim is to facilitate the researchers in the field of AI; help them establish and grow AI industry following international trends and seek solutions to the indigenous problems through AI.

CONTENTS

THE UNIVERSITY

University of Engineering and Technology, Peshawar, is a premier institution of higher learning in the field of engineering sciences. Starting as a College in 1952, with an initial enrollment of only twenty students, today it boasts twenty two engineering departments, covering an entire spectrum of engineering disciplines, from the traditional, such as electrical and mechanical, to the cutting-edge technologies such as electronics, mechatronics, and industrial engineering. To-date, thousands of students that graduated are serving the needs of Pakistan, and many have achieved high positions of responsibility and excellence in their chosen fields.

Besides bachelors degree courses, there is a robust post-graduate programme, where scholars are engaged in rigorous training and research leading to Master's and Ph.D degrees. UET also has a strong out-reach programme, under which academic linkages with the world class universities of UK, Canada, USA, Malaysia, Italy and Thailand offering invaluable training to faculty and students, through split programmes, joint research and faculty exchanges.

Over the last few years, with Higher Education Commission's support, UET had initiated a number of research and infrastructure development projects, with a portfolio of Rs. 9 billion. Major projects include "Earthquake Engineering Center", serving as a hub of applied research in South Asia, "Institute of Mechatronics Engineering", "National Institute of Urban Infrastructure Planning" and "Gems and Jewelery Center of Excellence".

In order to increase access to engineering education, particularly for the people of Khyber Pakhtunkhwa, UET has been awarded a "mega" project of Rs. 6.56 billion to develop a new campus called, "Establishment of Jalozai Campus." The Jalozai Campus promises to push boundaries for engineering education and will double its student intake from 4000 to 8000.

PESHAWAR CAMPUS

With a modest beginning in 1952 as a "constituent" college of Peshawar University, UET, Peshawar was established in 1980. Since then, five satellite campuses in Mardan, Bannu, Abbottabad, Kohat and Jalozai have been added. We have also established centers of excellence and institutions. However, Peshawar Campus remains the nucleus of the University, keeping everything moving along the correct path.

Located in the historic city of Peshawar, UET is a reflection of the surrounding environment. While the ambiance on campus is predominantly academic, there is a strong cultural flavor, easily discernable in every facet of its activities. Our unique cultural diversity is readily recognizable.

There are many disciplines at Peshawar for students to choose from. These are supported by well-equipped laboratories, departmental research, and a central library, sports facilities and enough dormitory accommodation to house most students that need campus housing.

SATELLITE CAMPUSES

ABBOTTABAD CAMPUS

The Chancellor, UET, Peshawar inaugurated Abbottabad Campus in October, 2002, in the old premises of Ayub Medical College. The city of Abbottabad gained fame as a city of schools and colleges. Due to a pleasant climate, people from all parts of the country send their children to study in reputed educational institutions such as Army Burn Hall, Abbottabad Public School, COMSATS Institute of Information Technology etc. In addition, five medical colleges in the city also attract students. Establishment of a campus of UET, Peshawar in Abbottabad has not only addressed a longstanding public demand, but also enhanced the city's image as a seat of learning. Known for its natural beauty, better climatic conditions and a vast network of educational institutions, Abbottabad was ideally suited for such an institution of higher learning in applied sciences. A new girls hostel with a capacity to accommodate hundred students has been constructed at the campus.

BANNU CAMPUS

Bannu Campus became operational in May 2002, in the premises of the Comprehensive High School in the city. This has brought higher education in engineering sciences to this neglected middle-southern region. Prior to this, students would go to Dera Ismail Khan, Kohat or Peshawar to pursue their higher studies.

Currently, two traditional disciplines in engi-neering sciences are offered, and efforts are afoot to consolidate these programmes. Large investment in strengthening laboratories, and upgrading infras-tructure are being done to quickly bring this campus at par with others.

KOHAT CAMPUS

The administrative and management control of Engineering Academic Programmes of Kohat University of Science and Technology (KUST) was handed over to UET, Peshawar on April 3, 2012. At present, UET Kohat Campus is offering B.Sc. electrical engineering in leased premises, providing all necessary facilities to the students.

JALOZAI CAMPUS

The Jalozai Campus funded by HEC at the cost of Rs. 6,565.272 Million is established on Pabbi-Cherat Road at 11 KM Southwards from GT Road in district Nowshera. At present there are five engineering and non-engineering departments which are offering undergraduate degree programs including civil engineering, electrical engineering, mechanical engineering, industrial engineering and Computer Science & Information Technology (IT). Having the services of all Ph.D faculty Jalozai Campus will offer education in eight engineering disciplines.

Faculties

There are four faculties created to administered the performance of respective departments.

Faculty of Electrical and Computer Engineering

- Department of Electrical Engineering, Peshawar
- Department of Electrical Engineering, Bannu Campus
- Department of Electrical Engineering, Jalozai Campus
- Department of Electrical Engineering, Kohat Campus
- Department of Computer Systems Engineering, Peshawar Campus
- Department of Electronic Engineering, Abbottabad Campus
- Department of Computer Science & IT, Peshawar Campus
- Department of Computer Science & IT, Jalozai Campus

Faculty of Mechanical, Chemical & Industrial Engineering

- Department of Mechanical Engineering, Peshawar Campus
- Department of Mechanical Engineering, Jalozai Campus
- Department of Industrial Engineering, Peshawar Campus
- Department of Industrial Engineering, Jalozai Campus
- Department of Mechatronics Engineering, Peshawar Campus
- Department of Chemical Engineering, Peshawar Campus
- Center for Advanced Studies in Energy, Peshawar

Faculty of Civil, Agricultural & Mining Engineering

- Department of Civil Engineering, Peshawar Campus
- Department of Civil Engineering, Jalozai Campus
- Department of Civil Engineering, Bannu Campus
- Department of Mining Engineering, Peshawar Campus
- Department of Agricultural Engineering, Peshawar Campus
- National Institute of Urban Infrastructure Planning, Peshawar
- Gems & Jewelry Center of Excellence, Peshawar Campus
- Earthquake Engineering Center, Peshawar Campus

Faculty of Architecture, Allied Sciences & Humanities

- Department of Architecture, Abbottabad Campus
- Department of Basic Science & Islamiat, Peshawar Campus

Department of
Agricultural Engineering

The Department of Agricultural Engineering was established in 1961 and has the honor of producing the first batch of Agricultural Engineers in Pakistan. Since then it has produced thousands of undergraduate and postgraduate students. Many of these graduates have worked and still working on key positions in various governmental, semi-governmental, private and international organizations. The Department started its MSc Engineering program in 1990 with emphasis on Soil and Water Engineering. In 1994, another area of specialization was added with emphasis on Farm Machinery and Power Engineering. The Department also started PhD program in these two major areas of Agricultural Engineering in 2004. These postgraduate programs in Agricultural Engineering require completion of advanced course work and a research project by the students to become skilled in research methodology. Our students are expected to plan, conduct and analyze a comprehensive research project, and to report the findings in a thesis, a scholarly document of research conducted in accordance with accepted scientific methodology. They benefit from a diverse applied engineering curriculum and enjoy small class size and frequent one-to-one contact with the faculty.

Agricultural Engineering is the application of engineering knowledge and techniques to agriculture. The constantly expanding population of the world has required and will continue to demand an ever-increasing agricultural production of food and fibers through improved irrigation and drainage systems, farm mechanization, and management of soil and water resources. Agricultural Engineering has been one of the major contributors to the increased production that has been realized during the past century. It is oriented to the design and control of equipment and systems for the production, processing and transportation of food, feed, and fiber, as well as the effective use of natural resources. However, it is not limited to agriculture only but has a broad spectrum of other applications like animal husbandry, fisheries, poultry, dairy industry, food processing industry, and grain and cold storages. Renewable energy, bioenergy and biological engineering are a recent addition to this list. In all of these fields the major portion of investment is engineering in nature. This warrants the recruitment of only qualified agricultural engineers to appropriate positions in these fields as agricultural engineering is the only discipline that integrates relevant knowledge of other inter-related disciplines of engineering and natural sciences into one discipline.

Dean, Faculty of Civil, Agricultural and Mining Engineering

Prof. Dr. Akhtar Naeem Khan

Chairman

Prof. Dr. Zia-ul-Haq	Ph.D. (UK)

Professors

Prof. Dr. Taj Ali Khan	Ph.D. (UK)
Prof. Dr. Zia-ul-Haq	Ph.D. (UK)
Prof. Dr. Muhammad Shahzad Khan	D.Engg. (Bangkok)
Prof. Dr. Abdul Malik	Ph.D. (Pak)

Associate Professors

Dr. Muhammad Ajmal	Ph.D. (S.Korea)

Assistant Professors

Engr. Mahmood Alam Khan	M.Sc. (Pak)
Engr. Khurram Sheraz	M.Sc. (Pak)

Lecturers

Engr. Muhammad Hamed Khan	M.Sc. (Pak)
Engr. Sajjad Ahmad	M.Sc. (Pak)
Engr. Nazia Arfeen	B.Sc. (Pak)
Engr. Arshad Ali	M.Sc. (Pak)

RESEARCH PROJECTS AND FACILITIES

Our qualified faculty is actively engaged in research projects/studies. Following faculty projects/studies have been conducted in collaboration with different national and international agencies.

- Development of Sugar Beet Planter for Small Farm holdings in Pakistan and Consumptive use study in Peshawar Valley.
- Revision of standards and specifications for Water Management at Farm level.
- Design and development of sugarcane planter for small and medium landholdings of Pakistan.
- Improving Efficiency of on-farm water use and application.
- Integrated Land and Water Management for Stressed Lands.
- To study the drinking water quality in selected areas of Peshawar.
- To determine the sources of ground water pollution in Peshawar.

AREAS OF SPECIALIZATION

Soil and Water Engineering

The Department is offering specialization in Soil and Water Engineering. Increasing problems with the scarcity and misuse of water supplies call for extensive research and extension efforts. Improved utilization and management technologies of all aspects of water use have to be actively researched. Emphasis is given to the design and evaluation of pressurized irrigation systems and various water harvesting techniques.

Farm Machinery and Power

Specialization in Farm machinery and Power is aimed to produce qualified technical manpower in the field of Agricultural Engineering. The role of Agricultural Machinery for the increase and timely production of crops cannot be ignored. Therefore it is important to acquire trained qualified agricultural engineers to handle agricultural machinery problems of modern age. This programme offers research based higher technical education to enable our graduates to apply necessary knowledge and skills to upgrade and modify the use of power and machinery according to the local field conditions of Khyber Pakhtunkhwa.

Interaction with Industry

The Department has a strong research linkages with the following organizations:-

- On Farm Water Management (OFWM)
- National Agricultural Research Council (NARC)
- National Drainage Programme (NDP) and International Water Management Institute (IWMI)
- Environmental Protection Agency (EPA)
- Farm Machinery Institute (FMI)
- Pakistan Council for Research in Water Resources (PCRWR)
- Agricultural Processing Industry, Livestock and Poultry Industry

The Department has conducted successful collaborative research programmes with national and international organizations such as PARC/NARC, UGC, EPA, USAID and GTZ.

LIST OF APPROVED COURSES

SOIL AND WATER ENGINEERING

AE 5410 SURFACE IRRIGATION (3)

The practice of irrigation; selecting an irrigation method. The irrigation requirements; types of surface systems; field measurement techniques; Evaluation of field System, Furrow, Border and Basin Irrigation Design; Land Leveling; Operation of surface irrigation systems; Headland facilities; Debris and sediment removal; Fundamentals of surface irrigation Hydraulics.

AE 5411 SPRINKLE AND TRICKLE IRRIGATION SYSTEM (3)

Sprinkle system components, sprinkle system design procedures; Hydraulics of Sprinkle system. Various types of agricultural sprinkle systems. Installation, Operation and Maintenance of Sprinkle Systems. Extend and advantages to Trickle irrigation; Trickle system components and design; Maintenance and operation requirements.

AE 5413 DESIGN OF CANAL STRUCTURES (3)

General requirements and design considerations. Design of conveyance structures. Regulating structures, Protective structures, Water measurement structures; and energy dissipaters. Transition and erosion protection; Pipe and pipe appurtenances, safety:

AE 5414 IRRIGATION PUMPING PLANTS (3)

Hydraulic Fundamentals, Friction of Water, properties of water, Centrifugal pumps performance; NPSH for pumps and pumping liquids. Electric motor characteristics, Water Flow from pipes and pumps testing. Turbine and Propeller Pumps, Submersible pumps, Peripheral pumps, Water System, Pumps selection and maintenance.

AE 5415 APPLIED WATERSHED HYDROLOGY (3)

Hydrologic cycle and its processes, water balance, precipitation types, estimation of precipitation, analysis of precipitation data. Infiltration phenomena, solutions of the Richard's equation, approximate infiltration models. Runoff estimation and hydrograph analysis, Overland flow theory, lateral flow, water storage in the root zone. Principles and methods of evapotranspiration. Watershed characteristics, watershed resource management and watershed modeling using computer models.

AE 5416 SOIL AND WATER POLLUTION (3)

Types of pollution, point and non-point pollution, sources of pollutants, solid waste management. Water quality analysis and standards. EPA objectives and EIA. Transport phenomena, advection and dispersion, pollution of surface and groundwater, salt-water intrusion. Agricultural pollution, soil pollution, water logging and soil salinization, soil erosion and sedimentation.

AE 5417 CLIMATE CHANGE AND WATER RESOURCES (3)

The natural composition and structure of the atmosphere. Global carbon cycle, Emission scenarios, Climate variability and change: global warming and its impacts, Global Climate System, Energy Balance, and the Hydrological Cycle, Climate Variability and Change, Detection and Attribution of Climate Change, Uncertainty in Climate Change Studies, Climate Change Impacts on Water Resources and Selected Water Use Sectors, Economics of Climate Change, Climate Change Vulnerability Assessment, Climate Change Adaptation in Water, Managing Climate Risk for the Water Sector with Tools and Decision Support, Transboundary River Systems in the Context of Climate Change, International Negotiations on Climate Change and Water, Adaptation and Mitigation.

AE 5418 STATISTICAL HYDROLOGY (3)

Introduction to Statistical Hydrology, Models based on process descriptions, Data interpretation, Data transformations, Hypothesis testing, Correlation coefficient and its significance in statistical analysis, Parametric and non-parametric variables analysis, Multivariate regression analysis, Modeling hydrologic uncertainty, Analysis of hydrologic extremes, Frequency analysis using different distributions, Rainfall-Runoff conceptual models, Continuous hydrologic systems analysis, Discrete hydrologic systems, Concepts of distributed hydrologic modeling, Calibration and validation of models, Evaluation of models performance, Parameters Estimation of Flood Routing models, Flood forecasting, Drought analysis, Impact of land use changes and climate change on hydrology, Review of commonly used hydrologic models.

AE 5419 GIS/RS APPLICATIONS IN WATER RESOURCE MANAGEMENT (3)

Data Acquisition, Manipulation and analysis of data, Statistical and geometrical Geo-processing techniques, Accuracy assessment using Statistical tests, Open GIS, Review of open source software for spatial data analysis, Map design and layout, Charting and Tabular representation of the results using GIS. RS applications in different sectors, Digital image and display, Radiometric (contrast) enhancement. Radiometric correction, Geometric correction, Image Arithmetic (Vegetation Indices and rescaling factors), Principal Components Transformation, Pan Sharpening, Interpretation and information extraction from image, Pixels based approaches, Object based image information extraction (concepts and terms), Ground truthing and accuracy assessment, Precision agriculture, Mini project.

AE 5420 SALINITY AND SOIL WATER MANAGEMENT (3)

Salinity and Soil Water Management

Irrigation and salinity in perspective, Methods of salinity related analysis and units; Properties and chemistry of salts. Origin of salt ions and accommodation of salts in water and soils; Effect of salinity on plant growth. Reclamation and management of salt-affected and water-logged soils, managing salinity and water logging in the Indus Basin of Pakistan, sources of salts in the Indus basin, water management in irrigated areas, water management in rainfed areas.

AE 5421 SOIL AND WATER CONSERVATION (3)

Water Erosion and sedimentation, Wind Erosion and Deposition, Wind Erosion Control, Predicting Soil loss, Cropping System. Tillage Practices for Conservation, Conservation Structures, Water Conservation, Farm Ponds.

AE 5422 ADVANCED SOIL PHYSICS (3)

Composition and formation of soil, Interaction of soil and water, Measurement of water content and potential, Principles of water movement in soil, Measurement of infiltration and hydraulic conductivity, Soil structure, Soil architecture and physical properties, Deformation of soil, Soil aeration, Soil temperature, Soil nutrient management.

AE 5423 MODELING DYNAMIC EXCHANGE OF WATER AND ENERGY (3)

Introduction to continuity in biosphere, Microenvironments, Energy exchange, Models, Heterogeneity and scale, Typical behavior of atmospheric and soil temperature, Modeling vertical variation in air and soil temperature, Modeling temporal variation in air temperature, Soil temperature changes with depth and time, Spatial and temporal variation of atmospheric water vapor estimating the vapor concentration in air, Relation of liquid- to gas-phase water, Modeling the variation in wind speed, Finding the zero plane displacement and the roughness length, Wind within crop canopies, Resistances and conductance, Conductance ratios, Heat flow in the soil thermal properties of soils: Volumetric heat capacity, Water balance, Radiation basics, Attenuation of radiation spectral distribution of blackbody radiation, Radiant emittance, Evapotranspiration big leaf theory.

AE 5424 HYDRAULICS OF SEDIMENT TRANSPORT (3)

Hydraulics of open channel flow, Design of different hydraulic structures, Sediments and its properties, Mechanics of sediment transport, Interaction of fluid and particle, Flow resistance drag force, Lift force concept, Resistance flow in open channel with moveable boundaries and bed form. Incipient motion, suspended load, bed load and total load computation. Bed form measurement. Sediment carrying capacity of channel. Degradation, aggradations and local scour in alluvial channel. Stable alluvial channel design. A review of sediment transport models.

AE 5425 HYDROLOGIC SYSTEM MODELING (3)

Classification of models, Models and computer programs, Runoff volume models, Direct runoff models, Base flow models, Routing models, Model evaluation, Terrain processing, Basin processing, Stream and water shed characteristics estimation, Hydrologic parameter estimation, Hydrologic modeling system connections, HEC-Geo HMS applications, HEC-HMS calibration and validation through real time data.

AE 5426 WATER RESOURCES PLANNING AND MANAGEMENT (3)

Introduction, the Planning process: Identifying and prioritizing issues, Defining and implementing the plan of action, Monitoring implementation progress, Evaluating progress and updating the plan, Estimation of demand and supply of water, Strategies for water resources management, Sustainability issues, Conflicts and challenges in water resource management, Water management measures: Fundamental, institutional, operational and facilities-related water management measures, Legal, institutional, and environmental considerations, Existing water management measures and programs, Environmental review. Assembling a water management plan.

AE 5430 GROUND WATER HYDROLOGY (3)

Groundwater and aquifers; Physical properties of aquifers and vadose zones; Darcy's Law and Hydraulic conductivity; well

flow systems; Measurement of Hydraulic conductivity; Transmissivity; Specific yield and Storage Coefficient Ground water exploration; Well construction and pumping; Flow system analysis, Models and unsaturated flow, Surface water relations; Ground water quality and contaminations.

AE 5432 FLOW THROUGH POROUS MEDIA (3)

Properties of porous media and fluid mixtures; Heterogeneous fluids in static systems; Equations of fluid flow in Porous media. Steady flow in Heterogeneous fluid systems, unsteady flow of Heterogeneous fluids. Similitude for flow of two fluids.

AE 5441 SUB-SURFACE DRAINAGE (3)

Drainage investigations; Hydraulic conductivity determination; Design procedure for the interceptor drains, open drains, pipe drains, spacing of drains; Investigation and layout for drains; Operations and maintenance of drainage system; Special drainage problems.

AE 5490 SPECIAL STUDIES (UPTO 3 CREDITS)

Individual studies on selected topics.

AE 5491 TECHNICAL REPORT WRITING AND RESEARCH METHODOLOGY (3)

Basics of technical writing process, Technical writing techniques and applications, Definition and basics of research, Research purpose, Design of research methods, Identification of research problem, Literature review, Selection of data collection techniques, Selection of representative sample, Writing of research proposals, Use of references manager (e.g., EndNote, Zotero, Mendeley etc.),Data collection and analysis techniques, Limitations and significance of research techniques, Quantitative and qualitative research procedures, Writing of research reports, Presentation skills, and oral presentations.

AE 5499 Master's THESIS (6)

AE 6499 Ph.D. THESIS (1-9)

FARM MACHINERY AND POWER

AE 5450 TRACTION DYNAMICS (3)

Traction theory, Mechanics of wheels and stability dynamic forces, tracks and vehicles pressure distribution in soil, rolling resistance, tractive efficiency and economics of vehicle operating on soil, hard surfaces and roads, technical study of design and performance of agricultural tractors.

AE 5451 ADVANCED AGRICULTURAL MACHINERY DESIGN (3)

Definition Analysis and Solution of a design problem in Agricultural Engineering, Design of machine elements, the use of theory of failures, fatigue, stress concentration, Shock and impact analysis in the design of machine members, design of cylindrical mold board, design of discs, jointers, subsoilers and coulters. Laboratory work will include an in-depth study of the testing and analysis of machine components.

AE 5452 KINEMATICS AND DYNAMICS OF MACHINERY (3)

Introduction to numerical methods, the first and second differences, adjustment calculus. Role of Kinematics, determination of acceleration and velocities, analysis of slider crank mechanism application of method and special role of four-bar linkage. Introduction to dynamics, DAlembert Principle equation of motion for machine with one degree of freedom. Balancing of rigid machines and linkages, principle of vibro-isolation. Eigen Value problem, vibration analysis by computer, computer simulation of high speed and cam mechanisms.

AE 5453 INSTRUMENTATION AND CONTROLS IN AGRICULTURAL ENGINEERING (3)

Theory of basic electronics and standard measurements. Theory of basic instrumentation, transducers and microprocessor or interfacing and application Agricultural Engineering problems.

AE 5454 HARVESTING MACHINERY (3)

Introduction: Mechanism of separation, cutting-threshing and traction mechanism, loss of grain, settings for various crops,

regulation for movement of combines and maintenance. Threshing History, methods of threshing (tangential axial, radial, combined). Power requirements for threshing, factors affecting grain damage and threshing methods of evaluating grain damage, new approaches and concepts in grain threshing. Shelling, Historical development of shelling, concave studies, forces acting on the concave, ear orientation studies damage evaluation, time of relaxation. Combine header History characteristics, header component analysis and evaluation. Cutterbars, Fundamentals of cutting, cutting forces, influences of cutter bar speed on header losses, impact cutting. Conveyors; Critical speeds of conveyors, grain damage, Harvesting machines for wheat and rice.

AE 5455 TRACTOR AND MACHINERY TESTING AND EVALUATION (3)

A study of the principles and procedures used in conducting the Nebraska Tractor Test. Actual PTO drawbar, sound level and hydraulic lift test will be run. Importance testing of Agricultural Machinery, procedure for Farm Machinery Testing and simulating the performance on computer. An additional special project may be elected for additional credit.

AE 5456 THEORY OF MODELS-I (3)

Dimensional analysis: Basics of dimensional analysis, application of dimensional analysis, classification of equations, conversion of equations, form of dimensional equations, determination of exponents by dimensional analysis. Development of predication equation; Basic procedures the Buckingghan Pi theorem, determination of Pi terms, determination of functions, conditions for function to be a product, conditions for unction to be a sum.

Models: Purpose of models, definition of a model, theory of models, types of models, scales, classes of pertinent quantities. Structural Model: True structural models forces, dynamic loading and vibrate fabrication, distorted structural models, predication factor. Soil Models: Selection of variables, true and distorted models.

1. Tillage tools models.
2. Tractor equipment models.

AE 5457 THEORY OF MODELS-II (3)

Fluid flow Model: Pipes and closed conduits, models of pipe lines carrying gas, cavitation in pipe lines, models of pipe channels, weirs, orifices, aerodynamic forces, models of ships. Reynold's Number, Froud Number, Webber Number, Cauchy Number, and Mach Number. Models of Rivers: General considerations, design conditions, materials and construction, erosion and sedimentation, distorted models. Thermal Models: Thermal properties, volume change in gas heat transfer, analysis with four dimensions, scales, Prendl Number, Jusselt Number. Electrical and Magnetic Models: Electrical Characteristics, basic DC Circuit basic AC Circuit, network analyzers, magnetic characteristics bass magnetic circuit problem, electromagnetic models, Introduction to dissimilar models.

AE 5458 COMPUTER-AIDED-DESIGN (3)

Use of Engineering Software such as Lotus 123, Freelance Graphics, AutoCAD, Application of Graphics in Design, Computer representation of Farm Machinery parts and Assemblies.

AE 5459 SPECIAL PROBLEMS IN AGRICULTURAL ENGG (3)

A special problem in Agricultural Engineering will be selected by the student in consultation with his major professor. A careful study of the problem will be made and a report will be submitted by the student.

AE 5460 SEMINAR

Each Master student in Agricultural Engineering will give seminar of at least 2 credit during his program of studies. During a semester the seminar course of one credit can be offered jointly by the departments of Farm Machinery and Power and Soil and Water.

AE 5499 MASTER'S THESIS (6)

AE 6499 Ph.D. THESIS (1-9)

Department of
Civil Engineering

Civil engineers plan, design, supervise the construction of and maintain many of the facilities and systems that are essential to modern life in both the public and private sectors. The civil engineering profession is one of the most stable and most diverse of the engineering disciplines. Civil engineers today are designing methods and facilities to cope with many of our planet's most serious problems. In the face of foul air; decaying cities; roadways, and bridges; clogged airports and highways; polluted streams, rivers and lakes, the civil engineer is being called on to design solutions that are workable and cost-effective.

Civil Engineering Department (CED) was established in 1953-54. CED was the first one to introduce postgraduate studies with specialization in Water Resources and Structural Engineering in 1984-85. CED has the honor to be the first among all departments to start the Ph.D. programme in 2000. The ever-evolving PG (Post Graduate) programme of CED aims towards inculcating leadership skills, a strong sense of professionalism and ethical responsibility in the students and prepares them to recognize the need to engage in life long learning.

The students can select a programme that enhances their ability to work as professional engineers in a local/global economy by pursuing a Master's of Science degree with a thesis that represents independent work, or Master's degree with course work focuses on training of Civil Engineering practice in design and construction. Ph.D. programme requires training through course work, research and participation in seminars, conferences, workshops etc. Thus, original contribution to knowledge through Ph.D. research ensures a career in research academia or consultancy.

Dean, Faculty of Civil, Agricultural and Mining Engineering

Prof. Dr. Akhtar Naeem Khan

Chairman

Prof. Dr. Qaisar Ali	Ph.D. (Pak)

Professors

Prof. Dr. Akhtar Naeem Khan (TI)	Ph.D.(USA)
Prof. Dr. Qaisar Ali	Ph.D. (Pak)
Prof. Dr. Irshad Ahmad	Ph.D. (Pak)
Prof. Dr. Amjad Naseer	Ph.D. (Pak)
Prof. Dr. Muhammad Javed	Ph.D. (Pak)
Prof. Dr. Bashir Alam	Ph.D. (USA)
Prof. Dr. Syed Muhammad Ali	Ph.D. (Pak)
Prof. Dr. Rawid Khan	Ph.D. (UK)

Associate Professors

Dr. Mohammad Ashraf	Ph.D. (Pak)
Dr. Khan Shahzada	Ph.D. (Pak)
Dr. Muhammad Fahad	Ph.D (USA)
Dr. Naveed Ahmad	Ph.D. (Italy)
Dr. Mujahid Khan	Ph.D. (Pak)
Dr. Muhammad Waseem	Ph.D. (Italy)
Dr. SajjadWali Khan	Ph.D. (UK)

Assistant Professors

Dr. Mohammad Adil	Ph.D. (UK)
Engr. Haleema Attaullah	M.Sc. (Pak)
Engr. Tabinda Masud	M.Sc. (Pak)
Engr. Faisal ur Rehman	M.Sc. (Pak)
Engr. Mansoor Khan	M.Sc. (Pak)
Engr. M. Adeel Arshad	M.Sc. (Italy)
Dr. Qazi Samiullah	Ph.D. (France)
Dr. Muhammad Tariq Khan	Ph.D. (UK)

Lecturers

Dr. Alamgir Khalil	Ph.D. (Thailand)
Dr. Wajid Khan	Ph.D. (USA)
Dr. Muhammad Faheem	Ph.D. (Canada)
Engr. Arsalaan Khan	M.Sc. (Pak)
Engr. Muhammad Salman	M.Sc. (Pak)
Engr. Zain ulAbidin	M.Sc. (Pak)
Dr. Muhammad Rizwan	Ph.D. (Pak)
Engr. Asim Abbas	M.Sc. (Pak)
Engr. Aizaz Ahmad	M.Sc. (Pak)
Engr. Manzoor Elahi	M.Sc. (Pak)
Engr. Irfan Jamil	M.Sc. (Pak)
Engr. Fayyaz-ur-Rehman	M.Sc. (Pak)
Engr. Hanif Ullah	M.Sc. (Pak)
Engr. Zohaib Hassan	M.Sc. (Pak)
Engr. Sheheryar	M.Sc. (Pak)
Engr.ShabirHussain	M.Sc. (Pak)
Engr. Waqar Ahmad Khan	M.Sc. (Pak)
Engr.Waqas Ahmad Khan	M.Sc. (Pak)
Engr. Hazrat Amin	M.Sc. (Pak)
Engr.Muhammad Waseem	M.Sc. (Pak)
Engr. Kamran Ahmad	M.Sc. (Pak)
Engr. Zia-ur-Rehman	M.Sc. (Pak)
Engr.Aizaz Ahmad	M.Sc. (Pak)
Engr.Wisal Khan	M.Sc. (Pak)
Engr.Muhammad Asim	M.Sc. (Pak)
Engr.Wajid Ali	M.Sc. (Pak)
Engr.Muhammad Tufial	M.Sc. (Pak)
Engr. Johar Hafeez	M.Sc. (Pak)
Engr. Zahoor Ahmad	M.Sc. (Pak)
Engr. Abdus Salam	M.Sc. (Pak)

RESEARCH PROJECTS AND FACILITIES

In order to facilitate the Postgraduate study CED fulfills all the necessary infrastructural requirements like Research & Development (R&D) and Post Graduate computing center, Postgraduate Library, laboratory facilities such as 16m tilting flume, 200 Tons straining frame,2OO Tons computer controlled U.T.M. and a large test frame with latest data acquisition system and computer controlled tri-axial compression machine, etc., have been installed.

CED helps students to gain practical understanding of the concepts and facilitates Postgraduate research work through its various state-of-the-art laboratories such as Concrete Laboratory, Soil Mechanics & Highway Engineering Laboratory, Structural Laboratory, Hydraulics Laboratory, Material Testing Laboratory, Surveying Laboratory and Public Health Laboratory.

The department offers consultancy services, technical assistance, and laboratory facilities to various government, semi-government and private agencies. The laboratories that are used for these commercial testing include Soil Mechanics and Highway Laboratory, Material Testing Laboratory, Concrete Laboratory and Public Health Laboratory. CED extends its advisory and consultancy services for the diversified nature of Civil engineering problems/design faced by commercial sector (e.g. Non-Destructive Testing, Structural Design, Rehabilitation of existing structures etc). Other civil engineering institutions of the country seek help of CED that has improved upon its intellectual and physical resources over a long period of time. The provincial department often hires the design, vetting and forensic services of our department in connection to various infrastructural projects.

AREAS OF SPECIALIZATION

The objective of the specialization programme is to provide quality education that is well balanced in theoretical and practical considerations and to prepare quality human resource keeping in view the national needs and thus aspiring towards making the country self-sufficient in the various fields of study. The postgraduate research programme also requires the students to attend seminars, conferences, symposia and publish papers in the journals of national and international repute. Upon the culmination of the postgraduate degree, graduates of the Postgraduate programme will become contributing engineering professionals and influential leaders in the field. In response to national needs, the Department of Civil Engineering offers Master and Ph.D. degrees in Civil Engineering in the following areas of specialization:

1. Structural Engineering
2. Water-Resource Engineering
3. Environmental Engineering
4. Transportation Engineering
5. Geotechnical Engineering

In addition, the Department of Civil Engineering also offers advisory and consultancy services for the diversified nature of Master's degree program in Construction Project Management.

LIST OF APPROVED COURSES

STRUCTURAL ENGINEERING

CE 5110 ADVANCED STRUCTURAL ANALYSIS-I (3)

Review of fundamental principles of structural analysis. Analysis of complex planar structure using Classical methods like Moment Distribution, Slope-Deflection, Column Analogy, Consistent Deformation. Matrix methods and their applications to simple planar structures.

CE 5111 ADVANCED STRUCTURAL ANALYSIS-II (3)

Application of stiffness and flexibility methods to trusses, frames and arches. Analysis of space frames. Development of computer programme based on stiffness methods. Use of commercially available computer programmes for structural analysis.

CE 5112 ADVANCED MECHANICS OF MATERIALS (3)

Analysis of stress and strain. Elasticity and Plasticity, plane stress and plane strain problems, stress functions, two and three dimensional stress problems. Torsion of various shapes members and the associated twist. Energy principles, fracture. Introduction to shell and plate structures.

CE 5114 BEHAVIOUR OF CONCRETE STRUCTURES (3)

Analysis of reinforced and prestressed concrete section based on the mechanics of elastic and inelastic performance of steel and concrete and principles of equilibrium and compatibility. Behaviour of reinforced concrete and prestressed concrete members to failure under compression, tension, flexure, torsion and shear; Moment-curvature, Load- deflection. Torque-twist relations.

CE 5115 ADVANCE CONCRETE DESIGN (3)

(Pre-requisite CE 5110)

Design of Reinforce Concrete Structures for Gravity & lateral loads, various structural systems. Design of Flat Slabs (by DDM, EQM), Shear Wall, Shear Wall Frame Interaction, Design of various structural joints such as Beam Column joints etc. Yield line analysis of slabs, portion design.

CE 5152 PRE-STRESSED CONCRETE DESIGN (3)

Design consideration, pre-stressing Techniques, Materials, Analysis of Pre-stress members, Stresses at various stages of Pre-stressing, continuous Pre-cast Pre-stressed structures, moment-curvature relationship, deflection, draped strands, losses in Pre-stress. Design project or term paper.

CE 5153 ADVANCE STEEL STRUCTURE-I (3)

Design Philosophies, Safety code and specification, behavior and design of Building system, members with axial load plus bending, Elastic frame Behavior and bracing system, Behavior and design of connection, Plate-girder Design, Design project or term paper.

CE 5154 INTRODUCTION TO BRIDGE ENGINEERING (3)

Bridge Elements, load (AASHTO code, code of practice in Pakistan), Analysis and Modeling Technique, Simplified live load distribution procedure, influence lines and surfaces, Design of steel/Pre-stress bridges, sub-structure design, Design Project or term paper.

CE 5155 FINITE ELEMENT ANALYSIS OF STRUCTURAL SYSTEMS (3)

Relationship between the finite element method and the Rayleigh-Ritz method. Derivation of element stiffness

matrices. Construction of general stiffness matrices in global coordinates. Problems in plane stress, plates, and shells under static and dynamic loads.

CE 5156 PLATE AND SHELL STRUCTURES (3)

(Pre-requisite CE 5155)

Analysis of plate and shell structures with particular emphasis on Civil Engineering applications and shells. Analysis of plates by finite differences, Membrane solution of shells of revolution, cylinders, elliptic, and hyperbolic paraboloids. Asymptotic solution for symmetrically loaded shells of revolution, Folded plates.

CE 5192 ADVANCE CONCRETE TECHNOLOGY

Course Outlines: Evolution of concrete, Compositions of concrete, Required properties of concrete, Theory a aggregate assembly, consistency and pumpability of fresh concrete, Plasticizers and super plasticizers, Hydration & hardening process of concrete, Hardened structure of hydrated cement gel, Heat and thermal stresses, concerting in sever conditions, durability design of concrete structures, moisture transport in concrete, Alkali aggregate reactivity, Delay ettringite formation, Autogeneious and drying shrinkage, corrosion of reinforcement, Additives and admixtures, Advances in concrete technology, High performance concrete, Autoclaved cellular concrete, Concrete mix design, Environmental concerns related with cement and concrete

Recommended Books

1. Concrete Technology theory & practice by M.S Shetty
2. Properties of Concrete by A.M Nevelle.

Reference Books

1. Advance Concrete Technology Constituents Materials by John Newman , Bang Seng Choo
2. Advance Concrete Technology Concrete Properties by John Newman , Bang Seng Choo

CE 5190 SPECIAL TOPICS (UPTO 3 CREDIT HOURS)

CE 5199 MASTER'S THESIS (6)

CE 6199 Ph.D. THESIS (1-9)

WATER RESOURCE ENGINEERING

CE 5120 FLUID MECHANICS (3)

The Navier-stokes and energy equations and their exact solutions, theory of laminar boundary layers, stability and transition of turbulent flow, equations of mass, momentum and conservation of turbulent flow: turbulent boundary layers, wakes and jet dirfusion.

CE 5121 OPEN CHANNEL FLOW (3)

Uniform flow in open channels, hydraulic jump surges, non-uniform flow subcritical and supercritical flow around bends or through transition. Unsteady flow in canals and rivers. Model analysis.

CE 5122 SEDIMENT TRANSPORT (3)

Frequency distribution of sediment particles setting velocities Transportation and deposition. Bed load functions, Movement and distribution of suspended load, Empirical formulae, Bed roughness in alluvial channels, Meanders, Sedimentation in reservoirs.

CE 5123 HYDRAULIC STRUCTURES (4)

Design of gravity dams, spill-ways, stilling basins, power intakes, transition and control structures, canal falls, the use of models in hydraulic design.

CE 5124 DAM ENGINEERING (4)

General features of earth and rockfill dams, types of embankments earth pressure and stability analysis; settlement studies; soil and rock investigations; earth dam design and construction; rockfill dam construction; construction testing; performance measurements, earth quake allowance.

CE 5125 SURFACE WATER HYDROLOGY (3)

Methods of measurement of stream flow stage discharge relation Unit Hydrograph theory. Transposition of Hydrograph, Synthesis of hydrography from basin characteristics stream flow routing. Flood Frequency analysis. Attenuation of Flood Flows.

CE 5126 WATER RESOURCES ENGINEERING & PLANNING (3)

Water resources investigations, comparison of alternatives, screening and formulation of projects, economic analysis of single and multipurpose projects. Probability concepts in planning. Mathematical models systems analysis.

CE 5127 RIVER MECHANICS (3)

Concepts of Fluvial Geomorphology. Stream forms and classification Quantitative response of river systems, Prediction of general river response to change. Applications of quantitative analysis. Application of the concept of the beginning of motion to practical problems. Design of stable channels, permissible velocity and tractive force, method of maximum permissible velocity, method of critical shear stress, the ideal stable cross section.

CE 5128 ATER RESOURCES ENGINEERING (3)

Characteristics of Groundwater, Aquifers, Basic Groundwater Parameters and Laws, Heterogeneity and Anisotropy, Steady State Groundwater Flow, Compressibility of Aquifers, Transmissivity and Strorativity, Radial Flow in Aquifers, Superposition of Elementary Solutions in Groundwater flow, Pumping Near Hydrogeologic Boundaries, Transient Groundwater Flow, Pumping Test analysis, Groundwater Modeling (Based on Finite Element Method and Finite Difference Method).

CE 5190 SPECIAL TOPICS (UPTO 3 CREDIT HOURS)

CE 5199 MASTER'S THESIS (6)

CE 6199 Ph.D. THESIS (1-9)

ENVIRONMENTAL ENGINEERING

CE 5140 WATER SUPPLY ENGINEERING (3)

Forecasting population and water consumption Sources and Yields. Rainfall, runoff and river flows. Improvement and collection of surface water. Ground water collection. Storage and distribution. Analysis of net-works. Quality and standards for various purposes. Treatment process; Clarification, filtration, disinfection and miscellaneous water treatment methods, laboratory experiments in water treatment.

CE 5141 SANITARY ENGINEERING (3)

Sewerage systems, sewage flowrates, wastewater characteristics, sewer construction and maintenance. The design of sewage treatment works: screens, grit chambers, sedimentation tanks, percolating filters, activated sludge systems and chemical treatment. Sludge treatment, digestion and disposal, stream pollution and self-purification. Laboratory experiments in sewage treatment.

CE 5142 CHEMISTRY AND BIOLOGY OF WATER & SEWAGE (3)

Basic concepts from qualitative, quantitative, organic, physical and biochemistry. Sampling and examination procedures. Water and wastewater characteristics. Sewage treatment, Standards for raw and treated waters.

CE 5143 PUBLIC HEALTH ENGINEERING (3)

History of environmental engineering, food and water sanitation, air sanitation, refuse collection and disposal, diseases, plumbing, air condition, stream sanitation studies, major industrial wastes and their treatment.

CE 5144 SOLID WASTE MANAGEMENT (3)

Basic concepts in approaching and solving solid management problems. Health significance, collection, transport and various ways of disposal including incineration, sanitary land fill, composting, recovery and re-utilization.

CE 5145 AIR POLLUTION AND CONTROL (3)

Classification and sources of air pollution, air composition, types of air pollutants and their concentrations, ambient air standards, principles of meteorology and diffusion of pollutants and their models, stationary and moving sources emission factors, emission inventories; effects on human beings, plants, properties, air pollution episodes, global effects control of particulate and gaseous pollutants, control techniques and equipment; standard methods for sampling and analysis.

CE 5146 WATER QUALITY MODELLING (3)

Basic concepts of modeling, water quality criteria and standards, relationship of water quality to water uses, sources of pollution and types of wastes, general mathematical formulations and water quality modeling, BOD and Dissolved Oxygen models, Bacterial decay models data requirements in modeling.

CE 5147 ECONOMICS AND PLANNING OF ENVIRONMENTAL HEALTH ENGINEERING PROJECTS (3)

General principles of project analysis. demand. excess capacity. principles of engineering economics. mathematics of economic analysis. discounting techniques capital costs. operation and maintenance costs. cost and benefit curves. optimality. conception. Costing and evaluation of alternatives in water supply. sewerage and water and wastewater treatment projects.

CE 5148 PRINCIPLES OF WATER AND WASTEWATER TREATMENT PROCESSES (4)

Fundamentals of process engineering. Reactions and reaction kinetics. Mechanisms of mass transport. Reactor theory. ideal reactors. Non-ideal flow in reactors theory and application of physio-chemical processes for the treatment of water and wastewater including sedimentation. Adsorption. Principles of biological treatment. Bacterial growth kinetics. Kinetics of Sub strate utilization. Attached and suspended growth processes.

CE 5149 INDUSTRIAL WASTE WATER POLLUTION, CONTROL AND MANAGEMENT (3)

Effect of industrial waste on streams and wastewater plants. Stream protection measures. Computation of organic waste loads on streams; stream sampling. Strength Reduction. Neutralization. Equalization and proportioning. Removal of Suspended and Colloidal solids. inorganic Dissolved solid. Application of biological

treatment to industrial wastewaters. Treatment and disposal of Sludge solids.

Application of UASB technology to agro-based industrial wastewater treatment. Waste minimization and resource recovery from local industries. Environmental Quality Standards in Pakistan.

CE 5150 ENVIRONMENTAL IMPACT ASSESSMENT (EIA) (4)

An Introduction to E1A. Definitions: Environmental Inventory. Environmental Assessment. Environmental impact Statement. Methods. Techniques and Procedures of EIA. Format for the organization of EIA Report. Design of an EIA. Legislative and Regulatory Consideration. Quality of Life Values components of EIA process. Assessment of Impacts on water resources. Modelling Impacts of waste discharges on water quality in Rivers. Estimating air Quality Impact. Impacts of Sanitary Land Fills. Case studies of EIA: Thermal power plants. Cement plants, Urbanization and Industrialization in Pakistan.

CE 5151 ENVIRONMENTAL POLLUTION CONTROL (3)

Pollution of Water. Land and Air: Causes and effects. health and ecological considerations. Over view of the Environmental Profile of Pakistan. Environmental authorities and jurisdiction. Environmental Regulations and Standards: Pakistan & International, The Pakistan National Conservation Strategy. The Sarhad Provincial Conservation Strategy. Environmental quality objectives, criteria and standards of pollution Control. Noise and Marine pollution and control.

UIE 5818: WATER, SANITATION & HYGIENE IN EMERGENCIES (3)

Introduction to the context and scope of WASH in Emergency, Need for interdisciplinary approach, Principles, tools and skills for coordination in emergency, Overview of the international legal framework and guiding principles of humanitarian action, Risk management tools, Contingency planning and disaster preparedness, Planning the response – Hygiene, SPHERE and other standards followed by international humanitarian organizations, Emergency planning and management, Decision making, Monitoring and reporting.

Recommended Books

1. Emergency Sanitation: Assessment and Programme Design, P. Harvey, S. Baghri, and B. Reed, WEDC, Loughborough University, United Kingdom, 2002
2. Emergency water sources: Guidelines for selection and treatment. 3rd edition (3rd edn), S. House and B. Reed, WEDC, Loughborough University, United Kingdom, 2004
3. Principles of emergency planning and management. D. Alexander, Terra Publishing, Harpenden, 2002.

CE 5190 SPECIAL TOPICS (UPTO 3 CREDIT HOURS)

CE 5199 MASTER'S THESIS (6)

CE 6199 Ph.D. THESIS (1-9)

CONSTRUCTION PROJECT MANAGEMENT

CE 5172 PROJECT MANAGEMENT THEORY, PRACTICE & APPLICATION (3)

Construction project management concepts, standards and services, Organizational structures for the delivery of project management services, Management strategies for clients and stakeholder briefing, Issues related to the management of the construction project

design process and budget setting, Project manager's role and responsibilities, Managing project scope, Managing design, Managing cost, Managing time, Managing Quality and Safety. Functions of Management, Identifications of Projects, Types of Projects, Life Cycle of Projects, Key Players of The Projects. Alignment of Projects With Organizational Strategies.

Recommended Books

1. Kerzner, H. "A systems approach to planning, scheduling and controlling" Fifth Edition, 2004. Van Nostrand Reinhold ISBN 0-442-01907-6
2. "Association for Project Management Body of Knowledge", The Association for Project Management Thornton House, 150 West High Wycombe Road, High Wycombe, Buckinghamshire,

CE 5173 PROJECT PLANNING, SCHEDULING AND ESTIMATING (3)

Issues affecting international construction organizations, Pre-tender Planning, Pre-Contract Planning, Planning Techniques, Resource Analysis, Short Term Planning, Computer-Aided Planning, Project Monitoring and Control, Contract Documentation, Managing the Design Process, Pre-Contract Estimating, available planning techniques, contract documentation and cost estimates.

Recommended Books

1. Smith, N,J, Engineering Project Management, Blackwell Publishing, 2002.
2. Code of estimating practice. in RICS, M & E Procurement Guide., 7th Edition, CIOB / Longmans., 2009

CE 5174 CONSTRUCTION FINANCIAL MANAGEMENT (3)

Company Level Analysis [setting up corporate strategies, the production of company budgets and the production of financial plans and developing income streams], Project Level Financial Management [Cash Flow and Cost Control, Corporate Analysis -accounts, ratios and their potential impacts upon future corporate strategy] and Investment & Development Appraisal Techniques [the use of financial techniques to appraise alternative investment decisions and life cycle costing and the optimum replacement age for a variety of different assets]. Taxation System, Financial Statements and Elements Of Financial Statements, Balance Sheets, Means Of Financing,

Recommended Book

Journal of Construction Management and Economics

CE 5175 MANAGEMENT AND PROFESSIONAL DEVELOPMENT (3)

This module will be based on the framework provided by the Institution of Civil Engineers' [UK] Management Development in the Construction Industry, covering topics of Corporate Mana-gement; Business Management; Financial and Management Systems; Promotion and Business Development; Communications and Presentations; The Client and Relationships; Respect for People; Project Management; Professional, Commercial and Contractual Practice; Information and Comm-unication Technology; Health, Safety and Welfare and The Construction Profession and Society.

Recommended Book

"Management Development in the Construction Industry", Institute of Civil Engineering [UK], Thomas Telford, 2004.

CE 5176 VALUE & RISK MANAGEMENT (4)

Value and risk management and the construction procurement process, An Introduction to Value Management, Value Engineering [VE]- Function Analysis and other VE tools, Risk, uncertainty and the construction industry, Risk and procurement, The Risk Management framework., Sources, events and effects of project risk, Tools and techniques of Risk Management, Risk response and mitigation, Client Briefing, A Review of North American Practice in Value and risk management. Managing International Risks.

Recommended Book

Kelly, John, Male, Stephen, Graham, Drummond, Value Management of Construction Projects, Blackwell Science 2002

CE 5177 HUMAN RESOURCE MANAGEMENT IN CONSTRUCTION (3)

Challenges of managing people in construction; organization and management theory; Human Resource Management [HRM] theory; strategic HRM approaches; operational HRM approaches; employees relations; employee empowerment; diversity and work/life balance; employee welfare; strategic human resource development and employment legislation.

Recommended Books

1. Harris, F. & McCaffer, R., Modern construction management., 4th Edition, Blackwell science, 1995 Neale, R. H. & Neale, D. E., Construction planning., Thomas Telford, 1989
2. Loosemore, M., Dainty, A and Lingard, H., Human resource management in construction projects: strategic and operational approaches: Spon Press, London, 2003

CE 5178 PROJECT MANAGEMENT – STRATEGIC ISSUES (3)

Lean Construction; Process Mapping and Lean Processes; Planning for Lean construction; Performance Measurement and Benchmarking; Leadership and Influence; Supply Chain Management and Strategic Partnering Lessons learned from other industries. Knowledge Management.

Recommended Books

1. Buchattaa D & Huczynski A, 2005. Organizational Behaviour: An Introductory Text. Prentice Hall, Third Edition.
2. Dingle J, 2005, Project Management: Orientation for Decision Makers, Arnold.

CE 5179 MANAGEMENT INFORMATION SYSTEMS FOR CONSTRUCTION PROJECT MANAGEMENT (4)

Information Management within the construction organization. The classification of Information Systems: Personal Information Systems. Managers' requirements: support for planning, control, and decision making at an operational and executive level. Modeling information flow. Information Technology: hardware, software, and communications equipment. The impact of Electronic Information Exchange, Multi-Media, Knowledge Management, Intelligent Systems and e-Business. The development of a Management Information Systems [MIS] strategy for an organization. Systems development. Systems selection and acquisition and implementing new systems within construction organizations.

Recommended Books

1. Laudon, K. C. & Laudon, P. L., Management information systems, organization and technology., 6th End, Prentice-Hall, New Jersey, USA, 2000
2. Paulson, Boyd, C. Jnr., Computer applications in construction., McGraw-Hill International editions, McGraw-Hill Inc., New York. USA., 1995

CE 5116 RESEARCH, INNOVATION AND COMMUNICATIONS (3)

An introduction to the library and other information resources including the internet; an introduction to qualitative and quantitative research methods (including computer aided data analysis techniques); presentation skills including verbal, written and IT-based methods; time management strategies; writing a thesis, academic papers and research summaries, and innovative approaches to research.

Recommended Books

1. aoum, S. G., Dissertation research and writing for construction students, 1st Edition, Oxford : Butterworth-Heinemann, 2004
2. Fellows, R. F., Research methods for construction, 1st Edition, Oxford : Blackwell Science, 2003
3. Easterby-Smith, M., Thorpe, R. & Lowe, A., Management research: An introduction., Sage Publications, London, 1991.

CE 5117 ENGINEERING CONTRACTS AND TENDERING PROCESS (3)

Engineering Contracts:The reasoning of Contracts, the Law of Contracts, Labor Laws, Types of Engineering Contract Administration, Litigation, Equity, Arbitration, Claims Preparation and Dispute Resolution.

Procurement Process

The Procurement Cycle, Procurement Procedure, Type of Procurement, Competitive-Bid Contracts, Surety Bonds, Pre-qualification of contractors, specification writing (General and Technical Provision), Assembling the specification.

Recommended Reading/References

1. Abbett, R.W. (1960), Engineering Contracts and Specifications 3rd Edition, John Wiley and Sons, Inc.
2. Smith G.R., (2003). Contracts and Claims. In: Chen, W.F. and Richard Liew, J.Y., The Civil Engineering Hand Book. 2nd Edition CRC Press LLC.

CE 5190 SPECIAL TOPICS (UPTO 3 CREDIT HOURS)

CE 5199 MASTER'S THESIS (6)

TRANSPORTATION ENGINEERING

CE 5180 ADVANCED PAVEMENT DESIGN (3)

Pavement types, Wheel loads and design factor, Stresses in Flexible Pavements, Stresses in Rigid Pavements, Vehicle and Traffic Characteristics, Climate, Environment, The Economic Factor, Design Strategies, System Analysis, Design of Flexible Airport Pavements, Design of Flexible Highway Pavements, Design of Rigid Airport Pavements, Design of Rigid Highway Pavements, Modern Concept of Pavement Designs, ELSYM5, CHEVRON, BASAR Computer packages. Recommended Book: Principles of Pavement Design by E.J. Yoder, M.W. Witzak, Publishers: John Weley.

CE 5181 AVEMENT MANAGEMENT AND REHABILITATION (3)

Pavement Evaluation and Performance: General Concept of Pavement Evaluation, Evaluation of

Pavement Performance, Evaluation of Pavement Structural Capacity, Evaluation of pavement Distress, Condition Surveys, Evaluation of Pavement Safety, Design Alternatives; Analysis, Evaluation and Selection.

Implementation: Implementation of PMS, Construction, Maintenance and Rehabilitation, Feedback data system, Examples of Working Design and Management. Future Research Needs.

Recommended Book

Pavement Management Systems, By Haas and W. Ronald Hudson., Publishers: John Weley

CE 5182 ADVANCE PAVEMENT MATERIALS (3)

Soil Classification, Material Characterization, Soil and Base Stabilization, Sub grades, Bases and Sub bases, Bituminous Surfaces, Material Variability, Asphalt Concrete Mix Design. Physical and mechanical properties of asphalt and Portland cement concrete mixtures, Portland Concrete Mixture Design.

Reference Literature: ASTM, AASHTO & other standards on Materials. This course would mainly consist of seminars, term projects, lab tests and Research paper Discussions.

CE 5183 HIGHWAYS GEOMETRIC DESIGN (3)

Highway function, Design controls & criteria, Elements of design, Cross section Elements, Local Roads & Streets, Collector Roads & Streets, Rural & Urban arterials, Freeways, At Grade Intersection, Grade Separation & Interchanges, Practical problems, Roadside design.

Recommended Book

A Policy on Geometric Design of Highways & Streets (AASHTO)

CE 5184 AIRPORT DESIGN (3)

The structural and Organization of Air Transport, Forecasting Air Transport Demand, Characteristics of Aircraft as they Affect Airports, Airport Master's Planning, Air Traffic control, Lighting and Signing, Airport Capacity and Configuration, Geometric Design of the Airside, Passenger Terminal, Air Cargo Facilities, Airport Drainage and Pavement Design, Airport Access, Requirements of V/STOL system, Environmental Impact of Airport.

Recommended Book

Airport Engineering, By Norman Ashford & Paul H. Wright. Publishers: Wiley Intersciences.

CE 5185 TRAFFIC ENGINEERING & PRACTICE (3)

The road user, vehicle, roadways and geometrics design, Introduction to Urban Transportation Planning, Origin and Destination Studies, Highway Economy Studies, Travel Time and Delay Studies, Spot speed Studies, Volume Studies.

Traffic Theory: Flow & Control.Highway Capacity: Introduction, Freeways and Expressways, Urban Streets and Arterials, Rural Highways without excess control.Pedestrian Studies, Parking studies, Accident Studies, Traffic laws and Ordinances, Traffic Control Devices, Traffic Sign and markings, Traffic Signals, Street and Highway lightings, The Intersection (Control measures), Coordination of Signal System (Control measures), Speed Control & Zoning, One way streets, unbalanced flow and reserved transit lanes, Curb Parking

Controls, Special Application of Traffic Control to Limited Access Facilities, Applications for Highway safety, TRANSYT 7F Application.

Recommended Book

Traffic Engineering (Theory & Practices), By Louis J. Pignataro, Publishers: Prentice Hall.

CE 5186 TRANSPORTATION PLANNING & MODELING (3)

Introduction, Demand Theory, Transportation supply, Urban passenger Travel Demand, Analysis of Travel Choices, Trip Distribution analysis, Mode & Route Choices, Intercity Passenger Travel Demand, The Demand Air Transportation, Commodity Transport Demand, Computer Application of "QUICK RESPONSE SYSTEM".

Recommended Book

Transportation Demand Analysis, By Abid Kanafani. Publishers: McGraw Hill.

CE 5187 INFRASTRUCTURE MANAGEMENT (3)

Introduction, Framework for Infrastructure Management, Planning, Need, Assessment & Performance Indicators, Data Base Management & Decision Support System, Inventory, Historic & Environmental Data.

In service Monitoring & Evaluation Data, Uses of Monitoring Data & Examples of In Service Evaluation, Performance Modeling & Failure Analysis, Design for Infrastructure Service Life, Construction, Maintenance, Rehabilitation & Reconstruction Strategies, Including Operations, Dealing with New or Alternate Concept, Maintenance, Rehabilitation & Reconstruction Policies and Treatment Alternatives, Life Cycle Cost and Benefit Analysis, Prioritization, Optimization and Work Program, Concept of Integrated Infrastructure Management System.

Visual IMS: A working Infrastructure Management System and Application.

Benefits of Implementing IMS, Future Research Needs, Practical Application.

Recommended Book

Infrastructure Management, By W. Ronald Hudson, Ralph Haas, Waheed Uddin, Publishers: McGraw Hill.

CE 5188 TRAFFIC IMPACT & SAFETY STUDIES (3)

Overview of transport project impacts. Trip and parking generation. Site traffic impact analysis.

Assessment of environmental impacts of transport facilities: noise, pollutant emission, visual impact. Measures to mitigate traffic impacts. Road safety study: accident characteristics, analysis techniques, remedial and prevention measures.

CE 5189 GEOTECHNICAL ASPECTS OF HIGHWAY (3)

Site investigation for highways, soil classification, Rock classification,

Geotechnical Properties of earthen/soil material for embankments, suitability of soil/rock for embankments, stability of slopes, theory of compaction, Methods of determining compaction, safe side slopes based on geotechnical properties of cut material, Retaining structure for highway embankments.

CE 5190 SPECIAL TOPICS (UPTO 3 CREDIT HOURS)

CE 5199 MASTER'S THESIS (6)

CE 6199 Ph.D. THESIS (1-9)

GEOTECHNICAL ENGINEERING

CE 5130 ADVANCED SOIL MECHANICS-I (3)

Fundamental concepts stress distribution in continuous media, Elastics displacements, Compressibility and Consolidation, Settlements.

CE 5131 ADVANCED SOIL MECHANICS-II (3)

Review of Shear strength concepts, Stress path, Critical state concept, Limiting equilibrium, Lateral earth pressure, Retaining structures, slope stability.

CE 5132 HYDRAULICS OF GROUND WATER (3)

Principles of Ground water hydraulics, Theory of flow through idealized porous media, the flow net solution, seepage, well problems.

CE 5133 FOUNDATION ENGINEERING (3)

Sub-soil Investigation, Excavations, Design of sheeting and bracing system, control of water, footing grillage, pile foundation cassion and coffer dam, methods of construction.

CE 5134 ENGINEERING PROPERTIES OF SOIL-I (3)

Study of soil properties that are significant in Earth Work Engineering including properties of soil solids, basic physiochemical concepts, classification and stabilization, laboratory work includes classification, permeability and compaction tests.

CE 5135 ENGINEERING PROPERTIES OF SOIL-II (3)

Continuation of engineering properties of Soil-l, including the study of compressibility, stress-stain relationship and shear strength theories for soils. Laboratory work include consolidation and shear strength tests.

CE 5136 DYNAMICS OF SOIL FOUNDATION (3)

Application of vibration and wave propagation theories to soil media, review of existing experimental data and empirical procedure for analysis of foundation vibration, prediction of soil responses to impulse load, dynamic properties of soil and methods for their determination, design procedure for foundation subjected to dynamic forces.

CE 5190 SPECIAL TOPICS (UPTO 3 CREDIT HOURS)

CE 5199 Master's THESIS (6)

CE 6199 Ph.D. THESIS (1-9)

Dean, Faculty of Civil, Agricultural and Mining Engineering

Prof. Dr. Akhtar Naeem Khan

Director

Prof. Dr. Syed Muhammad Ali Ph.D. (Pak)

Assistant Professors

Dr. Awais Ahmed	Ph.D (Netherlands)
Dr. Shahid Ullah	Ph.D (Germany)
Dr. Muhammad Safdar	Ph.D (Canada)

EARTHQUAKE ENGINEERING

Pakistan is among the high seismic active areas in the world with large population. These challenges coupled with socio-economic issues demands resilient economical infrastructure for the growing needs of Pakistan. Earthquake Engineering Center (EEC) was started in year 2003 with the objective to address unique challenges of Pakistan through education, research and innovation and providing support to industry. Higher Education Commission (HEC) provided the grant to establish EEC which is the first earthquake engineering research center of Pakistan with the honor to have first seismic simulator (shake table) installed in year 2005 along with other basic research and testing facilities.

EEC played pivotal role after the 2005 destructive earthquake in advising to public and government. In recognition to unprecedented support of EEC and being the only earthquake engineering center in Pakistan at that time; the federal government through HEC provided further grant to strengthen the EEC. As a result, the largest seismic lab of Pakistan was built with largest shake table of Pakistan which places Pakistan as fourth in world order (Giuseppe Maddaloni, Naples-Italy 2008) and with addition of state-of-the-art lab testing facilities. The EEC has become multidisciplinary research center of the region by undertaking activities of varied nature. The center has contributed extensively on development of national policy formulations in the form of code development on national level under the auspices of Pakistan Engineering Council (PEC) for which Statutory Regulatory Orders (SROs) have been issued.

Objectives

- Research: To conduct research focused on indigenous issues of Pakistan
- Education: Award of diploma and degrees at postgraduate level
- Training: Conducting training of skilled and non-skilled professionals
- University-Industry Interaction: To provide expertise to private and public sectors in multidisciplinary areas

Areas of Research and Study

- Seismic design of buildings and infrastructure (bridges, dams, towers, tall structures, electrical and electronic support systems)
- Engineering seismology
- Bridge engineering
- Steel structures
- Numerical studies
- Hybrid simulation
- Base Isolation systems
- Seismic resilience
- Strengthening and retrofitting of structures
- Active and passive control systems
- Site specific and micro-zonation studies
- Non-destructive testing and evaluations
- Seismic qualification testing of electrical, electronic, communication, mechanical systems, etc.
- Instrumentation and control
- Smart structures
- Review and development of seismic code provisions

State-of-the-art Lab Facilities

- 6 x 6 meter shake table, 6 DOF, 60-ton capacity
- 1.5 meter x 1.5 meter shake table, 1 DOF, 8-ton capacity
- Eccentric Mass vibrator, 10 ton capacity, 0-25 Hz
- Long stroke, fatigue rated, 100-ton dynamic actuators
- 12 meter and 6.8 meter tall strong wall with large strong floors
- Multi-channel high sampling data acquisitions systems
- Base isolator tester
- 540 GPM hydraulic power supplies
- 200 ton cooling tower
- Accelerometers, broadband seismometers, displacement transducers etc.
- 60-ton and 20-ton overhead cranes
- 1.5 megawatt capacity diesel generators
- 5-ton fork-lifter, welding plants, cutting, lifting and tooling equipment

EQE 5113 DYNAMICS OF STRUCTURES-I (3)

Introduction to SDOF, MDOF and Continuous Systems. Formulation of equation of motion for SDOF systems, Principles of Analytical Mechanics, Response of SDOF and continuous systems to Damped and Un-damped, free, forced harmonic and general dynamic loading and transient response. Approximate and numerical methods for analysis of SDOF and continuous systems. Analysis of response in the frequency domain, Wave propagation analysis.

Recommended Books

1. Dynamics of Structures 2nd Edition by Jagmohan L. Huimar
2. Vibration Problem in Structures Practical Guidelines by Hugo Vachmann, Lorrenz Steinbeisser
3. Structural dynamics, theory & computation by Mario Paz, 5th Edition, Springer publications
4. Mechanical vibrations by S.S. Rao, 4th edition, Prentice-Hall Publishers.

EQE 5157 EARTHQUAKE ENGINEERING – I (3) (PRE-REQUISITE CE 5113)

earthquake excitation, Response quantities, Response history and Response Spectrum concepts, Pseudo velocity and acceleration, Design spectra, Effects of yielding, Relative effects of yielding and damping, Inelastic design spectrum, Structural dynamics in building codes, Evaluation of building codes, Introduction to Base isolation and Structural Controls in buildings

Recommended Book

Dynamics of structures by Anil K. Chopra, 2nd Edition, Prentice-Hall Publishers

EQE 5158 DYNAMICS OF STRUCTURES-II (4) (PRE-REQUISITE CE 5113)

Part-1: Formulation of equation of Motion for MDOF systems. Free vibration response of MDOF systems, Numerical solution of the eigen problem, Forced dynamic response of MDOF systems, Mode superposition method, effect of support excitation, forced vibration of unrestrained systems, Approximate and Numerical Methods for Analysis of MDOF systems, Raleigh-Ritz method, Direct Integration of the equation of motion. Analysis in the frequency domain. Analysis of Non-linear problems in structural dynamics.

Part-II: Effect of wind on bridges, suspension systems and tall buildings using random vibration theory, Application to problems in material behavior such as fatigue in cables, hysterisis loops in concrete and steel, and damping in structural systems.

Recommended Books

1. Dynamics of Structures by Jagmohan L. Huimar, 2nd Edition

2. Structural Dynamics by Mario Paz
3. Wind's effects on structures: Fundamentals & applications to design by Emil SImiu, Scanlan, John willy & sons.

EQE 5159 EARTHQUAKE ENGINEERING – II (4) (PRE-REQUISITE CE 5157)

Modal analysis, Multistory buildings with symmetric and un-symmetric plans, torsional response of symmetric-plan buildings, multiple support excitation, Earthquake response and design of multistory buildings, Modal contribution factors, Earthquake response of inelastic buildings, Allowable ductility and ductility demand, Active and Passive control systems in structures, Recent advances and Innovation in earthquake engineering, projects

Recommended Book

Dynamics of Structures by Anil. K. Chopra

EQE 5160 ENGINEERING SEISMOLOGY (4)

Seismological and tectonic processes causing earthquake occurrence. Earthquake parameters. Seismic effects parameters. Regional seismic effects. Seismological mathematical models. Local soil effects. Geotechnical and Geophysical investigations. Soil models. Response spectra. Seismic hazard analysis. Seismic zoning and micro zoning. Seismic risk. Seismic design parameters.

Recommended Books

1. An Introduction to Seismology Earthquakes, and Earth Structure by Seth Stein and Michael Wysession
2. Earthquake, by Bruce Bolt, 5th edition, Freeman publishers

EQE 5161 DYNAMIC SOIL STRUCTURE INTERACTION (4) (PRE-REQUISITE CE 5113)

Dynamic properties of soils and their determination. Response of soil media to earthquake ground motions. Dynamic instabilities of soils: causes of soil failure during earthquakes, soil liquefaction, soil settlement, landslides and slope instability. Foundation vibration:

vertical, torsional and simultaneous translational and rocking vibration of non-embedded and embedded foundations. Soil-structure interaction effects: model formulation, dynamic properties and response analysis of structures, experimental full-scale testing for determination of soil-structure interaction effects. Practical considerations in design and construction practice.

Recommended Books

1. Fundamentals of soil dynamics by B. M Dass, Elsevier science
2. Soil Structure Interaction Analysis by John P. Wolf & C. Zhang, Elsevier science
3. A Short course in Soil-structures Engineering of

Deep Foundations, Excavations and Tunnels by Charles W.W. Ng

EQE 5162 EXPERIMENTAL MECHANICS OF STRUCTURES (4)

Introduction to physical models in structural engineering, Dimensional analysis and similarity criteria. Elastic and inelastic models, Linear and nonlinear models in earthquake engineering. Shaking tables. Simulation and control of earthquake motion. Collection of data and analysis. Transducers. Quasi-static test of joints, elements and assemblages. Philosophy and principles of testing. Equipment for testing and measurements.

Collected data and analysis. Full-scale test of structures. Resonant method. Ambient vibration technique. Equipment for simulation of motion, measurement and analysis. Identified quantities.

Recommended Book

Structural modeling & Experimental techniques, by Haris & Sabins CRC publishers, 2nd edition

EQE 5163 COMPUTER APPLICATIONS TO STRUCTURAL ENGINEERING (3)

Theoretical basis of practical computer-oriented structural analysis methods. Design of earthquake resistant buildings and engineering structures using state-of-the-art finite element based software. Case studies and projects

Recommended Books

1. Progra3ming the Dynamic Analysis of Structures by P. Phatt, Span press
2. Finite Element Procedures by Klaus-Jurgen Bathe
3. Applied finite element analysis for engineers by Frank Stasa, Oxford University press, USA
4. Concept & application of finite element analysis by Cook, Malkens & Pleshe, 4th Edition, John Willey.

EQE 5164 SEISMIC RISK REDUCTION (4)

Fundamentals of seismic hazard analysis: seismic parameters for vulnerability and risk analysis. Earthquake damage and usability classification: inventory of elements at risk; damage and usability classification of buildings, transportation systems and lifelines, facilities with essential emergency functions, facilities with a potential for large loss. Development of vulnerability functions: empirical, experimental and analytical vulnerability functions in buildings and structures: damage potential and vulnerability of transportation systems and lifelines.

Vulnerability of non-aseismic and aseismic structures. Seismic risk analysis and loss prediction: presentation and density distribution of elements at risk, loss prediction potential, loss per elements at risk, cumulative, loss analysis and presentation; seismic risk analysis; optimization of seismic risk, acceptable level of seismic risk. Earthquake disaster management: strategies for earthquake disaster

management, pre-disaster, planning for mitigation of seismic risk, post-disaster reduction of earthquake consequences.

Recommended Book

Seismic Hazard and Risk Analysis by Earthquake Engineering Research Institute, USA.

EQE 5165 APPLICATION AND DEVELOPMENT OF EARTHQUAKE CODES (3)

Introduction. Basic principles and parameters. Review of the earthquake codes in the world practice. Comparison of the seismic forces obtained by different codes. Techniques for developing the national earthquake codes.

Recommended Books

1. Pakistan Building code
2. UBC code
3. EuroCode
4. NEHRP Code
5. Other relevant code

EQE 5166 SEISMIC DESIGN OF CONCRETE AND MASONRY STRUCTURES (4)

Structural design of reinforced-concrete building. Strength and stress characteristics of concrete and reinforced steel for hysteretic behaviors. Basic principles of nonlinear analysis of reinforced concrete cross-section and members subject to bending, axial and shear forces. Nonlinear behavior of the members, components and structures under earthquake conditions. Aseismic design of reinforced-concrete structures with basic principles, calculation and analysis. Frame systems and new structural systems as seismically resistant building structures.

Behavior of masonry buildings during the past earthquakes, characteristics of materials of masonry structures. Seismic resistant design of masonry buildings, Un-reinforced, reinforced and confined masonry.

Recommended Books

1. Seismic Design of Reinforced Concrete and Masonry Building by Priestly & T. Paulay, John willey
2. Earthquake-Resistant Design of Masonry Buildings by Miha Tomazevic, IC press

EQE 5167 SEISMIC DESIGN OF STEEL STRUCTURES (4) (PRE-REQUISITE CE 5153)

Introduction: Seismic design concepts of building codes, Structural steel materials, Analysis and Detailing of Special Moment Resisting Frames: Beam design, Beam-to-column connections, Beam to column panel zones, column design, Behavior and Design of Concentrically Braced Frames: Design philosophy, Hysteretic energy dissipation capacity of braces, Design requirements, Bracing connections design requirements, Columns and

beams, Special bracing configuration requirements, Behavior and Design of Eccentrically Braced Frames: Basic concept, EBF and link Behavior, Capacity design of other structural components, Design Examples: Special moment frames (SMF), Special concentrically braced frames (SCBFs), Eccentrically braced frames EBFs)

Recommended Books

1. Steel Structure, controlling behavior through design by R. Englekirk, John Willey
2. Seismic Design Handbook by Farzad Naiem

EQE 5168 ASEISMIC DESIGN OF BRIDGES (4)

(PRE- REQUISITE CE 5154)

Seismic performance of highway bridges in past earthquakes. General concept for aseismic design of highway bridges. Code specification and advanced procedures. General requirements. Load combinations and design forces for structural members, foundations and connections. Design displacements. Foundations and abutments. Design of structural members and detailing. Application of modem analysis methods, and advanced capacity design concept for aseismic design of highway bridges. Recent advances in seismic isolation and vibration control systems for seismic resistance improvement of bridge structures.

Recommended Books

1. Bridge Engineering Seismic Design by Wai-fah Chen
2. Seismic design & retroffiting of bridges by priestlay & sabble, John willey publishers.

EQE 5169 SEISMIC DESIGN OF DAMS (4)

Introduction to earth fill, gravity and arch dams. Criteria ensuring static and seismic stability of dam structures under seismic effects. Seismic loads description. Mathematical models for analysis including three media defining hydro technical structures: water fluid dam body. Dam body fluid integration. Application of finite element methods for discretization of dam body and rock mass. Application of contact elements for modeling of dam-rock contact zone. Dam body - rock interaction. Practical examples of estimation of static and seismic stability of dams.

Recommended Book

Earthquake Engineering for Large Dams by Priscu et al

EQE 5170 SEISMIC DESIGN OF LIFE-LINE STRUCTURES (3)

Life-line systems - definitions and classification; behavior and damage in past earthquakes; engineering practice and research; methodologies of life-line earthquake engineering; life- line vulnerability and seismic risk; fundamental concepts of seismic design codes, overview of existing design codes; post-earthquake serviceability and functional restoration; seismic damage rehabilitation, retrofitting and economic evaluations.

Recommended Books

1. Seismic Design Handbook by Farzad Naiem
2. Earthquake Engineering handbook by W.F. Chen, CRC publishers

EQE 5171 REPAIR AND STRENGTHENING OF STRUCTURES (4)

Introduction: typical failure modes of particular civil engineering structures, damage inspection, data collection and evaluation, emergency and post-earthquake reconstruction programme. Repair and strengthening design procedure: Criteria for repair and / or strengthening of structures, selection of repair and/or strengthening method. Repair and/or strengthening of structural components and upgrading of integral structural systems

of bridges, industrial halls, complex buildings, etc. Applicable analysis methods and structural methods for seismic safety evaluation of repaired structures, design improvement and detailing.

Recommended Books

1. Masonry Design and Construction, Problems and Repair by Melander/Lauersdort
2. Concrete Repair Manual Vol. 1 2nd Edition by ACI International
3. Earthquake-Resistant Design of Masonry Building by Miha Tomazevic
4. Seismic design & retrofitting of bridges by Priestly, Sabble, Willey publishers

EQE 5190 SPECIAL TOPICS (UPTO 3 CREDIT HOURS)

EQE 5199 MASTER'S THESIS (6)

EQE 6199 Ph.D. THESIS (1-9)

Department of
Electrical Engineering

The Department of Electrical Engineering was established in 1952 as part of Faculty of Engineering, currently offering undergraduate and postgraduate academic programmes in electrical engineering (communications) and electrical engineering (power).

Academic programme at postgraduate level is designed to prepare students to get a thorough knowledge of basic principles in high performance communication systems the work focuses on the provision of secure mixed media communications systems in a verity of mobile environments.

The challenging problems facing the electrical power industry today are much greater than before. System design trends have been towards higher power rating and higher operating voltages. Planning and designing of modern power system call for an increasing number of specialized engineers. These requirements cannot be met by undergraduate courses because of the very wide range of studies undertaken at this level. Specialization in electrical power engineering is therefore essential in order to prepare the engineers to face these challenges. It is only at the graduate level that an engineer will attain competency to relate the theoretical knowledge to a specific problem in planning, designing and operation of a modern electrical power system.

The Department has adequate competent facilities which are available at both educational and professional level. The programme of Postgraduate education in electrical engineering has been designed to include course work in the major subjects of electrical power engineering and communication engineering with a research thesis to be done independently by each student. Emphasis will be given on imparting indepth knowledge and developing research capabilities among the students.

Dean, Faculty of Electrical and Computer Engineering

Prof. Dr. Syed Waqar Shah

Chairman

Prof. Dr. Syed Waqar Shah	Ph.D. (UK)

Professors

Prof. Dr. Syed Waqar Shah	Ph.D. (UK)
Prof. Dr. M. Inayatullah Khan Babar	Ph.D. (USA)
Prof. Dr. Haseeb Zafar	Ph.D. (UK)
Prof. Dr. Amjad Ullah	Ph.D. (Pak)

Associate Professor

Dr. Tariqullah Jan	Ph.D. (UK)
Dr. Gul Muhammad Khan	Ph.D. (UK)
Dr. Gulzar Ahmad	Ph.D. (Pak)

Assistant Professors

Dr. S. M. Majid Ashraf	Ph.D. (Pak)
Dr. M. Iftikhar Khan	Ph.D. (Pak)
Dr. Siddique Ali	Ph.D. (UK)
Dr. Shahid Bashir	Ph.D. (UK)

Lecturers

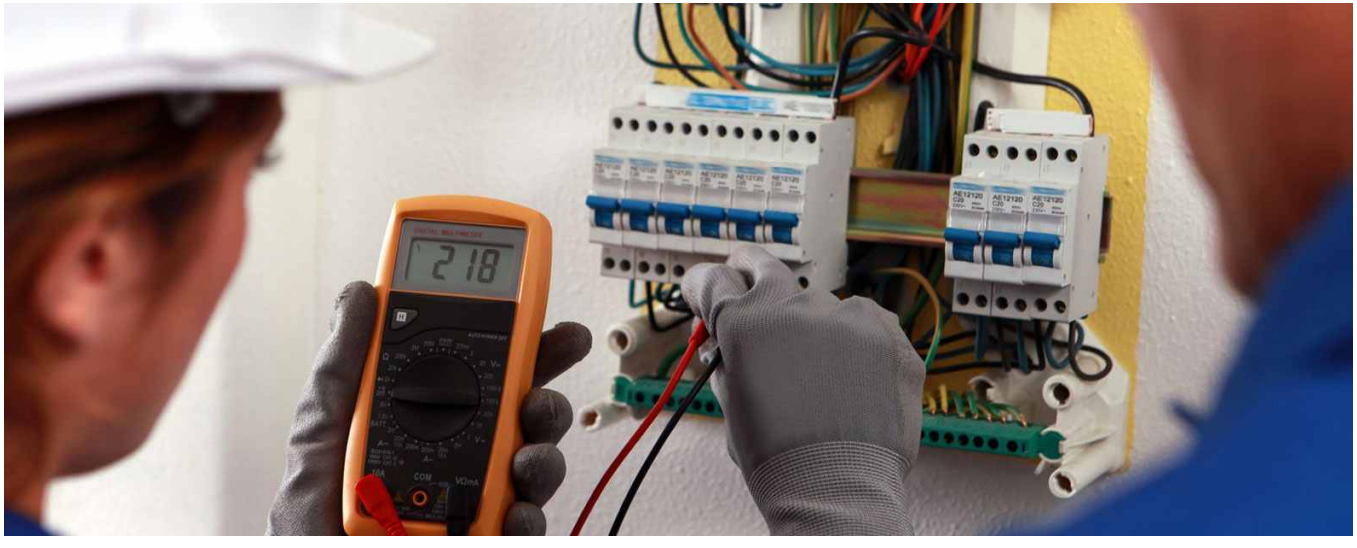
Dr. Muhammad Amir	Ph.D. (Pak)
Dr. Faheem Ali	Ph.D. (Pak)
Engr. Asiya Jahangir	M.Sc. (Pak)
Engr. Seema Mir Akbar	M.Sc. (Pak)
Engr. Salman Ilahi	M.Sc. (Pak)
Engr. Bilal-ur-Rehman	M.Sc. (Pak)
Engr. Hina Zahir	M.Sc. (Pak)
Engr. M. Usman Ali Khan	M.Sc. (Pak)
Engr. S.M. Faheem	M.Sc. (Sweden)
Engr. Muhammad Farooq	M.Sc. (Pak)
Engr. M. Kashif Khan	M.Sc. (Pak)
Engr. M. Nasar Jamal	M.Sc. (Pak)
Engr. Ruhul Amin Khalil	M.Sc. (Pak)
Engr. Waseem Habib	M.Sc. (Pak)
Engr. Ammar Ahmad	M.Sc. (Pak)
Engr. Kifayat Ullah	M.Sc. (Pak)

RESEARCH PROJECTS AND FACILITIES

The department is actively participating in research activities at both Master's. and Ph.D. level. The research projects are scrutinized for their application towards problem solving in industry.

INTERACTION WITH INDUSTRY

The Department presently has industrial links mainly with power and communication related companies and organizations like WAPDA and PTCL. A team of well-organized experts in the field of electric power, electronics and telecommunications holds regular meetings with these organization through departmental steering committee and seminars. A number of research projects. especially at Ph.D. level are presently underway, pertaining to problems faced by the industry. The endowment fund programme by the Government of Pakistan provides financial assistace for the research projects.



LIST OF APPROVED COURSES

ELECTRICAL POWER ENGINEERING

EEP 5201 POWER SYSTEM ANALYSIS-I (3)

Circuit concepts, power system representation transmission lines, the power transformer, the synchronous machine.

EEP 5202 POWER SYSTEM ANALYSIS-II (3)

The power flow problem, balance and unbalance faults, fault analysis by computer methods.power system stability.

EEP 5203 POWER SYSTEM PROTECTION (3)

Detection of system variables, relays, fuses and circuit breakers, protection of power transformer, motor, generator and lines, voltage and current transformers.

EEP 5204 POWER ELECTRONICS (3)

Thyristers operation and characteristics, Thyister controlled circuits, Thyrister controlled motors, Introduction to power semi-conductor devices and their application in generation and control of electrical energy.

A study of analogue and digital process control including signal conditioning. transducers, actuators. and control element.

EEP 5205 HIGH VOLTAGE D.C. TRANSMISSION (3)

Economics of transmission. Converter operation and design, controls and protection, harmonics and filters.

EEP 5206 HIGH VOLTAGE TRANSMISSION SYSTEM (3)

High voltage transmission systems, electrical characteristics corona on a.c. lines, Radio and Television Interference, Audible noise, corona loss, Insulation design, Electrostatic effects.

EEP 5207 ELECTRICAL TRANSIENTS IN POWER SYSTEM (3)

Transient performance of power systems, circuit interruption, switching transients, traveling waves, behavior of windings under transient conditions, protection against transient over voltage, Insulation coordination.

EEP 5208 OPERATION OF POWER SYSTEM (3)

Operation objectives, load forecasting, Dispatch of real and reactive power, Characteristics and economic operation of steam and Hydro plants, Transmission loss formula, incremental production costs and incremental transmission losses for optimum economy, generation scheduling, environmental constraints.

EEP 5209 FIELD THEORY (3)

Introduction to basic analogies in field systems, calculation of simple field, two dimensional analytic solutions, mapping, Sohwartz-Christofell transformation, Relaxation methods, field plotting method, three dimensions fields.

EEP 5210 DIRECT ENERGY CONVERSION (3)

Introduction to specialized electric energy sources e.g. photovoltaic. Thermionic converters, Magnetohydrodynamics generation, fuel cell, wind-electric system. Solar Thermal system. Coordination of alternate energy plants.

EEP 5211 POWER SYSTEM RELIABILITY (3)

Concept of P.S. reliability, reliability indices, component reliability, evaluation of generating capacity, reliability evaluation of transmission and distribution system, evaluation of composite generation/transmission system failures modes. Parallel and series systems.

EEP 5212 POWER SYSTEM CONTROL (3)

General characteristic of system control, computer and microprocessor applications., Telemetry channel, Data acquisition and logging Man/Machine interface, Automatic generator control voltage and reactive control optimum dispatch. Power station controllers.

EEP 5213 MATERIALS SCIENCE (3)

Physical, electrical and optical properties of metals, semi conductor, dielectric and magnetic materials and their application in power equipment, Super conductivity.

EEP 5214 POWER SYSTEM PLANNING (3)

An introduction to planning procedures for large electrical system, technical and economical constraints in planning.

EEP 5216 ADVANCED ELECTRONIC CIRCUITS (3)

Specifications and applications of available IC's OPAMPS, phase Lock Loops, AID, DlA converters etc. Communications on power lines.

EEP 5217 DIGITAL SYSTEMS (3)

Introduction to computer hardware and architectures: Principles of Micro processor based system designs.

EEP 5224 POWER ELECTRONICS: CONVERTER MODELING, ANALYSIS AND DESIGN (3)

Principles of electronic power conversion in switched-mode converters. Analysis and design of PWM (Pulse-Width-Modulated) converters including the selection of components, design of magnetic components, design of feedback loop, measurement of performance, and fundamentals of circuit layout and EMI (ElectroMagnetic Interference).

Recommended Book

Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, Second Edition, Kluwer Academic Publishers, 2001, ISBN 0-7923-7270-0.

EEP 5228 ELECTRICAL INSULATION ENGINEERING (3)

INTRODUCTION

Physical properties of insulating materials, Electrical and Mechanical strength parameters, Ionization and dissociation processes, charge transport

mechanism, recombination and ion formation, Thermal processes.

Dielectric Properties:

Polarization and dielectric relaxation, dielectric constant, an-isotropic and homogeneous dielectrics, Dielectric breakdown, Dielectric behavior in high electric and magnetic fields, Displacement currents. Dielectric types and their characteristics, Classification of insulation in terms of their dielectric properties.

Insulation Failure

Townsend and Streamer theories, Elect-romechanical and thermal instability, Discharges in insulation defects, Effects of impurities on insulation behavior, Avalanches and secondary streamers. Time lags and TOV. Arc and plasma formation.

Insulation under polluted conditions: Behavior of overhead line insulation under pollution, scintillation and dry band formation, surface energy and contamination measurement (ESDD).

Insulation Design

Material properties, Capacitance and sheath grading, Composite design, Determination of voltage and electric field distribution, Calculation of CFI and BIL. Insulation design for Transformers, Rotating Machinery and Underground cables, Insulation design for overhead transmission lines.

Insulation Testing

Impulse testing of insulation, Insulation testing under lightning and switching surges, Tests with chopped waves, Insulation testing under HVAC and HVDC conditions, Wet and dry tests, Voltage withstand tests, Fog chambers, Schering bridge, Determination of loss tangent for various types of insulation. High frequency electric field testing of insulation.

Special Purpose Insulation: Insulation for cables in nuclear environment, cryogenic temperatures, Insulation for super-conducting magnet coils, Insulation for cables used in spacecrafts.

Recommended Books

1. Insulators for High Voltage, J. S. T. Looms.
2. Electrical Insulation, Edited by Bradwell, IEE Monogram Series.

EEP 5238 ADVANCED POWER ELECTRONICS (3)

Averaged switch modeling of switched-mode converters, input filter design, current-programmed control of converters, power and harmonics in non-sinusoidal systems, and line-commutated and pulse-width-modulated rectifiers.

Recommended Book

Robert W. Erickson and Dragan Maksimovic, Fundamentals of power Electronics, Second Edition. Kluwer Academic Publishers, 2001 ISBN 0-7923-7270-0

EEP 5290 SPECIAL STUDIES (3)

INDIVIDUAL STUDIES ON SPECIAL TOPICS.

EEP 5299 MASTER'S THESIS (6)

EEP 6299 Ph.D. THESIS (1-9)

COMMUNICATION AND ELECTRONIC ENGINEERING

EEC 5276 DIGITAL COMMUNICATION SYSTEMS (3)

This course is designed to prepare students for engineering work in the industry and for advanced graduate work in the area of digital communications. The course covers concepts and useful tools for design and performance analysis of transmitters and receivers in the physical layer of a communication system. Students will get a chance to implement several of the concept studied in Matlab. Signal and Spectra: Digital Communication Signal Processing, Classification of Signals, Spectral Density, Autocorrelation, Random Signals. Formatting and Baseband Modulation: PCM, Waveform representation of Binary Digits. Baseband Demodulation/Detection: Detection of Binary Signals in AWGN, The matched filter, ISI, Channel Equalization, Eye Patterns Bandpass Modulation and Demodulation/ Detection: ASK, FSK, PSK, QAM, Coherent and non-coherent detection. Synchronization: Phase locked loops, Symbol Timing Recovery Design and performance analysis of a Digital Communication System.

Recommended Book

Digital Communications: Fundamentals and Applications by Bernard Sklar

EEC 5277 WIRELESS COMMUNICATION (3)

This course is designed to prepare students for engineering work in the industry and for advanced graduate work in the area of mobile communications. The course covers concepts and useful tools for design and performance analysis of wireless communication systems.

To achieve the goal the topic that will be covered include: Introduction to wireless communication systems and networks, Cellular Wireless Networks and System Principles, Antennas and Radio Propagation, Signal Encoding and Modulation techniques, Coding and Error Control , Multiple access techniques, 1G, 2G, and 2.5G wireless systems (AMPS, GSM, GPRS, EDGE, etc.), The UMTS network and radio access technology Wireless LANs, IEEE 802.1x

Recommended Books

1. T.S. Rappaport, "Wireless Communications: Principles & Practice", Second Edition, Prentice Hall, 2002.
2. Simon Haykin & Michael Moher, "Modern Wireless Communications", Prentice Hall, 2004.

EEC 5278 RANDOM SIGNALS AND NOISE (3)

Review Of Probability Theory, Probabilistic Models, Analysis Of Practical Models, Random Signals And Systems, Specifying Random Experiments, The Cumulative Distribution Function, The Probability Density Function Functions Of A Random Variable, The Expected Value Of Random Variables , The Markov And Chebyshev Inequalities, Testing The Fit Of A Distribution To Data Transform Methods,Conditional Probability, Independence Of Events, Multiple Random Variables, Functions Of Several Random Variables , Expected Value Of Functions Of Random Variables , Jointly Gaussian Random Variables, Mean Square Estimation, Sequential Experiments, Vector Random Variables, Independence Of Two Random Variables, Conditional Probability, Conditional Expectation, The Sample Mean And The Laws Of Large Numbers, The Central Limit Theorem, Confidence Intervals, Long-Term Arrival Rates, Convergence Of Sequences Of Random Variables, Definition Of A Random Process.

Recommended Books

1. Alberto Leon-Garcia, "Probability and Random Processes for Electrical Engineering", 2nd Edition, Pearson Education
2. Papoulis, "Probability, Random variables and Stochastic Processes", McGraw Hill

EEC 5279 STOCHASTIC PROCESSES (3)

To acquaint students with various ways to model stochastic phenomena in dynamic systems. The interplay between the theoretical framework and practical applications is crucial in this course. To achieve the goal the topic that will be covered include: Introduction to Random Processes, Characterization of Random Processes, The Complex Random Processes, Mean, Correlation, and Covariance Functions, The Concept of Stationarity and Ergodicity, Properties of Autocorrelation Function, Properties of

Cross Correlation Function, Periodic Random Processes, Cyclostationery Processes.

Recommended Book

Probability, Random Variable, and Scholastic Processes, 2nd Edition. By Popoulis, McGraw- hill

EEC 5211 SIGNAL DETECTION & ESTIMATION (3)

To acquaint students with various methods to detect and estimate the signal in dynamic systems. The interplay between the theoretical framework and practical applications is crucial in this course. To achieve the goal the topic that will be covered include Introduction to Estimation, Minimum Variance Unbiased Estimation, Kramer-Rao Lower Bound, Linear Estimators, General Minimum Variance, Unbiased Estimation, Best Linear Unbiased Estimators, Maximum Likelihood

Estimation, Least Square Approach, Bayesian Estimators, and Elements of Detection Theory

Recommended Books

1. Steven M. Kay, Fundamentals of Statistical signal Processing: Estimation Theory, (Prentice Hall 1993.)
2. Steven M. Kay, Fundamentals of Statistical signal Processing: Detection Theory, (Prentice Hall 1998.)

EEC 5280 INFORMATION AND CODING THEORY (3)

Information theory also deals with source coding, channels and channel capacity, entropy, Shannon's theorems etc. Coding theory deals with the issues of protection of data while passing through hostile environment. It deals with techniques that add enough redundancy in data to protect the information bits without overloading the system. Every information transfer system today employs one form or another of channel coding technique. To understand these concepts, the topics that will be covered are:

Discrete Sources and Entropy, Channels and Channel Capacity, Run-length Limited Codes,

Linear Block Error-correcting Codes, Cyclic Codes, Convolutional Codes, Trellis Coded Modulation and Information Theory and Cryptography.

Recommended Book

Applied Coding and Information Theory for Engineers" by Richard B. Wells

EEC 5281 COMPUTER NETWORKS (3)

In this course, we shall explore the issues for networked communication from local area networks up to the global Internet and shall study a range of solutions to the associated problems. The course will focus on the TCP/IP protocol suite. The main heading covered

during the semester are: Layered architectures (Internet and the OSI Reference Model), Overview of networking and communication software (Sockets), Standards in networks access protocols (CSMA, etc.), Architectures and control algorithms of local-area, point-to- point, and mobile networks, Models of network interconnection, Design issues and protocols in the data link, network, and transport layers, Direct Link Networks, Encoding and Framing, Error Detection and Reliable Transmission, Ethernet and Token Ring Networks, Wireless 802.11 Networks, Packet-Switched Networks, Switching and Forwarding, Bridges and LAN Switches, Cell Switching (ATM),

Internetworking, Internet Protocol (IP), Unicast and Multicast Routing, Global Internet, MPLS, End-to-End Protocols, UDP, TCP and RPC.

Recommended Book

Computer Networks: A Systems Approach, 3rd Edition by Larry Peterson, Bruce Davie, Morgan Kaufman Publishers, 2003.

EEC 5282 MOBILE NETWORKING (3)

This course examines mobile data networks, mobility issues in networking and covers fundamentals of mobile network architectures. Another focus of this course is on routing schemes for mobile and nomadic hosts, including Mobile IP, mobile ad hoc network (MANET) protocols, DHCP and IPv6. To achieve the goal the following topics will be explored: Basics of Wireless Networks and Mobile Computing, Mobility Management in Bluetooth PANs, IEEE 802.11 Wireless LANs ,GPRS, UMTS WANs and Wireless ATM. Multiple Access Methods, Mobile IP, Mobile Ad Hoc Networks (MANETs) and Mobility support in DHCP and IPv6.

Recommended Books

1. Ad Hoc Networking by Charls Perkins, Ist Edition, Eddison-Wesley.
2. Mobile IP by Charlse Perkins, Ist Edition, Prentice Hall.
3. Wireless LANs by James T. Geier and Jim Geier, Seceond Edition, SAMS.

EEC 5283 PERFORMANCE EVALUATION AND MODELING OF COMMUNICATION NETWORKS (3)

Modeling simple queues, network of queues, Modeling of packet loss and priority of systems in packet switched network, modeling of data communication networks. Modeling of end- to-end delays in store and forward networks, Modeling of servers, servers with vacations and cyclic servers (token ring).

EEC 5212 DIGITAL SIGNAL PROCESSING (3)

Introduction scope, Comparison between continuous time signal and discrete time sequences, properties of LSI system, difference equations, causality, stability.

Discrete Fourier transforms. Applications of DSP. Digital signals, systems and convolution. Fourier transform and frequency response, sampling. discrete time Fourier transform, DFT and FFT algorithms, Z-transform, FIR and IIR filters and their implementations, FIR filter design methods, IIR filter design methods

Recommended Book

Discrete Time Signal Processing By Alan V. Oppenheim, Ronald W. Schafer, John R. Buck

EEC 5213 ADVANCED DIGITAL SIGNAL PROCESSING (3)

This course provides an in depth knowledge of the theory and application of DSP and provide a solid foundation in the basics of DSP related to both signal analysis, system analysis and design. To achieve the objective the following topics will be explored: Sampling of continuous-time signal and sampling rate conversion: the sampling theorem and some of its variations, reconstruction formulae, application to the discrete-time processing of

continuous-time signals, sampling rate conversion in mutilate systems. Transform analysis of LTI systems: pole-zero representation for rational systems, study of various important systems including all-pass system, inverse system and minimum-phase system. Structure for discrete-time systems: signal flow graph representation, basic structures for FIR and IIR systems (direct forms, parallel, cascade, etc.) transposition theorem, effects of coefficient quantization on frequency response, round-off noise in digital filtering. Filter design techniques: filter design as a numerical approximation problem. transformation techniques for the design of IIR filters, FIR filter design by windowing. Discrete Fourier transform (DFT): definition and properties of the discrete Fourier series, definition of the DFT and its properties, application to linear convolution. Computation of the DFT: the computational problem, most commonly used Fast Fourier Transform (FFT) algorithms (radix-2, decimation- in-time, decimation infrequency,etc.), possible generalizations and specializations

Recommended Book

Discrete Time Signal Processing By Alan V. Oppenheim, Ronald W. Schafer, John R. Buck

EEC 5214 ADAPTIVE FILTERS (3)

Review of discrete time stochastic processes, Wiener Filters Steepest Descent Method, Theory of LMS algorithm, Recursive Least Square (RLS) algorithm, Kalman Filtering Applications: Line Echo Cancellation, adaptive beam forming, Kalman filter based estimation and measurements

EEC 5223 ADVANCED DIGITAL DESIGN (3)

This course is designed to introduce engineers and designers advanced digital design concepts. The students are taught different steps in the design flow of VLSI IC circuit designing using HDLs. The main topic covered during the course are: High-level digital design methodology using Verilog, Reusable Methodology, HDL coding for synthesis, FPGA based Digital Design, XILINX ISE 6.1i synthesys and implementation tool workshop, Datapath and Controller Design Partitioning, Design of Datapath Units, Algorithmic state machine based design, Time shared and pipeline architectures, Digital design of high speed computational unit, Single Cycle and Pipelined Processor, and VLIW and SuperScalor Architecture.

Recommended Books

1. Advanced Digital Design with the Verilog HDL by Michael D. Cilietti
2. Micro programmed Statemachine Design by Michel A. Lynch
3. Digital Design of Signal Processing and Communication Systems by Shoab Khan (draft)
4. Verilog HDL-A guide to digital design and synthesis

by Samir Palnitkar, Prentice Hall Publisher

5. Reuse methodology manual for system-on-a-chip designs by M. Keating and P. Bricaud, Kluwer Academic Publisher, 1998
6. UCLA theses on high speed computational unit

EEC 5296 DATABASE DESIGN & MANAGEMENT (3)

Introduction to File Systems and Databases, Relational Database Model, Entity Relationship (E-R) Modeling, SQL, Normalization of Database Tables, Software Engineering Processes, Internet Database Environment, Distributed Database Management Systems, Object- Oriented Databases, Client/Server Systems, The Data Warehouse.

Recommended Book

Modern Database Management, by Hoffer, Prescott and McFadden

EEC 5284 TELECOM SWITCHING & SIGNALING SYSTEMS (3)

The course presents the principles and history of the public switched telephone network and to describe the hardware and software architectures of several commercial telephone systems. It describes signaling and the Intelligent Network, and how they inter-operate to provide telephone service, it compares switching paradigms and the evolving infrastructure, and it discusses the future of telephony. The topics include; Introduction, Background, Line side, Trunk side, Traffic theory, Circuit Switching Technologies (Past, present and the future) Interconnection fabrics, Toll point, Enterprise switching, Signaling System 7, Programme control, Digital switching concepts & 4E, Sys75 & 5E hardware, Sys75 & 5E software, Bell System, Signaling, Software, Intelligent Network, Private networks, Switching paradigms, Evolving infrastructure, Future networks.

Recommended Book

Telephone Switching Systems, by Thompson

EEC 5285 OPTICAL & HIGH SPEED NETWORKS (3)

Optical beams and resonators including ray tracing, Gaussian beam propagation, stable and unstable resonators; classical theory of spontaneous and stimulated emission including a discussion of homogeneous and inhomogeneous line broadening; laser pumping and population inversion in three level and four level systems; fundamentals of laser oscillation, dynamics and threshold; laser cavity equations; laser spiking and mode competition; Q- switching; active and passive mode locking; injection locking; single frequency operation; introduction to fiber lasers and active optical fiber devices. Design Considerations of a Fiber Optics Communication Systems: Analog and Digital Modulator, Noise in Detection Process, BIT Error Rate (BER). System design, Maximum

Transmission distance due to attenuation and dispersion.

Recommended Books

1. Optical Fiber Communications, by Cruiser, Gerdkiser
2. Opto-Electronic, by Wilson and Hawks
3. Laser Electronics, by Joseph T. Verdeyen

EEC 5246 MICROWAVE ENGINEERING (3)

Microwave components: waveguides, waveguide junctions, directional couplers, isolators, circulators, resonators. Microwave generators: microwave tubes, two cavity klystron, reflex klystron, TWT, magnetron.

Microwave semiconductor devices. Gunn diode, Impact diode, PIN diode, Mixers, Detectors. Microwave measurements, measurement of frequency, VSWR, power, noise and impedance.

Recommended Book

Electronic Communication Systems, 4th edition, by Kenned

EEC 5286 TELECOMM ENGINEERING (3)

Noise in Analogue and digital systems, Packet Switched Networks, Satellite Communication, Mobile communication.

EEC5287 FIBER OPTIC COMMUNICATION SYSTEM (3)

System Design and Analysis, Performance limits, Component Parts, Advanced Topics in Lightwave Networks.

EEC 5247 THEORY AND DESIGN OF ANTENNAS (3)

Time varying fields, Retarded potentials, Poynting's theorem. Reciprocity. Regions of reactive, transition, and far-field. Ideal dipole. Antenna parameters: Directivity, Gain, and Aperture, Dipole and loop antennas, Driving point impedance, CEM techniques for antennas, Balanced and unbalanced antennas, Antenna polarization, Antenna temperature and noise, Aperture antennas, Feed structures, Antenna arrays.

Recommended Books

1. Stutzman, Warren L., and Gary A. Thiele, Antenna theory and design, 2nd edition
2. Kraus, John D., and R.J. Marhefka, Antennas 2nd Edition McGraw-Hill
3. Balanis, Constantine A., Antenna Theory 2nd Edition Wiley
4. Elliott, Robert S., Antenna Theory and Design IEEE press series on electromagnetic wave theory, Wiley-IEEE press

EEC 5288 INTEGRATED SERVICES OVER PACKET NETWORKS (NEW GENERATION NETWORKS)(3)

Applications and Transport Protocols, Signaling in Packet Networks, Traffic Control and QoS, Applications

Recommended Book

Carrier Grade Voice Over IP, by Denniel Collins.

EEC 5289 NETWORK SECURITY (3)

General Introduction (Network Security Overview, Common Security Threats, ARP/IP Address/DNS Spoofing, Anonymity/anti-anonymity(tracking), Virtual private networking, Network address translation and tunneling), Network Layer Security (Cryptography, Message Confidentiality and Symmetric Encryption, Message Authentication, Authentication and Encryption Protocols, IPSEC, AH, ESP, Public-Key Cryptography, Key management and use, IKE/ISAKMP, Network Management Security (SNMP)), Transport Layer Security (SSL/TLS, SET), Application Layer Security, Authentication Applications (Kerberos, X.509) Electronic Mail Security (PGP, S/MIME), System Security(Intruders and intrusion detection, Malicious Software, (viruses), Firewalls and trusted systems , Operating System Security

Recommended Books

1. William Stallings, Cryptography and Network Security, 3rd Edition, Prentice Hall
2. Ed Skoudis, Counter Hack - A Step by Step Guide to Computer Attacks and Effective Defenses, First Edition 2002, Prentice Hall
3. IPsec: The New Security Standard for the Internet, Intranets, and Virtual Private Networks by Naganand Doraswamy and Dan Harkins, Publisher: Prentice Hall; 1st Edition (July 1999)

EEC 5236 ADVANCED ELECTRONICS (3)

Integrated Circuit Fabrication, Operation Amplifier, Current Sources and Output Stages, case Studies e.g Ap Amp 741, 555 timers.

EEC 5237 POWER ELECTRONICS: CONVERTER MODELLING, ANALYSIS AND DESIGN (3)

Principles of electronic power conversion in switched-mode converters. Analysis and design of PWM (Pulse-Width-Modulated) converters including the selection of components, design of magnetic components, design of feedback loop, measurement of performance, and fundamentals of circuit layout and EMI (ElectroMagnetic Interference).

Recommended Book

Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, Second Edition, Kluwer Academic Publishers, 2001, ISBN 0-7923-7270-0.

EEC 5238 ADVANCED POWER ELECTRONICS (3)

Averaged switch modelling of switched-mode converters, input filter design, current-programmed control of converters, power and

harmonics in non-sinusoidal systems, and line-commutated and pulse-width-modulated rectifiers.

Recommended Book

Robert W. Erickson and Dragan Maksimovic, Fundamentals of Power Electronics, Second Edition, Kluwer Academic Publishers, 2001, ISBN 0-7923-7270-0.

EEC 5222 COMPUTER SYSTEM ARCHITECTURE AND ORGANIZATION (3)

Computer Organization review, Instruction Set Design principles and MIPS architecture ,Pipelining(Basic pipelining ,Data and control Hazards, Exceptions, Branch Prediction)Instruction level Parallelism, Compilers and code optimization, Caches(Cache basics, Techniques to reduce miss rate, Techniques to reduce miss penalty), Programming for memory performance, Main memory organization, Virtual Memory and paging , Storage devices, Beyond ILP: Future microprocessor architectures

Recommended Books

1. Computer Architecture: A Quantitative Approach, Third Edition By David Petterson and John Hennessy
2. Computer Organization and Design: The hardware/software Interface Second Edition By David Petterson and John Hennessy

EEC 5221 SWITCHING THEORY AND LOGIC DESIGN (3)

Information Representation, Binary number system and codes, Introduction to Boolean Algebra, Logic Gates and Special Functions, Logic reduction techniques

Logic reduction techniques continued, Don't Cares, NAND and NOR implementations, Combinational Logic Design concepts, Design methodology, HDL introduction, Code

Converters, Encoders/Decoders

Combinational Logic Building Blocks: multiplexers, demultiplexers, arithmetic circuits

Combinational Circuit Design, Delays, Transient Operation, Hazards

Sequential Logic Circuit Fundamentals, Flip Flops, characteristic tables

Sequential Circuit Analysis and Design Techniques and HDL representation

Sequential Logic Building Blocks, Registers and counters

Programmable Logic Devices; ROM, PAL, PLD and FPGAs

Design of Large Complex Circuits (e.g. Digital Computer), Separation of Data and Control path, Data path design, pipelined data path, the ALU

Control path design, State machine design

Computer Architecture concepts, Instruction Set Architectures

CPU designs; CISC and RISC

Computer Memory Organization; RAM, CACHE, Virtual Memory, Bulk Storage

Input Output devices and Communication buses, PCI, DMA

Detailed demonstration of Verilog HDL and simulation of complex digital circuit using

Verilog HDL.

Recommended Book

M. Morris Mano and Charles R. Kime, Logic and Computer Design Fundamentals, Pearson Education Inc.

EEC 5224 VLSI CIRCUIT DESIGN (3)

Overview of VLSI systems(complexity, wires and switches), Fabrication and layout, MOS Transistors, switch and gate logic, CMOS gates, capacitance and switch level simulation, Gate logic: Logic optimization, High level design, hardware description languages, Clocking of VLSI systems, Synthesis, implementation constraints and high level planning, Cell design issues, Pseudo NMOS and pre-charged logic, MOS memory design, MOS decoders (gate sizing, MOS delay models, distributed RC Tree), Data-path functional units(Adders, shifters and multipliers), Testing, design for testability, Input/output issues, Pads, ESD, Power, low power design

EEC 5231 LIGHTWAVE DEVICES (3)

Electro-optics, Acousto-optics, Photo-switching, Fiber optic devices

EEC 5297 DATA STRUCTURES AND ALGORITHMS (3)

Structures and Unions, Arrays, Strings as character arrays, Pointer variables, Memory Management, File Handling, Iteration vs. Recursion, Data Organization Overview, Linked-List, Types of Linked-Lists, Binary Tree,

Balanced Binary Trees, Rapid Sorting Algorithms, Useful Sorting Techniques, Merge Strategies, Introducing Graphs, Working with Graphs.

Recommended Book

Data Structures and Algorithms in C++ by Adam Drozdek

EEC 5215 COMPUTER VISION (3)

Background: Projective geometry (2D, 3D), Parameter estimation, Algorithm evaluation.Single View: Camera model, Calibration, Single View Geometry. Two Views:

Epipolar Geometry, 3D reconstruction, Computing F, Computing structure, Plane and homographies. Three Views: Trifocal Tensor, Computing T. More Views: N-Linearities, Multiple view reconstruction, Bundle adjustment, auto-calibration, Dynamic SfM, Cheirality, Duality with Graphs.

EEC 5216 DIGITAL IMAGE PROCESSING (3)

Introduction to Image Processing,Digital Image Fundamentals and Image Acquisition, Image Enhancement in Spatial Domain(Pixel Operations & Histogram Processing, Histogram Equalization, Histogram specification and local enhancement techniques, Local enhancement techniques using Spatial (Mask) Filtering),Image Enhancement in Frequency Domain(Basic Properties of Fourier Transforms, Properties and Implementation (FFT's), Frequency Domain Filtering, Image Sampling, Image Restoration, Noise models and additive noise removal. Adaptive filtering, notch filtering and interactive restoration techniques for additive noise removal , Degraded image restoration , Geometric transformations), Color Imaging, Multi-resolution Processing (including Wavelet Transforms) , Image Compression (Introduction. Error-free compression, Predictive coding ,Transform coding),Morphological Image Processing(Morphological Processing on Binary Images, Morphological Processing on Grey Scale Images), Image segmentation(Point, Line and Edge Detection, Edge Linking, and Thresholding), Water Marking and other Advanced Topics

Recommended Books

1. Digital Image Processing, R. C. Gonzalez and R. E. woods, 2nd edition, Pearson Education, Inc., 2002.
2. Digital Image Processing using MATLAB, R. C. Gonzalez ,R. E. Woods and S.L. Eddins, Pearson Education, Inc., 2004.

EEC 5266 LINEAR SYSTEMS AND CONTROLS (3)

Introduction to state-space and system modeling, state-space representation of dynamic systems, simultaneous linear equations, state-transformations and state-transition matrix, eigen-values and eige-vectors, Cayley-Hamilton theorem, analysis and stability of continuous-time systems, controllability and absorbability for linear systems , controller and observer design, sampled-data systems and discrete-time systems, simultaneous linear difference equations, discrete-time systems, simultaneous linear difference equations, discrete-time transation matrix, discrete-time controller design and implementation.

Recommended Books

1. Linear System Theory by C.T. Chan
2. Linear Systems by Rugh.

EEC 5267 DIGITAL CONTROL SYSTEMS (3)

Introduction to discrete time systems. Practical aspects of discrete time systems, Z -Transform and Inverse –Transform, Z -Transform analysis of SISO systems , Digital Signal Processing ,Delta Transform , Discrete Time Fourier Transform and Applications, Introduction to Discrete Time Control , Root Locus , Nyquist Theorem, State Space Analysis and design (Pole Placement , Observers,Optimal Control)

Recommended Book

Discrete-Time Control Systems, 2e, Katsuhiko Ogata, Prentice Hall, 1995.

EEC 5298 OPTIMIZATION TECHNIQUES (3)

Classical Optimization Techniques with equality constraints (e.g. Lagrange Multipliers etc) for 1 variable, two variables and many variables, Linear Programming, Integer Programming, Assignment problem, Transportation problem, PERT, CPM, Misc. topics in optimization techniques

EEC 5290 PROPAGATION FOR WIRELESS COMMUNICATION

Wireless Communication, The Electromagnetic Spectrum for Wireless Communication, System Types, The Cellular Networks, Aims of Cellular Networks, Power Received by the Mobile Phones in a Cell, Frequency Reuse Concept, Cells Clusters and Shift Parameters, 3-Cells Cluster and its Cochannel Cells in the 1st Tier, 7-Cells Cluster and its Cochannels, 9-Cells, 13-Cells and 16-Cells Clusters and its Cochannels in the 1st Tier, Carrier to Interference Power Ratio, Worse Scenario Omni-Directional Antenna Carrier to Interference Ratio, Cell Sectorisation (3 -Sectors Directional Antennas and 6- Sectors Directional Antennas). Trunking, Traffic, Blocking Probability, Erlang –B Formula, Different Multiple Access Techniques, FDMA/FDD, TDMA/FDD,CDMA, The relative Capacity of Different Systems.

Maxwell's Equations, Constitutive Relations, Wave Equations and Wave Solutions, Time Hormanic Fields, Conservation of Power, Boundary Conditions, Plane Waves, Dielectric and Conductor, Highly Conducting Medium, Slightly Conducting Medium, Quasi Conductor, Reflection and Transmission of Plane Waves,

Brewster's Angle, TM Mode or Vertical Polarization.

Free Space Model, Friis Equations, Fresenel Zones, Diffraction Loss, Line of Sight (Two- Ray)

Model, Flat Earth Model, Okumura –Hata Model, Hata/ Cost 23/CCIR/Model, The Lee Model

Recommended Books

1. Antennas and Propagation for Wireless communications By Simon R. Saunders
2. Wireless Communication By Rappaport

EEC 5266 SPECIAL STUDIES (3)

EEC 5299 MASTER'S THESIS (6)

EEC 6299 Ph.D. THESIS (1-9)

Department of
Industrial Engineering

Industrial engineering addresses how systems operate and is concerned with the effective and efficient delivery of quality products and services. The tools applied include analytic modeling, system simulation, queuing systems, work design, project planning, facilities design and quality management and control.

Industrial engineers seek to allocate limited resources in an effective manner. A unifying theme focusing this body of knowledge and methods into a coherent entity is the systems point of view. Industrial engineering encompasses the search for similarity among concepts, laws and models of different disciplines; the emphasis on the adaptation, integration and exploitation of existing techniques in areas other than their fields of origin; and, above all, a unique point of view dealing with relationships rather than with components. Industrial engineers are thus in a strategic position to bring about the best integration of people, materials, machines, time and money in any endeavor.

These techniques are applied in a very wide range of organizations. There are industrial engineers in banks, hospitals, government, transportation and communications, construction, social service, facilities design, manufacturing, warehousing and information processing. Many industrial engineers move from analyzing and designing productive systems to managing those systems. While engineering and management are different fields, both require the ability to make decisions based on valid information. Industrial engineers are especially trained to obtain and evaluate such information.

The Department of Industrial Engineering was established in 2006. The Post Graduate programme started in Fall-2008, and is currently offering a Master's degree in Manufacturing Systems Engineering which is one of the streams of Industrial Engineering. The Department has also started Ph.D. programme.

Dean, Faculty of Mechanical, Chemical and Industrial Engineering

Prof. Dr. Muhammad Abdul Aziz Irfan

Chairman

Prof. Dr. Sahar Noor	Ph.D. (UK)

Professor

Prof. Dr. Iftikhar Hussain	Ph.D. (UK)
Prof. Dr. Sahar Noor	Ph.D. (UK)
Prof. Dr. Misbah Ullah	Ph.D. (S.Korea)

Assistant Professors

Dr. Rashid Nawaz	Ph.D. (Pak)
Engr. Fawad Haidar	M.Sc. (UK)
Dr. Sikandar Bilal Khattak	Ph.D. (Pak)
Engr. Khawar Naeem	M.Sc. (Pak)
Dr. Imran Ahmad	Ph.D. (S.Korea)
Engr. Altaf Hussain	M.Sc. (Pak)
Engr. Aamir Sikandar	M.Sc. (UK)

Lecturers

Engr. Abdur Rehman Babar	M.Sc. (Pak)
Engr. Mahawish Mahmood	M.Sc. (Pak)
Engr. Muhammad Abas	M.Sc. (Pak)

POST GRADUATE PROGRAMME

The graduate programme in Industrial Engineering (IE) offers both Doctor of Philosophy and Master of Science in Industrial Engineering with thesis option only. The programme is designed to accommodate the working engineers as well, by offering classes in the evening and on weekends. The curriculum for the thesis option is designed to give students greater breadth and depth of technical and practical IE knowledge. This option allows specialization in Industrial Systems Engineering, Manufacturing Systems Engineering, Operations Research, Quality Engineering, Industrial Management, and Human Factor Engineering areas. These are distinct areas, each tailored to specific IE career needs and characterized by both breadth and depth in its curriculum. Presently, the Department of Industrial Engineering offers master and Ph.D programme in the Manufacturing Systems Engineering and Master degree programme in Engineering Management.

Manufacturing Systems Engineering

Core area of specialization

1. IE 5710 Manufacturing Planning and Control
2. IE 5722 Engineering Experimental Design
3. IE 5726 Engineering Optimization
4. IE 5730 Maintenance & Safety Engineering
5. IE 5734 Quality Engineering
6. IE 5738 Computer Modelling and Simulations
7. IE 5750 Facility Analysis and Design
8. IE 5754 Design and Analysis of Manufacturing Systems
9. IE 5758 Advanced Manufacturing Processes
10. IE 5770 Mathematics
11. IE 5772 Technical Report Writing and Research Methodology

Optional Courses

1. IE 5701 Engineering Economics
2. IE 5702 Mathematical Statistics
3. IE 5703 Queuing Theory
4. IE 5704 Inferential Statistics
5. IE 5705 Finite Element Analysis
6. IE 5706 Organizational Systems
7. IE 5707 Dynamic Programming
8. IE 5708 Project Management Framework & Tool
9. IE 5709 Human Resource Management
10. IE 5711 Game Theory
11. IE 5712 Concurrent Engineering
12. IE 5713 Benchmarking
13. IE 5714 Operations Research
14. IE 5715 Network Analysis
15. IE 5716 Reliability Analysis
16. IE 5717 Tool Design
17. IE 5718 Scheduling
18. IE 5719 Replacement Models
19. IE 5720 Real Analysis
20. IE 5721 Ergonomics
21. IE 5723 Energy Management
22. IE 5724 Organizational Behavior

23. IE 5725 Supply Chain Management
24. IE 5727 Business Process Re-engineering
25. IE 5728 Management Information System
26. IE 5729 Combinatorial Optimization
27. IE 5731 Quality Assurance
28. IE 5732 Statistical Quality Control
29. IE 5733 Project Management
30. IE 5735 Stochastic Optimization
31. IE 5737 Six Sigma Methodologies
32. IE 5739 Cost & Management Accounting
33. IE 5740 Total Quality Management
34. IE 5741 Project Evaluation & Feasibility Analysis
35. IE 5742 CAD/CAM
36. IE 5743 Business Forecasting
37. IE 5744 Operations Management
38. IE 5745 Environmental Management & Safety
39. IE 5747 Marketing Management
40. IE 5762 Computer Integrated Manufacturing
41. IE 5766 Artificial Intelligence with applications
42. IE 5780 Computer Applications
43. IE 5784 Deterministic Optimization
44. IE 5788 Stochastic Optimization
45. IE 5790 Special Topic

IE 5799 Master's Thesis

IE 6799 PhD Thesis

LIST OF APPROVED COURSES

IE 5701 Engineering Economics 3 (3,0)

Cost concepts and design economics, cost estimation techniques, developing project cash flows, lease versus buy decisions, replacement analysis, dealing with uncertainty, impact of Income tax and inflation on economic analysis, capital financing and allocation.

IE 5702 Mathematical Statistics 3 (3,0)

Probability spaces and random elements, Integration and differentiation, probability distributions and their characteristics, conditional expectations, asymptotic theory; Populations, samples, and models; statistics, sufficiency and completeness; statistical decision theory; statistical inference; asymptotic criteria and inference; Unbiased statistics, their variances, the Least squares estimates

(LSE) in Linear models, the UMVUE and the BLUE, robustness of LSEs, Bayes decisions and estimators, invariance, maximum likelihood, the likelihood function and the MLEs, Uniform, Gamma, and Beta processes, Normal and the exponential family of processes, Sampling statistics, probability generating function, moment generating function.

IE 5703 Queuing Theory 3 (3,0)

Description and characteristics of queuing systems, Poisson process and exponential distribution, Markovian property, stochastic processes and Markov Chain.

Birth-death queuing models: Kendall notation, steady-

state solution for M/M/1 models, steady-state difference equation, M/M/c, and M/M/c/k models, Erlang formula, queuing with unlimited services, Network, Series and Cyclic queues, Models with general arrival and service patterns: Single server and multiple server queues with Poisson arrivals and general service, multi-channel queues with Poisson arrivals and constant service.

IE 5704 Inferential Statistics 3 (3,0)

Fundamentals of hypothesis testing: one-sample t-test, Two-sample t-tests, ANOVA and other tests with numerical data, Two-sample and c-sample tests with categorical data, multiple regression and response surfaces.

IE 5705 Finite Element Analysis 3 (3,0)

Matrix forces method, Matrix stiffness method, variational formulation and approximation (Boundary and initial-Value problems, gradient and divergence theorems), Ritz methods, method of weighted residuals, time-dependent problems. Finite Element Error Analysis (Approximation Errors, Various measures of errors, Convergence of solutions and accuracy of solutions), Numerical integration & computer implementation, Coordinate transformation (Integration on a Master Element, Modeling, Mesh Generation), Load Representation, use of finite element software.

IE 5706 Organizational Systems 3 (3,0)

Integrating management systems, management, safety, managing indirect costs, controlling risks and cost, Management commitment and policy, responsibility and authority, objectives and targets, plan consideration, plan implementation, standard operating procedures, employees involvement, management and control of contactors and vendors, emergency preparedness and contingency planning, document control and record keeping processes, process risk analysis and assessment, measurement and evaluation, non-conformances and incident investigations

IE 5707 Dynamic Programming 3 (3,0)

Introduction: Sequential decision processes, DP functional equations, problem formulation and solution, State transition graph models, state-space generation, complexity, greedy algorithms, probabilistic dynamic programming. Applications of DP: Optimal allotment, all-pairs shortest path problems, assembly-line balancing, optimal binary search tree problem, optimal covering problem, discounted profits problem, flowshop problem, Integer linear programming.

Integer knapsack problem, mini max problem, optimal distribution and optimal permutation problems, optimal selection problem, Process scheduling problem, Transportation problem, Traveling salesman problem. Modelling of DP problems. Introduction to DPS.

IE 5708 Project Management Framework and Tools 3 (3,0)

Define project, program and portfolio management, project structure, project life span, modelling project management, project management model in three decades, model with portfolio potential, logical progression, Marasco pyramid model, Project dynamics, project environment, project control, program and portfolio management, optimization portfolio

management

IE 5709 Human Resource Management 3 (3,0)

Role and Organization of Personnel Function, Behaviour Aspects, Human Resources Planning, Recruitment, Job Analysis and Design, Managing Performance. Training and Development, Pays and Benefits, Industrial Relations.

IE 5710 Manufacturing Planning & Control 3 (3,0)

Deterministic inventory problems, Material requirement planning, manufacturing resource

planning, Enterprise resource planning, Just-in-time manufacturing, Variability basics and their influence, Push-Pull and hybrid production systems and Supply chain management.

IE 5711 Game Theory 3 (3,0)

Theory of rational choice, integration with intelligence and decision making, axioms, the expected utility maximization theorem, Bayesian conditional probability systems.

Basic Models: Games in extensive form, strategic forms and normal representation, Equivalence and reduced normal representation, elimination of dominated strategies.

Equilibria of strategic form games: Nash equilibrium theory, computation and significance of Nash equilibria, the Focal point effect, Purification of randomized strategies in equilibria, infinite strategies sets, The two person zero-sum game with equilibrium points, two-person non-zero sum game, Mixed strategies and behavioural strategies, Auctions, bargaining and cooperation in two-person games.

IE 5712 Concurrent Engineering 3 (3,0)

Theory and philosophy of Concurrent Engineering, Planning the transition and Reducing organizational and cultural barriers, Product cycle time, Customer satisfaction, Reduction in engineering change orders or reworks, Strategies for selecting, staffing and managing multi-disciplinary functional project-teams. Principles of DFA/DFM for parts reduction and assembly, Learn design for X concepts (e.g., DFM, DFA, DFS, etc.) Pinpoint organization change and the effects of new engineering order, QFD, Taguchi method, Axiomatic design.

IE 5713 Benchmarking 3 (3,0)

Strategic planning and the evolution of benchmarking, types of benchmarking, common criticisms of benchmarking; Steps in benchmarking, planning benchmark study- seven 'to-do' items, determination of activities to benchmark, identifying the benchmark team, scheduling the study and determination of key factors to measure, Identification of target organization (benchmark partner). Execution of the study: Data collection, data analysis. Implementing improvement, strategy assessment.

IE 5714 Operations Research 3 (3,0)

How the simplex method works, Tableau and Dictionary methods, pitfalls (initialization, iteration and termination) in Simplex method and ways to avoid those, Speed of computation, How fast is Simplex method, The Duality theorem, Gaussian Elimination and matrices-number of steps, speed and accuracy issues, the LP

decomposition of matrices, the revised Simplex method, General LP problems and their solution by Simplex Method, Theorems on Duality, Feasibility and infeasibility of problems, Primal-dual relationship, sensitivity analysis, Efficient allocation of scarce resources, scheduling production and inventory, the cutting stock problem, matrix games.

IE 5715 Network Analysis 3 (3,0)

Formulation of network problems as linear programming problem, The transshipment problem, trees and feasible tree solutions, economic motivation for network Simplex method, degeneracy and cycling, termination and initialization issues, decomposition into sub problems, computer implementation, Inequality constraints, scheduling production and inventory, the Caterer problem, the Integrality theorem, doubly stochastic matrices, covers and matchings in bipartite graphs, chains and antichains in partially ordered sets, The assignment and transportation problems as network problems, Upper-bounded trans-shipment problems, Maximum flow through networks: The primal-dual method for network flows.

IE 5716 Reliability Analysis 3 (3,0)

Models and Uncertainties, Standards and Guidelines, Failure Models, Qualitative System Analysis, Systems of Independent Components, Component Importance, Dependent Failures, Counting Processes, Markov Processes, Reliability of Maintained Systems, Reliability of Safety Systems, Life Data Analysis, Accelerated Life Testing, Bayesian Reliability Analysis, Reliability Data Sources, use of Minitab or some other software.

IE 5717 Tool Design 3 (3,0)

Tool design objectives and nomenclature, Tool Materials, Work holding principles, Jig Design, Fixture Design, Tool Design for Inspection and Gauging, Forming and Drawing Tools, Tool Design for Joining Processes, Computers in Tool Design.

IE 5718 Scheduling 3 (3,0)

Introduction to scheduling problem, performance measures of scheduling, single and multi-machines scheduling, parallel machines scheduling, flow shop scheduling, job shop scheduling, open shop scheduling and project scheduling.

IE 5719 Replacement Models 3 (3,0)

Introduction to replacement models, decision whether to repair or replace, modelling the

decision, assumptions related to replacement decision, uncertainty in replacement acquisition costs, modelling and estimation of model parameters, modelling maintenance requirements and estimation of maintenance as well as life cycle costs.

IE 5720 Real Analysis 3 (3,0)

Topological properties of the real numbers, Completeness and least upper bound property. Cardinality of sets. Theory of metric spaces, Cauchy and convergent sequences, compactness, completeness, and connectedness, Continuous functions between metric spaces, Differentiability of functions of one variable, Differentiability of functions of several variables.

IE 5721 Ergonomics 3 (3,0)

Principles of ergonomics, Human characteristics

relevant to Ergonomics, the system approach and aspects of Ergonomics, role of human factors engineering in Artificial Intelligence, anthropometry, types of anthropometry, body dimensions of various organs, failure of design, anthropology and its types, climatic factors, sound and its measurements, effects of noise on various organs, principles of good lighting.

Basic cognitive capabilities and limitations of the workers, environmental situation and limitations conducting an ergonomic assessment, Developing an ergonomic program, Ergonomic issues related to posture, materials Handling/Lifting using the NIOSH, Frequent types of injuries related to workplace design, Repetitive motion, and cumulative trauma disorders, Preventing ergonomically related injuries by redesigning the workplace, Designing displays for Workers, Transfer and design of information, Controls and control arrangements.

IE 5722 Engineering Experimental Design 3 (3,0)

Sampling and descriptive statistics, Parameter estimation, Tests of hypothesis on the means, variance,and portions, testing of goodness of fit, Non-parametric tests, Experiments with single factor, Randomized blocks, latin squares and incomplete block designs, Regression analysis, Taguchi's concepts and approach to parameter design, Response surface methodology.

IE 5723 Energy Management 3 (3,0)

Attitudes to energy efficiency, objective of energy management, priorities, and strategies. Plant control, control and use of an energy management system.

Monitoring: Remote monitoring and out-station operation, degree days performance lines and targeting, Audits, Environmental, energy and social.

Energy Modelling and Forecasting, reserves and relation of resources to future options. Energy demand models, Energy Transmission & Utilization, Waste Heat Recovery System, Energy Resources, Solar Energy Conversion Systems.

IE 5724 Organizational Behaviour 3 (3,0)

Management functions and roles. Need for systematic study of human behaviour. Challenges and opportunities for O.B., Responses to Global and Cultural Diversity. Foundations of Individual Behaviour, Perception and Industrial Decision Making. Values, Attitudes and Job Satisfaction, Motivation Concepts, Group Behaviour & Work Teams, Organization System.

IE 5725 Supply Chain Management 3 (3,0)

The era of Physical Distribution Management, the Concept of Supply Chain, Channels Strategy and Alliances, the Changing Business Environment, Customer Focus in the Supply Chain, Achieving Customer Satisfaction Objectives, Transportation Choices in the Supply Chain, Inventory Management in the Supply Chain, Supply Chain Communications, International Supply Chain Management. Issues and Implications, Information for Supply Chain Management.

IE 5726 Engineering Optimization 3 (3,0)

Modelling techniques for selected case studies, and linear and nonlinear programming applications in engineering, duality and optimality conditions, Revised

primal and dual simplex methods, Sensitivity analysis, branch and bound methods, heuristic methods (Simulated annealing, Tabu search, Genetic algorithms, Artificial neural networks) and computerized real applications.

IE 5727 Business Process Reengineering 3 (3,0)

Fundamentals of process management; importance of process decisions and process choices; strategic process decisions for manufacturing and service environments. Costs, quality, and timeliness as the primary attributes of value; creation of value through strategies and processes.

Process improvement tools and frameworks; process maps, value stream mapping, service blueprinting, reengineering, Poka-Yoke, lean systems and sixsigma.

Simulation and modelling of discrete event systems and processes. Implementing BPR methodology, building the reengineering organization; identifying BPR opportunities, understanding existing processes, reengineering processes, blueprinting new business systems, performing transformation.

IE 5728 Management Information System 3 (3,0)

Introduction of MIS, Meaning & Role, organization structures, Business Process, Systems Approach. Programmed & Non- Programmed, Strategic & Project Planning for MIS, Models of Decision Making different types of IS: MIS, DSS, ESS. MIS and the information Concepts, System Concepts, Handling system complexity MIS and system concepts, need for system analysis, SSAD, MIS and System Analysis. Development of MIS, Ascertaining the Class of information, Management of quality in MIS, MIS: the factors of success and failure. EMS and MIS, MIS Service industry, choice of IT in MIS.

IE 5729 Combinatorial Optimization 3 (3,0)

Algorithmic and structural approaches in combinatorial optimization with a focus upon theory and applications. Topics include: polyhedral methods, network optimization, the ellipsoid method, graph algorithms, matroid theory and sub modular functions.

IE 5730 Maintenance & Safety Engineering 3 (3,0)

Planned and preventive maintenance, Predictive maintenance, Corrective maintenance, Advanced concepts (Reliability centred maintenance, Total productive Maintenance), Concepts of maintainability engineering, Design for maintainability, Availability, Decision models in maintenance management. National and international standards for preventing accidents in the workplace, recent developments in industrial systems' safety and risk analysis techniques.

IE5731 Quality Assurance 3 (3,0)

Basic elements of a quality assurance system, Quality standards such as ISO 9001 and ISO 17025, Structuring quality management system documentation: quality manual, quality plans, procedures, work instructions, records, QMS implementation and maintenance, Strategic and competitiveness issues in QMS, Computer-based information systems for QMS, Role of TQM and statistical methodologies in QMS, Quality auditing and management reviews, Continuous improvement through corrective and preventive action,

Familiarization with other standards such as ISO 14001, SA 8000, OHSAS 18000.

IE 5732 Statistical Quality Control 3 (3,0)

Review of Probability Theory, Effect of sample size on Control charts for variable (X-Bar and R or S) and attributes (p, np, c, u, CUSUM etc), determining the control limits and plotting the data; interpretation of charts, Gauge R & R analysis, identification of out-of-statistical control situations, trends and control mechanisms, Process capability and related indices, Type I and Type II errors, Single, double, multiple and sequential sampling, developing operating characteristic curves, acceptance Sampling: Sampling Plans, the ABC and Mil Standards.

IE 5733 Project Management 3 (3,0)

Project Management and Project Control, Qualitative and Quantitative Risk Management, Project Management Structures Strategy, Portfolio and Program Management, Project cost estimation, Project procurement management, Managing Data and Configurations for effective project management, Managing Technology: Innovation, Learning and Maturity. Time, Cost and Critical Chain Management, Project Performance Measurement & Value Management, Improving quality in project and program, use of MS Project or Primavera.

IE 5734 Quality Engineering 3 (3,0)

Principles of modern quality control techniques, KAIZEN by TQC/TQM, Management and Planning Tools, Affinity Diagrams, Interrelationship Digraph, Tree Diagram, Project teams, Project Management Techniques, Adventure based team building and leadership, Basic Tools, Prioritization matrices and Matrix diagrams, Organizational and cultural issues, Implementing change and new technologies, Deming, Baldrige and other total quality awards, Introduction to Six Sigma, Quality assurance Audit Programs, and ISO certification.

IE 5737 Six Sigma Methodologies 3 (3,0)

Introduction to Six Sigma, Internal & External Customers, Define Measure Analyse Improve Control (DMAIC) Cycle, Six Sigma goals and Matrices, Six Sigma Training, Six Sigma Teams, Green, Black and Master Black Belt, Design for Six Sigma, Define Measure Analyse Design Verify (DMADV) , Case Studies.

IE 5738 Computer Modelling and Simulations 3 (3,0)

Concept of simulation modelling, selecting the appropriate input distribution, random number generation, simulation languages, output analysis, alternatives comparison, variance reduction technique, models of complex systems. Modelling Physical Phenomena and mathematical equations using MATLAB, matrix analysis, numerical visualization, building of graphical user interface, data analysis, case studies for simulation using any simulation software.

IE 5739 Cost and Management Accounting 3 (3,0)

Financial Accounting, Income statement and principles of accrual accounting, Balance sheet and recording of transactions, Accounting process, Revenue recognition, Inventory/cost of goods sold, Statement of cash flow, Long term assets/depreciation, long term debt, Current

liabilities and contingencies, Marketable securities, intangibles, Cost concepts, Indirect allocation of cost.

IE 5740 Total Quality Management 3 (3,0)

The concepts and principles of quality management, the quality management leading companies in the implementation of total quality management, techniques philosophies of modern quality leaders, the strategies used by some of the for process management, introduction and application of tools.

IE 5741 Project Evaluation & Feasibility Analysis 3 (3,0)

Project Planning & Appraisal, Managing Project with Project Management Tools, Project Management Control, Indicators and Measurement of Monitoring and Evaluation, General Management Skills, Financial aspects of new project, Feasibility analysis of a model project, Sensitivity analysis.

IE 5742 CAD/CAM 3 (3,0)

Computer methods in industrial design, Advanced computer geometric modeling, transformations and projection, CAD/CAM databases, Introduction to automated machine tools and cutting tools, tool path planning, Management of cutting tools, Numerical control, Motion control, Robotics, CNC machine tools programming, use of modelling software.

IE 5743 Business Forecasting 3 (3,0)

Forecasting alphabet, applications, classification of forecasting methods, Importance of sales forecast, Forecasting approaches (deterministic and probabilistic), Time series causal forecasting, Time series projective forecasting, Service level models, Information for dependent demand, Use of computer software in business forecasting.

IE 5744 Operations Management 3 (3,0)

Operations and productivity, operations strategy for competitive advantages, forecasting, design of goods and services, managing quality including SPC, capacity planning, location and layout strategies, supply chain management, inventory management including JIT, aggregate planning, MRP, maintenance and reliability, decision making tools, linear programming, transportation models, waiting lines model, learning curves, introduction to simulation, statistical tools for management.

IE 5745 Environmental Management & Safety 3 (3,0)

Professional and self development, Quality and resource planning, Integrated business risk management, Environmental and waste management, Workplace evaluation and control, Health and safety management and legislation, Environmental impact assessment, ISO 14000, eduction of carbon footprint.

IE 5747 Marketing Management 3 (3,0)

Introduction to the fundamental concepts of marketing, customer orientation, competition and core strengths, introductory finance, Marketing research and analysis, Marketing strategy, Implementation planning, Project, Process and supplier management, market segmentation, product life cycle, distribution networks, social marketing, product promotions, Marketing Mix.

IE 5754 Design and Analysis of Manufacturing Systems 3 (3,0)

Classification of manufacturing systems; High volume manufacturing systems; Flexible manufacturing systems; Assembly systems design and planning; Material handling systems; Automated storage/ retrieval systems; Modelling manufacturing systems; Manufacturing management and strategies; Emerging trends in manufacturing systems engineering.

IE 5758 Advanced Manufacturing Processes 3 (3,0)

Non traditional machining and thermal cutting processes - Super finishing processes - Selection of manufacturing materials and processes - Joining and assembly processes - Design for manufacturing (processing and assembly) - Product and production relationships.

IE 5762 Computer Integrated Manufacturing 3 (3,0)

CIM strategy, CIM components, Concurrent engineering, GT and cellular systems, FMS, Robotic systems, Systems integration, Selection of CIM systems, Modeling and implementation of CIM systems, Enterprise resource planning, Future trends in CIM.

IE5766 Artificial Intelligence 3 (3,0)

Introduction to AI, expert systems, knowledge-based systems, inductive logic programming, fuzzy sets and systems, evolutionary computation techniques, hyper heuristics, machine learning, hybrid intelligent systems, data mining and knowledge discovery, Genetic algorithm and artificial neural networks.

IE 5770 Mathematics 3 (3,0)

Approximations and error analysis, methods to find roots of non-linear algebraic equations, solution of systems of linear algebraic equations, deriving empirical equations to suit experimental data, numerical differentiation and integration, numerical solution of differential equations, the determination of Eigen values, Fourier analysis and its engineering applications.

IE 5772 Technical Report Writing and Research Methodology 3 (3,0)

Basics of technical writing process, Technical writing techniques and applications, definition and basics of research, Research purpose, Design of research methods, Identification of research problems, literature review, selection of data collection techniques, selection of representative sample, writing of research proposals, data collection and analysis techniques, limitations and significance of research techniques, quantitative and qualitative research procedures, writing of research reports, presentation skills, oral presentations.

IE 5780 Computer Applications 3 (3,0)

Computer hardware and software, Databases, Communication and networks, Constants and variables, Arithmetic operations, Intrinsic functions, Algorithm design, Flowcharts, and Pseudo codes, IF statements, Do loop, While loop, Data files, Formatted Input and Output, Logical and character data type, Arrays: onedimensional, two-dimensional, Subprograms: Functions and subroutines, Numerical Applications, Introduction to programming language.

IE 5784 Deterministic Optimization 3 (3,0)

Selection of an OR tool for a particular production/ operations management application, Formulating deterministic optimization models, Defining objectives, decisions and constraints, Writing symbolic models and implementing those using optimization software, Using Excel data table functions to conduct sensitivity analysis, Interpretation of sensitivity tables, simplex tableaus, duality analysis, application of OR methods.

IE 5788 Stochastic Optimization 3 (3,0)

Approaches to optimization with uncertainty, stochastic optimization, and dynamic (multi-stage) stochastic optimization, two-stage and multistage stochastic programs, dynamic programming (Markov decision process) approach, finite and infinite horizon problems, deterministic DP approximation method for large-scale problems. Usage of computational techniques and applications.

Engineering Management Program

Engineering management program at Department of Industrial Engineering, University of Engineering and Technology, Peshawar, is designed for engineers who seek broad education in modern management techniques and tools for efficient operation of scientific and technical organizations to be ahead of competitors. In addition, this program is an interface between business sectors and engineering.

Management skills are mandatory for engineers to lead organizations effectively and make good technology related investment decisions. The top executives of the world class organizations need to have both technical and management skills for innovating and optimizing their products. Indeed, innovation and optimization of business processes leads to customer retention and satisfaction. In addition, engineering management tools enable engineers in conceiving an idea and shape them into reality by having business and entrepreneurial skills. Engineers with management knowledge also serve a mediator between technical and business people of the organization.

The Engineering management program will enhance the knowledge of those interested in this area and will also provide us with a platform for relevant research in the field of Engineering Management. Furthermore, this program will help students in becoming successful professionals in engineering disciplines and academia by giving the students the opportunity to present the industrial problems and discuss the business challenges.

Program Mission Statement:

"To produce quality graduates who are capable of serving the society through integrity, ethical conduct, creating knowledge, innovation, and excellence."

Program Vision Statement:

"The Engineering Management program of Department of Industrial Engineering, UET Peshawar will be a world class graduate program where students, faculty, alumni can fulfill their passion for academic excellence and gearing towards nation's benefit."

Degree Program

- M.Sc in Engineering Management

Objectives

- To expand student's engineering knowledge and skills.
- To provide an understanding of a range of management skills, tools, and techniques essential for engineering management practice
- To improve your communication skills to resolve disputes and in managing conflict
- To discuss the important technological issues involved with engineering business and engineering management.
- To help student's in becoming successful professionals in engineering disciplines and academia

Eligibility Criteria

Students of all engineering disciplines, B. Tech (Honors), MBA and BBA (Honors) with at least 16 years of education are eligible to take admission in the program.

Seat Allocation

The intake of students should be at least 30 on open merit and 10 on self-finance basis.

Degree Requirements

The Master's degree program of Engineering Management at the Department of Industrial Engineering, University of Engineering and Technology, Peshawar, requires a total of 30 credit hours (including 24 credit hours of courses and 6 credit hours of research) are required to complete the Master's Degree Program. The 24 credit hours of course work shall include a minimum of 18 credit hours from the core courses and 12 credit hours from elective courses. At least 6 core courses are required for MS Degree in Engineering Management.

List of Core Courses in Engineering Management Program

1. IE5744 Operations Management
2. IE5733 Project Management
3. IE5725 Supply Chain Management
3. IE5740 Total Quality Management
4. IE5724 Organizational Behavior
5. IE5791 Risk Analysis and Management
5. IE5792 Business Analytics
6. IE5793 Management of Technical Organizations
7. IE5794 Technology and Innovation Management

List of Elective Courses in Engineering Management Program

IE5728 Management Information System
IE5741 Project Evaluation & Feasibility Analysis
IE5743 Business Forecasting
IE5723 Energy Management
IE5745 Environmental Management and Safety
IE5747 Marketing Management
IE5739 Cost & Management Accounting
IE5713 Benchmarking
IE5727 Business Process Re-engineering
IE5701 Engineering Economics
IE5709 Human Resource Management
IE5714 Operations Research
IE5704 Inferential Statistics
IE5790 Special Topic
IE5795 Systems Engineering and Management
IE5796 Knowledge Management
IE5797 Decision Making with Uncertainty for Managers
Ie5798 Conflict Management and Negotiations

CONTENTS OF NEW CORE COURSES

IE5791 Risk Analysis and Management

Fundamental of risk modeling, assessment and management. The role of modeling in risk analysis process, Decision analysis, multiobjective trade-off analysis, defining uncertainty and sensitivity analysis, risk ranking and management, Risk of extreme events, fault tree analysis.

Recommended Books

1. Risk Modeling, Assessment and Management by Yacov Y. Haimes, A John Wiley & Sons, Inc. New Jersey.

IE 5792 Business Analytics

Overview of business analytics, data issues, introduction to data mining, data mining process, data mining tools, regression trees, optimization, marketing mix, capital budgeting, portfolio optimization, decision making under uncertainty, inventory management, capital investment analysis, market share estimation.

Recommended books:

1. Business analytics by James R. Evans, Pearson, 2013
2. Data mining for business intelligence: Concepts, Techniques, and Applications in Microsoft Office Excel with XLMiner by Galit Shmueli, Nitin R. Patel, Peer C. Bruce, John Wiley and sons Inc., New Jersery, 2016

IE 5793 Management of Technical Organizations

Management vs leadership, challenges in managing technical organizations, trends in management, management cultures, leadership lessons, legal issues in management, Modern challenges in partner ecosystem, management challenges across culture

Recommended Books:

1. Good to Great: Why Some Companies Make the Leap. And Others Don't by Jim Collins, An imprint of Harpercollins publisher
2. Winning by Jack Welch, Harpercollins publisher
3. When Cultures Collide: Leading Across Cultures by Richard D. Lewis, Third Edition: 2006

IE 5794 Technology and Innovation Management

Introduction to Technology Management. Functions of Technology Management. Planning, technological forecasting, regression analysis. Decision-making, Align Information Technology and Business Strategy, Information Technology Role in Organizational Change. Organizing, Importance of Information Systems Management in the Global Economy. Staffing Technical Organizations, Managing people in technical organizations. Motivation and leadership, managing groups. Controlling, Managing Organizational Transformation. Managing Information Systems Organizations, Planning Production Activity. Technology life cycle, innovation, managing innovation. Outsourcing, Global strategy, Global Competitive Advantages, Product life cycle, E Business Technology Developments, work design and process. Business organizations, technology management tools, business model framework, Management Challenges Across Cultures, legal issues in technology management

Recommended Books:

1. Managing Engineering and Technology by Daniel L. Babcock and Lucy C. Morse, Pearson Education.
2. Operations Management by Jay Heizer and Barry Render, Pearson, ISBN-10: 0132921146
3. Organizational Behavior by Stephen P. Robbins and Timothy A. Judge, Prentice Hall, ISBN-10: 0132834871.

CONTENTS OF NEW ELECTIVE COURSES

IE5795 Systems Engineering and Management

Core concepts in systems engineering; processes of system decomposition and integration; upfront conceptual design, rapid prototyping, structured testing, balanced work, lean processes, and design for manufacturability. The systems approach to designing, building, and operating complex engineering systems; requirements, functional decomposition, systems architecting, analysis of alternatives, project life cycle modeling, cost analysis, and technical performance measurement.

Recommended Books:

1. Frederick Hillier and Mark Hillier, 2007. Introduction to Management Science: A Modeling and Case Studies Approach with Spreadsheets, 3rd Edition. McGraw-Hill/Irwin, New York, NY.

IE5796 Knowledge Management

The foundations of knowledge management, including cultural issues, technology applications, organizational concepts and processes, management aspects, and decision support systems. Case studies. Students work in teams, applying principles and processes of systems thinking, systems engineering, and integrative management in the design and implementation of a knowledge management system.

Recommended book:

1. Knowledge Management by Gamble & Blackwell, Kogan Page Business Books
2. Knowledge management in theory and practive by Kimiz Dalkir

IE5797 Decision Making with Uncertainty for Managers

Introduction to decision analysis. Influence diagram and decision trees, probability and calculus for decision analysis, solving decision trees, sensitivity analysis, value of information, subjective probability, and theoretical probability models

Recommended book:

1. Making Hard Decisions with Decision Tools by Robert T. Clemen and Terence Reilly

IE5798 Conflict Management and Negotiations

The nature of negotiation, planning and preparation. Strategy and tactics of bargaining, communication process, the role of power, norms of cooperations and conflict, 3 party coalition, Competitive negotiation skills, collaborative negotiations skills, mediation skills, inter-cultural negotiations, converting win/loss to win/win, ethics in negotiation.

Recommended Books:

1. Negotiation by Roy J. Lewicki and Joesph A. Litterer

Department of
Mechanical Engineering

Mechanical Engineering encompasses the generation, conversion, transmission, and utilization of mechanical and thermal energy as well as the design, construction, and operation of all kinds of machines. Of all the engineering disciplines, mechanical engineering offers the greatest breadth, flexibility, and individuality. The professions taken up by mechanical engineers are very diverse and touch every walk of life. One usually thinks of mechanical engineers finding employment in traditional industries such as the automotive, power generation and manufacturing, but it must be kept in mind that the high-tech "smart products" combining computer chips into mechanical devices are also designed and manufactured by mechanical engineers.

Mission

The mission of the Mechanical Engineering Department is to produce leaders in mechanical engineering for the 21st century by providing each student with a balance of intellectual knowledge and practical experience in order to prepare the graduates to address a variety of societal needs. The programme prepares each student with higher competencies as a practicing mechanical engineer, or for higher studies in engineering. With solid grounding in the principles and practice of mechanical engineering, graduates are ready to engage in a lifetime of learning about employing new concepts, technologies, and methodologies.

The Department of Mechanical Engineering was conceived in 1952 as part of the Faculty of Engineering, Peshawar University, which was later upgraded to the status of a full-fledged Engineering University in 1980. The postgraduate programme in the department started in 1991 and offers a Masters degree in Mechanical Engineering as well as Ph.D.

Dean, Faculty of Mechanical, Chemical and Industrial Engineering

Prof. Dr. Muhammad Abdul Aziz Irfan

Chairman

Prof. Dr. M. Naeem Khan	Ph.D. (Pak)

Professors

Prof. Dr. M.A Irfan	Ph.D. (USA)
Prof. Dr. Rizwan M. Gul	Ph.D. (USA)
Prof. Dr. Hamid Ullah	Ph.D. (Thailand)
Prof. Dr. M. Naeem Khan	Ph.D. (Pak)
Prof. Dr. Afzal Khan	Ph.D. (USA)
Prof. Dr. Abdul Shakoor	Ph.D. (UK)

Associate Professors

Engr. M. Masood Ahmad	M.Sc. (Pak)
Dr. S. Shaukat Ali Shah	Ph.D. (Thailand)
Dr. M. Sadiq Khattak	Ph.D. (USA)
Dr. Feroz Shah	Ph.D. (Pak)
Dr. M. Ali Kamran	Ph.D. (UK)
Dr. Kareem Akhter	Ph.D. (USA)

Assistant Professors

Dr. M. Alam Zaib Khan	Ph.D. (UK)
Dr. Umar Ibrahim	Ph.D. (USA)
Engr. Ihsan Ullah	M.Sc. (Pak)
Dr. Naveed Ullah	(S. Korea)
Engr. Naveed Ahmad	M.Sc. (USA)

Lecturers

Dr. Fakhre Alam	Ph.D. (S.Korea)
Engr. Zeeshan Zahir	Ph.D. (S.Korea)
Engr. Tabassum Yasmin	M.Sc. (Pak)
Engr. Zuhaib Ali Khan	M.Sc. (Pak)
Engr. Fazli Yazdan	M.Sc. (Pak)
Engr. Adnan Rasheed	M.Sc. (Pak)
Engr. M. Usman Khan	M.Sc. (Pak)
Engr. Numan Khan	M.Sc. (Pak)
Engr. Awais Ahmad	M.Sc. (KSA)
Engr. Arsalan Khan	M.Sc. (Pak)
Engr. Qazi M. Yaseen	M.Sc. (Pak)
Engr. Shafi-ud-Din	M.Sc. (Pak)
Engr. Kaleem Ullah Khalil	M.Sc. (Pak)
Engr. Ismail Khan	M.Sc. (Pak)
Engr. Imran Khan	M.Sc. (Pak)
Engr. Umer Farooq	M.Sc. (Pak)

RESEARCH AREAS

Current research in the department focuses on die-casting, design of renewable energy systems, implant materials characterization, driving safety issues, and technology management. The department boasts well-qualified permanent faculty with Ph.D. and Master degrees from both USA and UK. Extensive computational and laboratory facilities are available for teaching and research purposes. The laboratories include an Impact Research Lab, a Rapid Prototyping facility, a Metallurgy Lab with a 10-ton computerized Universal Testing Machine, Advanced Manufacturing Lab, Dynamics and Control Lab, etc. A seminar library provides latest books of interest to researchers and postgraduate students. This is in addition to the Central Library, which stocks mostly undergraduate books.

INDUSTRIAL INTERACTION

The Department maintains regular interaction with the local industry for solving industrial problems. Courses in latest engineering techniques of interest to the industry are offered regularly and can also be arranged on request. Such courses include Finite Element Analysis using ANSYS, Solid Modelling using ProE, Condition Monitoring of Rotating Machinery, Experimental Stress Analysis, Computer-Aided-Drafting using AutoCAD, etc. Several research projects sponsored by industry have been undertaken by the faculty.

POST GRADUATE PROGRAMME

The Department offers Master's degree in Mechanical Engineering in the following three specializations:

1. Mechanical Engineering Design
2. Dynamics and Control
3. Materials Engineering

In addition to core courses in each specialization, elective courses must be taken in consultation with advisor from amongst the approved courses. However, a maximum of one course can be taken out of the management related courses.

Core Courses for MS Mechanical Engineering Design

ME 5303 Finite Element Analysis
ME 5305 Experimental Stress Analysis
ME 5312 Advanced Stress Analysis
ME 5313 Continuum Mechanics
ME 5375 Product Design and Development
ME 5306 Fatigue of Metal Structures

Core Courses for MS Dynamics and Control

ME 5332 Advanced Mechanical Vibration
ME 5335 Design of Mechanisms
ME 5338 Modeling of Dynamic Systems
ME 5339 Advanced Control Engineering
ME 5371 Modeling and Simulation
ME 5336 Industrial Robotics

Core Courses for MS Materials Engineering

ME 5352: Materials Thermodynamics
ME 5365: Phase Transformation and Microstructures
ME 5392: Mechanical Behavior of Materials
ME 5351: Characterization of Materials
ME 5391: Applications and Selection of Materials
ME 5353: Composite Materials

Doctoral programme of studies was started in the department in 2002 and is currently focused on the following areas of specialization:

1. Manufacturing Processes
2. Design optimization
3. Renewable energy systems
4. Advanced materials engineering
5. Design and manufacturing methods
6. Thermal and Fluid Sciences
7. Nano technology

LIST OF APPROVED COURSES

ME5301 THEORY OF ELASTICITY (3)

Formulation of Problem in Elasticity. Stress and Displacement Formulations for Plane Stress and Plane Strain Problems. Displacement Formulation for 3-D Problems. Biharmonic Equations. Airy Stress Function. Plain Stress and Plain Strain Problems in Cartesian and Polar Coordinates. Axisymmetric Plane Problems. Semi-inverse Method, Thermoelasticity. Contact Problems. Energy Methods in Elasticity, General Solution of Torsion Problem. Stress and Displacement Formulation for Torsion Problem. Torsion of Simply and Multiply Connected Prismatic Bodies. Solution Derived from Equations of Boundaries. Approximate Solution for Torsion of Cellular Sections.

Recommended Books

1. Theory of Elasticity by S.P. Timoshenko and Goodier, McGraw Hill
2. Elasticity, Tensor and Dyadic Approach by Pe-Chi-Chou, John Wiley
3. Advance Mechanics of Material by Hugh Ford, McGraw Hill
4. Elasticity by J.R. Barber, Kuwler Academic Press

ME 5303 FINITE ELEMENT ANALYSIS (3)

Review of Relevant Mathematics, Matrix, Algebra. Variation Calculus, Direct Formulation of Finite Element Method, Analysis. Variational and Weighed Residual Formulations. Principle of Minimum Potential Energy. Principle of Virtual Displacement. Parameter Functions for 1-D, 2-D and 3-D Elements. Two-Dimensional and Axi-Symmetric Stress Analysis. Modeling of Industrial Problems. Truss, Beam, Plate. Use of Commercial FEA Package.

Recommended Books

1. Introduction to Finite Element Method by Frank Stasa, CBS
2. Finite Element Procedures by Bathe, Prentice Hall
3. ANSYS Manuals, ANSYS Publication

ME 5305 EXPERIMENTAL STRESS ANALYSIS (3)

Revision of fundamental concepts of stress and strain in two and three dimensions.

Strain Gages: Different types of strain gages. Properties of strain gage-system. Electrical resistance strain gages. Strain sensitivity. Gage constructions. Gage sensitivity and gage factor. Power dissipation by a gage. Selection of a gage. Strain gage circuits.

Potentiometer and Wheatstone bridge. Commercial strain indicators. Effects of lead wires. Swatch etc. Load cell and transducers. Strain-analysis methods. Two, Three and Four Element Rosettes.

Photoelasticity: Optical description of light. Design of optical elements. Wave plates. Stress optic law. Place and circular polariscope. Identification/ Analysis of Isochromatic and Isoclinic fringes. Compensation techniques. Separation methods. Scaling model to prototype stresses. Stress freezing techniques for 3-dimensional photoelasticity.

Brittle Coatings: Brittle coating Stress. Stress and Strain relation for coating, strain sensitivity of coating. Law of failure of brittle coating, primary and secondary cracks failure chart for coating.

Recommended Books

1. Experimental Stress Analysis by J.W. Dally and W.F. Riley
2. Handbook on Experimental Mechanics. Edited by Albert S. Kobayashi

ME 5306 FATIGUE OF METALS AND STRUCTURES (3)

Nature of fatigue failure. Crack nucleation and crack propagation in fatigue loading. Fatigue testing machines. High cycle fatigue S-N-P curves. Factors affecting S-N-P Curves. Influence of non-zero mean stresses. Multi-axial fatigue stresses. Fatigue failure theories. Cumulative fatigue damage and life prediction. Low cycle fatigue. Fatigue stress concentration factor for elastic and plastic ranges. Cyclic stress-strain curve, cycle counting methods, and cumulative damage in low cycle fatigue.

Recommended Books

1. Failure of Materials in Mechanical Design: Analysis, Prediction and Prevention by J.A. Collins
2. Engineering Consideration of Stress-Strain and Strength by Robert C. Juvinall

ME 5308 MECHANICS OF FIBER REINFORCED COMPOSITE MATERIALS (3)

Classification and characteristics of composite materials, Mechanical behavior of composite materials, Manufacturing processes of composite materials, Advantages of Fiber reinforced composite materials, Macro-Mechanical behavior of a lamina, Stress-Strain relations for plan stress in orthotropic materials, Stress strain relations for lamina of arbitrary orientation, Strengths of an orthotropic lamina, Biaxial strength criteria for an orthotropic lamina, Micro Mechanical behavior of a lamina, Mechanics of material approach stiffness and strength, Macro-Mechanical behavior of a laminate, Classical lamination theory, Various laminate configurations, Design of laminates, Strength of laminates, Failure theories for composites.

Recommended Books

1. Analysis and performance of fiber composites by B.D. Agarwal and L.J. Broutenan, John Willey.
2. Mechanics of composite Materials by Robert M. Jones.
3. Principles of Composite Material Mechanics by Ronald F. Gibson

4. Composite Materials Engg. And Science by F. L. Mathhews and Rawlings.

ME 5309 FRACTURE MECHANICS (3)

Review of Stress and Strain, Elasticity and Plasticity. Yield Criteria, Necking. Yielding Microstructure Effect. Fracture Appearances and Features, Elements of Fracture Mechanics. Brittle Fracture, Griffith's Theory, Nucleation vs. Propagation, Stress concentration, Elastic and Plastic Solution, Fracture Toughness, Testing Technique, Plane Stress vs. Plane Strain Fracture, Procedures and Techniques for Evaluating Klc (Plane Strain Fracture Toughness) Micro-Structural Aspects of Brittle Fracture. Ductile Fracture and Micro-Void Coalescence, Inter-Granular Fracture. Yielding Fracture Mechanics, R-Curve J Integral. Critical COD, Failure Analysis, Case Studies.

Recommended Book

Fracture Mechanics by T.L. Anderson, CRC Press

ME 5310 BEHAVIOR OF MATERIALS UNDER IMPACT LOADING (3)

Stress Waves: Propagation of Elastic Waves in Continuum. Wave Reflection and Interaclion. Solution of Wave Equation by Method of Characteristics. Experimental Techniques, Diagnostic Tools: Laser Interferometry, Rotating Cameras. Experimental Techniques for Impact Loading: Hopkinson Bar, Kolsky Bar, Fracture Bar, Gas Gun. Material Behavior Under High Strain Rates: Steels, Aluminum Alloys, MMCs, Plastics. Dynamic Fracture: Fracture Mechanics, Limiting Crack Speed. Crack Branching. Stress Wave Loading of Cracks. Spalling. Fragmentation. Dynamic Fracture of Steels, Aluminum Alloys, Plastics. Applications: Introduction, Shaped Charges and Projectiles. Penetration. Armor. Dynamic Effects in Geological Materials.

Dynamic Events in Space.

Recommended Book

Dynamic Behavior Of Materials By M. A. Meyers, McGraw Hill.

ME 5312 ADVANCED STRESS ANALYSIS (3)

State of Stress at a Point, Stress Vector, Normal and Shear Stress Components, Stress Transformation, Principal Stress and Principal Planes, Mohr circle for Three Dimensional State of Stress, Stress Equilibrium.

Deformation and Strain, Component of Strain, Strain Transformation, Principal Strain, Plane Stress and Plane Stress, Strain Displacement Relation.

Generalized Hook's Law three dimensional, Stress Strain relation for Isotropic and homogenous material, elastic constants.

Failure Criteria of Material, Yielding, Fracture and Fatigue, Theories of Failure, Maximum Principal Stress theory, Tresca theory, Maximum Distortion Energy theory, application of failure theories.

Plane Elasticity, Governing equation for plane stress and strain problems, Airy stress function. Bending of cured beams and rings. Energy method deflection. Thick wall cylinder and sphere. Torsion of circular and non circular sections, Torsion of thin multi-cell sections. Stress concentration and its application in actual structures.

ME 5313 CONTINUUM MECHANICS (3)

Vector and Tensors: Vector and tensors, indicial Notation, Rectangular Cartesian Components, Tensor Properties, Vector and Tensor Calculus, Stress: Body Force and Surface Force, Traction or Stress Vector, Principal Axes of Stresses and Principal Stress, Invariants, Mohr's Circle and Lame's ellipsoid.

Strain and Deformation: Small Strain and Rotation in three dimension, Kinematics of a continuous medium, Rate of deformation tensor, Finite Strain and Deformationl Eulerian and Lagrangian formulation, Geometric measure of Strain, Relative deformation Gradient. Rotation and Stretch Tensors, Compatibility Condition, Determination of Displacements.

General Principles: Integral Transformation, Conservation of mass, Energy continuity, momentum and equation of motion, Principal of Virtual Displacements, Entropy and second Law of Thermodynamics and Clausius Inequality,

Constitutive Equations: Ideal Materials, Generalize Hooks Law, Anisotropy and Isotropy, Strain energy function, Elastic Symmetry, Plastic Symmetry, Plastic Behavior of Metals, work hardening, Levy¬ Mises Perfectly Plastic, Prandtl-Reuss Elastic, Perfectly Plastic and Visco-plastic Materials.

Applications to Linearized Theory of Elasticity.

Recommended Books

1. Introduction to the Mechanics of a Continuous Medium L. E. Malvern Prentice Hall.
2. Continuum Mechanics by A.J.M. Spencer, Longman

ME 5314 METAL FORMING (3)

Introduction to Stress and Strain analysis. True stress and True strain. Yield Criteria for ductile metals. Stress-Strain Relations for elastic and plastic ranges. Strain Hardening Hypothesis. Behavior after Necking, Plastic instability. Strain Rates and Temperature, Ideal work for Plastic Deformation, Slab Analysis, Upper Bound Analysis, Plane Strain Frictionless Extrusion. Plane Strain Indentation. Slip-Line Field theory and its application. Cupping, drawing, redrawing.

Recommended Books

1. Metal Forming Mechanics and Metallurgy by William F. Hosford and Robert M. Caddell
2. Theory of Plasticity by J. Lubliner
3. Mechanical Metallurgy by Dieter

ME 5321 COMPRESSIBLE FLOWS (3)

Review of the Thermodynamic and Fluid Mechanics quantities, Flow Regimes, Integral and Differential

forms of the NS (Navier Stokes).

One Dimensional flow, Normal Shock relations. Flow with Heat Transfer, Flow with Friction.

Two Dimensional Oblique Shocks, Reflection of Shocks from Solid Boundary, Intersection of Shocks, Pressure Deflection Diagrams, Expansion Waves and their relations, Shocks Expansion Theory.

Quasi 1D flow, Flow through Converging and Convergent-Divergent nozzles, Diffusers Waves Reflections.

Unsteady Wave motion, Moving Normal Shock Waves, Incident and Reflected Expansion Waves, Finite Compression Waves.

Recommended Book

Modern Compressible Flow: With Historical Perspective by John D. Anderson, McGraw Hill, 3rd Edition.

ME 5322 COMPUTATIONAL FLUID DYNAMICS (CFD) (3)

Derivation of the NS equations, Conservation and Non Conservation Forms, Shock Capturing and Shock Fitting.

Mathematical Behaviour of PDEs, Eigen Value Method, Types of Flow (Parabolic, Elliptical, Hyperbolic)

Discretisation methods, Finite Difference equations, Explicit and Implicit approaches, Errors, Stability Analysis.

Grids, Transformation of equations, Metrics and Jacobians, Finite Volume Method.

Simple CFD Techniques: Lax-Wendroff Techniques, MacCormacks Techniques, Alternating Direct Implicit (ADI) Technique.

Introduction to commercially available CFD Software

Recommended Books

1. Computational Fluid Dynamics—The Basis with Applications by John D. Anderson, McGraw-Hill, 1995.
2. An Introduction to Computational Fluid Dynamics: The Finite Volume Method by H. Versteeg and W.Malalasekra, Pearson Education, 2nd Edition
3. Computational Techniques for Fluid Dynamics by C.A.J. Flectcher, Vols I and II, Springer Verlag, Berlin, 1988.

ME 5331 DYNAMICS OF MECHANISMS (3)

Prerequisite: ME 5335 Design of Mechanisms.

Review of basic concepts in dynamics of rigid bodies. Kinetostatic analysis of mechanisms: Graphical method, Analytical method. Matrix method. Time response analysis of mechanisms. Analytical methods in dynamics: Virtual work. Lagrange's equations. Use of commercial software, e.g. M.SC Adams, to solve practical problems of mechanism dynamics.

Recommended Books

1. Mechanism Design: Analysis and Synthesis, Vols. I and II, A Erdman and G Sandor, Prentice Hall.
2. Theory of Machines and Mechanisms, J Shigley and J Uicker, McGraw Hill.
3. Principles of Dynamics, D Greenwood, Prentice Hall.

ME 5332 ADVANCED MECHANICAL VIBRATION (3)

Review of single degree-of-freedom systems. Frequency response. Response to general periodic excitation. Impulse and step response. Convolution integral and Fourier Integral. Multi-DOF systems: Principal coordinates. Influence coefficients. Lagrange's equation. Determining natural frequencies and mode shapes: Dunkerley's formula, Rayleigh's method, Holzer method, matrix iteration method, Jacobi's method. Continuous systems: Transverse vibration of string or cable. Longitudinal, torsional, and lateral vibration of bars and beams. Vibration of membranes. Nonlinear vibrations: Nonlinear stiffness, Duffing equation, perturbation method, nonlinear damping, Van der Pol equation.

Recommended Books

1. Mechanical Vibrations, S. S. Rao, Prentice Hall, 4th edition.
2. Theory of Vibration with Applications, W T Thomson and M D Dahleh, Prentice Hall, 5th edition.
3. Fundamentals of Mechanical Vibrations, S G Kelly, McGraw Hill, 2nd edition.
4. Engineering Vibration, D J Inman, Prentice Hall, 2nd edition.

ME 5333 VIBRATION MEASUREMENT AND ANALYSIS (3)

Introduction Characterization of Vibration. Vibration Measuring Instruments. Measurement of Overall Vibration levels. Frequency Analysis. Predictive Maintenance Systems. Special Vibration Measuring Techniques. Vibration Control Measures.

Recommended Books

1. Nakra and Chaudhry, Instrumentation, Measurement and Analysis, Tata McGraw Hill Publishing Company.
2. Nakra, Yadava, Thuestad, Vibration Measurement and Analysis, National Productivity Council, New Delhi, India.
3. R.H. Wallace, Understanding and Measuring Vibrations, Springer, New York.
4. I.T. Brock Mechanical Vibration and Shock Measurement, Bruel and Kjaer, Naerum, The Netherlands.

ME 5334 MODAL ANALYSIS (3)

Introduction, Application and Philosophy of Modal Testing, Summary of Theory, Measurement Methods, Analysis and Test Procedures. Introduction to Mobility Measurement Techniques, Basic Measurement System Structure Preparation, Excitation of Structure, Transducer and Amplifiers, Analyzers, Digital Signal Processing, Use of Different Excitation Types, Calibration, Mass Cancellation, Rotational Mobility Measurement, Measurements on Non-linear Structure, Multi Excitation Methods. Introduction to Modal Parameters Extraction Methods, Preliminary Checks of PRF Data, SDOF Modal Analysis, I Peak Amplitude, SDOF Modal Analysis-II, CircleFit Method, SDOF Modal Analysis- II Inverse Method, Residual, MDOF Curve-Fitting Procedures, MDOF Curve -Fitting in the Same Domain, Global or Multi Curve-Fitting, Nonlinear Systems. Introduction to Derivation Mathematical

Models, Modal Models, Display of Modal Model, Response Models, Spatial Models, Mobility Skeletons and System Models. Applications, Comparison of Experiment and Prediction, Correction Of Adjustment of Models, Structure Modifications; Coupled Structure Analysis, Response Prediction Modifications, Coupled Structure Analysis, Response Prediction and Force Determination.

Recommended Books

1. Modal Analysis By D.J. Ewins, Wiley.
2. Modal Testing, Theory And Practice By D.J. Ewins, Wiley.

ME 5335 DESIGN OF MECHANISMS (3)

Introduction to kinematics and mechanisms: The four-bar and six-bar linkages. Degrees of freedom. Computer-Aided-Design of mechanisms. Displacement and velocity analysis of mechanisms: Graphical and analytical methods. Relative velocity and instant center methods. Mechanical advantage. Acceleration analysis of mechanisms. Kinematic synthesis of mechanisms: Tasks and types of synthesis. Graphical synthesis. Analytical synthesis. Students will write computer programmes to implement the methods studied.

Recommended Books

1. Mechanism Design: Analysis and Synthesis, Vol. I, A Erdman and G Sandor, Prentice Hall.
2. Theory of Machines and Mechanisms, J Shigley and J Uicker, McGraw Hill.

ME 5336 INDUSTRIAL ROBOTICS (3)

Introduction to Robotics, Types of Robots, Motions of Robot, Parts of Robot, Robotics Applications Growth and Cost, Drive Methods, Sensors for Robots. Spatial Description and Transformation, Forward Kinematics (To Compute The Position and Orientation of the EndEffect of the Manipulator) Inverse Kinematics (Given the Position And Orientation of The EndEffect Calculate All Possible Sets of Joint Angle Which Could be Used to Attain This Given Position and Orientation) Jacobean (It Specifies a Mapping From Velocities in Joint Space to Velocities in Cartesian Space).

Recommended Books

Introduction to Robotics: Mechanics and Control By John J. Craig

ME 5338 MODELING OF DYNAMIC SYSTEMS (3)

Introduction to Simulink.

Differential equations, transfer functions, block diagrams and simulation of: electromechanical elements, fluid elements, thermal elements and power conversion elements. Linearization.

Introduction to frequency domain analysis: Fourier series and Fourier transform, Spectra of different signals.

Simulation of First and Second Order System: Impulse, Step and Ramp response. Frequency response. Electrical, Mechanical, Thermal, Fluid and Mixed systems. Analysis of filters.

Recommended Books

1. System Dynamics: modeling, analysis, simulation, design, E O Doeblin, Marcel Dekker
2. Analysis and Design of Dynamic Systems, I Cochin and W Cadwallender, Addison-Wesley.

ME 5339 ADVANCED CONTROL ENGINEERING (3)

Prerequisite: ME5338 Modeling of Dynamic Systems

Review of the basic concepts: Open and Closed loop control system, Block diagram algebra, stability, and Root Locus analysis. Control System Design by the Root-Locus Method: Lag-Lead Compensation, Parallel Compensation.

Frequency Response Methods: Frequency response plot and measurements, performance specifications in the frequency domain, Log magnitude and Phase diagrams, mapping contours in the s-plane, Nyquist criterion, system bandwidth.

Control System Design by Frequency Response: Lag-Lead Compensation, System design using integrated network, system with pre-filters. PID Controls: Tuning rules for PID controllers, Zero-placement approach to improve response. Analysis and design of control systems in state space: State space representation of transfer function, Controllability, Observability, Pole placement using state feed back, Ackermann's formula, internal model design.

Note: Matlab and Simulink will be used throughout the course.

Recommended Books

1. Modern Control System by Richard C. Dorf and Robert H. Bishop 7th edition.
2. Modern Control Engineering by Katsuhiko Ogata 4th edition

ME 5341 ADVANCED HEAT TRANSFER (3)

Review and Engineering applications of Heat Transfer.

Two Dimensional Steady State Conduction, Separation of Variable Method, Graphical Method and Numerical method, Finite Difference Equations, Finite Difference Solutions, Matrix Inverse Method.

Transient Heat Conduction, Lumped Capacity Method, Transient Heat Transfer in Large Plane Wall, Long Cylinder, Spheres, and Semi Infinite Solids.

Convection Heat Transfer, Convection, Velocity and Thermal Boundary Layers, Heat and Momentum Transfer in Turbulent Flows, Significance of Dimensionless Parameters, Differential Convection Equations, Integral Solution of Boundary Layer Equation for Flat Plate, Relation between Fluid Friction and Heat Transfer, Turbulent Boundary Heat Transfer.

Forced Convection over Cylinders, Spheres and Tube Banks, Free Convection over Plates and Cylinders.

Recommended Books

1. Heat Transfer Textbook by John H. Lienhard
2. Heat and Mass Transfer by Frank P. Incropera

ME 5342 ENERGY ENGINEERING (3)

Codes & Standards, Energy Accounting and Economics, Energy Audits and Instrumentation, Electrical System Optimization, Peak Shaving, Thermodynamics of Waste Heat recovery, Design of Heat Exchangers, Utility Systems Optimization Energy Usage in HVACs.

Use of Commercial Software for energy benchmarking.

Recommended Books

1. Handbook of Energy Engineering by Albert Thumman and D. Paul Mehta, CRC Press, 2008.
2. Handbook of Energy Audits by Albert Thumman and William Younger, CRC Press, 2008.

ME 5351 CHARACTERIZATION OF MATERIALS (3)

Optical microscopy and quantitative metallography. Advanced Microscopy Techniques: AFM, SEM, EDS, TEM and STEM, Non-destructive evaluation: radiography, eddy current, ultrasonic techniques, optical microscopes, magnetic flux and fluorescence methods. Introduction to spectroscopy: FTIR, Emission Spectroscopy and others, Thermal Characterization, DTA, DSC and DMA, Crystallographic and X-ray diffraction.

Recommended Books:

1. Douglas B.Murphy Fundamental of Light Microscopy and Electronics Imaging Kindle Edition 2001.
2. B.D.Cullity Elements of X-ray Diffraction, Addision Wesely Reading Mass 1978
3. Robert Cahn Concise Encyclopedia of Materials Characterization, Second Edition: 2nd Edition (Advances in materials Science and Engineering) Elsevier Publication 2005.

ME 5352 MATERIALS THERMODYNAMICS

Concepts of Helmholtz Free Energy and Gibbs Free Energy, Energy-Property relationships, Thermal Equilibria, Chemical Equilibria, Ellingham Diagrams, 1st order and 2nd order Transformations, Gibbs Helmholtz Relationships, Fugacity and Chemical activity, Equilibrium constant and its variation with temperature, Vant Hoff's equation, Effect of temperature and pressure on phase transformations, Clapeyron equation, Thermodynamics of solutions.

Recommended Books:

1. Thermodynamics of Materials (David V. Ragone)
2. Introduction to Thermodynamics of Materials (D. R. Gaskell)
3. Thermodynamics, an Advanced Text for Material Scientists (J. Hudson)
4. Physical Metallurgy Principles (Reed-Hill)

ME5353 COMPOSITE MATERIALS

Composites: Basic principles, applications and properties. Processing of reinforcements: Particulates, whiskers and continuous fibers.Methods of production for PMCs, MMCs and CMCs. Mechanical behavior of composite materials. Fracture mechanics. Nanocomposites.

Recommended Books:

1. Composite Materials: Engineering and Science by Matthew and Rawlings.
2. An Introduction to Composite Materials by D. Hull
3. Fiber-Reinforced Composites by P. K. Mallick

ME 5354 HEAT TREATMENT OF METALS AND ALLOYS

Relation of structural changes and kinetics of transformation to continuous heat treatment processes. Controlled atmosphere for heat treatment. Applications of thermodynamics and mass transfer theory to the heat treatment processes.

Recommended books:

1. Physical Metallurgy by Avener
2. ASM Handbook on Ferrous materials

ME 5355 POLYMERS SCIENCE AND ENGINEERING

Introduction to the molecular, morphological, mechanical and other properties of conventional and engineering polymers. Major topics include: Configuration of Polymer chains, Thermodynamics and phase equilibria in polymer systems, Visco-elasticity and rubber elasticity, Deformation mechanisms in glassy amorphous polymers and toughening mechanisms

Recommended Books:

1. Principles of Polymer Chemistry by Paul J. Flory.
2. Mechanical Properties of Solid Polymers by I. M. Ward.
3. Introduction to Polymers by R. J. Young and P. A. Lovell
4. Principles of Polymer Engineering by N. G. McCrum, C. P. Buckley and C. B. Bucknall

ME 5356 BIOMATERIALS

Applications of materials science and engineering to artificial materials in the human body with the objective of detailed understanding of synthetic materials and biopolymers.Biocompatibility and its consequences on tissue–implant interfaces.Design and development of new implant materials, smart drugs, and drug delivery systems.

Recommended Books:

1. Buddy D. Ratner, Biomaterials Science: An Introduction to Materials in Medicine 2nd Ed. 2004
2. Joon B. Park, Biomaterials: Principles and Applications, 2002.

ME 5357 EVALUATION TECHNIQUES & INSTRUMENTATION

Introduction to materials evaluation techniques; their role in quality assurance and production environments.Classification of materials evaluation techniques. Destructive testing - hardness, tensile, compression, impact, fatigue and creep. Neutron Diffraction, X-Ray absorption, X-Ray Fluorescence spectroscopy, Electron Diffraction- diffraction pattern in specific modes, LEED and RHEED, Electron Optics, Electron Microscopy-Transmission and Scanning Electron Microscopy, STM and AFM,

Compositional analysis employing AES, ESCA and Electron Probe Microanalysis.

Recommended Books:

1. David D. Brandon and Wayne D. Kaplan Microstructural Characterization of Materials
2. Dawn Bonnel, Scanning Probe Microscopy and Spectroscopy: Theory, Techniques, and Applications 2000.
3. D.J. O'Connor Surface Analysis Methods in Materials Science , Springer 2008.
4. Adam J. Schwartz, Mukul Kumar, Brent L. Adams, and David P. Field Electron Backscatter Diffraction in Materials Science by 2009
5. Robert Cahn Concise Encyclopedia of Materials Characterization, Second Edition: 2nd Edition (Advances in Materials Science and Engineering) Elsevier Publication 2005.
6. Ray F. Egerton Physical Principles of Electron Microscopy: An Introduction to TEM, SEM, and AEM Springer , 2008.

ME 5361 NUMERICAL METHODS FOR ENGINEERS (3)

Approximations and Error Analysis. Methods to Find Roots of Non-Linear Algebraic Equations. Solution of Systems of Linear Algebraic Equations. Deriving Empirical Equations to Suit Experimental Data. Numerical Differentiation and Integration. Numerical Solution of Differential Equations. The Determination of Eigen Values. Fourier Analysis and its Engineering Applications.

Recommended Books

1. Numerical Methods for Engineers By Steven C. Chapra & Raymond P. Canale.
2. Numerical Mathematics and Computing By Ward Cheney & David Kincaid.

ME 5362 COMPUTER APPLICATIONS IN MECHANICAL ENGINEERING (3)

3D Modeling, Assembly and Drawing, Using Pro-E. Use of3D Models in Conceptual Design & Iterations. Project Based Assignments. Modeling Physical Phenomenon and Mathematical Equations Using MATLAB. Matrix Analysis, Numerical Visualization. Building of Graphical User Interface. Data Analysis.

Recommended Books

1. Inside Pro-Engineer by Utz and Ulman, Onward Press, USA.
2. Introduction to MATLAB by D.M. Etter, McGraw Hill.
3. MATLAB Manuals.

ME 5363 ENGINEERING DESIGN OPTIMIZATION (3)

Modeling. Mathematical Model. Nature of Design Process. Analysis and Design Models. Optimal Design. Formal Optimization Model. Boundedness, Feasibility and Constraint Activity. Topography of the Design Space. Mathematical Review. Notation. Multi-Variable Functions. Continuity' Gradient and Directional Derivatives. Hussein Taylor's Series. Quadratic Forms and Definite Matrices. Convergence of Algorithms. Conditions of Optimality: Necessary

and Sufficient Conditions for Unconstrained and Constrained Optima. Meaning of Lagrange Multipliers. Methods of Unconstrained Optima. One Dimensional Minimization. Bisection And Golden Section Initial Bracketing, Polynomial Interpolation. Multi-Dimensional Minimization. Steepest Descent. Conjugate Direction & Conjugate Gradient Methods. Newton's Method and its Modifications. Quasi-Newton Methods. Scaling. Stopping Criteria. Methods For Constrained Optima. Interior and Exterior Penalty Methods. Augmented Lagrangian Method. Direct Methods

Recommended Books

1. Principles of Optimal Design by Papalambros & Wilde, McGraw Hill.
2. Introduction To Optimum Design by J. Arora, McGraw Hill.

ME 5364 CONDITION MONITORING OF ROTATING MACHINERY (3)

Introduction to Basic Concepts of Machine Condition Monitoring, Condition Based Maintenance Techniques in Industry, Predictive Analysis, Diagnostic Analysis, Major Benefits of a Condition Monitoring Programme. Practical Machine Condition Monitoring Systems in Industry, Vibration Monitoring Wear Debris Monitoring, Temperature Monitoring, Noise Monitoring, Noise Monitoring, Performance Monitoring, Data Accusation Methods, Data Analysis Techniques, Data Interpretations and Diagl liStics, Instrumentation Required. Computer Aided Machine Condition Monitoring, Use of Rotor Dynamic Simulation as an Aid to Fault Diagnostics, Intelligent Knowledge Based Experts systems for Coutinuous Machine Surveillance in Advanced Condition Monitoring. Selection and Installation of a Machine Condition Monitoring System, Analysis of the Problem Measurable Parameters, System Requirements, Economic Considerations in the Selection and Installation of a Machine Condition Monitoring System, Case Studies.

Recommended Books

1. Machiuery Health Monitoring by Bruel and Kjaer Hand Book, Naerum, Denmark.
2. Condition Monitoring by J.S. Rao, Narosa Publishing House, New Delhi.
3. Handbook of Condition Monitoring by Alan Davis, Chapman and Hall.

ME 5365 PHASE TRANSFORMATION AND MICROSTRUCTURES (3)

Equilibrium transformations: First order and second order. Order-disorder transitions. Transformations in complex structures. Diffusional and diffusion-less transformations.

Solidification: Homogeneous and heterogeneous nucleation. Interfaces. Grain boundaries and microstructures. Precipitation phenomena and influence on properties.

Thermomechanical treatment. Micro and Nano-phases in alloys and Materials.

Recommended Books

1. Phase Transformations in Metals and Alloys by D.A. Porter and K.E. Easterling 2nd edition 1992
2. Phase Transformations in Materials by G. Kostorz 2001.

ME 5366 FINANCIAL ANALYSIS (3)

Financial Statement Analysis, Funds Analysis, Cash Flow Analysis, Cash Budget, Working Capital Management, Cash & Marketable Securities Management, Accounts Receivable and Inventory Management, Short Term Financing, Capital Budgeting and Estimating Cash Flows, Capital Budgeting Techniques, Risk and Managerial Option in Capital Budgeting, Required Return and Cost of Capital, Operating and Financial Leverage, Capital Structure Determination, Dividend Policy, Intermediate and Long Term Financing.

Recommended Books

Fundamentals of Financial Management by James C, Van Home and John M.Wachowiez, JR" Prentice Hall.

ME 5367 HUMAN RESOURCE MANAGEMENT (3)

Human Resources in a Globally Competitive Business Environment, Human Resource Management (A Field Of Transition), Diversity at Work, Job Analysis and Human Resource Planning, Recruiting, Staffing, Orienting and Training, Appraising Employee Performance, Managing Careers, Pay System, Indirect Compensation: Employee Benefit Plans, Motivational Strategies for Improving Performance and Productivity, Union Representation and Collective Bargaining.

Recommended Books

1. Managing Human Resources by Wayre F. Cascio: McGraw Hill Book Company.
2. Human Resource Management by David A Decendzo Stephen P. Robbins, Oxford Press.

ME 5368 TOTAL QUALITY MANAGEMENT (3)

ISO-9000 Quality Models, Quality in Manufacturing and Service, Principles of Total Quality Management, Leadership and Strategic Planning, A Focus on the Custo!ller, Quality Measurement, Methods for Continuous Improvement, Participation and Teamwork, Implementation Issue and Strategies.

Recommended Books

1. Total Quality Management by James R. Evans, American Management Assoc.
2. Total Quality Management by Johns Ornland Amriu S. Soha, Pacific Rim.

ME 5369 DIGITAL CONTROL SYSTEMS (3)

Prerequisite: ME5339 Advanced Control Engineering

Introduction to Discrete-Time Control Systems: Digital control systems, Quantizing and quantization

error, Data acquisition and distribution. The Z Transform: Z Transform, Z transform of elementary functions, its properties and theorems, Inverse z transform. Z-plane Analysis of Discrete-Time Control Systems: Impulse sampling and data hold, obtaining the z transform by the convolution integral method, Reconstructing original signal from sampled signals, Pulse transfer function, Digital controllers and filters.

Design of Discrete Time Control System: Mapping between s plane and z plane, Stability analysis of closed loop system in z plane, Transient and steady state response analysis, Root locus design, Analytical design method.

State Space Analysis of Discrete-Time Control System Pole Placement And Observer Design: Controllability, Observability, design via placement, State observers, Servo systems

Recommended Books

1. Discrete-Time Control Systems by Katsuhiko Ogata, 2nd edition
2. Digital Controls of Dynamic Systems by G F Franklin, J D Powell, and M Workman,3rd edition
3. Computer Controlled Systems -- Theory and Design by Karl J.Astron, BjornWhittenmark 3rd edition

ME 5370 INDUSTRIAL AUTOMATION (3)

Automation: Automated Flow Lines, Basic configuration, Methods of work part transport, Analysis of Automated Flow lines, Analysis of transfer lines without storage, Buffer Storage, Automated flow lines with buffers storage. Programmable Logic Controllers: Introduction to PLCs, Advantages of PLCs, Ladder Logic Diagrams, PLC Hardware/Components of PLC, PLC Operating Cycle, Additional capabilities of a PLC, Programming the PLC, Latches, Design Cases (Deadman Switches, Conveyor, Accept/Reject Sorting), Addressing. CNC Machines: Review of Basic concepts (Fundamentals of CNC, Knowledge about machine, Motion type, Compensation type, Programme formatting), floating zero point system, Absolute and Incremental System, Classification of CNC system, Application of Numerical Control, Direct Numerical/Distributed Numerical Control. CNC Programming, Computer assisted part programming, Automatically programmed tools (APT Programming System), CAD/CAM approach to part programming, CAD/CAM application (turning problem, surface milling, machining of curved surfaces).

Recommended Books

1. Automation, Production System and Computer Integrated Manufacturing by Mikell P.Groover, Prentice Hall.
2. CADCAM From Principles to Practice by Chris McMahon and Jimmie Browne, Addison Wesley

Publishing Company.

ME 5371 MODELING AND SIMULATION (3)

Introduction to Modeling and Simulation

Introduction to Matlab: The Matlab environment. Vectors, matrices arrays in Matlab. Linear Algebra in Matlab: Matrix operations. Linear Systems of equations. Inverses and Determinants, Cholesky, LU and QR factorizaitons. Eigenvalues. singular value decomposition. polynomials and interpolation.

Data analysis and statistics. Regression and Cure fitting. Fourier Analysis.

Differential Equations: Numerical differentiation and integration. Initial value problems, boundary value problems, partial differential equations. Symbolic mathematics in Matlab. Building Graphical User Interface in Matlab. Introduction to Simulink.

Recommended Books

1. Introduction to Matlab for Engineers, by W J Palm III.
2. Advance Engineering Mathematics, by Wyle. McGraw Hill

ME 5372 RANDOM VIBRATION (3)

Prerequisite: ME5332 Advanced Mechanical Vibration

Characteristics of random vibrations. Use of probability distribution and spectral densities for he description of random vibration. Random vibration in mechanical systems. Analyses of random data. Stochastic response of linear and nonlinear systems. Failure due to random vibrations.

Recommended Books

1. An Introduction to Random Vibration in Mechanical Systems, J D Robson, Academic Press 1963, Elsevier 1963/1970.
2. Random Vibration, S H Crandall (ed), MIT Press, 2 volumes.
3. An Introduction to random Vibrations, D E Newland, Longman.
4. Introduction to random Vibrations, N C Nigam, MIT Press.

ME 5373 ORGANIZATIONAL BEHAVIOR FOR ENGINEERS (3)

Introduction to Organizational Behavior, Values, Attitudes, Job Satisfaction, Personality and Emotion, Perception and Individual Decision Making. Basic Motivation Concepts/theories, Motivation: From Concepts to Applications, Foundations of Group Behavior, Understanding Work Teams, Communication, Basic Approaches to Leadership, Contemporary Issues in Leadership, Power and Politics, Conflict and Negotiation, Organizational Culture, Stress in Organizations and its Management.

Recommended Books

1. Organizational Behavior, 8th Ed. By Stephen P.

Robbins (Prentice Hall).

2. Understanding and Managing Organizational Behavior, 4th Ed. by George & Jones.
3. Managing Behavior in Organizations, 4th Ed. by Jerald Greenberg

ME 5374 PROBLEM SOLVING AND DECISION MAKING (3)

Introduction to decision analysis, Why are Decisions Hard? Where is Decision Analysis used?, Elements of Decision Problems, Values and Objectives, Structuring Decisions Structuring Values, Influence Diagrams Decision Trees and Expected Monetary Value Solving Influence Diagrams: Overview, Solving Influence Diagrams Creativity and Decision Making, What is Creativity?, Theories of Creativity Sensitivity Analysis, Probability Basics, Probability Theory, Venn Diagrams, Uncertain Quantities, Discrete Probability Distributions, Expected Value, Variance and Standard Deviation Monte Carlo Simulation, Utility Function use.

Recommended Books

Making Hard Decisions, 2nd Ed. by Robert T. Clemen

ME 5375 PRODUCT DESIGN AND DEVELOPMENT (3)

The design process, Total Design. Market/ User Needs, Product Design Specification. Conceptual Design & evaluation. Design for Manufacture & Design for Assembly. Electronic Aids & Standards for computer aided design. The Total approach to product development. Design Matrix. Concept Generation & Concept Selection. Industrial Design. Effective Prototyping. Economics of Product Development. Managing Product Development.

Mini Project: The course includes a mini project of Product Design and Development with weekly assignments leading to complete design of a new product on Pro-Engineer.

Software: Pro- Engineer

Recommended Books

1. CAD/CAM by McMohen & Brownie.
2. Product Design & Development by Ulrich & Eppinger.
3. Total Design by Pugh.

ME 5383 ADVANCED CAD/CAM (3)

Graphics Hardware/Software Structure/Selection, Engineering Specifications Generation, Data Standards, Knowledge-Intensive CAD. Fundamentals of Numerical Control, Programming of CNC Machines, Programmable Logic Controllers (PLC's). Integration of the Computer Controller Machine Tool. Case Study of 5-Axis Machining.

Recommended Books

1. V.B. Anand: Computer Graphics and Geometric Modeling for Engineers, John Wiley and Sons, 1993.
2. H.B. Kief and T.F. Waters: "Computer Numerical

Control", A CNC Reference Guide, GLECOE, McGraw-Hill, 1992

3. S. Finger, T. Tomiyama and M. Mantyla: Knowledge Intensive Computer Aided Design, Kluwer Academic Publications, 1998

ME 5384 ECO-DESIGN AND MANUFACTURING SYSTEMS (3)

Introduction, Industrial Production, consumer Products, Environmental Impact Lifecycle Assessment, Goal and Scope Definition, Inventory, Impact Assessment. Computer Modeling of Product Systems. LCA as a Tool in Eco-Design, Design for Recycling/Reuse, Energy, Raw Materials, Waste, Disposal, Labeling of Materials and Products. Design for Disassembly, Inverse Manufacturing, Impact of Take Back of Products. Automated Disassembly and Separation Systems. Case Studies and Project.

Recommended Books

H. Wenzel, M. Hausschild, and L. Alting: Environmental Assessment of Products, Vol. 1, Methodology, Tools and Case Studies in Product Development, Chapman and Hall, London, U.K., 1997.

ME 5385 ARTIFICIAL INTELLIGENCE IN DESIGN AND MANUFACTURING (3)

Introduction to AI. Knowledge-Based Systems, Inductive Logic Programming, Fuzzy Sets and Systems. Evolutionary Computation techniques Hyper heuristics, Machine Learning, Hybrid Intelligent Systems, Data mining and knowledge discovery.

Recommended Books

Artificial Intelligence: A Guide to Intelligent Systems by Michael Negnevitsky

ME 5391 APPLICATIONS AND SELECTION OF MATERIALS (3)

Design process and materials selection methodology. Basic material properties and materials selection charts. Selection of materials and shape. Case studies in materials selection. Multiple constraints and compound objectives.Interaction of materials, processing and design. Environmental issues in materials and process selection. Selection and use of materials in various engineering applications. Economics of materials and manufacturing processes.

Recommended Books

1. Materials Selection in Mechanical Design, 3rd Edition, 2005 by Michael F. Ashby, Butterworth and Heinemann, Oxford.

2. Selection and Use of Engineering Materials, 3rd Edition, 1997 by J A Charles, F A A Crane and J A G Furness, Butterworth and Heinemann, Oxford.

ME 5392 MECHANICAL BEHAVIOR OF MATERIALS (3)

Overview of Mechanical Behavior, Elastic Behavior, Dislocations, Plastic Deformation in Single and Polycrystalline Materials. Strengthening of Crystalline Materials, Viscoelasticity, Deformation of Non-crystalline Materials, High Temperature Deformation and Fracture of Materials. Fracture and Fatigue of

Engineering Materials.

Recommended Books

1. T.H. Courtney, Mechanical Behavior of Materials, 2nd ed. (McGraw Hill; Boston) 2000.
2. K.J. Bowman, Mechanical Behavior of Materials.)John Wiley; Hoboken, NJ) 2004
3. G.E. Dieter, Mechanical Metallurgy, 3rd ed. (McGraw Hill New York) 1986
4. R.W. Hertzberg, Deformation and Fracture Mechanics of Engineering Materials, 4th ed. (J. Wiley & Sons; New York) 1995
5. M.A. Meyers and K.K. Chawla, Mechanical Metallurgy; Principles and Applications. (Prentice-Hall; Englewood Cliff, NJ) 1984.

ME 5390 SPECIAL TOPICS RELATED TO MECHANICAL ENGINEERING DESIGN (3)

ME 5398 TECHNICAL REPORT WRITING AND RESEARCH METHODOLOGY (3)

Basics of Technical Writing Process, technical writing techniques and applications, definitions and basics of research, research purpose, design of research methods, identification of research problems, literature review, selection of data collection techniques, selection of representative sample, writing of research proposals, data collection and analysis techniques, Quantitative and Qualitative research procedures, writing of research reports, presentation skills, oral presentations.

ME 5399 MASTER'S THESIS (6)

ME 6399 Ph.D. THESIS (1-9)

Department of
Mechatronics Engineering

INTRODUCTION

Mechatronics is a multidisciplinary field of engineering comprising of mechanical, electronic, control, computer, system design and software engineering. The integration of several engineering disciplines and technologies leads to the design of innovative components and systems to produce autonomous and smart products.

The aim of the Postgraduate program at the institute of Mechatronics is to develop expertise in the areas of robotics, bio-Mechatronics, intelligent control systems, smart sensors and actuators, and Micro/Nano Electro-Mechanical Systems (MEMS & NEMS) for automotive, aviation and aerospace, transportation, manufacturing and production engineering, energy, industrial, biomedical and healthcare applications.

MISSION

The mission of the post graduate program at Institute of Mechatronics is to perform leading edge research and to groom quality researchers for the country's needs in the field of education, research and industry. To establish state of the art education and research environment for outstanding graduates, industry and community.

OBJECTIVES

- To actively participate in providing solutions to the existing and future needs of local, national and international industries.
- To develop research, technical writing and communication skills needed for scientific papers, articles, proposals, reports and presentations in national and international scientific workshops, seminars, conferences and journals.

Dean, Faculty of Mechanical, Chemical and Industrial Engineering

Prof. Dr. Muhammad Abdul Aziz Irfan

Chairman

Prof. Dr. M. Tahir Khan	Ph.D. (Canada)

Professors

Prof. Dr. S. Riaz Akbar Shah	Ph.D. (USA)
Prof. Dr. M. Tahir Khan	Ph.D. (Canada)
Prof. Dr. Faridullah Khan	Ph.D. (Canada)

Associate Professor

Dr. Izhar-ul-Haq	Ph.D. (UK)
Dr. Kamran Shah	Ph.D. (UK)
Dr. Shahzad Anwar	Ph.D. (UK)

Assistant Professors

Dr. Muhammad Akmal	Ph.D. (Turkey)
Dr. Sheraz Ali Khan	Ph.D. (S. Korea)
Dr. Qari M. Khalid Waheed	Ph.D. (UK)
Dr. Muhammad Tufail	Ph.D. (Canada)

Lecturers

Engr. Hamid Khan	M.Sc. (Pak)
Engr. Nayyar Fazal	M.Sc. (Pak)
Dr. Anam Abid	Ph.D. (Pak)
Dr. Zubair Ahmad	Ph.D. (Pak)
Engr. Sadaf Sardar	M.Sc. (Pak)

- To prepare excellent Mechatronics researchers and experts for the national research institutions, universities and industries.
- To establish an effective collaboration with local, national and international research institutions, universities and industries related to Mechatronics.

ELIGIBILITY CRITERIA FOR ADMISSION IN M.Sc IN MECHATRONICS ENGINEERING

Bachelor's degree in any of the following disciplines:

- Mechatronics Engineering
- Mechanical Engineering
- Electrical / Electronics / Telecom Engineering
- Industrial Engineering
- Computer Software/Systems/Computer Engineering

FIELDS OF SPECIALIZATION AND SEAT ALLOCATION

The master's program at the institute of Mechatronics offers specialization in Automation and Control.

Seat allocation (per semester) for M.Sc in Mechatronics Engineering

Specialization	Seats reserved for open merit	Seats reserved for rationalized fee basis	Total
Automation and Control	10	10	20

CORE COURSES

There are twenty three core courses for the specialization in Automation and Control that must be taken by the students.

Course No.	Course title	Credits
MtE 5101	Advance Manufacturing Automation	3
MtE 5103	Reconfigurable Machine Tool Design	3
MtE 5104	Laser Applications in Engineering	3
MtE 5105	Drives & Control in Industrial Automation	3
MtE 5106	Micro-fabrication	3
MtE 5107	Advanced Mechatronics Systems Design	3
MtE 5108	Advanced Industrial Control	3
MtE 5109	Advanced Micro-Electromechanical Systems	3
MtE 5110	Advanced Micro & Nano Fabrication Technology	3
MtE 5111	Microrobotics	3
MtE 5113	Advanced Control Engineering	3
MtE 5114	Computer Applications in Robotics	3
MtE 5116	Biomechatronics	3
MtE 5117	Multidisciplinary Engineering Design Optimization	3
MtE 5119	Robotics I	3
MtE 5120	Advanced Robotics	3
MtE 5121	Robotics II	3
MtE 5122	Fuzzy Logic Control	3
MtE 5123	Advanced Digital Systems	3
MtE 5125	Machine Learning	3
MtE 5128	Advanced Digital Signal Processing	3
MtE 5129	Digital Image Processing	3
MtE 5130	Machine Vision	3

DOCTORAL (PhD) PROGRAM

The research areas that are open to doctoral students in the institute of Mechatronics include but are not limited to:

1. Intelligent Transportation
2. Robotics
3. Laser and its applications in industry
4. Bio-Mechatronics
5. Intelligent control systems
6. Smart sensors and actuators
7. Micro/Nano Electro-Mechanical Systems (MEMS & NEMS)

LIST OF APPROVED COURSES

MtE 5101 ADVANCE MANUFACTURING AUTOMATION (3)

Introduction to automation, Building blocks for automation, Advanced Automation Functions, Levels of Automation, Hardware components for automation and process control, material handling and identification technologies, Numerical control and CAD/CAM, computer aided part programming (APT language, structure and subroutines), Application of computer for design, Benefits of CAD, Geometric modelling techniques - Multiple view 2D input, Wire frame geometry, Surface models, Geometric entities - Curves and Surfaces, Solid modelers, Feature recognition. Computer Integrated Manufacturing, Interfacing, Local area networks and standards, Flexible Manufacturing Systems, Artificial intelligence in the design of FMS, Artificial intelligence in process planning (Group Technology).

Recommended Books:

1. C. Ray Asfahl, (1992), "Robots and Manufacturing Automation" John Wiley & Sons, Inc.
2. M. P. Groover, (2007) " Automation, Production Systems and Computer Integrated Manufacturing" 3rd Edition, Prentice Hall

MtE 5102 ENGINEERING PROJECT MANAGEMENT (3)

Introduction to project management, Project Life Cycles, Project initiation, selection, approval, and preliminary scope statement, Project Planning Process. Work Break Down Structure, Time, cost & human resource scheduling, Quality, Risk, Procurement, and Communication Management, Project execution process; work performance information and deliverable management, Team management and information distribution. Monitoring & Controlling, Earned Value Management, Risk Monitoring and Forecasting, Scope verification, change control process, and quality controlling. Project Closing; contract closing and project closing with lesson learned, Code of professional ethics and responsibility.

Recommended Books:

1. Project Management: A Systems Approach to Planning, Scheduling, and Controlling Tenth Edition, by Haroldkerzner, Wiley.
2. Project Management: A Managerial Approach by Jack R. Meredith and Samuel J. Mantel, John Wiley & Sons.
3. A guide to the project management body of knowledge, 4th edition, Project Management Institute, 2008, ISBN # 978-1-933890-51-7.

MtE 5103 RECONFIGURABLE MACHINE TOOL DESIGN (3)

Globalization and Decentralization of Manufacturing, New Trends in Production, General Characteristics of Reconfigurable Manufacturing Systems. Comparison with Dedicated and Flexible Systems, Enabling Technologies and Reconfiguration Characteristics Reconfigurable Machines, Status/Progress in Reconfigurable Manufacturing Systems, Reconfigurable Manufacturing Equipment (Manufacturing Equipment Types, Reconfigurable Machine Tools) Design Methodology for Reconfigurable Machine Tool Design, Challenges in

the Design of Reconfigurable Machine Tools, Reconfigurable Fixtures for Automotive Engine Machining and Assembly Applications, Control Systems for RMS and Methods of their Reconfiguration, Future Trends, Economics of RMS, Virtual Production – Computer Model-Based Planning and Analyzing

Recommended Book:

1. Hoda A. Elmaraghy (2009), "Changeable and reconfigurable manufacturing systems", ISBN: 978-1-84882-066-1, Springer-Verlag London Ltd.

MtE 5104 LASER APPLICATIONS IN ENGINEERING (3)

Basics of lasers covering fundamentals of laser operation, their variety, optical components, beam delivery and properties of focused radiation, Components of industrial laser systems including motion systems and beam delivery systems, Laser materials processing covering the interaction of a laser beam with materials, phase changes produced and why some lasers are better at processing some materials than other lasers , Industrial applications of lasers including , Laser deposition process, laser cutting, laser welding, laser surface texturing, laser drilling. Laser applications in alignment, gauging, interferometry, holography and inspection. Laser safety and classification.

Recommended Books:

1. W. M. Steen (2003), "Laser Material Processing", Springer-Verlag, London.
2. Elijah Kannatey-Asibu, Jr. (2009), "Principles of laser materials processing", John Wiley & Sons, Inc.
3. John C. Ion (2005), "Laser Processing of Engineering Materials principles, procedure and industrial application", Elsevier Butterworth-Heinemann.

MtE 5105 DRIVES AND CONTROL IN INDUSTRIAL AUTOMATION (3)

Overview of drives and control (measurement, actuation, power moderation, and control) Electric Drives (overview of Electric drives, electric motors), power electronics(DC to DC Converter, DC to AC Converter, AC to AC Converter, AC to DC Converter), position, velocity and acceleration measurement sensors, Piezoelectric Drives, Control System in Servo Drives, Digital Communication Protocols, Trends in Motion Control.

Recommended Book:

Tan Kok Kiong and Andi Sudjana Putra (2011), "Drives and Control for Industrial Automation" Springer-Verlag London L

MtE 5106 MICRO-FABRICATION (3)

Miniaturization application, Lithography, Pattern transfer with dry etching techniques, Bulk micromachining, surface micromachining, LIGA and micromolding, SU-8 molding and electroplating, soft lithography techniques, Top-down and bottom-up manufacturing, Multi-User MEMS-Process (such as Silicon-On-Insulator, Poly MUMPs and Metal MUMPs), micro sensors, micro actuators, micro fluidics, power MEMS, lab on the chip, Low cost microfabrication techniques.

Recommended Books:

1. Fundamentals of Microfabrication: The Science of Miniaturization by Marc J. Madou, CRC press, USA.

2. Introduction to Microfabrication by Sami Franssila, John Wiley and Sons Ltd, UK.

3. Handbook of microlithography, micromachining, and microfabrication by P. Rai-Choudhury, SPIE Press.

MtE 5107 ADVANCED MECHATRONICS SYSTEM DESIGN (3)

Overview of Mechatronics (Industrial applications, design approach, Functions, Integration and Information processing for Mechatronic system) Modeling and simulation of physical systems(Modeling of Electromechanical systems, Rigid body models, Dynamic Models, Mechanical System Modeling), Fluid Power Systems, Sensors and actuators, Fundamentals of time and frequency, Types and characteristics of sensor and actuators, Control design of Mechatronic system, Computers and Logic Systems, Fault analysis in Mechatronic system.

Recommended Books:

1. The Mechatronics Handbook by Robert H. Bishop CRC Press, 2002

2. Mechatronic Systems Devices, Design, Control, Operation and Monitoring by Clarence W. de Silva CRC Press, 2008

3. Mechatronics by W. Bolton, Pearson Education, Asia, II-edition, 2001

MtE 5108 ADVANCED INDUSTRIAL CONTROL (3)

Design and operational characteristics (Programmable logic controllers, I/O devices), PLC information and communication techniques (Digital systems, I/O processing), Programming Methods (Ladder and functional block programming, IL, SFC and ST Programming methods), Programming techniques (Internal relays, Jump and call, timers, counters, shift registers, data handling), HMIs and SCADA systems.

Recommended Books:

1. W. Bolton, (2009) “Programmable Logic Controllers”, 5th edition, Elsevier

2. John F. (2003) “Programmable Controllers- An engineer's guide”, 3rd edition, Elsevier Plc group.

3. Stuart A. Boyer (2009) “SCADA: Supervisory Control and Data Acquisition” 4th edition, ISA.

MtE 5109 ADVANCED MICRO-ELECTROMECHANICAL SYSTEMS (3)

Overview of MEMS and microsystems, applications and uses of MEMS technology, working principles of microsystems, microactuators, microsensors, micro-domain forces, microfabrication, Lithography, thin-film deposition methods, etching techniques, device architecture, design rules and fabrication procedures, RF MEMS, micro-opto-electro-mechanical-systems (MOEMS), and micro biosensing. MEMS actuation mechanisms (such as, thermal, electrostatic, electromagnetic and piezoelectric), MEMS sensing mechanisms (such as capacitive, peizoresistive, optical, and bio-transduction), mechanics for MEMS design, MEMS packaging.

Recommended Books:

1. Micromachined Transducers Sourcebook by Gregory T.A. Kovacs, WCB/McGraw-Hill, Singapore.

2. Mems & Microsystems Design & Manufacture by Tai-Ran Hsu, Tata McGraw-Hill, New Delhi.

MtE 5110 ADVANCED MICRO & NANO FABRICATION TECHNOLOGIES (3)

Principles of micro and nano fabrication, material and process selection for micro fabrication, Integrated circuit (IC) technology, silicon micromachining, micromachining high aspect ratio structures, LIGA, microfabrication using X-rays lithography, maskless fabrication techniques, micro-Electric Discharge Machining (EDM), mechanical processing for micro fabrication, laser micro and nano fabrication; nanostructuring, nano imprinting methods, carbon nano tube (CNT), fabrication techniques for CNT's, Applications of CNT's to MEMS/NEMS and other emerging devices.

Recommended Books:

1. Micro and nanomanufacturing by Mark J. Jackson, Springer, USA.
2. Micro-Nanofabrication: Technologies and Applications by Zheng Cui, Springer, USA.
3. Microfabrication for Industrial Applications by Regina Luttge, Elsevier, Netherlands.

MtE 5111 MICROROBOTICS (3)

Microsystems technology and microrobots, application and future prospects of microrobots, Classification of microrobots, Microgripper Technologies: Overview, microassembly with the help of microrobots, Autonomous or Semiautonomous microrobots.

Recommended Books:

1. Microrobotics: methods and applications by Yves Bellouard, CRC Press, USA.
2. Microsystem technology and microrobotics by Sergej Fatikow and Ulrich Rembold, Springer-Verlag, Berlin, Germany.
3. Cellular robotics and micro robotic systems by Toshio Fukuda and Tsuyoshi Ueyama, World Scientific Publishing Co., Singapore.
4. Automated nanohandling by microrobots by Sergej Fatikow, Springer, USA.

MtE 5112 NANOROBOTIC SYSTEMS (3)

Introduction of nanorobotic system, Potential application of nanorobots, Nanorobotic components, Design methodology of nanorobots, Bio-nanorobotic structures, Characterization of Bio-nano and Nanorobotic devices, Prototyping of nanostructures, Future prospects.

Recommended Books:

1. Design, Modeling and Characterization of Bio-Nanorobotic Systems by Mustapha Hamdi and Antoine Ferreira, Springer, USA.
2. Nanomedicine and Nanorobotics by Klaus D. Sattler, CRC Press, USA.

MtE 5113 ADVANCED CONTROL ENGINEERING (3)

Systems response analysis: General structure of controllers; First order systems; Higher order systems; Routh's stability criterion; Integral and derivative control actions: effects on systems performance; Steady-state errors.

Root-locus method: The concept of root-locus; Rules for constructing root-loci; Root-locus analysis of control systems; Control-systems design by the root-locus approach.

Frequency-response method: Response to sinusoidal inputs; Bode diagrams; Polar plots; Experimental determination of transfer functions; Control-systems design by the frequency-response approach.

Recommended Books:

1. Ogata, K., Modern control engineering - Fifth edition. Prentice Hall, 2009
2. Ogata, K., Modern control engineering - Fourth edition. Prentice Hall, 2001
3. Kuo B.C., Golnaraghi F., 2003, Automatic Control Systems, 8th Ed., Wiley

MtE 5114 COMPUTER APPLICATIONS IN ROBOTICS (3)

3D modeling, assembly and drawing of robotic system using Pro-E. Application of 3D modeling in conceptual design and iterations for robotic systems. Project based Assignments in Pro-E. Modeling and simulation of robot components in FEM softwares (such as Comsol, Ansys etc.). Modeling physical phenomenon and mathematical equations using MATLAB. (such as matrix analysis, numerical visualization, building of graphical user interface, data analysis). Modeling robot trajectory, control or dynamics using matlab. Project based Assignments in MATLAB.

Recommended Books:

1. Getting started with Pro/Engineer by Robert Rizza, Prentice Hall, USA.
2. Inside Pro-Engineer by Utz and Ulman, Onward Press, USA.
3. Introduction to Matlab 7 for Engineers by William John Palm, McGraw-Hill, USA.
4. Introduction to MATLAB by D.M. Etter, McGraw Hill, USA.
5. Robotics, Vision and Control: Fundamental Algorithms in MATLAB by Peter Corke, Springer, Germany.

MtE 5115 BIOMEDICAL ENGINEERING (3)

A historical prospective of biomedical engineering, biomedical applications, autonomy and physiology, biomechanics, biotechnology, biomaterial, tissue engineering, prostheses and artificial organs, rehabilitation engineering, biochemical reactions and enzyme kinetics, bioinstrumentations, biomedical sensors, artificial actuators, biosignal processing, bioelectric phenomena, biomedical transport phenomena, radiation imagine, medical imaging, biomedical optics and lasers. Bio-MEMS, micro-needle technology, lab-on-a-chip technology, microfabricated stents for heart patients, implantable micro devices, micro drug delivery systems.

Recommended Books:

1. Introduction to Biomedical Engineering by John D. Enderle and Joseph D. Bronzino, Elsevier, USA.
2. Biomedical Engineering: Health Care Systems, Technology and Techniques by Sang Suh, Varadraj P. Gurupur and Murat M. Tanik, springer, USA.
3. Introduction to Biomedical Engineering: Biomechanics and Bioelectricity by Douglas Christensen, Margon & Claypool Publishers, USA.
4. The biomedical engineering handbook by Joseph D. Bronzino, Springer-Verlag, Germany.

MtE 5116 BIOMECHATRONICS (3)

Overview of mechatronic systems, biosensors, mechanical sensors, controller, actuator biomechanics and signal processing. Introduction to

biomechatronics, applications of biomechanics, bioelectronic circuits, design and control of biomechatronic systems. active and passive limb prostheses, hearing prostheses, visual prostheses, sensory, substitution, electrocardiography, artificial hearts, respiration aids, artificial muscles, medical imaging, robotic surgery, bio-compatible materials, biomedical embedded systems and BioMEMS. Future of bionics and biomechatronics.

Recommended Books:

1. Introduction to Biomechatronics by Graham M. Brooker, SciTech Publishing, USA.
2. Biomechatronics in Medicine and Health Care by Raymond K. Y. Tong, Pan Stanford Publishing, Singapore.
3. The Bionic Human by Allan B. Cobb, The Rosen Publishing Group, USA.

MtE 5117 MULTIDISCIPLINARY ENGINEERING DESIGN OPTIMIZATION (3)

Multidisciplinary optimization procedure in design processes: basic ideas, aims, scope, concepts, old and new non-gradient methods in engineering optimization, optimal engineering design by means of stochastic optimization methods, response surface approximations for engineering optimization, modeling and approximation strategies in optimization: global and mid-range approximations, response surface methods, genetic programming, low/high fidelity models, strategies for modeling, approximation, and decomposition in genetic algorithms based multidisciplinary design.

Recommended Books:

1. Emerging methods for multidisciplinary optimization by Jan Blachut and Hans Eschenauer, Springer-Verlag, USA.
2. Multidisciplinary design optimization: state of the art by Natalia M. Alexandrov and M. Yousuff Hussaini, SIAM, USA.

MtE 5118 GENETIC ALGORITHMS (3)

An overview of Design Optimization (Design parameters and constraints, objective function, mathematical modeling, design spaces, design optimization, Multi-objective optimization). Evolutionary computation, genetic algorithms (introduction, biological background, conventional optimization and search techniques, a simple genetic algorithm, comparison with other optimization techniques), applications of genetic algorithms, terminologies and operatives of genetic algorithms (such as gene, chromosomes, fitness, populations, search space, encoding, breeding, schemata, convergence criteria and search termination etc.), advanced operators and techniques in genetic algorithms, classification of genetic algorithms, genetic programming, genetic algorithms optimization problems, genetic algorithms implementation using Matlab or C++. Limitations of genetic algorithms.

Recommended Books:

1. Introduction to genetic algorithms by S. N. Sivanandam and S. N. Deepa, Springer-Verlag, Germany.
2. An introduction to genetic algorithms by Melanie Mitchel, The MIT Press, USA.

3. An introduction to genetic algorithms for scientists and engineers by David A. Coley, World Scientific Publication Co., Singapore.
4. Genetic Algorithms in Search, Optimization and Machine Learning by D E Goldberg, Pearson Education, USA.
5. Genetic Algorithm Toolbox User's Guide, Department of Automatic Control and Systems Engineering, University of Sheffield.

MtE 5119 ROBOTICS I (3)

Introduction to Robotics, Types of Robots, Motions of Robot, classification Kinematics: homogeneous transformations, manipulator kinematic equations, forward and inverse kinematic solution methods, Introduction to dynamics of manipulators.

Recommended Books:

1. Mark W. Spong, Seth Hutchinson and M. Vidyasagar, Robot Modeling and Control , John Wiley and Sons, 2006.
2. Sciavicco, L. and Siciliano, B., Modeling and Control of Robot Manipulators, McGraw Hill, New York, 2nd Ed, Springer-Verlag, 2000.
3. S. B. Niku, Introduction to Robotics, Analysis, Systems, Applications, Prentice Hall, 2001.
4. J.J. Craig, Introduction to Robotics: Mechanics and Controls, 3rd Ed., Addison Wesley, 2003.

MtE 5120 ADVANCED ROBOTICS (3)

Forward and inverse kinematic, motion trajectories, manipulator jacobian, Joint Space Dynamics, Newton-Euler Equations, Lagrange Equations, Equations of Motion, Control: methods of control, robot control hierarchy, control of single joint and multiple link manipulators.

Recommended Books:

1. Mark W. Spong, Seth Hutchinson and M. Vidyasagar, Robot Modeling and Control , John Wiley and Sons, 2006.
2. Sciavicco, L. and Siciliano, B., Modeling and Control of Robot Manipulators, McGraw Hill, New York, 2nd Ed, Springer-Verlag, 2000.
3. S. B. Niku, Introduction to Robotics, Analysis, Systems, Applications, Prentice Hall, 2001.
4. J.J. Craig, Introduction to Robotics: Mechanics and Controls, 3rd Ed., Addison Wesley, 2003.
5. C.W. de Silva, Control, Sensors and Actuators, Prentice Hall, 1989.

MtE 5121 MULTI-ROBOT SYSTEMS (3)

A research based course on Multi-robot systems: Cooperation, coordination, fault tolerance, Techniques and approached used for multi-robot systems. Market based approaches, Artificial Immune system based approaches.

Recommended book:

There is no text book. Journal papers in the respective area will be used for references.

MtE 5122 FUZZY LOGIC CONTROL (3)

Review of traditional control techniques and comparison with intelligent control, methods of representing and processing knowledge;

conventional sets and crisp logic, fuzzy logic, fuzzy logic control, hierarchical fuzzy control, control system tuning, industrial applications.

Recommended book:

1. Karray, F. O. and de Silva, C. W., Soft Computing and Intelligent Systems Design-Theory, Tools, and Applications (Addison Wesley, 2004), ISBN 0-321-11617-8.

MtE 5123 ADVANCED DIGITAL SYSTEMS (3)

Algebraic structures for digital logic functions, synthesis of logic functions with multiplexers, realization of logic functions with PLA's, realization with FPGA's, Introduction to FPGA's and various Xilinx FPGA chips esp. Spartan III (due to availability of boards) or latest. Design cycles for digital systems using hardware description languages, Verilog, digital arithmetic, floating point math, design of data path components adders, fast adders, multipliers, encoders, decoders and extension towards the design of signal processing architectures using Verilog along with the synthesis, simulation and implementation of such systems on FPGA boards.

Recommended books:

1. Fundamentals of Switching Theory and Logic Design, Jaakko T. Astola, Springer
2. Advanced Digital Design with the Verilog, Michael D. Ciletti, Pearson

MtE 5124 STATISTICAL SIGNAL PROCESSING (3)

Probability and measure theory, random variables, vectors and processes, expectation and averages, Estimation theory, Gaussian Random processes, Poisson counting processes, ergodicity etc..

Recommended book:

1. Introduction to Statistical Signal Processing, Robert M. Gray, Cambridge University Press.

MtE 5125 MACHINE LEARNING (3)

Introduction to machine learning and statistical pattern recognition, supervised learning (generative/discriminative learning, parametric/ non-parametric learning, neural networks, support vector machines); unsupervised learning (clustering, dimensionality reduction, kernel methods); learning theory (bias/variance tradeoffs; VC theory; large margins); reinforcement learning and adaptive control, applications of machine learning, such as to robotic control, data mining, autonomous navigation, bioinformatics, speech recognition, and text and web data processing.

Recommended book:

1. Pattern Recognition and Machine Learning, Christopher Bishop, Springer, 2006.

MtE 5126 WEARABLE ROBOTS (3)

Introduction to wearable robots, application and scope of wearable robots, basis for bioinspiration and biomimetisum in wearable robots, kinematics and dynamics of wearable robots, network architecture for wearable robots, human-robot cognitive interaction, human-robot physical interaction, wearable robots technologies, communication networks for wearable robots, actuation module for wearable robots, wearable upper limb robots, wearable lower limb and full-body robots.

Recommended Books:

1. Wearable robots: biomechatronic exoskeletons by Jose L. Pons, John Wiley & Sons Ltd, USA.

2. Advances in Robot Kinematics: Motion in Man and Machine by Jadran Lenarcic, Springer, USA.
3. Intelligent wearable interfaces by Yangsheng Xu, Wen J. Li and Ka Keung Caramon Lee, John Wiley & Sons Ltd, USA.

MtE 5127 INDUSTRIAL POLLUTION CONTROL (3)

Source and Characteristics of Industrial Air Pollution and its control techniques, Source and Characteristics of Industrial wastewater; Environmental Quality Standards for Industrial wastewater, Wastewater treatment Processes, Equalization, Neutralization, Sedimentation, Flotation; Adsorption, Ion exchange, and biological processes, case studies of air and wastewater treatment for Iron and steel industries, cement industries; paper and pulp industries, Tanning industries and Chemical industries, Impact of Environmental Regulations.

MtE 5128 ADVANCED DIGITAL SIGNAL PROCESSING (3)

Theory and Applications of Discrete Time Signals and Systems; The Z-Transform; Input/Output Relationships, Discrete Time Networks; Sampling Continuous time signals; Discrete Fourier Transform; Programming Considerations, Digital Filters, IIR Filters, FIR Filter Design Techniques, Filter Design by Modelling, Quantization Effects, Signal Processing Algorithms, DSP System Design, DSP Chips; Digital Filter Implementation. Filter and System Examples

Recommended books:

1. Discrete Time Signal Processing, Oppenheim, Schaffer
2. Digital Signal Processing, Proakis, Monalakis, Prentice Hall Inc.

MtE 5129 DIGITAL IMAGE PROCESSING (3)

Image sampling and quantization, color, point operations, segmentation, morphological image processing, linear image filtering and correlation, image transforms, eigenimages, multiresolution image processing, wavelets, noise reduction and restoration, feature extraction and recognition tasks, and image registration.

Recommended books:

1. Digital Image Processing, R. C. Gonzalez and R. E. woods, 2nd edition, Pearson Education, Inc., 2002.
2. Digital Image Processing using MATLAB, R. C. Gonzalez, R. E. Woods and S.L. Eddins, Pearson Education, Inc., 2004.

MtE 5130 MACHINE VISION (3)

Machine vision, Image Formation and Filtering, Grouping and Fitting, Image segmentation, Texture analysis, Shape analysis, Object Modeling, , Stereo Vision and Depth Analysis, Calibration, Dynamic Vision, Change Detection, Segmentation using motion, motion correspondence, Image Flow, Segmentation using a moving camera, Tracking, Object Recognition, Optical Flow.

Recommended Books:

1. Machine Vision, Ramesh Jain, Rangachar Kasturi, Brian G. Schunck, Published by McGraw-Hill, Inc.
2. Computer Vision: Algorithms & Applications by Richard Szeliski, 2nd edition, Pearson Education, Inc., 2002.

MtE 5131 TECHNICAL REPORT WRITING AND RESEARCH METHODOLOGY (2)

Basics of technical writing process, technical writing techniques and applications, definition and basics of research, research purpose, design of research methods, identification of research problem, literature review, selection of data collection techniques, selection of representative sample, writing of research proposals, data collection and analysis techniques, limitation and significance of research techniques, quantitative and qualitative research procedures, writing of research reports, presentation skills, oral presentations.

Recommended Books:

1. Research Methodology: Methods and Techniques by C. R. Kothari, New Age International Ltd. Publishers, New Delhi.
2. Technical Writing for Success by Darlene Smith-Worthington and Sue Jefferson, South-Western Cengage Learning, USA.

MtE 5132 PATTERN RECOGNITION (3)

Foundations of pattern recognition algorithms and machines, including statistical and structural methods. Pattern representation, feature selection, classification. Supervised and unsupervised learning, use of contextual evidence, clustering, object recognition and image understanding. Advanced research areas in machine vision.

Recommended Books:

1. Bishop, C.M. Pattern Recognition and Machine Learning. Springer 2007.
2. Duda, R.O., Hart, P.E., and Strok, D.G. Pattern Classification. Wiley-Interscience, 2nd Edition 2001.
3. Bishop, C.M. Neural Networks for Pattern Recognition, Oxford University Press 1995.

Journals and Magazines

1. International Journal of Computer Vision
2. Machine Vision and Application - An International Journal
3. Pattern Recognition

MtE 5197 SPECIAL TOPICS RELATED TO MECHATRONICS ENGINEERING (3)

MtE 5198 MASTER'S THESIS (6)
MtE 5199 Ph.D. THESIS (1-9)

Department of
Mining Engineering

The Department of Mining Engineering was established in 1974. It has been offering PostGraduate degree in Mining Engineering since 1991. During the earlier years the department offered research specializations within the mining discipline in rock Mechanics and mineral processing. With the passage of time the faculty of this department obtained higher qualification in their respective fields from abroad. New venues for research were introduced and broad spectrum of research specialization is now being offered in areas of ventilation system in mines, occupational safety and health of workers, mine planning and design and mineral processing. The spectrum of courses has also broadened and now world class curriculum is offered incorporating modern software applications in Mining industry. The faculty has earned its reputation in mining not only on National level but also at International level. Computer applications in mining, advancement in quarrying methods, research in health & safety, application of rock mechanics in tunneling and underground excavations and demand for coal as energy resource have formed a vital base for this development.

A number of professionals, serving in the industry have taken advantage of our M.Sc programme. Our M.Sc programme is specially oriented for professionals working in the industry, therefore the classes are accustomed to the requirements and development of the local mining industry. Over the years the postgraduate students have taken a number of M.Sc projects that have facilitated the industry. The research is applied to enhance the skills and applied knowledge of students who serve the public and private sector mining industry. The department also offers Ph.D. program in core subjects of mining engineering.

Research projects for economic beneficiation of copper ore deposit of North Waziristan Agency, up-gradation of local coal resources for its use in the cement industry identifying causes and means of control of respiratory diseases in coal mine workers in Khyber Pakhtunkhwa, Block modeling and resource estimation of mineral deposits, rock mechanics applications for solving mining and tunneling problems in Khyber Pakhtunkhwa province have been successfully completed.

Dean, Faculty of Civil, Agricultural and Mining Engineering

Prof. Dr. Akhtar Naeem Khan

Chairman

Prof. Dr. Akhtar Naeem Khan (TI) Ph.D.(USA)

Assistant to Dean

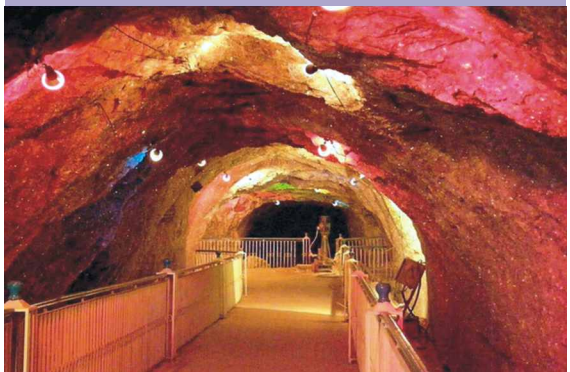
Dr. Nisar Mohammad	Ph.D. (Pak)

Assistant Professors

Dr. Nisar Mohammad	Ph.D. (Pak)
Dr. Salim Raza	Ph.D. (Canada)
Dr. Ishaq Ahmad	Ph.D.(Germany)
Dr. Khan Muhammad	Ph.D. (UK)

Lecturers

Engr. Saira Sherin	M.Sc. (Pak)
Engr. Talat Bilal	M.Sc. (Pak)
Engr. Zahid-ur-Rehman	M.Sc. (Pak)
Engr. Sajjad Hussain	M.Sc. (Pak)



RESEARCH PROJECTS AND FACILITIES

The Department is actively involved in various research projects of national importance related to different areas of Mining Engineering.

The department has completed following R&D Projects:-

1. Investigation into incidence of pneumoconiosis and related diseases among mine workers of KP.
2. Development of block model for cement quarry operations.
3. Re-cleaning of concentrate from the basic flotation circuit of North Waziristan copper ore at pilot scale.
4. Development and application of extraction techniques for mining of dimensional blocks of marble.
5. Development of cutoff grade optimization software with consideration of dynamic metal price, cost escalation and stock piles during mine life.
6. Determination of index and geo-chemical properties of marble of KP.
7. Designing, fabrication and installation of mineral concentration plant.
8. Design and safety improvements of underground coal mines in Cherat area,KP.
9. Beneficiation studies of Malakand low grade graphite ore for industrial use.

INTERACTION WITH INDUSTRY

The department has a strong research linkage with the following Organizations:

1. Directorate General of Mines and Minerals, Govt. of Khyber Pakhtunkhwa.
2. Pakistan Mineral Development Corporation (PMDC).
3. Pakistan Stone Development Company (PASDEC).
4. Agha Khan Rural Support Programme (AKRSP), Chitral
5. Pakistan Science Foundation
6. DG Khan Cement Company Ltd.
7. Kohat Cement Factory, Kohat
8. Cherat Cement Factory, Nowshera
9. Marble Mining Organizations in Pakhtunkhwa
10. FATA Development Authority Livelihood Program.
11. Frontier Works Organization (FWO).

LIST OF APPROVED COURSES

MinE 5510 MINE ADMINISTRATION AND LABOUR RELATIONS (3)

Essentials of management, Decision making, Communication, Managerial accounts, History of Labour movement world wide, Labour movement in Pakistan, Unions, Strikes, Lockouts, Negotiations, Agreements.

MinE 5511 LOSS CONTROL AND SAFETY IN MINING (3)

Mining as a hazardous industry. Hazards of mining operations. Causes of mine accidents, concept of accident prevention, Basic principles of accident prevention, Safety performance measurement, importance of accident investigation, accident investigation techniques, concept of total loss control, loss control through safety management, Cost of accidents, cost analysis of mine accidents.

MinE 5512 TECHNICAL REPORT WRITING AND RESEARCH METHODOLOGY (3)

Basics of technical writing process; Technical writing techniques and applicaitons; Definition and basics of research, research purpose; Design of research methods, identificaiton of research problem, Literature review, selection of data collection techniques, Seleciton of representative sample, writing of research proposals, Data colleciton and analysis techniques, limitations and significance of research techniques; quantitative and qualitative research procedures; writing of research reports; presentation skills, oral presentations.

MinE 5513 APPLICATIONS OF ERGONOMICS TO OCCUPATIONAL SAFETY AND HEALTH (3)

Introduction to Ergonomics, Basic principles of Ergonomics; Principles of workplace design; job analysis and workplace assessment, Design of Physical environment; Human-machine interaction, work organization; system design; engineering controls, administrative controls.

MinE 5515 ADVANCED MINERAL PROCESSING (3)

Smelter schedule selection of comminution method for specific concentrating process and machines. Advanced classification techniques in conjunction with autogenous grinding. Comprehensive study of gravity concentration along with wet magnetic separation. Optical sorting technique and electrostatic/ electrodynamic separation methods. Control review of methods and techniques for mineral properties modification to suit process. Recent advances in froth flotation. Agglomeration, selective flocculation and its application.

MinE 5516 HAZARDOUS WASTE MANAGEMENT (3)

Introduction, historical roots, classification, regulatory process, fate and transport methods of

contaminants, toxic effects and carcinogens, environmental audits, pollution prevention, physical treatment process, biological methods of treatment, stabilization methods, thermal methods, land disposal, quantitative risk assessment, site and sub surface characterization, case studies.

MinE 5517 ENVIRONMENTAL CONTROLS IN MINING (3)

Introduction to environmental pollution, environmental pollution laws and regulations, National Environmental Quality Standards (NEQS), types of pollutants and pollution sampling and measuring techniques, ecological impacts and reclamation of mined land, sources of acid mine water, drainage and controls, vibration and air blast due to blasting and its controls.

MinE 5520 COAL PREPARATION (3)

Properties of coal and coal impurities. Sampling of coal. Raw coal preparation. Size reduction of coal. Screening wet concentration of coarse and fine coal. Dense medium separation Hydraulic concentration. Froth flotation. Agglomeration. Dry concentration. Mechanical and thermal dewatering. Dust collection in coal processing and handling. Coal storage and loading plant waste and Environmental consideration.

MinE 5525 ADVANCED ROCK MECHANICS (3)

Rock pressure theory and theory of failures. Rock bursts. ground control and supports. Mining with high technology equipment. Concept of finite method. Empirical methods of design.

MinE 5530 ADVANCED MINE VENTILATION NETWORKS AND ENVIRONMENT (3)

Thermodynamics analysis of mine air flow. Network analysis of mine resistance. Methane drainage. Ventilation in radio active mines. Instrumentation and controls. Hazardous mine dusts and control. Role of computers in ventilation networks.

MinE 5535 COMPUTER APPLICATION IN MINING & ADVANCED PROGRAMMING (4)

A history of computers and their applications. Advent in Mining Industries Mainframes. Minis and Micros. Programming languages. Some advanced programming related to Mining applications. Computer aided design of Mine workings.

MinE 5540 OPERATIONS RESEARCH (3)

Scope of systems engineering. Production scheduling and planning. Linear programming. simplex methods. Transportation and assignment problem. Critical Path Methods. Management and cost control systems.

MinE 5545 HYDROMETALLURGY (3)

Surface chemistry of mineral particle.

Chemistry of flotation and agglomeration. Amalgamation and cyanidation.

MinE 5550 MINERAL PROCESS DESIGN (3)

Mineralogical approach of the ore and material minerals with respect to process selection. Advanced technique of liberation studies process selection and process testing for reproducing of test results. Economic and technical evaluation of the process selected. Pilot plant testing and statistical feasibility studies. Detailed discussions of standard flow sheets and techniques of designing.

MinE 5551 FINE PARTICLE SCIENCE AND PROCESSING (3)

Particle characterization, particle dimensions (geometric and statistics dimensions), physical and geometric equivalent diameters, specific surface, particle shape analysis, particle size distribution and its types, cumulative and differential distributions, GGS and RRSB distributions, Sauter diameter.

Characterization of separation process, separation efficiency, separation limits, particle mechanics in sieving. Centrifuges and hydrocyclones.

Overview of two phase maxing processes, solid-solid and solid-liquid mixing, characterization of mixing quality.

Comminution, batch and continuous size reduction.

Fine particles flotation and flocculation.

Storage and flow of bulk materials: Silos, resting bulk materials force balance, flowing bulk materials, Silos design.

Fluids solids flow, single particle in fluid, flow through solid beds.

Agglomeration, adhesion forces, built up agglomeration, advantages and application of particle size increase.

Bulk solids properties, solid-liquid separation, derivation and solution of filtration equation, filter capacity, sedimentation.

Books:

i. Introduction to Particle Technology, 2nd Ed. by M. Rhodes. John Wiley & Sons 2008.

ii. M.E.Fayed & L. Otten: Handbook of Powder Science and Technology, 2nd Ed. Chapman & Hall, 1997.

Reference Books:

I. Fine particles processing Vol I and II by Somasunderan AIME publisher.

ii. Fundamentals of Particle Technology by R.D. Holdish, Midland information technology publishing, 2002.

MinE 5555 ANALYSIS OF DEFORMED GEOLOGICAL STRUCTURES (3)

Principles of Rock deformation, deformation mechanics, primary structure folding foliation,

lineation, intrusive and extrusive structures, faults and joints, and deformation of lithosphere.

MinE 5560 UNDERGROUND MINE DESIGN (3)

Pressure Theories. Theoretical and physical modelling methods. Design of Support. Support Characteristics. Functional reliability of reinforcement. Subsidence and strata control.

MinE 5561 SUBSIDENCE ENGINEERING (3)

Prediction of surface subsidence: profile function method, influence function method, finite element method, computer models for subsidence prediction. Surface structure damages: types of damages, criteria for damages. Prevention of surface structural damages: mining layout, protective measures for housel pipes, highways, and bridges. Subsidence measurement techniques: measurement of surface movement, measurement of subsurface movement, measurement of structural damages.

MinE 5562 ADVANCED SURFACE MINE DESIGN (3)

Analysis of elements of surface mining operations and design of surface mining system components including ore estimates, unit operations, equipment selection, ultimate pit limits, long and short range planning, haul road, waste dump planning, and cost estimation. Study of 3D ultimate pit limit design algorithms, mathematical programming for sequencing and scheduling of open pit and quarry operations, various approaches to cutoff grade optimization for open pit mining operations, computerized ore control, haul road and dump design, and truck dispatching. Case studies of various renowned surface mining operations.

MinE 5563 MINE SYSTEM SIMULATION (3)

Introduction to probability theory, discrete probability distributions, fundamentals of queuing theory, queuing models, cost analysis of queuing models, deterministic and probabilistic simulations, manual simulation, principles and practices of computer simulation in the design and analysis of operating mines.

MinE 5564 SURFACE COAL MINE DESIGN (3)

Reserve estimation, surface coal mine design methods, pit geometry, surface coal mining in gentle and steep deposits, dragline, bucket wheel excavator, and shovel-truck operations.

MinE 5565 ROCK MECHANICS IN MINE DESIGN (3)

Design process in Mining Engineering. Design approach for excavation in Rock. Input parameters for design. Empirical observations and analytical methods of design. Integrated design.

MinE 5570 ROCK SLOPE ENGINEERING (3)

Designing of civil and mining Slopes. Modes of slope failures. Economic and planning considerations. Graphical representation. Probablistic approach to slope design.

MinE 5571 ADVANCE EXCAVATION ENGINEERING (3)

Introduction, classification of structures, strategies for subsurface investigation and testing, advance design methods, advance excavation methods for underground structures. Advance design philosophies for tunnels in soils, swelling and squeezing grounds and seismic zones. Support of underground opening and rock reinforcement, ground water control.

MinE 5575 PROJECT MANAGEMENT (4)

Introduction: Project Management vs Leadership, Management process and managerial functions, Project life cycle, Project manager: Role and responsibility, qualities of a good manager.

Project Initiation

1. Project evaluation and Selection: Project selection models: criteria, nature and types project proposal.
2. Project Organization: Project as part of functional organization, pure project organization, matrix organization and mixed organization. Chosing an organizational form.
3. Project Planning: Initial project coordination, system integration, elements of project plan, linear responsibility chart -exercise.

Project Implementation:

1. Introduction to budgeting: Budgeting methods, cost estimation.
2. Scheduling: Network techniques CPM, PERT and Gantt Chart -Exercise.
3. Monitoring and information System. Designing a monitoring system, Data collection, report types, common reporting problems, milestone reporting.
4. Project Control: Purpose, physical assets, human resources, and financial control.

   Project Termination: When to terminate a project: Termination by extinction, termination by Inclusion, termination by integration, Project History Report.

Other Aspects of Project Management

1. Quality Management: Demings' fourteen principles for continuous improvement, introduction to statistical process control.
2. Risk Management -An Introduction.
3. Conflict Management -An Introduction.
4. Negotiation Techniques.
5. Interviewing as Business Function: Types of Interview.

MinE 5576 SPATIAL DATA ANALYSIS AND RESERVE ESTIMATION (3)

Review of elementary statistics, univariate and bivariate description of data, spatial description, spatial continuity, introduction to variograms, random function models, reserve estimation techniques, fundamental concepts of

geostatistics, estimation, global estimation, point estimation.

MinE 5577 ADVANCE GEOSTATISTICS (3)

Modeling the sample variograms, ordinary kriging, block kriging, search strategy, cross validation, co-kriging, change of support, assessing uncertainty, practical aspects of geostatistical modeling in mining.

MinE 5580 GEOCHEMISTRY (3)

Structure of the Earth - crust, mantle, core, mass moment of interia seismic evidence. Temperature and pressure distribution.

Geochemistry: Main Chemical Elements - Relative abundances of some elements and types of compounds. Densities and compositions of different layers. Chemistry of igneous, sedimentary and metamorphic rocks. Structural Aspects silicate chemistry, bond angles, coordination of ions, ion replacement. Some important series.

Geochemistry of Surface and Sub-Surface Water: Effects of Water-hydrothermal processes, supercritical water, crystallization. Effect of water on melting points. Thermodynamis - silicate systems, phase changes; Three-component diagrams, composition of layers in the mantle, at high pressures, Oxidation and Reduction - Composition of atmosphere, changes, effects on iron in different minerals, Electrical conduction by silicates. Less abundant elements Segregation in the crust. Availability of useful elements, formation of ore deposits.

MinE 5581 DIMENSION STONE MINING (3)

Concept, types, and uses of dimension stones, index and geochemical properties, reserves and production of dimension stones, quarrying techniques, conventional methods, advanced methods, comparison of various methods, processing methods, marketing trends, environmental impacts, equipment selection, case studies.

MinE 5582 MINE ENVIRONMENTAL CONTROL FOR BLASTING (3)

Review of blasting theory, controlled blasting techniques, ground vibrations and control, blasting seismograph operation, geological effects on blasting, air blast and control, fly rock control, blasting security, toxicity and pollution control.

MinE 5590 SPECIAL STUDIES (3)

Individual studies on selected topics.

MinE 5599 MASTER'S THESIS (6)

MinE 6599 Ph.D. THESIS (1-9)

Department of

Computer Systems Engineering

The field of Computer Systems Engineering has emerged as one of the principal areas of study throughout the world, making the subject area critical in the development of new computer systems, devices and products. The task of this branch of engineering is to solve practical engineering problems by creating computer based systems, in particular, systems that have a computer embedded in a larger system. It includes a diverse set of engineering skills in the areas such as sensing real world quantities, signal conditioning for sensors, digitizing signals, decision making in hardware and software, software engineering, control systems, robotics, electronic devices for actuators, actuator design; any system that must sense, make decisions, and act in the real world. Increasingly, the computers are used in real time control applications, such as appliances, automobiles, industrial processes, alarm systems, communication systems, robotics and automation. The research in computer systems has its applications in a broad range of situations, such as consumer and medical electronics, custom electronic design, digital communication systems, computer networks, wireless networks, transport systems, electricity generating stations, automation, and heavy machinery.

At postgraduate level, the department offers M.Sc. and Ph.D. programs in computer systems engineering. The postgraduate programs provide knowledge and research skills in a wide range of subjects related to computer systems engineering particularly signal processing, system design, artificial intelligence, robotics, computer vision, computational bioinformatics and networks.

Dean, Faculty of Electrical and Computer Engineering

Prof. Dr. Syed Waqar Shah

Chairman

Prof. Dr. Laiq Hasan	Ph.D. (The Netherland)

Professor

Prof. Dr. Laiq Hasan	Ph.D. (The Netherland)

Associate Professors

Dr. Nasir Ahmad	Ph.D. (UK)
Dr. Nasru Minallah	Ph.D. (UK)

Assistant Professors

Dr. Zahid Wadud Mufti	Ph.D. (Pak)
Dr. M. Athar Javed Sethi	Ph.D. (Malaysia)
Dr. Arbab Masood Ahmed	Ph.D. (Pak)
Dr. Safdar Nawaz Marwat	Ph.D. (Germany)
Dr. Salman Ahmed	Ph.D. (Canada)
Dr. Aftab Khan	Ph.D. (UK)
Dr. Samad Baseer	Ph.D. (Thailand)
Dr. Tariq Kamal	Ph.D. (USA)
Dr. Bilal Habib	Ph.D. (USA)
Dr. Khurram Shehzad Khattak	Ph.D (USA)
Engr. Ihsan Ul Haq	M.Sc. (Pak)

Lecturers

Engr. Rehmat Ullah	M.Sc. (Pak)
Engr. Saleem Ullah	M.Sc. (Pak)
Engr. Sumayyea Salahuddin	M.Sc. (Pak)
Engr. Madiha Sher	M.Sc. (Pak)
Engr. Asif Ali Khan	M.Sc. (Pak)
Engr. Abeer Irfan	M.Sc. (Pak)
Engr. Muniba Ashfaq	M.Sc. (Pak)
Engr. Durr-e-Nayab	M.Sc. (Pak)
Engr. Amaad Khalil	M.Sc. (Pak)
Engr. Naina Said	M.Sc. (Pak)
Engr. Madeha Mushtaq	M.Sc. (USA)
Engr. Yasir Salim Afridi	M.Sc. (Pak)

RESEARCH PROJECTS AND FACILITIES

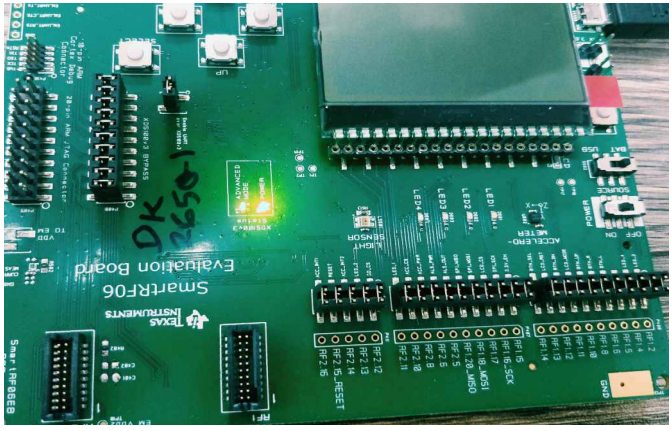
The department has highly qualified faculty, which is actively participating in the university's research activities. Research activities are carried out mostly in the field of computer networks, digital signal processing, control systems, artificial intelligence and neural networks, embedded systems, advance digital design, computational bioinformatics and computer architecture.

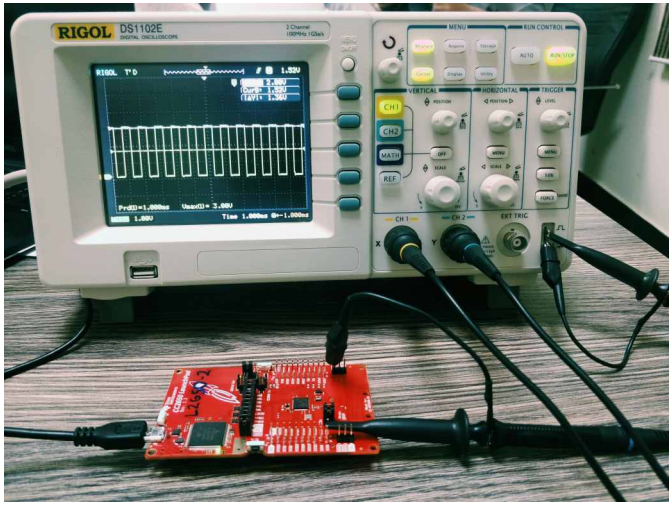
For this purpose the department boosts well equipped laboratories as detailed below:

1. Three state of the art computing laboratories
2. Digital/Electronics Laboratory
3. Microprocessor Laboratory
4. DSP/Advance Digital Design Laboratory
5. Project Laboratory
6. Embedded Networks Laboratory

INTERACTION WITH INDUSTRY

The department maintains regular interaction with the public and private sector organizations. Courses in latest engineering techniques of interest to the industry are offered on regular bases.





LIST OF APPROVED COURSES

Note: The courses offered in a semester will be announced by the department at the time of registration of students.

CSE5601 Advanced Computer Networks (3)

This course covers a set of advanced topics in computer networks. The goals of the course are to develop a strong understanding of network from the physical to application layer. The focus is on principles, architectures, and protocols used in modern networked systems, wireless and mobile networks. Topics include Protocol layering, Internet protocol, Transmission Control Protocol, routing algorithms and application specific protocols. It also examines the fundamentals of mobile network architecture, mobility issues in networking, routing schemes for mobile and nomadic hosts, including Mobile IP, Mobile Ad Hoc Network (MANET) protocols, DHCP and IPv6. Unix Programming Environment for Socket Programming including UDP, TCP, Routing and Raw Sockets is also discussed in detail.

Recommended Books:

1. C. Perkins, "Ad Hoc Networking", 1st Edition, Eddison-Wesley.
2. C. Perkins, "Mobile IP", 1st Edition, Prentice Hall.
3. W. R. Stevens, B. Fenner and A. M. Rudoff, "Unix Network Programming; The Sockets Networking", 3rd Edition, Eddison-Wesley.
4. J. Matthews, "Computer Networking: Internet Protocols in Action", John Wiley & Sons.

CSE5602 Integrated Services Over Packet Networks (3)

Introduction to packet networks, from physical layer up to the transport layer, specifically focusing on Internet Protocol. Both real-time and non-real-time applications and transport mechanisms shall be discussed. Signaling aspects, signaling in packet networks, traffic control and QoS, voice over IP and video over IP.

Recommended Books:

1. Denniel Collins, "Carrier Grade Voice over IP".

CSE5603 Cryptography and Network Security (3)

Introduction to computer security, Classical Cryptography, Block ciphers and Symmetric (secret key) cryptography, Asymmetric (public key) cryptography, Key exchange protocols, Certificates, Message authentication and Hash functions, Hash algorithms, Digital signatures and authentication protocols, Authentication applications, Electronic mail security, IP security and web security, Intruders, Intruding techniques, Intrusion detection and password management, Malicious software, Firewalls.

Recommended book:

1. William Stallings, "Network Security and Cryptography".

CSE5604 Network Modeling and Simulation (3)

This course provides the student with a Quantitative Approach to Networking and covers analytic methodologies for design and evaluation of communication networks. Contents of the course are: Network Performance and source characterizations, Network Delay, Delay Jitter and Playout Delay, QoS Objectives, Traffic Models, Scheduling, Shaped Traffic Analysis, Bandwidth Sharing and control techniques. Routing Engineering Issues, Algorithms for Shortest Path Routing, on Demand Routing, MPLS(Multi-Protocol Label Switching).

Recommended Books:

1. Anurag Kumar, D. Manjunath and Joy Kuri, "Communication Networking".

CSE5605 Mobile Communication Systems (3)

This course is designed to prepare students for engineering work in the industry and for the advanced graduate work in the area of mobile communication. The course covers concepts and useful tools for design and performance analysis of wireless communication systems. To achieve the goal the topics that will be covered include:

Introduction to wireless communication systems and networks, Cellular Wireless Networks and System Principles, Antennas and radio Propagation, Signal Encoding and Modulation techniques, 1G, 2G and 3G wireless systems (AMPS, GSM, GPRS, EDGE, etc), the UMTS network and radio access technology Wireless LANs, IEEE802.1x.

Recommended Books:

1. T. S. Rappaport, "Wireless Communication: Principles and Practice", 2nd Edition, Prentice Hall, 2002.
2. S. Haykin and M. Moher, "Modern Wireless Communications", Prentice Hall, 2004.
3. R. Steele, C. Lee and P. Gould, "GSM, CDMA, One and 3G Systems", 2001, John Wiley & Sons.
4. M. R. Karim, M. Sarraf, "W-CDMA and cdma2000 for 3G Mobile Networks", 2002, McGraw-Hill.

CSE5606 Wireless Networks (3)

Wireless channels and transmission fundamentals. MAC and link layer protocols for wireless networks. Wireless LANs; IEEE 802.11, HIPERLAN and Bluetooth. Wireless ATM. Mobile IP and TCP. Ad hoc networks. Mobility support; World Wide Web and WAP.

CSE5607 Wireless Sensor Networks (3)

Application scenarios, design of sensor nodes, architecture of sensor networks, challenges in sensor networks, energy-aware MAC & link layer, naming & addressing, clock synchronization, localization and positioning, topology control & routing protocols.

CSE5608 Peer to Peer Networked Systems (3)

Peer-to-Peer systems and applications, basics of Peer-to-Peer networking: motivation, characteristics, challenges, goals, unstructured Peer-to-Peer systems, e.g. Gnutella, FreeNet, etc., structured Peer-to-Peer systems, mainly the concept of distributed hash tables (Chord, CAN, Pastry), Peer-to-Peer applications, like end-system-based multicast, distributed file systems, instant messaging, P2P-VoIP, etc.

CSE5609 Delay Tolerant Networks (3)

Delay Tolerant Networks (DTN) routing, energy-aware routing protocol for DTNs, a routing-compatible credit-based incentive scheme, R-P2P: a data-centric middleware for delay tolerant applications, mobile peer-to-peer systems over DTNs, delay-tolerant monitoring of mobility-assisted WSN, message dissemination in vehicular networks, DTN protocols for space communications, DTN for satellite communications.

CSE5610 Cloud Computing (3)

Concept and motivation, virtualization technologies, architectures, networking, storage and file systems, programming models, application development.

CSE5611 Stochastic Processes (3)

This course is designed to make the student to understand the fundamentals of the tools of probabilistic modeling and random processes useful for communication, control and signal processing. Differences between continuous state continuous time processes, continuous state discrete time processes, discrete state discrete time processes, discrete state continuous time processes, Gaussian processes, Markov processes, Bernaulli processes, Poison processes, Random Walk and Weiner processes, Complex random processes, mean correlation and covariance functions, stationarity, wide sense stationarity, strict sense stationarity, ergodicity, properties of autocorrelation function, signal pulses with random amplitudes and arrival times, periodic random processes, cyclostationary processes and power spectral density.

Recommended Books:

1. Gregory F. Lawler, “Introduction to Stochastic Processes”, Second Edition 2006.
2. David. Stirzaker, “Stochastic processes and models”, Oxford University Press 2005.

CSE5612 Advanced Digital Signal Processing (3)

This course provides an in depth knowledge of theory and applications of DSP. The following topics are covered: Overview of Sampling and Quantization, FIR Filter Design, IIR Filter Design, State Space representation of Digital Signal Processing Systems, Spectrum Estimation. Signal Modeling and Levinson Recursion. Introduction to Wiener Filtering and Adaptive Signal Processing, Least mean square algorithm and a final Project.

Recommended Books:

1. Alan V Oppenheim, Ronald W Schafer, John R Buck, "Discrete Time Signal Processing".
2. Monson. H. Hayes, "Statistical Digital Signal Processing and Modeling".

CSE5613 Advanced Digital Image Processing (3)

Advanced Digital Image Processing investigates algorithms and techniques for a variety of imaging applications. The techniques build on the background that is established in the course, Introduction to Digital Image Processing, which focuses on basic image processing methods.

This course contains the advanced topics in digital image compression. The different topics covered in this course includes, Image Enhancement in Spatial Domain, Image Enhancement in Frequency Domain, Image Restoration, Color Image Processing, Morphological Image Processing, Image Segmentation, Object Recognition, Wavelet and Multi-resolution Processing, Feature Detection & Classification. The group projects enable the students to work on substantial designs that require the understanding of the task domain, exploration of solution methods, and implementation of a selected approach. Each team presents a preliminary plan, an approach with feasibility analysis, and a final demonstration.

Recommended Book:

1. Digital Image Processing 3rd Edition by Gonzalez and Woods Prentice Hall, 2008.
2. Digital Image Processing Using MATLAB by Gonzalez, Woods, Prentice Hall, 2004.

CSE5614 Speech Processing (3)

This course introduces the basic principles of digital processing of Speech signal. The topics covered includes speech production, Speech signal analysis, Speech perception and Automatic speech recognition.

Recommended Books:

1. Rabiner and Schafer: Theory and Applications of Digital Speech Processing, Prentice Hall, 2010.

CSE5615 Signal Detection & Estimation (3)

To acquaint students with various methods to detect and estimate the signal in dynamic systems.

The topics covered include: Introduction to estimation, Minimum Variance unbiased Estimation, Kramer Rao lower bound, Linear estimators, General minimum variance unbiased estimation, Best linear unbiased estimators, Maximum likelihood estimation, Least Square approach, Bayesian Estimation and elements of Detection theory.

Recommended Books:

1. Steven M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory".
2. Steven M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory".

CSE5616 Information Theory and Coding (3)

The concepts of source and channel. Measure if information, entropy, and mutual information. The noiseless coding theorem. The noisy coding theorem. Channel capacity: symmetric and non-symmetric channels. Rate-distortion theory. Basics of multiple user information theory.

Linear codes: parity and generator matrices, syndrome error correction and detection capability, minimum distance. Performance bounds of linear codes, hamming and Golay codes, Galois fields, shift register implementation, cyclic codes. BCH decoding algorithm, burst correction codes.

Recommended Books:

1. Robert J. McEliece, "The Theory of Information and Coding", Student Edition, Cambridge University Press 2004.

CSE5617 Image and Video Compression (3)

Image and Video compression techniques can be regarded as the backbone of digital communication and multimedia systems. This course is designed to give a broad overview of the basics of digital images and videos and to familiarize students with the theory and standards of image and video compression and coding. The students will be familiarizedwith the theory and standards of image and video compression/coding. Assignments and home works will be geared towards this goal. This course is intended to be a foundation course for the multimedia concentration area.

Recommended Books:

1. Mohammed Ghanbari, "Standard Codecs: Image Compression to Advanced Video Coding Video", The Institution of Electrical Engineers (IEE), London, UK, 2003.
2. Rafael C. Gonzalez and Richard E. Woods, "Digital Image Processing", Addison-Wesley Publishing Company, 2003.
3. Yun Q. Shi, Huifang Sun, "Image and Video Compression for Multimedia Engineering:

Fundamentals, Algorithms, and Standards", CRC Press, 2000.

4. Peter Symes, "Digital Video Compression", McGraw-Hill companies, Inc. 2004.

CSE5618 Multimedia Communications (3)

Due to continuous advancements in the capabilities of internet its use is gradually further increasing. With the growth of the Internet, new applications and services are immerging which combines a verity of services, such as video, audio and data traffic to provide heterogeneous facilities. This course provides an introduction to the technological issues related to the transport of multimedia traffic over the Internet. This course also introduces fundamental technologies for multimedia communications and networking.

The course will aim to introduce the concepts, technologies, issues, protocols and standards related to the transport of multimedia traffic over the Internet or similar network sub-system.

Recommended Books:

1. Fred Halsall, "Multimedia Communications Applications, Networks, Protocols & Standards", Pearson Education Ltd.

2. K.R. Roa, Zoran S. Bojkovic and Dragorard A. Milanvanovic, "Multimedia Communication Systems, techniques, standards and networks, Pearson Education Ltd.

CSE5619 Code Optimization for DSP Applications

The course will look at different practical techniques that are employed for DSP (Image and Video) code optimization. As DSP applications are usually very computationally intensive, thus to run them in real-time, we have to employ very aggressive code optimization techniques. For example Loop Unrolling, Efficient Memory Accesses and the use of DSP processor specific instructions (intrinsic).

The course will be a practical hands-on course in which the students will take well known DSP (Image and Video) algorithms such as DFT, DCT, Motion Estimation, H.264/VC-1 Deblocking Filters, H.264/VC-1 Arithmetic VLC coding, H.264/VC-1 Intra Prediction and implement them in C Language on DSP processors. The aim of the implementations will be to optimize the code as much as possible so that the code runs as fast as possible.

Recommend Reading:

1. Introduction to TMS320C6000 DSP Optimisation. October 2011, http://www.ti.com/lit/an/sprabf2/sprabf2.pdf

CSE5620 Pattern Recognition (3)

This course covers the fundamentals of Pattern Classification. The topics covered includes Baye's classification rule, minimum error rate classifier, discriminant functions, decision boundaries, univariate and multivariate probability distribution

(normal case), Hidden Markov Models (HMM), Artificial Neural Networks (ANN), Features extraction for classification, Dimensionality reduction and design of experiments on classifiers.

Recommended Book:

1. R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification (2nd ed), John Wiley & Sons, 2000

CSE5621 Artificial Intelligence (3)

Representation and space search. Heuristic search. Predicate calculus. Knowledge representation and knowledge engineering for expert systems. Rule-based, hybrid, and OO systems. Semantic nets, frames and natural language. Theorem provers. Overview of planning. Learning, neural nets. Use of AI languages. Feed forward neural network models, single and multilayer neural networks, learning strategy in computers, supervised and unsupervised neural learning algorithms, back propagation.

Recommended Books:

1. Stuart J. Russell, "Artificial Intelligence: A Modern Approach", 3rd Edition, Prentice Hall, 2009.

CSE5622 Computer Vision (3)

Image processing: edge detection, segmentation, local features, shape and region description in 2D and 3D. Insight from human vision studies. Representation for vision: object models, synthetic images, matching, gaps, algorithms. Interference, production system, synthetic networks. Planning spatial reasoning for robot vision.

Recommended Books:

1. Linda G. Shapiro, "Computer Vision", Prentice Hall, 2001.

CSE5623 Computational Bioinformatics (3)

The course provides an overview of computational molecular biology and discusses various fields of bioinformatics, more specifically sequence alignment, its types and applications. It details pair wise global alignment methods like Dot plot and Needleman-Wunsch algorithm and local alignment methods like the Smith-Waterman. It explains Sequence Alignment Heuristics like FASTA and BLAST and Multiple Sequence Alignment methods like ClustalW and HMMER.

Recommended Books:

1. Alexander Isaev, "Introduction to mathematical methods in bioinformatics", Springer 2006.
2. Venkatarajan S. Mathura, "Bioinformatics: a concept-based introduction", Springer 2009.

CSE5624 Nonlinear Systems (3)

Introduction to Linear and Nonlinear Systems, Approximate analysis of Nonlinear Systems -

describing functions, Krylov and Bogoliubov asymptotical method and Typskin Locus. Forced Oscillations – jumps resonance. Stability analysis - Liapunov criterion. Lure problem and Popov Method.

Recommended Books:

1. Hassan K. Khalil, "Nonlinear Systems", 3rd Edition, Prentice Hall, 2001.

CSE5625 Digital Control Systems (3)

Introduction to state space and System Modeling, State Space Representation of Dynamic Systems, optimal Control, Sampled Data Systems and Discrete time Systems, Digital Control and dynamic analysis of Discrete Systems, Quantization Effects, Sample Rate Selection, System Identification.

Recommended Books:

1. Gene F. Franklin, J. David Powell and Michael Workman, "Digital Control of Dynamic Systems".

CSE5626 Digital Communication Systems (3)

Analysis and design of digital communications systems for voice, video and data. Digital coding of waveforms: Nyquist criteria, inter symbol interference (ISI), Partial response signaling, Practical considerations in design of signals for modems and recording media. Digital switching and integrated services digital networks.

Recommended Books:

1. Bernard Sklar, "Digital Communications: Fundamentals and Applications", 2nd Edition, Prentice Hall.
2. John G. Proakis, Digital Communications, 5th Edition, McGraw Hill.

CSE5627 Optimization Techniques (3)

Parameter optimization problems, and theory of minima and maxima. Optimization problems for dynamic systems, calculus of variations, the maximum principle and the Hamilton-Jacobi equation. Optimization problems with constraints, optimal feedback systems, Numerical solution of optimal problems.

Recommended Books:

1. V. Chvatal, "Linear Programming", 1983 Freeman, TVX 2806.
2. Dimitris Alevras and Manfred W. Padberg, "Linear Optimization and Extensions", Springer 2001.
3. Alexander Schrijver, "Theory of Linear and Integer Optimization", 1999, Wiley, TLG 1627.
4. Jiri Matousek and Bernd Gartner, "Understanding and Using Linear Programming", Springer, 2007, TVX 3577.

CSE5628 Advanced Software Engineering (3)

Ideas and techniques for designing, developing and modifying large software systems, specification and

documentation. Functions oriented and object oriented modular approach designing for reuse and maintainability, specification and documentation. Verification and validation. Cost and quality metrics and estimation. Project team organization and management

Recommended Books:

1. Ian Sommerville, Software Engineering (International Computer Science Series), Addison-Wesley.
2. Roger S. Pressman, Software Engineering : A Practitioner's Approach, McGraw Hill.

CSE5629 Advanced Computer Architecture (3)

Review of technology trends: Cost, Performance and qualitative analysis, Instruction set Architecture, Instruction Level Parallelism, Advanced Pipelining, VLIW and superscalar Processor, Data Path and Controller Design, Peripheral Busses, Memory and Caches, DSP Architecture and Applications, Multiprocessor System.

Recommended Books:

1. David Money Harris "Digital Design and Computer Architecture", Morgan Kaufmann, 1st edition, 2007.

CSE5630 Parallel Processing (3)

Introduction to Parallel Processing, Instruction Level Parallelism, Thread level parallelism, Transformations that enhance data locality in cache and main memories, Programming languages features, Principles and practice of optimizing and parallelizing compilers, Data dependence analysis, Concurrency analysis, Shared memory, Multiprocessors, message passing architectures.

Recommended Book:

1. Alberty Y. H. Zomay, (Eds.), "Parallel & Distributed Computing Handbook", McGraw-Hill Series on Computer Engineering.

CSE5631 Advanced Digital Design (3)

Number Systems, Logic Design and VLSI, Fixed-Point Addition, Subtraction, Multiplication and Division, Decimal Arithmetic, Floating-Point Arithmetic, High-Throughput Arithmetic, Low-Power Arithmetic, Fault-Tolerant Arithmetic, Structure of Sequential Machines, Asynchronous Circuit Design, Assignments using logic synthesis tools.

Recommended Books:

1. Joseph J. F. Cavanagh, "Digital Computer Arithmetic, Design and Implementation".
2. Behrooz Parhami, "Computer Arithmetic, Algorithms and Hardware Designs".

CSE5632 Advanced Embedded System Design (3)

Includes topics related to Embedded System Designing, applications based on Microcontrollers/

ARM etc, System on Chip modeling and its architecture, Network on Chip and other relevant topics will be included with the consent of the instructor.

Recommended Book:

1. Frank Vahid and Tony Givargis, "Embedded System Design: A Unified Hardware/Software Introduction", John Wiley & Sons, Inc.

CSE5633 High Performance Computing (3)

This course is intended for students who are interested in computing-intensive research. Attention is paid to algorithms that are being used within a diversity of research areas. The scaling behavior of these algorithms in case of an increasing problem size and/or increasing number of processing elements is analyzed. By analyzing certain applications with respect to their compute-intensive character, possible bottlenecks will be determined. Based on performance analysis, it will be indicated how the effect of those bottlenecks can be reduced. The goal is to learn how to get a high performance with the available hardware resources.

Recommended books:

1. Georg Hager, Gerhard Wellein, "Introduction to High Performance Computing for Scientists and Engineers (Chapman & Hall/CRC Computational Science)".

CSE5634 Analysis of Algorithms (3)

This course teaches techniques for the design and analysis of efficient algorithms, emphasizing methods useful in practice. Morespecifically, this course will focus on following topics,

- To provide a Comprehensive understanding of Computer Algorithms.
- To provide in detailed understanding to Analysis and Design of Algorithms.
- To become familiar with solution of classical problems and to study how these solutions can help in solving other related problems.
- To study and design approximate algorithms for problems, which cannot be solved by exact algorithms.

Recommended Book:

1. Thomas H Corman, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", 2nd edition, 2001.

CSE5635 Integrated Electronic / VLSI Design (3)

Algorithms for minimization of two-level and multi-level VLSI systems, optimization of sequential logic, completely specified and incompletely specified FSMs, technology mapping, floorplanning, placement, global and local routing, CMOS logic, design of combinational and sequential logic using CMOS, DC characteristics of CMOS circuits, Delay analysis and optimization of CMOS, Power analysis and optimization CMOS, Interconnects, Ultra low

power circuits, scalability of transistors and their effects on performance.

Recommended books:

1. Jan Rabaey, "Digital Integrated Circuits".
2. Neil Weste et al., "CMOS VLSI design, a circuits and systems perspective".

CSE5636 Advanced Operating Systems (3)

Distributed operating system, parallel operating, system, overview of the operating systems: UNIX, DOS, VMS, Windows NT, Novell Netware 4.xx, Linux, memory management, multiprogramming, virtual paging, segmentation, principle of DOP, advanced features of DOP and parallel operating systems, and parallel operating systems.

Recommended Books:

1. William Stallings, Operating Systems: Internals and Design Principles, Prentice Hall
2. Andrew S. Tanenbaum, Modern Operating Systems, Prentice Hall
3. Yair Wiseman and Song Jiang, Advanced Operating Systems and Kernel Applications: Techniques and Technologies, Information Science Reference
4. Mukesh Singhal, Niranjan Shivaratri, Advanced Concepts In Operating Systems, McGraw-Hill

CSE5637 Advanced Database Design & Management (3)

Introduction to file systems and databases, Relational Database Model, Relational Algebra for databases, Complex SQL Queries, Internet database environment, Distributed database management systems, Object-oriented databases, Client/Server Systems, Data warehousing, ETL for Data warehousing, memory resident databases, database optimization, advanced configuration options for database files.

Recommended Books:

1. Abraham Silberschatz, Henry Korth and S. Sudarshan, Database System Concepts, McGraw-Hill
2. Hoffer, Prescott and McFadden, Modern Database Management

CSE5638 Advanced Object-Oriented Programming (3)

The design patterns of Gamma, Helm, Johnson, and Vlissides. The C++ Standard Template Library (STL), a generic programming paradigm that has been adapted to the C++ programming language, and is an extensible framework for generic and interoperable components.

Recommended Books:

1. Robert Lafore, Object Oriented Programming using C++, Sams Publishing

CSE5639 Advanced Data Structures (3)

Sparse matrix transpose and multiplication, List insertion and deletion, lists of available space.

Inorder, preorder, and postorder traversal of trees. Topological sorting. Binary search trees, AVL trees, B-Trees, and tries. Dynamic hashing.

Recommended Books:

1. Thomas H Cormen, Charles E Leiserson, Ronald L Rivest, Clifford Stein, Introduction To Algorithms, The MIT Press.
2. Peter Brass, Advanced Data Structures, Cambridge University Press.

CSE5640 Management Information System (3)

Why information systems, difference between Computers and Information Systems, Information systems and Organizations, Information systems and Decision Making, Enhancing Management Decision Making (DSS, GDSS, QFD).

Recommended Books:

1. James O. Brien and George Marakas, "Management Information Systems", McGraw-Hill, 9th edition, 2010.

CSE5641 Engineering Project Management (3)

Course gives the student the necessary Knowledge to make a project proposal, plan, budget and schedule a project. Compare alternative projects. Analyze the risks and uncertainties of a project. It also requires the student to be able to proficiently use a project management tool such as Microsoft Project or Primavera.

Recommended Books:

1. Jack R. Meredith and Samuel. J. Mantel, "Project Management a Managerial Approach".

CSE5691 Tech. Report Writing & Research Methodology (3)

This course covers the basic introduction to modern approaches to science and particularly engineering. The student will get an insight into the history and philosophy of science and into how scientific methods are applied in the science of engineering. The goal is to enable the students to read contemporary scientific literature in the chosen field of specialization and distill the main ideas of a paper and to write these down in his/her own words. At the end of this course the student will have acquired knowledge of how to conduct a research project and of how to write scientific texts. Content covered includes,

- The principles of theory of science.
- Different research areas and their application areas in engineering science
- Methods for information seeking.
- Reviewing/ assessing of scientific publications
- To work in a group and group organizational control tools
- Scientific writing
- How to write and organize a scientific publication.
- Research ethics/morals.
- Presentation of/acting as opponent of research results

Recommended Books:

1. Chalmers, A. F., "What is this Thing Called Science?".
2. Graziano, A. M., Raulin, M. L., "Research Methods. A Process on Inquiry".

CSE5690 Special Topics (3)

CSE5699 Master's Thesis (6)

CSE6699 Ph. D. Thesis (1-9)

Department of
Chemical Engineering

Chemical Engineering is the branch of engineering, which blends the basic sciences with engineering knowledge and design fundamentals to develop, design, analyze and engineer the industrial processes and plants that turn raw materials into valuable products. These processes must be accomplished in a competitive economy and environmentally safe manner to create products, which are useful and essential to the modern world. Chemical Engineering science is based upon the fundamentals of mass, momentum, and heat transfer, thermodynamics and chemical kinetics. Chemical engineers are extremely versatile and able to handle a wide range of technical problems. They are familiar with the necessary skills that encompass detailed understanding of all aspects of design, testing, scale-up, operation, control, and optimization of different unit operations. They are familiar with many industries such as fuels and petrochemicals, plastics, fibers, paper, foods, building materials, water desalination and pharmaceuticals. A chemical engineering degree is also good preparation for careers in pollution prevention and waste minimization.

Dean, Faculty of Mechanical, Chemical and Industrial Engineering

Prof. Dr. Muhammad Abdul Aziz Irfan

Chairman

Prof. Dr. Muddasar Habib	Ph.D. (UK)

Professors

Prof. Dr. Saeed Gul	Ph.D. (Austria)
Prof. Dr. M. Younas	Ph.D. (France)
Prof. Dr. Muddasar Habib	Ph.D. (UK)

Associate Professor

Dr. Jamil Ahmad	Ph.D. (Norway)
Dr. Nehar Ullah	Ph.D (Canada)
Dr. M. Imran Ahmad	Ph.D. (UK)

Assistant Professors

Engr. Imran Khan Swati	M.Sc. (Pak)
Dr. Asmat Ullah	Ph.D. (UK)
Engr. Sultan Ali	M.Sc. (Pak)
Engr. Amad Ullah Khan	M.Sc. (Pak)
Dr. Moazzam Arshad	Ph.D. (Austria)
Dr. Muhammad Daud	Ph.D. (KSA)
Dr. Irshad Ali	Ph.D. (Canada)
Dr. S. Naveed-ul-Hassan	Ph.D. (Australia)
Dr. Naseer Ahmad Khan	Ph.D. (Australia)
Dr. Hayat Khan	Ph.D. (Canada)

Lecturers

Engr. Qurat-ul-Ain	M.Sc. (Pak)
Engr. Mansoor-ul-Hassan	M.Sc. (Pak)
Engr. Saira Bano	M.Sc. (Pak)
Engr. Unsia Habib	M.Sc. (Pak)
Engr. Wajid Ali	M.Sc. (Pak)

RESEARCH PROJECTS AND FACILITIES

The mission of the Department of Chemical Engineering at University of Engineering & Technology, Peshawar is is to be a national leader in chemical engineering research and to achieve excellence in teaching. Chemical Engineering Department offers state of the art equipment and high-tech laboratories to facilitate the post graduate students in research projects and to acquire the understanding of various chemical processes by providing small-scale units and simulated industrial work environment. Chemical Engineering Department helps students equip with practical knowledge and trouble shooting through its various computer-controlled upto-date laboratories such as of Chemical Process Technology, Chemical Reaction Engineering, Chemistry, Environmental Engineering, Fluid Flow, Fuel and Combustion, Heat Transfer, Instrumentation and Control, Mass Transfer, Particle Technology, SHMT, Thermodynamics.

AREA OF SPECIALIZAITON

M.Sc Advanced Chemical Engineering (ACE)

This programme is aimed to enhance the technical and communication skills of the chemical engineers. It is built around a core of six chemical engineering courses including advanced mass transfer, advanced chemical reaction engineering, advanced heat transfer and advanced chemical engineering thermodynamics. Electives in other areas to broaden the students' exposure are also offered. Moreover, it includes independent research, and defence of a thesis based on this research. The results of the thesis must be publishable in a technical refereed journal. The programme will prepare chemical engineers for careers in teaching research and development, and management in academia, government, and industry. This programme provides a basis for continued study leading to the Ph.D. degree.

Ph.D in Chemical Engineering

The Department of Chemical Engineering offers robust doctoral programme in Chemical Engineering. The department has five (5) faculty members with Ph.D degrees from technically advanced countries. All the doctoral faculty are on "HEC approved Supervisor" List. The interested candidates are offered the admission based on expertise of respective faculty member's following area of specialization:

- Membrane Separation Processes
- Bio-Engineering
- Process intensification
- Computational Fluid Dynamics
- Process Modeling and Simulation
- Resource Conservation and Recycling

LIST OF APPROVED COURSES

A. Compulsory courses

ChE 5615	Advanced Mass Transfer
ChE 5616	Advanced Chemical Reaction Engineering

ChE 5621	Process Dynamics and Control
ChE 5618	Process Simulation and Optimization
ChE 5619	Advanced Heat Transfer
ChE 5620	Advanced Chemical Engineering Thermodynamics
ChE 5607	Mathematical Methods in Chemical Engineering
ChE 5626	Advanced Transport Phenomena

B. Elective Courses

ChE 5601	Membrane separation processes
ChE 5602	Multi-Phase flow
ChE 5603	Biochemical engineering
ChE 5604	Experimental Design and analysis
ChE 5606	Advanced Chemical Process Analysis and Design
ChE 5608	Polymer Engineering
ChE 5609	Application of Corrosion Engineering in Process Industries
ChE 5610	Heat Recovery System Design
ChE 5611	Separation System Design
ChE 5612	Management in Technical Organizations
ChE 5613	Industrial Waste Management
ChE 5614	Occupational Health and Safety in Process Industries
ChE 5623	Computational Fluid Dynamics
ChE 5624	Clean Coal Technology
ChE 5627	Technical Report Writing & Research Methodology
ChE 5698	Special Topics related to Chemical Engineering
ChE 5699	Master's Thesis
ChE 6699	Ph.D Thesis

ChE 5615 ADVANCED MASS TRANSFER (3)

Advanced treatment of theories of mass transfer; film theory; penetration theory; convective mass transfer, concentration boundary layer, turbulent transport and other mass transfer models, mass transfer accompanied by chemical reactions of various orders both reversible and irreversible; enhancement factor; design equations. Application of mass transfer to selected industrial separation processes.

ChE 5616 ADVANCED CHEMICAL REACTION ENGINEERING (3)

Review of fundamental principles; order of reactions and rate equation; theory of rate processes; diffusion and types of reactors. Estimation of reaction rate parameters using empirical and quantum chemical methods, detailed chemical kinetic modeling. Design of

chemical reactors for homogeneous and heterogeneous reactions. Analysis and comparison of the differences between batch and continuous reactor by using kinetics and mass, energy and momentum balances. Design of fixed-bed, fluidized-bed and Industrial catalytic reactors.

ChE 5618 PROCESS SIMULATION AND OPTIMIZATION

Introduction to simulation in process systems engineering, model building framework, conservation principles, model analysis, solution strategies. Model reduction framework Linearization. Deterministic optimization methods, stochastic optimization. Dynamic optimization: Indirect methods, sequential methods, simultaneous methods. Parameter estimation and parametric sensitivity.

ChE 5619 ADVANCED HEAT TRANSFER (3)

Heat conduction equation; analytical methods in conduction heat transfer; Bessel equations; the methods of separation of variables; Laplace transforms; finite differences and finite elements. Methods of determination of the heat transfer coefficient, heat transfer in natural convection; forced convection; similarity theory; correlation of heat transfer coefficients; and heat transfer in boiling & condensation processes. Introduction to heat exchanger design. Radiation heat transfer; radioactive properties of. real materials; radiation exchange between back surfaces and between gray surfaces.

ChE 5620 ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS (3)

Laws of thermodynamics; unsteady state processes. Introduction to molecular thermodynamics; equation for activity coefficients and therm-odynamics property estimation. Determination of the multicomponent phase equilibrium.

ChE 5601 MEMBRANE SEPARATION PROCESSES (3)

Membrane structure and function; production of membrane; characterization. Selection and use of membrane system; application for separations in process industries.

ChE 5602 MULTI-PHASE FLOW (3)

Two-phase flow in chemical engineering systems; Definitions and averaging of two phase flows; Flow regimes and transitions; Two phase model and pressure drop; Pool boiling models; Choked two phase flow; Flow boiling; Condensation; Two-phase flow instability; Two-Component, Gas-Liquid Flow; Process Steam Line Design; Measurement of Two-Phase Flows.

ChE 5604 EXPERIMENTAL DESIGN AND ANALYSIS (3)

Fundamentals of design of experiments; Interactions in processes; a systematic methodology for design of experiments; single factor experiments, analytical comparisons among treatments and trend analysis; two factor experiments; higher-order factorial experiments; decreasing error variance; other designs; fitting regression models.

ChE 5603 BIOCHEMICAL ENGINEERING (3)

Biochemical fundamentals; Analysis of microbial kinetics for bioreactor design; Design and Analysis of batch, continuous and multiphase bioreactors; advanced control strategies of bioreactors. Enzyme and microbial kinetics; various fomenters for enzyme and pure cultures; Sterilization; Bioprocess economics; Recent developments on biotechnology.

ChE 5606 ADVANCED CHEMICAL PROCESS ANALYSIS AND DESIGN (3)

Introduction to process analysis and simulation; models and model building; models based on transport phenomena principles; principles of subsystem; responses to 'typical inputs; linearization of nonlinear models; transfer functions; stability; principle of systems analysis; decomposition of large-scale systems; system stability and sensitivity; system determinacy. Application of process system engineering to selected chemical engineering problems. Optimum design of large complex processes.

ChE 5607 MATHEMATICAL METHODS IN CHEMICAL ENGINEERING (3)

Formulation of differential equations modeling physical phenomena in chemical engineering. solutions of sets of ordinary differential equation; solution of partial differential equations using methods of infinite series and separation of variable; Bessel functions and Legendre polynomial; vector and tensor analysis; complex variables; analytic functions; harmonic functions; Cauchy's integral theorem; Laurent's expansion; and theory of residues; calculus of variation, analysis of multi-stage processes such as distillations towers, absorber and so on.

ChE 5608 POLYMER ENGINEERING (3)

Polymer and their application as engineering materials; structure and properties of polymers; crystalline; semi-crystalline and amorphous polymer. Mechanisms of polymerization reactions and practical production of polymers with desired properties. Mechanical properties. of polymers; theory of rubber elasticity; yielding of polymers; polymer rheology; viscoelastic of polymers and viscoelastic models and polymer composites.

ChE 5609 APPLICATION OF CORROSION ENGINEERING IN PROCESS INDUSTRIES (3)

Corrosion principles and applications, forms of corrosion, Types of Corrosive Environments, Corrosion processes kinetics; potential-current diagrams, corrosion processes control. Overview of the properties of commonly used engineering materials and their resistance to corrosion. Methods of corrosion control.

ChE 5621 PROCESS DYNAMICS AND CONTROL (3)

Mathematical modeling and identification of chemical processes. State-space process representation and analysis: stability, observability, controllability and reachability. Analysis and design of advanced -control systems: internal model control, dynamic matrix control and model predictive control. Synthesis of multivariable control systems: interaction analysis, singular value decomposition, decoupler design. Continuous and sampled-data systems, on-line process identification. State and parameter estimation techniques: Luenberger observer and Kalman filter. Knowledge of Laplace transforms, material and energy balances, computer programming and matrix algebra is required.

Pre requisite an undergraduate course in process control.

ChE 5623 COMPUTATIONAL FLUID DYNAMICS

General Differential Equations; Numerical solutions of energy and Navier-Stokes Equations; Numerical schemes and algorithms; Methods of obtaining convergence; Transient analysis; finite difference and finite element methods applied to fluid mechanics; Matrix solving Techniques; Recent developments in CFD; Control Volume Formulation, Finite Volume Method. Development of computer programs for CFD problems.

ChE 5624 CLEAN COAL TECHONOLOGY

Introduction to clean coal technology. Classification of coal. Energy mix, Contribution of coal to energy mix. Technology for coal utilization: coal combustion, gasification, liquefaction, co-gasification. Principles of coal gasification, gasification, gasifier types, commercial gasification systems. Emissions control strategies for power plants. Chemical looping combustion technology, packed bed and fluidized bed reactors using coal and syngas.

ChE 5626 ADVANCED TRANSPORT PHENOMENA (3)

Fundamentals of momentum; energy and mass transport; determination of transport properties; conservation of mass momentum and energy in laminar flow and turbulent flow in microscopic approach; equation of change for multi

component systems; dimensional analysis equation of change; simultaneous heat; mass; momentum transfer; laminar and turbulent boundary layer theory.

ChE 5610 DESIGN OF HEAT RECOVERY SYSTEMS (3)

Introduction to Heat Integration, Energy targeting and Pinch Analysis, Heat exchanger network design for maximum heat recovery, Heat exchanger design, Utilities provision, Capital and Energy Trade-Offs, Automated design of heat exchanger networks, Retrofit of heat exchanger networks, Heat engines, heat pumps, and refrigeration, Heat integration of reactors, Heat integration of distillation, Heat integration of other separation processes, Process modifications, Data extraction, Putting it into practice.

ChE 5611 SEPARATION SYSTEM DESIGN (3)

Introduction to separation system design, Choice of separation technology, Separation of heterogeneous and homogeneous mixtures, Distillation system design, Physical and thermodynamic property modeling, Retrofit distillation design, Distillation sequencing

Azeotropic distillation design, Absorption, Adsorption, Extraction, Membrane separation, Crystallization, Evaporation.

ChE 5612 MANAGEMENT IN TECHNICAL ORGANIZATIONS (3)

Principles of Management, Communication

Planning, Leadership, Human Resource Management, Organizational Culture, Change Management, Technology Management, Innovation & Creativity, Introduction & Applications of Management Tools.

ChE 5613 INDUSTRIAL WASTE MANAGEMENT (3)

Characteristics of industrial wastes, Processes for treatment of industrial waste, Legislative and regulatory concerns, Environmental quality standards for industrial waste waters, Applications of biological treatment to industrial waste waters, Environmental management in process industries, Waste minimization and resource recovery in process industries, Cleaner production technologies, Case studies on waste management: Pulp & Paper, Tannery, Textile, Fertilizer, Sugar, Petroleum, Pharmaceutical, and Corn Starch industries.

ChE 5614 OCCUPATIONAL HEALTH & SAFETY IN PROCESS INDUSTRIES (3)

Introduction to occupational health and safety, Basic concepts of health and safety in process industries, Hazards, and types of hazards in chemical and process industries, Causes of accidents in industries, concept and basic

principles of accident prevention in industries, Risk analysis, safety performance measurement in industries, Strategies for control of occupational safety and health hazards in process industries.

ChE 5627 TECHNICAL REPORT WRITING & RESEARCH METHODOLOGY (3)

Basics of technical writing process, Technical writing techniques and applications, Definition and basics of research, research purpose, Design of research methods, Identification of research problem, literature review, Selection of data collection techniques, selection of representative sample, writing of research proposals, Data collection and analysis techniques, Limitations and significance of research techniques, Quantitative and qualitative research procedures, Writing of research reports, Presentation skills, oral presentations.

ChE 5698 SPECIAL TOPICS RELATED TO CHEMICAL ENGINEERING (3)

ChE 5699 MASTER'S THESIS (6)

ChE 6699 Ph.D. THESIS (1 - 9)

Department of

Computer Science & Information Technology

The Department of Computer Science & Information Technology (CS&IT) offers graduate courses leading to the award of Master of Science (MS) and Ph. D in Computer Science. The Department owes its emergence to the relentlessly growing demand of professionals with expertise in areas of computers, communications and information processing technologies. The Department has strong collaborations with other engineering departments of the University. The Department is equipped with laboratories having state-of-the-art computer systems running a wide range of applications and specialized software supporting the courses. The Department provides a stimulating and challenging environment essential for high quality education. Students receive training in design, development and application of computer science and information processing techniques. The graduates of this Department will be able to meet the highest standards for leadership in computer science and Information Technology and fulfill the demands of the huge IT market of the 21st century.

Mission

The mission of the CS & IT Department is:

- To provide undergraduate/graduate education to the community in computing discipline and to create and disseminate computing knowledge/technology.
- To achieve excellence in research by solving problems of real-world complexity with the potential for significant long-term impact on the fields of computer science and multidisciplinary computing.
- To achieve excellence in education, providing the nation with computer scientists having extensive knowledge allowing them to adapt to a rapidly changing technology and providing industry, academic and government sectors with the next generation of leaders.

Dean, Faculty of Electrical and Computer Engineering

Prof. Dr. Syed Waqar Shah

Assistant to Dean

Dr. Sadeeq Jan	Ph.D. (Luxembourg)

Assistant Professors

Dr. Sadeeq Jan	Ph.D. (Luxembourg)
Dr. Iftikhar Ahmad	Ph.D. (Germany)
Dr. Suhail Yousaf	Ph.D. (The Netherlands)
Dr. Wajeeha Khalil	Ph.D. (Austria)
Dr. Izhar Ullah	Ph.D. (UK)
Mr. Ismat Ullah Khan	M.Sc. (CS) (Pak)

Lecturers

Dr. Zakira Inayat	Ph.D. (Malaysia)
Dr. M. Imran Khan Khalil	Ph.D. (Pak)
Engr. Mujtaba Hassan	MS (CSE) (Pak)
Engr. Alauddin	MS (CSE) (Pak)
Mr. Dilawar Khan	MS (CS) (Pak)
Mr. Imran Rasheed	MS (CS) (Pak)
Mr. Sadiq-ur-Rehman	MS (CS) (Pak)
Mr. Amir Taj	MS (CS) (UK)
Miss. Aisha Javed	MIT (Pak)
Mr. Inayat Ullah	MS (CS) (Pak)

Computer Laboratories

The Department has a number of state-of-the-art computer laboratories equipped with latest computers having all the required development software and tools. These laboratories have also been connected with the Digital Resource Library of the Higher Education Commission (HEC) to provide latest resources and information to students as well as to faculty members of the Department.

List of Approved Courses

CS-5500 Advanced Theory of Computation (Core Course) (3)

This course will cover: Introduction, Finite Automata, Deterministic Finite Automata, Nondeterministic Finite Automata, Regular Expressions, Regular and non-regular Languages, Context-Free Grammars, Pushdown Automata, Properties of Context-Free Languages, Turing Machines, The Pumping Lemma for regular languages, Proving non-regularity using the Pumping Lemma, Proving non-regularity using reduction, Self-reference and incompleteness, Undecidability of the Halting problem, Diagonalization and reduction, Decidability, undecidability, recognizability, Enumerability, Post Correspondence Problem (PCP), Modified Post Correspondence Problem (MPCP), Undecidability of PCP and MPCP, Rice's theorem.

CS-5501 Advanced Algorithm Analysis (Core Course) (3)

This course will cover: Introduction to algorithm analysis including formal techniques and the underlying mathematical theory, Growth of Functions and asymptotic analysis of upper and average complexity bounds using big-O, little-o, and theta notation, Fundamental algorithmic strategies including brute-force, greedy, divide-and-conquer, backtracking, branch-and-bound, pattern matching, and numerical approximations, Standard graph and tree algorithms, 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, NP-completeness, Search Techniques, Randomized Algorithms, Heuristic and Approximation Algorithms.

CS-5504 Research Methodology (Core Course) (3)

This course will cover: Information Skills: Search and Critical Evaluation - To know skills to search, retrieve, and critically evaluate information, Research Ethics and Plagiarism - To identify the role and responsibilities of scientists, examine the ethical questions, and to introduce plagiarism, Statistics in Research - To examine fundamental elements of statistics and show their importance in making inferences from data, Research Methods I - The use of experimental methods to address research questions, and quantitative and qualitative methods to explore and investigate a hypothesis based on a given set of data, Research Methods II - The use of experimental methods to address research questions, and quantitative and qualitative methods to explore and investigate a hypothesis based on a given set of data, Latex I - A introduction to Latex (a document preparation system) and demonstrating its abilities to prepare both an article and a presentation, Latex II - A introduction to Latex (a document preparation system) and demonstrating its abilities to prepare both an article and a presentation. Academic Writing - To examine the context and key features of academic writing and techniques with practical exercises to improve writing, Critical Review of research papers - To develop practical experience to critically reviewing research papers and drawing conclusion from the arguments and data being presented, Data Presentation - To learn time saving tools and techniques to present your

data clearly and effectively in both tabular and graphical formats, SPSS - To introduce one of the popular and well-established statistical tool for scientific research in a variety of disciplines, Planning and Presenting a Talk - To help prepare and present a talk in a hand on interactive session, Paper Publication - It explore the publication process towards a good paper, reviewing process and general ethics for writing both conference and journal publications, Thesis Writing - It emphasises on structuring thesis, gaining understanding of assessor's perspective, and practical tips on managing your time, Preparing for Viva - To get practical tips on effective preparation and performing well in viva.

CS-5524 Linked Data (3)

Linked data introduction, linked data and the Semantic Web, rationale for linked data, technical background, principles of linked data, RDF: the data model for linked data, consuming linked data, creating linked data, querying linked data, RDF triplestore fundamentals, design considerations of linked data, deploying linked data: Methodologies and software tools, generating linked data in real-time from sensors data streams, publishing linked data, applications of linked data, conclusion: summary and outlook, open research challenges.

CS-5530 Requirement Engineering (3)

This course will cover: Definition of requirements engineering and role in system development, Fundamental concepts and activities of requirements engineering, Information elicitation techniques, Modeling scenarios, Fundamentals of goal-oriented requirements engineering, Modeling behavioral goals, Modeling quality goals, Goal modeling heuristics, Object modeling for requirements engineering, Object modeling notations, Object modeling heuristics, Identifying objects from goals, Modeling use cases and state machines, Deriving operational requirements from goals, Requirements Specification, Requirements verification and validation, Management of inconsistency and conflict, requirements engineering risks, the role of quality goals in the requirements selection process, Techniques for requirements evaluation, selection and prioritization; Requirements management; Requirements traceability and impact analysis.

CS-5531 Software System Architecture (3)

This course will cover: Definition and overview of software architecture, the architecture business cycle, Understanding and achieving quality attributes, Attribute-driven design, Documenting software architecture, Evaluating software architecture, Architecture reuse, Life-cycle view of architecture design and analysis methods, The QAW, a method for eliciting critical quality attributes, such as availability, performance, security, interoperability, and modifiability, Architecture Driven Design, Evaluating a software architecture (ATAM, CBAM, ARID), Principles of sound documentation, View types, styles, and views; Advanced concepts such as refinement, context diagrams, variability, software interfaces, and how to document interfaces; Documenting the behavior of software elements and software systems; Choosing relevant views; Building a documentation package.

CS-5532 Software Quality Assurance (3)

This course will cover: What Is Software Quality: Quality Assurance, Quality Engineering, SOFTWARE TESTING: Testing: Concepts, Issues, and Techniques, Test Activities, Management, and Automation, Coverage and Usage Testing Based on Checklists and Partitions, Input Domain Partitioning and Boundary Testing, Coverage and Usage Testing Based on Finite-State Machines and Markov Chains, Control Flow, Data Dependency, and Interaction Testing, Testing Techniques: Adaptation, Specialization, and Integration. QUALITY ASSURANCE BEYOND TESTING:

Defect Prevention and Process Improvement, Software Inspection, Formal Verification, Fault Tolerance and Failure Containment, Comparing Quality Assurance Techniques and Activities. QUANTIFIABLE QUALITY IMPROVEMENT: Feedback Loop and Activities for Quantifiable Quality Improvement, Quality Models and Measurements, Defect Classification and Analysis, Risk Identification for Quantifiable Quality Improvement, Software Reliability Engineering, Use of automated testing tools, Testing of a wide variety of software, Application of a wide variety of testing techniques, Inspecting of software in teams; comparison and analysis of results.

CS-5533 Software Project Management (3)

This course will cover: Executive Overview of Project Management, Bounding Project Scope, Project Classification Frameworks, Creating the Project Charter, Leading and Managing the Project Team, Work Breakdown and Organizational Structures, Task Planning, Labor-Driven Activities, Project Network Modeling, Project Management Software, Resource Leveling and Project Budget, Project Control, Project Quality Management, Contracting and Sub-contracting, Risk Management, Evaluating, Directing, & Closing Out a Project, Business Ethics.

CS-5534 Software Measurement and Metrics (3)

This course will cover: Measurement theory (overview of software metrics, basics of measurement theory, goal-based framework for software measurement, empirical investigation in software engineering), Software product and process measurements (measuring internal product attributes: size and structure, measuring external product attributes: quality, measuring cost and effort, measuring software reliability, software test metrics, object-oriented metrics), Measurement management.

CS-5535 Software Configuration Management (3)

This course will cover: Introduction to software configuration management, Configuration management process model, configuration identification, configuration control, configuration status accounting, configuration verification and audit, configuration management and data management, configuration change management, configuration management and software engineering standards reference, configuration management automation.

CS-5536 Software Design Patterns (3)

This course will cover: What is a design pattern, history, Creational patterns (Abstract Factory, Builder, Factory method, Lazy initialization, multiton, object pool, prototype, singleton), Structural patterns (Adaptor, bridge, composite, decorator, façade, flyweight, proxy), Behavioral Patterns (blackboard, chain of responsibility, command, interpreter, iterator, mediator, momento, null object, observer or publish subscribe, state, strategy, template method, visitor), Concurrency patterns

CS-5537 Formal Methods (3)

This course will cover: the concepts of formal methods more specifically formal specifications, underlying mathematical foundation of formal methods as well languages or language constructs for developing a software systems using formal methods. Course outline will be furnished by instructor as different options are available.

CS-5538 Software Engineering Ontologies (3)

Ontology Engineering: Principles, Methods, Tools, and Languages, Using Ontologies in Software Engineering, Development of Ontologies for SWEBOK (Software Engineering Body of Knowledge): Issues and Techniques, Some Ontologies for Software Development: Ontologies

for Requirements, Design, Maintenance, Measurements, Use of Ontologies in Domain Oriented Software Development Environments, Comparative Study of Semantics Coverage in Ontologies as per SWEBOK, Alignment of Different Available Ontologies.

CS-5539 Semantic Web Enabled Software Engineering (3)

This course will cover: Semantic web introduction, Metadata, metadata standards, XML+metadata specification, RDF and metadata processing, OWL. Semantic application. Classification and semantic metadata extraction techniques. Current problems and research possibilities.

CS-5540 Model Driven Software Development (3)

This course will cover: Models, Modeling, and Model-Driven Architecture (MDA). Basic Ideas and terminology, MDSD concept and terminology, Architecture centric MDSD, Generative Programming, Data driven development, Agile software development, Metamodeling, MDSD-capable target architecture, Building domain architectures, code generation techniques, Model Transformation, MDA standards, testing, versioning. Current research topics as decided by instructor.

CS-5541 Web Engineering (3)

This course will cover: Web engineering introduction, Requirements engineering for Web applications, design methods and technologies, interface design, usability of web applications, accessibility, testing, metrics, operation and maintenance of Web applications, security, and project management. Specific technologies covered in this course include client-side (XHTML, JavaScript, and CSS) and server-side (PHP, JSP and servlets). Data driven technologies using MySQL.

CS-5542 Software Testing (3)

This course will cover: Faults, Failures, and their Costs, Oracles and Principles, Model Based Testing , Models, Finite State Machines, Decision Tables & Markov Chains, Design and Unit testing, Design Metrics, Static Analysis, Domain, Coverage, Integration Testing, System Testing 1: Functional, Negative, Scenario, Mutation, Measuring and Monitoring the Test Process, Security & Reliability Testing , Regression, Performance, and Web Application Testing, Test Planning, Automated Software Testing, Search Based Software Testing.

CS-5543 Advanced Topics in Software Engg; (3)

The contents of this course will be developed by the instructor based on the emerging topics of interest and active research in the said area.

CS-5550 Computer Security (3)

The course will cover basic Information Security Concepts; (CIA) Confidentiality, Integrity, Availability. Security policies and mechanisms., Cryptology; Conventional encryption techniques, Transposition/Substitution, Caesar Cipher, Symmetric and asymmetric crypto primitives, Hash functions. Secret Key Cryptography; DES, AES algorithms. Message Digests. Public Key Cryptography, RSA, Selection of public and private keys. Authentication: identification & authentication, Passwords, Challenge-response, Biometrics, authentication protocols, Kerberos. Access Control Mechanisms; Access Control Lists, Capabilities. Digital Signatures. Security Technology; Firewalls, VPNs, Intrusion Detection and Prevention Systems. Security design principles: least-privilege, Malicious logic: Trojan horses, viruses, boot sector and executable infectors, worms, logic bombs and defenses against them.

CS-5551 Advanced Network Security (3)

This course will cover: Introduction to Networking and Computer Security, Cryptography concepts, The Threat Environment: Attackers and their Attacks. TCP Handshake, IP Spoofing & SYN Flood, Phishing attacks, Distributed DoS (DDoS) Attacks, Prevention and Detection, VPN, SSL/TLS, WAN Security, Ethernet Security, Wireless Security. IP Security, IPSec architecture & concepts, IPSec authentication header, IPSec encapsulating security payload, Key Management –Concepts, Manual Exchange, Internet Key Exchange, IP Security, Access Controls: Org and Human Controls, Physical Access and Security, Biometric Authentication, Cryptographic Authentication, Authorization, Central Authentication, Intrusion Detection Systems, Intrusion Detection: Theory (signature, anomaly, deep- packet inspection), Intrusion prevention systems, Web Application Security.

CS-5552 Security Management (3)

This course will cover: Assessing and managing security risks, Developing security policies and plans, Evaluating, validating and certifying the security of IT operations and systems, User authentication and privilege management, Ongoing security management and governance, Information Security Management Systems (ISMS) and International standards and requirements, including ISO/IEC27001: Information Security, COBIT and Sarbanes-Oxley. Risk assessment, risk valuation, risk treatment, residual risk, Managing for changes in technologies, environments and business needs, Social engineering (attack, techniques and defences),

CS-5553 Security in Mobile and Wireless Networks (3)

This course will cover: Introduction to wireless networks security, Analysis of threats and application requirements, Wireless networks security components, Security services in wireless and mobile networks: authentication, authorization, data confidentiality, data integrity and access control, Security infrastructure for wireless mobile networks: keys and certificate management, Secure group applications, Security of mobile code.

CS-5554 Applied Cryptography (3)

This course will cover: Classical cipher systems: Cryptography and Cryptanalysis, Transposition ciphers, Substitution ciphers, Rotor machines, enigma machine, cryptanalysis of mono-alphabetic, polyalphabetic substitution ciphers, Number theory. Secret-key cryptography: Block ciphers, Stream ciphers, Block Ciphers Shannon's Theory, Perfect Secrecy, Entropy. Pseudo-Random- Sequence Generators and Stream Ciphers-Linear Feedback Shift Registers, Nonlinear Filtering Functions, Design and Analysis of Stream Ciphers, Stream Ciphers. Public key Cryptography- RSA algorithm, The Rabin Cryptosystem, Discrete Logarithm Algorithms in Practice, Probabilistic public key encryption, Digital Signature and Authentications Threats, Authentication, Examples of signatures, Handshaking, RSA Signature system, Elgamal signature scheme and DSS, quadratic residue signature scheme, ECDSA, Message Authentication Codes, Hash Functions, Security of Hash Functions, MD5 message Digest algorithm, Secure Hash Algorithm. Integrity and authentication-Hash functions (MD5, SHA-1), Message-authentication codes.

CS-5555 Ethical Hacking (3)

This course will cover: the types of ethical hacking technologies, stages and classification of ethical hacking, vulnerability research and implications of hacking. Footprinting and social engineering, social engineering concepts, attacks, phishing attacks, online scams. Scanning and Enumeration: Port/Network Scanning, Vulnerability

Scanning, Ping Sweep techniques, proxy servers, IP spoofing and HTTP tunneling. System Hacking: Password cracking techniques, Password cracking countermeasures, Escalating Privileges, Buffer Overflow Attacks. Sniffing, Web Application vulnerabilities, Wireless Hacking, Penetration Testing Methodologies, Automated Penetration Testing Tools.

CS-5556 Software Engineering & Security Architecture (3)

This course will cover: known software vulnerabilities, different stages of the software development cycle to measures that can suitably alleviate software vulnerabilities. Assurance criteria evaluation methods are primarily represented by The Common Criteria. In order to gain a broad understanding of the method it is presented through several complementary perspectives. Software protection techniques, Software vulnerabilities and exploits, Buffer overflows, format strings vulnerabilities, Web application security (SQL injection, Cross-Site-Scripting, path traversal), Semantic web security

CS-5557 Database Security (3)

This course will cover: Database Implementation, Database Security Issues, Access Control and Encryption, Access control mechanisms, Access hierarchies, Access control lists (ACLs), Capabilities. Access control techniques, Discretionary access control (DAC), Mandatory access control (MAC), Lattice-based access control (LBAC), Role-based access control (RBAC), Information flow controls, Bell-LaPadula model, Biba integrity model, Clark-Wilson model, Chinese Wall model, Database security, Statistical database model, Inference control mechanisms, Methods of attack, Mechanisms that restrict statistics. Mechanisms that add noise, Security in object-oriented database systems.

CS-5558 Digital Forensics (3)

This course will cover: Computer Crime, legislation, enforcement, Computer Investigation Process, Initial Response Procedure, Computer Security Incident Response Teams, Computer Forensic Labs, Understanding File Systems and Hard Disks, Understanding Digital Media Devices, Windows, Linux and Macintosh Boot Processes, Windows Forensics, Linux Forensics, Data Acquisition and Duplication, Computer Forensic Tools (software, hardware, EnCase), Recovering Deleted Files and Deleted partitions, Image Files Forensics, Professional Ethics and codes of conduct, Advanced topics (Steganography, Application Password Crackers, Network Forensics & Investigating Logs).

CS-5559 Theory of Information (3)

This course will cover: Probability Theory, Random Processes, Information Theory and Measurement, Introduction, Uncertainty, Information, and Entropy, Joint and conditional entropy, Source-Coding Theorem, Data Compaction, Huffman Coding, Lempel-Ziv Coding, Discrete Memoryless Channels (DMC), Mutual Information, Channel Capacity, memory-less symmetric channels, erasure channels, Channel Coding Theorem, Information Capacity Theorem

CS-5560 Advanced Topics in Information & Comm. Security (3)

The contents of this course will be developed by the instructor based on the emerging topics of interest and active research in the said area.

CS-5561 Web Security (3)

The aim of the course is to study the principles/methods and current technologies in web security, vulnerability analysis, security testing and protection approaches for web applications and services. The course will mainly cover

the following topicsWeb Security: SSL/TLS, Vulnerabilities Analysis, OWASP Top 10 vulnerabilities, SQL Injection techniques and protection mechanisms, XML Injection, Cross-site Scripting and protection mechanisms, Security Testing: Objectives, scope/coverage, security testing tools, fuzzing, white-box testing, black-box testing, penetration testing, search-based security testing techniques, human factor. Blockchain security, Ransomware. Software Security: Security in software development life cycle, buffer overflows and countermeasures, input problems.

CS-5570 Parallel Processing (3)

This course will cover: Introduction to Parallel Processing, Introduction to Parallel Algorithms and its complexity, Parallel Processing architectures, SIMD and MIMD architectures, Shared memory and Distributed memory based architectures, Interconnect networks, Parallel Algorithms design strategies and development, Performance and reliability of Parallel Processing, Applications of Parallel Processing: Distributed Systems, Clusters and Grids, Mapping of sequential programs to parallel architectures, Data dependencies and parallelism, Parallel Programming concepts, Parallel Languages.

CS-5571 Distributed Systems (3)

This course will cover: architectures, processes, communication, naming, coordination, consistency and replication, fault tolerance, security.

CS-5572 Cloud Computing (3)

This course will cover: Introduction to Clouds, Evolution, Emerging Technologies Hype Cycle, Characteristics, Multiple Cloud Environments, Cloud Deployment Models/Types, Private, Public, Community, Hybrid, Cloud Owner Classification, Public, Private, Architecture, Virtualization, Platform Virtualization, Resource Virtualization, Virtualization in Practice, Virtual Infrastructures, Virtual Machines, Virtual Switches, VMware VSphere, Vsphere Networking, Clusters, Monitoring Virtual Data Centers, High Availability and Fault Tolerance, Cloud Service Stack, Every-thing-as-a-Service(XaaS), Software-as-a-Service, Platform-as-a-Service, Infrastructure-as-a-Service, Utility Computing and Service Oriented Computing, Cloud Computing vs Grid Computing, Cloud Providers, Cloud Applications, Map Reduce Technique, Cloud Roadmap, Research Challenges, Adoption by H/W and S/W providers, Mile stones in Cloud Quick-start, Level 1: Web Architecture, Level 2: Self-Service Architecture, Level 3: Dynamic Infrastructure, Case Studies, Amazon Web Services, Amazon EC2, Hadoop, Microsoft's Azure Infrastructure, Google's Big Table and DFS etc, Additional Topics

CS-5573 Distributed Computing Paradigms (3)

This course will cover: Introduction to Distributed Computing, Peer-to-Peer Computing, Client/Server Computing, Utility Computing, Cluster Computing, High Performance Computing, Grid Computing, Cloud Computing, Autonomous Computing, Ubiquitous Computing, Pervasive Computing, Mobile Computing, Green Computing, Characteristics, Architecture, Application and Examples from each Paradigms, Comparison of Paradigms and Scenarios for best option.

CS-5574 Virtual Organizations (3)

This course will cover: Characteristics, Types, Formal, Informal, Static, Dynamic, Permanent, Short termed, Profitable, Non-Profitable, Life Cycle , Creation, Maintenance, Management, Creation from Scratch, Pilot Approach, Application in different Domains (Weather Forecasting, Cancer Research, E-learning, Computational Science, Social Networks etc). Stakeholders, Trust Management, Business Models, Technological Aspects,

Social Aspects, Platform Support, Case Studies: LEAD, N2Grid, etc, Additional Topics

CS-5575 Grid Computing (3)

This course will cover: Background, Distributed Systems, Web services, Utility Computing, Service Oriented Architectures, Grid technology (background), Concepts, Architectures, Services, Protocols, The Open Grid Forum, International Grid Trust Federation, Computing Platforms, Grid middleware and tools, Legion, Globus, Unicore, Grid Middleware: Globus, Security, Information services, Resource management. Data transfer. Grid Applications, Examples: Physics, Visualization, Bioinformatics etc, Grid Infrastructures, Examples of large scale projects, EU GridLab, EU DataGrid, TeraGrid, E-infrastructures, Programming Languages and Environments, Programming the Grid, Legacy code, Resource management and scheduling: Characterization of resource management problems based on job requirements, characteristics, and availability of resources, Algorithms, tools and sample resource management systems, Sun Grid Engine , Condor-G, Nimrod-G, Performance Aspects on the Grid, Grid related issues, Knowledge Grid, Data Grid, Information Grid, Computational Grid, Grid related issues II, Grid portals, Quality of Service, Grid Economy, Collaboration on the Grid, Clouds, Additional Topics

CS-5576 Advanced topics in Distributed Computing (3)

The contents of this course will be developed by the instructor based on the emerging topics of interest and active research in the said area.

CS5590 Advance Computer Networks (3)

First part of the course focuses on building foundations required to build a network from scratch. Explicitly, a) perspectives on connecting devices to networks, b) internetworking, c) advanced internetworking, and d) end-to-end protocols. Later on, more advanced topics are covered that includes congestion control, resource allocation, Traffic engineering using Multiprotocol label switching (MPLS), Multimedia over the Internet, Network games, Internet measurements and future Internet architectures.

CS-5591 Advanced Topics in Computer Networks (3)

This course will cover: advanced introduction and research perspectives in the areas of switch/router architectures, scheduling for best-effort and guaranteed services, QoS mechanisms and architectures, web protocols and applications, network interface design, optical networking, and network economics. The course also includes a research project in computer networking involving literature survey, critical analysis, and finally, an original and novel research contribution. Overview of packet switching networks and devices. Fundamentals of Internet Protocol (IP) networking. Route lookup algorithms. Router architecture and performance. Detailed operation of Internet routing protocols such as Open Shortest Path First (OSPF) and Border Gateway Protocol (BGP). Integrated and differentiated network service models. Traffic Engineering (TE) concepts and mechanisms including label assignment, label distribution, and constraint-based routing algorithms. Multi-protocol label switching and its generalization. Quality of service mechanisms for multimedia and real-time communications. TE-based routing and signaling protocols. Fundamentals of per-flow and aggregate scheduling algorithms. Application-level and network-level signaling protocols for data, voice, and video communications. Resource signaling and resource reservation protocols. Worst-case analysis for multimedia networking.

CS-5592 Broadband and Satellite communication (3)

This course will cover: History of satellite communications, Overview of the course, Satellite Systems, Orbits and constellations: GEO, MEO and LEO, Satellite space segment, Propagation and satellite links, Satellite Communications Techniques, Modulation and coding techniques, Digital modulation schemes, FEC and ARQ, Multiple Access, On-board processing techniques, Satellite Communications Systems and Applications. INTELSAT systems, VSAT networks, GPS, GEO, MEO and LEO mobile communications, Satellite Communication Payload, Earth Station Technology, Broadband and Multimedia Systems, Spaceway, Teledesic,

CS-5593 Mobile and Pervasive Computing (3)

This course will cover: Introduction and Background, Ubiquitous Data Access, Exploiting Virtual Machines, Resource-Driven Dynamic Adaptation, Sensing and Actuation, Mobile Hardware Technologies, Location and Context Awareness, Security and Privacy, Design Methodologies and Infrastructure, End-to-End Application Considerations.

CS-5594 Wireless Networks (3)

This course will cover: Introduction to Wireless Communication System, First, second and third generation wireless networks (AMPS, GSM, GPRS… etc), Network layer issues and protocols – Mobile IP, addressing & routing for mobile systems, Wireless LANs: safety, security, cost. Bluetooth technology and applications, WSN (Wireless Sensor Network), RFID (Radio Frequency Identification), Transport and application layer protocols: WAP and beyond. Mobile agents, architectures and configurations. OS for mobile devices (such as Symbian, RIM, Android, Windows Phone, etc.). APIs for mobile devices and mobile communication. Software architectures and middle-ware for mobile enabled distributed systems. Security of mobile computing systems and applications.

CS-5595 Network Administration (3)

This course will cover the major utilities and concepts involved in using current network operating systems. This includes server organization, accounting, administrator duties, user addition, security, shared printing, rights, login scripts, menus and the most common network files and commands. It also covers the three most widely used network platforms: Novell NetWare, Microsoft Windows and Linux. Linux and its installation process are introduced in this course. Linux is a popular, widely used operating system. The class will explore Linux on a PC -- playing the role of a system administrator. Students will also learn how to run a Linux system using the command line and the GUI. They will learn how Linux boots up and shuts down and look at the X Windows system and how to configure and start it. Like other operating systems, Linux can use commands from a shell that is a blank screen with a cursor. The commands are similar in appearance to old-fashioned DOS commands and some programmers swear by this program.

CS5596 Network Performance Evaluation (3)

This is an advanced course in networks and protocols. Analytical, simulation and experimental methods should be used to evaluate and design networks and protocols. Investigate network management tools and techniques. Selection of techniques and metrics, types of workloads, monitors, capacity planning and benchmarking, queuing theory and simulation techniques will be studied.

CS-5610 Advanced Databases (3)

This course will cover: Advanced relational algebra and SQL, Set vs bag semantics, NULL values, Distinct operator, Semi join, left join, right join, SQL constraints and triggers,

Data mining and OLAP operators: Group By, Roll Up, Cube, Pivot, Relationally complete SQL and temporary tables, Distributed databases, Horizontal/vertical fragmentation, Basic distributed query processing, Semi-join query processing, Schema integration, Advanced ER modeling: generalizations, n-ary relationships, look-across and look-here semantics, Alternatives for the translation of an ER schemas into a relational schema, Translation of a relational schema into ER schemas, Translation of between equivalent ER schemas, Schema conforming, merging and improvement, XML for semi-structured data, XML language and its tree representation, XML schema language,XPath/XQuery languages, Translation of an XML schema into a relational schema, Temporal Databases, Valid time and transaction time, Discrete bounded linear flow of time and the temporal structure, US logic and derived model operators, Representation of US logic as a temporal relational algebra,

CS-5611 Multimedia Information Systems (3)

This course will cover: Definitions and components of Multimedia, Brain vs. Computer, Multimedia Applications, Multimedia Systems, Standards and Tools, Multimedia Delivery Methods, Multimedia on the Internet, Emerging Technologies, Multimedia Application Development, Sensations and Attention, Color and Constancy, Perceiving Objects, Space & Movement, Sound, Language & Thought, Interactivity, Learning

CS-5612 Distributed Database systems (3)

This course will cover: Distributed Databases Basics, Distributed Databases: What and Why? ; the Distributed Database Management Systems, The Distributed Transparency - - the Reference Architecture for Distributed Databases, Data Fragmentation, Distributed, Transparency for Read-Only and Applications, Distributed Database Access Primitives, Integrity Constraints, Distributed Database Design, Framework for Distributed Database Design, the Database Fragmentation Design, Allocation of Fragments. Translation of Global Queries to Fragment Queries, The Equivalence Transformation for Queries, Transforming Global Queries into Fragment Queries, Distributed Grouping and Aggregate Function Evaluation, Parametric Queries, Optimization Of Access Strategies, Framework for Query Optimization, Join Queries - - use of Semi-Join Programs for Join Queries, the SDD-l Algorithm, the AHY approach, Use of Join as Query Processing Tactic; General Queries - - Effect of Commuting Joins and Unions, Methods for the Optimization of General Queries. The Management of Distributed Transactions, The Framework for Transaction Management; Atomicity of Distributed Transactions; Concurrency Control for Distributed Transactions; Architectural Aspects of Distributed Transactions, Concurrency Control in distributed databases, Foundations of Distributed Concurrency Control; Distributed Deadlocks; Concurrency Control based on Timestamps; Optimistic Methods for Concurrency Control. Distributed Database Administration, Catalog Management in Distributed Databases, Authorization and Protection. The System R *, The Architecture of System R*; Compilation, Execution and Recompilation of Queries; Protocols for Data Definition and Authorization in R*, Transaction and Terminal Management.

CS-5613 Object oriented database systems (3)

This course will cover: The Object Oriented Databases, Object Oriented Databases - What and Why?, the Object Oriented Database Management Systems; Evolution of Object Oriented Concepts; Characteristics of an Object Oriented Data Model; Object Schema; Interobject Relationships; Late and Early Binding; Similarities and

differences between Object Oriented Database Models and other Data models. Object Oriented DBMS Architectural Approaches The Extended Relational Model Approach; Semantic Database Approach; Object Oriented Programming Language Extension Approach; DBMS Generator Approach; the Object Definition Language and the Object Query Language. The Object Oriented DBMS Architectures; Performance Issues in Object Oriented DBMS; Application Selection forObject Oriented DBMS; the Database Design for an Object Relational DBMS. The Structured Typed and ADTs;Extending the ER Model; Storage and Access Methods; Query Processing; Query Optimization; Design and Architecture of POSTGRES; Distributed Computing in CORBA and EJB

CS-5614 Data Mining (3)

This course will cover: Introduction to data mining, Data preprocessing, Data mining knowledge representation, Data mining algorithms (prediction, classification),Decision trees, Bayesian, Back-propagation, Rule-based classification, kNN, Ensemble and Evaluating, Clustering, Partitioning, Hierarchical clustering, Density-based methods, Cluster evaluation, Association rule mining, Apriori, FP-growth

CS-5615 Data Warehousing (3)

This course will cover: The Compelling Need for data warehousing: Escalating Need for strategic information, failures of Past decision-support systems, operational versus decision-support systems, data warehousing – the only viable solution, data warehouse defined, Data warehouse – The building Blocks: Defining Features, data warehouses and data marts, overview of the components, metadata in the data warehouse Defining the business requirements: Dimensional analysis, information packages – a new concept, requirements gathering methods, requirements definition: scope and content, Data warehousing Architecture-source, integration layer, staging area, targets, analysis and reporting, Data modeling-introduction, phases of data modeling, principles of dimensional modeling, STAR schema, multidimensional modeling, Data modeling tools-Erwin, forward engineering, reverse engineering, update model, alter database, Issues in data warehouse planning, design, implementation, and administration are discussed in a seminar format. The role of data warehouse in supporting Decision Support Systems (DSS), OLAP in data warehouse.

CS-5616 Temporal and Spatial Databases (3)

This course will cover: Introduction and motivation, Time ontology, structure, and granularity, Temporal data models, Temporal relational algebras, Temporal query languages, Algorithms for temporal join and aggregation, Spatial databases and data models, Logical geographic data models for spatial databases, including vector and raster model, Physical data storage, data access methods, query processing and optimization, Design conceptual data models for spatial databases using a ER diagram approach, Process and retrieve geographic data from spatial databases using OGIS/SQL1999 interface and other specific interface (SDK) from database vendors.

CS-5617 Transaction Processing Systems (3)

This course will cover: Introduction and motivation, Serializability theory, conflict serializable, Examples and page model, concurrency control, index concurrency, recovery, crash recovery, distributed commit protocol, two phase commit, replication, Parallelism, distribution design, federated and multi-databases.

CS-5618 Digital Libraries (3)

This course will cover: Digital libraries – definitions and examples, History of digital libraries, Digital objects –

multimedia and text, Collection development, Digitization, Harvesting, Digital markup, Knowledge representation, Metadata, Architectures and protocols, User behavior and interaction, Usability, DL services, Search engines, Digital reference., Recommender systems, Web publishing, Preservation, Sustainability, DL management, DL evaluation, Legal issues (such as copyright, cost and economic issues, Social issues, Future of DLs, Education for DLs, DL research initiatives.

CS-5619 Advanced Topics in Information Management (3)

The contents of this course will be developed by the instructor based on the emerging topics of interest and active research in the said area.

CS-5630 Machine Learning and Neural Networks (3)

This course will cover: Machine learning, Neural Networks, Density estimation, Supervised learning, Linear and logistic regression, Generative classification models, Multi-layer neural networks, Support vector machines, Multilayer Neural Network, Unsupervised learning, Bayesian belief networks (BBNs), Learning parameters and structure of BBNs, Expectation maximization, Clustering, Dimensionality reduction/feature selection, Feature filtering, Wrapper methods, PCA, Ensemble methods (mixtures of experts, bagging and boosting). Reinforcement Learning.

CS-5631 Decision Support System (3)

This course will cover: Introduction to DSS, Decision Making, Exploring the Range of DSS research, Knowledge Management, Model Oriented DSS, Visualization-oriented DSS, Business intelligence and data warehousing, Web-based & Distributed DSS Architectures, Spatial DSS.

CS-5632 Knowledge Based System (3)

This course will cover: Expert Systems – Introduction, Definition, characteristics, Typical Applications, Example Systems, Components of Expert Systems (Architecture), Knowledge Base, Knowledge Representation, Meta-Knowledge, Inference, Engine, Search Techniques, Reasoning With Uncertainty, User Interface, User Dialog, Explanation, Tutoring, Tools and Environments for Expert System Development, Building an Expert System, Problem Selection, Development Methodology, Knowledge Acquisition, Pitfalls, Evaluation an Expert System, Test Cases, Refinement, Performance, Intelligent Database Systems, Data Models, Active Database Systems, Derivable Attribute Values, Intelligent Information Systems, Blackboard Architecture, Wrapper Architecture, Dependent Agent Architecture, Any additional Topics.

CS-5633 Natural Language Processing (3)

This course will cover: Applications of NLP techniques (MT, grammar checkers, dictation, document generation, NL interfaces), The different analysis levels used for NLP (morpho-lexical, syntactic, semantic, pragmatic) markup (TEI, UNICODE), Finite state automata, Recursive and augmented transition networks, Lexical level, Error-tolerant lexical processing (spelling error correction), Transducers for the design of morphologic analyzers, Features, Towards syntax: Part-of-speech tagging (Brill, HMM), Efficient representations for linguistic resources (lexica, grammars,...): tries and finite-state automata, Syntactic level, Grammars (e.g. Formal/Chomsky hierarchy, dcgs, systemic, case, unification, stochastic), Parsing (top-down, bottom-up, chart (Earley algorithm), CYK algorithm), Automated estimation of probabilistic model parameters (inside-outside algorithm), Data Oriented Parsing, Semantic level, Logical forms, Ambiguity resolution, Semantic networks and parsers, Procedural semantics,

Montague semantics, Vector Space approaches, Distributional Semantics, Pragmatic level, Knowledge representation, Reasoning, Plan/goal recognition, Speech acts/intentions, Belief models, Discourse, Reference, Natural language generation, Content determination, Sentence planning, Surface realization, Other approaches, Statistical/corpus-based NLP, Connectionist NLP.

CS-5634 Human Computer Interaction (3)

This course will cover: Introduction to HCI, Paradigms of Interaction, Interaction Design Basics, HCI in software Process/ Usability Engineering, Design Rules, Evaluation Techniques, Hierarchical Task Analysis, Universal Design/User Support, Cognitive, Communication & Collaboration Models, Groupware and CSCW, Additional Topics, Survey Methods, User Experience, Scenario Based Development Framework, Digital Personas, Story-board, Usability Comparison of Websites, Adaptation of HCI in Conventional Software Life Cycle, HCI and Ubiquitous Computing, Case Studies.

CS-5635 Computer Vision (3)

This course will cover: Concepts behind computer-based recognition and extraction of features from raster images. Applications of vision systems and their limitations. Overview of early, intermediate and high level vision, Segmentation: region splitting and merging; quadtree structures for segmentation; mean and variance pyramids; computing the first and second derivatives of images using the isotropic, Sobel and Laplacian operators; grouping edge points into straight lines by means of the Hough transform; limitations of the Hough transform; parameterization of conic sections. Perceptual grouping: failure of the Hough transform; perceptual criteria; improved Hough transform with perceptual features; grouping line segments into curves. Overview of mammalian vision: experimental results of Hubel and Weisel; analogy to edge point detection and Hough transform; Relaxation labelling of images: detection of image features; Grouping of contours and straight lines into higher order features such as vertices and facets. Depth measurement in images.

CS-5636 Control System and Robotics (3)

This course will cover: Review of classical control analysis methods. Nyquist stability criterion. Classical design using frequency domain methods, phase lead and lag controllers, PID controllers. Relay auto tuning. Introduction to state space methods. State space models, state transformations, solution of the state equations. Controllability and observability. Design using state feedback. LQR design, pole placement, use of observers. Introduction to robotics. Transducers, actuators and robot control.

CS-5637 Advanced Topics in Artificial Intelligence (3)

The contents of this course will be developed by the instructor based on the emerging topics of interest and active research in the said area.

CS-5502 Advanced Operating System (3)

This course will cover: Introduction to OS, Characterization of Modern Operating Systems file systems memory management techniques, Process scheduling and resource management, Process Management Interrupt Handling, Threads System Models, Architecture Models, Distributed System, Characteristics, Design Issues, Distributed Operating Systems, Memory Management and Techniques, No abstraction Model, Abstraction Model, Virtual Memory management, Virtual Memory, Paging, Distributed File System, File Management, Inter process Communication, Message Passing, Issues of Security in Distributed Systems (Partial coverage), Concurrency

Control in Distributed Systems, Problems of coordination and agreement in Distributed Systems, Replication – Advantages and requirements, Fault-tolerant services, Mobile and Ubiquitous Computing, Advances Topics.

CS-5503 Advanced Computer Architecture (3)

This course will cover: Introductory concepts of Computer Architecture, Computer Architecture, Organization, ISA, RISC and CISC, Computational Models, Pipelining, Instruction Set Architecture, ISA and its components, Instruction classification, modes, Performance measures (Execution time, MIPS, MFLOPS, SPEC etc), Example of RISC Computer, Instruction formats, memory maps, assembly code and reverse assembly with example computations, CPU Design, Design and evaluation for modern uniprocessor computing systems, Register Sets and types, ALU design, data path, System bus, Control Unit architecture, Parallel Processing, Parallel Computing/processing, basic concepts, Process models, thread models, Concept of concurrent execution, Parallel execution, Types and level of parallelism, concurrent execution models, multi-tasking, multi-programming, multi-processing, Flyn's Taxonomy (SISD, SIMD, MISD and MIMD), Pipelining and Hazards, Pipelining basics and its characteristics, pipelining hazards (Structural hazards, Data hazards, control hazards), solution of such hazards, advantages/disadvantages of pipelining, Instruction Level Parallelism (ILP), ILP basics, challenges, data dependence and hazards, name dependences, instruction dependence example, control dependences, loop level parallelism, static and dynamic scheduling, Scoreboard and tomasolu algorithm, Superscalar and VLIW processors, Memory Hierarchy design, Cache memory, strategies, operation, performance measures, virtual memory, Input Output (I/O), I/O subsystems, major components of an I/O subsystems, interface, peripherals, memory mapped I/O vs isolated I/O, serial and parallel transfers, Programmed I/O, Interrupt-driver I/O, DMA, I/O buses

CS-5510 Advanced Operations Research (3)

This course's emphasis is on the formulation and application of advanced operations research techniques to problem solving and the theoretical issues involved. Topics that will be covered include: Introduction to Linear and non-linear Programming, Integer programing techniques, Revised Simplex Algorithm, Dimensional Cutting Stock Problem, Dantzig-Wolfe Decomposition Algorithm, Primal-Dual Algorithm, Goal Programming-Formulations, Goal Programming Solutions Complexity of Simplex Algorithm, Integer Programming-Formulations, Solving Zero-One Problems, Cutting Plane Algorithm, Advanced dynamic programming techniques including multiple states in forward node labeling algorithms, stochastic programming, dominance criteria, lower bound estimates, and relaxed dominance criteria for generating approximate solutions, Optimization techniques, multi-objective optimization, Quadratic and other non-linear optimization problems, Sub-gradient optimization, Heuristic methods, heuristics for TSP, Lagrangean relaxation, Network Models, Shortest Path Problem, Successive Shortest Path Problem, Maximum Flow Problem, Minimum Cost Flow Problem, Branch and Bound Algorithms for TSP, Vehicle Routing Problem, Queueing Models, Single Server Queueing Models,

CS-5511 E-Learning Design and Development (3)

This course will cover: Historical background and current trends in E-learning. Concepts and foundations of best practices for successful teaching online. E-learning theory, principles, learning management systems, and web-based technology tools. Engaged Learning in an Online Environment: Advantages of Online Education, Current

Research, Myths and Constraints of Online Teaching and Learning, Methods and Measures to Retain Students Enrolled in Online Education, Learning Theory in the Online Classroom, Trends in E-learning, Introduction to Asynchronous Discussion, Hands on Social Bookmarking, Critical Reflection, Building Learning Communities: Adapting Classroom Based Activities to Cyberspace, Choosing an Effective Communication Tool, Introduction to Moodle (Open Source CMS), Exploration of Blogs and Blogging, Critical Reflection, Activities to Engage Online Learners: Icebreakers, Creating and Facilitating a Discussion Forum, Questioning Strategies, Cooperative Learning, Sharing Web 2.0 Technologies, Critical Reflection, Measuring Online Learning: Student Performance, Course Evaluation, Program Evaluation, Survey and Quiz Technology, Creating Assignments and Assessments, Ethical Use of Digital Resources, Understanding Copyright and Fair Use, Exploration of Podcasting, Information Fluency: Evaluation of Websites, Power Searching Techniques, Critical Reflection, Power Searching: Theory into Practice; Research Project, Self-Paced and Self-Directed Learning, Creating a Personal Search Engine, Peer Feedback Exercise, Critical Reflection, Additional Topics.

CS-5512 Nature-inspired Algorithms (3)

This course will cover: Genetic Algorithms, Non-linear Programming Problem, Foundation of Genetic Algorithms, Metaheuristic Algorithms, Simulated Annealing, Tabu Search, Ant Algorithms, Particle Swarm Optimization, Bee Algorithms, The Other Nature-Inspired Metaheuristic Algorithms, and Application of these algorithms to some common optimization problems.

CS-5513 Semantic Web (3)

This course will cover: Introduction of Semantic Web, Semantic Web Architecture, The semantic web and the role of agents, Semantic Web Tools, Metadata: Syntax, Structure, Semantics, Social web and semantic web, Web 2.0/3.0, Ontology (OWL) and Reasoning on the web, Trust, Ontologies, Ontology languages, XML, RDF (Resource Description Framework), RDFS (RDF Schema), OWL (Web Ontology Language), Ontology Development using Protege editor, Ontology Querying, Ontology Reasoning and Description Logic (DL), Semantic Web Application Areas, Ontology programming with Jena API, Ontology Engg;, Latest trends & Research issues in Semantic Web.

CS-5514 Intelligent User Interfaces (3)

The increasing complexity of software and the proliferation of information makes intelligent user interfaces increasingly important. The promise of interfaces that are knowledgeable, sensitive to our needs, agile, and genuinely useful has motivated research across the world to advance the state of the art and practice in user interfaces that exhibit intelligence. The text covers the topic well.

CS-5515 Digital Signal Processing (3)

This course will cover: One- and N-dimensional signals and systems, Sampling theorem, Discrete-time Fourier transform, discrete Fourier transform, fast Fourier transform, z-transforms: stability and minimum phase signals/systems, Linear filtering of signal: Time domain: Difference equations and convolution, Impulse invariance, bilinear transform, FIR filter design, 2D filter design, Statistical signal processing: Stochastic signals: correlation functions and power density spectra, Optimal filtering: Wiener filters, Adaptive filters: LMS and array processing.

CS-5516 Theory of Programming Languages (3)

This course will cover: the Evolution of Programming Languages, Define Syntax, Define Structure, Define Language Paradigm, Know the different language

paradigms, Appreciate the relevance of this course in his future job, Apply variables, expressions and Statements, Write Concurrent and Functional programs, Complete the course requirements as scheduled.

CS-5517 Advanced Simulation and Modeling (3)

This course will cover: Basic process modeling, Input modeling, probability concepts, Monte carlo techniques, discrete event stochastic models, Markov models, Random number generation, Random variate generation, Finite and infinite horizon simulation, Comparing alternatives, Queuing and inventory models, Entity transfer and material handling, Geographically Distributed Simulation, World reference, Data Management and distribution, Dead reckoning, Time Management in Distributed Simulations, Protocol-based methods (DIS), Infrastructure-based methods (HLA), Live / Virtual / Constructive systems, Real-time modeling, Interoperability (TENA), Hardware-in-the-loop integration, Parallel simulation, Architectures, Conservative time management, Optimistic time management.

CS-5518 Rich Internet Applications (3)

This course will cover: The Rich Internet Application (RIA) Development course concentrates primarily on building rich client web applications in the browser for desktop and mobile devices, the concept and technology evolution regarding the internet applications and the use of interface tools. Mainly, the course can focus on any one of the technologies of modern day, for example, macromedia's FLASH. However, the course will use the concepts of data structures, object oriented programming, programming languages and the software design and engineering to develop projects of medium to large magnitude, technologies like HTML5, jQuery UI & Mobile, and Flex/ActionScript etc. Along with the fundamentals underlying these technologies, several applications will be showcased as case studies

CS-5519 Service Oriented Architectures (3)

This course will cover: XML technologies, basics, name-spaces, navigating XML trees with XPath, XPointer and XLink, validation, transformation and manipulation, Web technologies-HTTP protocol and early web applications, exchanging XML documents using SOAP, Service oriented architectures, technical details, design considerations, physical constraints, parameter passing, XML Considerations, Structure and architecture of SOAP, WSDL and UDDI, Develop registration and discovery techniques for Web services, SOAP Envelope, SOAP over HTTP, SOAP server, deployment descriptor, complex data types, Development and deployment of web services servers-RPC servers, WS-I servers, Generation from WSDL, Perform matchmaking on service oriented architectures, Develop registration and discovery techniques for Web services.

CS-5520 Real Time Operating Systems (3)

This course will cover: The principles of real-time and embedded systems inherent in many hardware platforms and applications being developed for engineering and science as well as for ubiquitous systems, including robotics and manufacturing, interactive and multimedia, immersive and omnipresent applications. Real-time and quality of service system principles, understand real-time operating systems and the resource management and quality of service issues that arise, and construct sample applications on representative platforms. Platforms range from handheld and mobile computers to media and real-time server systems. Platforms may also include specialized systems used in application-specific contexts, such as autonomous robotics, smart sensors, and others.

CS-5521 Advanced Compiler Design (3)

This course will cover: An in-depth study of compiler backend design for high-performance architectures. Topics

include control-flow and data-flow analysis, classical optimization, instruction scheduling, and register allocation. Advanced topics include memory hierarchy management, optimization for instruction-level parallelism, modulo scheduling, predicated and speculative execution. The class focus is processor-specific compilation techniques, thus familiarity with both computer architecture and compilers is recommended.

CS-5650 Online Algorithms and Competitive Analysis (3)

Online vs Offline Problems/Algorithms, Properties of Online Algorithms, Evaluation of Online Algorithms, Competitive Analysis, Max (Min) Search Problem - Reservation Price Policy, Threat-based Algorithms, k-Max (Min) Search problem. Online Portfolio Selection Problem, Paging - Competitive Analysis of different Paging Algorithms including FIFO, LIFO, LRU. List Update Problem, Online Scheduling, Online Optimization with Uncertain Information. Randomization in Online Algorithms.

CS-5651 Energy Efficient Algorithms (3)

Motivation for the Use, Design, Development and Analysis of Energy Efficient Algorithms, Power Down Mechanism (PDM) - PDM in 2 State Machines, PDM in Multiple States Machines, Combine Scheduling and Power Down Mechanism, Minimum Energy Broadcast Problem, Data Aggregation, Dynamic Speed Scaling. Energy Efficient Algorithms in Wireless Sensor Networks. Energy Efficient Algorithms in Cloud Computing.

CS-5652 Algorithm Engineering (3)

Algorithm Engineering (AE) – Motivation, Algorithm Engineering Cycle, External Memory Data Structures and Algorithms, Cache Oblivious Algorithms, Streaming Algorithms, Text Indexing in External Memory, Resilient Data Structures, The Cost of Address Translation.

CS-5653 Combinatorial Optimization (3)

Definition of Combinatorial Optimization, Examples, Approximation Algorithms, Network Flows - Maximum Flow and Minimum Cuts, Knapsack Problem - Greedy Solution, Dynamic Programming Solution, Fully Polynomial Time Approximation Schemes (FPTAS), Set Cover Problem, Satisfiability Problem -Randomized Solution, De-randomization, Scheduling – Make Span Scheduling, List Scheduling, Scheduling on unrelated machines.

CS-5654 Algorithmic Game Theory (3)

Algorithmic game theory – introduction, examples and motivation, Two player's zero sum games, Nash equilibria, Mechanism Design, VCG-mechanisms, Single-minded bidders, Algorithmic mechanism design, Truthful scheduling, Spectrum Auctions, Kidney Exchange, Stable Matching, Selfish Routing and the POA, Network Over-Provisioning, Hierarchy of Equilibrium Concepts, Smooth Games, Best-Case and Strong Nash Equilibria, Best-Response Dynamics, No-Regret Dynamics.

CS-5655 Graph Theory and Social Networks (3)

Introduction, Motivation, Random network models, Network Centrality, Community, Small world network models, optimization, strategic network formation and search, Contagion, opinion formation, coordination and cooperation, applications of SNA.

CS-5656 Advanced Topics in Algorithms (3)

The contents of this course will be developed by the instructor based on the emerging topics of interest and active research in the said area.

CS-5597 Vehicular Networking (3)

Vehicular networking promises to improve the traveling experience on roads. Vehicles and Road-Side-Units (RSUs) with sensing capabilities are now able to collect

information about the road and traffic situations with exceptional detail and ubiquity. As the motor industry aims to equip vehicles with the Dedicated Short Range Communication (DSRC) technology, we may soon experience services of a sustainable Intelligent Transportation Systems (ITS) with an aim to make traveling safer, comfortable and environmentally friendly. The focus of this course is to introduce the communication characteristics of inter-vehicle communication. Importantly, for a field which is attracting increasing commercial interest, you will learn about the future trends of this technology, its problems, and solutions to overcome them.

CS-5598 Research Topics in Mobile and Wireless Networks(3)

This course is primarily research oriented with a possibility of research publication at the end of the semester. This course will educate the students with the mobile and wireless networking research topics, including but not limited to communications, management, security, sensors, and mobile applications. Students will be required to choose a relevant research question (from a list provided by the instructor) and conduct an experimental venture. The course requires the students to indulge in group discussions in order to brainstorm possible solutions to the research questions. The explicit topics are to be determined by the instructor at the time of course offering.

CS-5599 Software Defined Networking (3)

One of the key technologies for a dynamic transformation of the Internet is Software Defined Networking (SDN). The key idea behind a software defined network is to de-couple the control plane and the forwarding plane in order to deploy new and complex solutions more rapidly and without any hardware modification. In this course, the students will learn the fundamental building blocks of a software defined network and the benefits of separating the control and data planes. Through the use of open-source tools/APIs (such as openflow), the students will learn how to program a sample SDN and configure network services using Networks Functions Virtualization (NFVs). Since SDN has become a hot topic in research, the students will also be exposed to relevant and current state-of-the-art research.

CS-5577 Data-intensive Computing Systems (3)

Scalable data processing - MapReduce and systems based on MapReduce, parallel processing, Scalable key-value stores (Amazon Dynamo, Google BigTable, HBase), Processing rapid, high-speed data streams. Indexes - Query plans and operators, Cost-based query optimization. Data Storage - Databases Vs. FileSystems (Google FileSystem, Hadoop Distributed FileSystem), Data layouts (row-stores, column-stores, partitioning, compression). Concurrency control and recovery - Consistency models for data (ACID, Serializability), Write-ahead logging.

CS-5523 Introduction to Bioinformatics (3)

This course provides an introduction to the field of Bioinformatics, an intersection of biology and computing. Fundamental concepts and methods in bioinformatics are discussed in this course. It surveys a wide range of topics including computational sequence analysis, sequence homology searching and motif finding, gene finding and genome annotation, protein structure analysis and modelling, genomics and SNP

analysis, DNA microarrays and gene expression analysis, Proteomics, network/systems biology, and biological knowledge discovery.

CS-5522 Special Topics in Computer Science (3)

The contents of this course will be developed based on the emerging topics of interest and research areas in computer science.

CS-5199 MS (CS) Thesis (6)

CS-6199 PhD (CS) Thesis (1-9)

National Institute of

Urban Infrastructure Planning (NIUIP)

NIUIP was established in December 2010 with Higher Education Commission (HEC) funding. It is committed to promote sustainable urban development in Pakistan, and apply research in combating challenges being faced by rapidly growing urban centers in the country. NIUIP is the first dedicated institute for Urban Infrastructure Planning and Engineering in Pakistan. NIUIP is playing a central role in responding to the challenges of service delivery and infrastructure planning and engineering in key areas such as Water Supply and Sanitation, Waste Management, Land Use and Transportation Systems, Energy and Environment, and GIS Modeling.

NIUIP is equipped with state of the art technologies and equipment such as satellite imagery, simulation modeling for water supply and sewerage systems, Oracle Database software, GPS and remote sensing tools, digital plotters, fully equipped GIS lab with GIS scanners and GIS software, statistical analysis software, and a fully equipped Library.

DIRECTOR

Prof. Dr. Rashid Rehan	Ph.D. (Canada)

PROFESSOR

Prof. Dr. Rashid Rehan	Ph.D. (Canada)

ASSISTANT PROFESSORS

Dr. Salman Saeed	Ph.D (Canada)
Dr. Muhammad Sagheer Aslam	Ph.D (Canada)
Dr. Fayaz Ahmad Khan	Ph.D (UK)
Dr. Zawar Hussain Khan	Ph.D. (Canada)
Dr. Ghousia Saeed	Ph.D (UK)
Dr. Yasir Irfan Badrashi	Ph.D (Pak)

LECTURER

Dr. Afed Ullah	Ph.D (China)

OBJECTIVES

- To develop it into a center of excellence for teaching, research, and training in urban infrastructure planning in Pakistan.
- To conduct research in emerging trends in urban planning and management.
- To identify and disseminate global best practices in urban planning and management.
- To develop national and international strategic partnerships for collaborative research.
- To train in-service professionals in government and non-government organizations in urban infrastructure planning.

PROFESSIONAL AND ADVISORY SERVICES

NIUIP is active in providing advisory and consultancy services on urban infrastructure project planning initiatives in Pakistan. NIUIP is striving to act as a think-tank for important policy making and regulatory issues, and standards for urban planning projects. NIUIP provides services in:

- Master planning of water supply systems.
- Master planning of sewerage systems.
- Transportation planning.
- Best management practices in urban watershed management
- Low cost waste disposal systems.
- Environmental issues and regulatory compliance.
- Storm water system design.
- Condition assessment and asset management of water & sewerage facilities.

AREAS OF RESEARCH AND STUDY

In addition to the core courses, students seeking post-graduate degreeat NIUIP (infrastructure engineering degree or infrastructure planning degree) will have the option to select a specialized area of research and study. Accordingly, elective courses and research thesis can be selected from the following areas of specializations:

- Infrastructure Planning
- Urban & Regional Planning
- Urban Hydrology and Hydraulics
- Land use Planning.
- Urban Transportation Planning.
- Urban Environment and Energy planning.
- Water Supply and Sanitation.
- Solid Waste Management.
- Spatial Modeling and GIS.
- GIS Application to Infrastructure Projects.
- Infrastructure Development and Finance.
- Infrastructure Utilities Planning & Service Delivery

NIUIP OFFERS

- M.Sc and Ph.D. Degree programmes in:
  - ❖ Urban Infrastructure Engineering
  - ❖ Urban Infrastructure Planning & Management

ELIGIBILITY CRITERIA FOR MSc. URBAN INFRASTRUCTURE ENGINEERING DEGREE PROGRAMME:

Bachelor's degree in any of the following disciplines:

- Civil Engineering,
- Transportation Engineering
- Water resource Engineering
- Sanitary Engineering
- Environmental Engineering
- Geoinformatics Engineering

URBAN INFRASTRUCTURE ENGINEERING

LIST OF APPROVED COURSES

Thematic Area*	Code	CourseTitle
A	UIE 5801	Water Supply Systems
	UIE 5802	Sewerage Systems
	UIE 5807	Urban Watershed Management
	UIE 5814	Energy and Water Conservation Planning & Management
	UIE 5818	Water, Sanitation and Hygiene in Emergencies
B	UIE 5805	Intelligent Transportation Systems
	UIE 5806	Urban Traffic Management
	UIE 5810	Transportation Planning
	UIE 5816	Vehicular Traffic Flow Dynamics
	UIE 5817	Pedestrian Traffic Flow Dynamics
C	UIE 5804	Computer-Aided Infrastructure Design, Construction & Management
	UIE 5808	Infrastructure Condition Assessment
	UIE 5809	Infrastructure Asset Management
	UIE 5811	Application of GIS/RS for Urban Infrastructure Planning & Management
	UIE 5815	Dynamics of Urban Infrastructure Systems
	UIP 5819	Sustainable Urban Infrastructure Planning & Management
D	UIE 5803	Operation and Maintenance of Bridges and Building Infrastructure
	UIE 5812	Disaster Preparedness & Management
	UIP 5824	Quantitative Methods and Statistics in Planning
	CE 5144	Solid Waste Management
	CE 5117	Engineering Contracts & Tendering Process
	UIE 5890	Special Topics
	UIE 5899	Master's Thesis(6)**
	UIE 6899	PhD Thesis (9)

**Mandatory

*Masters students are required to take at least one course from each of the above courses groups. Contents of courses bearing codes UIP and CE are in the respective sections of the prospectus on Urban Infrastructure Planning & Management and Civil Engineering programs, respectively.

UIE 5801: WATER SUPPLY SYSTEMS (3)

Process Technology covering water chemistry, water microbiology and process technology. World Health Organization standards and National Environmental Quality Standards for drinking water.Groundwater Resources and Treatment, water quality and treatment, including conventional and advanced groundwater treatment. Surface Water Treatment: water quality of lakes and rivers, bank filtration, coagulation and flocculation processes, chlorination and advanced disinfection. Water Treatment Processes and Plants: surface water collection and storage, water treatment processes and plants, operation and maintenance of water treatment plants, process and quality control.Water Transport and Distribution: introduction to water transport and distribution, pumping stations, urban water demand management, design of water supply networks, operation and maintenance of water supply systems, management of groundwater and surface water resources.

Recommended Books

1. Water Supply and Pollution Control by Warren Viessman Jr., Mark J. Hammer, Paul A. Chadik, Elizabeth M. Perez, 8th edition, Prentice Hall , June 2008, ISBN-13: 9780132337175

2. Water Distribution Modeling, Thomas M. Walski, Donald V. Chase, and Dragan A. Savic, Haestad Methods Inc. / Bentley Institute Press, 2001.

UIE 5802: SEWERAGE SYSTEMS (3)

Urban Drainage and Sewerage: urban drainage types and characteristics, urban drainage systems, determination of inputs to urban drainage systems, hydraulics of sewer systems, modeling of urban drainage hydraulics and urban drainage design. Waste Water Treatment Process Design and Engineering: sewage characterization, primary treatment, secondary treatment, state-of-the art technologies, sludge treatment and disposal, sludge characterization, sewage and sludge treatment in practice. Modeling and Industrial Waste Water Treatment: modeling of activated sludge waste water treatment, and industrial effluent (characterization, minimization and treatment options). Sustainable Waste Water Treatment and Re-use: anaerobic waste water treatment, natural systems for waste water treatment, and waste water re-use.

Recommended Books

1. Grigg, N.S "Water, Wastewater, and Storm-water Infrastructure Management" CRC Publishers
2. Design and Construction of Urban Stormwater Management System, (Manual of Practice No.77), ASCE Press, Reston, VA, 1993.
3. Wastewater Collection Systems Modeling and Design, by Thomas M. Walski, Thomas E. Barnard, LaVere B. Merritt, Eric Harold, Noah Walker, Brian E. Whitman, Haestad Methods Inc/ Bentley Institute Press.

UIE 5803: OPERATION AND MAINTENANCE OF BRIDGES AND BUILDING INFRASTRUCTURE (3)

Causes of damage/deterioration, Traffic and environmental information, historical design and construction data, Inspection, levels of inspection, visual, non-destructive testing, sample selection, Bridge assessment, risk analysis and reliability analysis, Theoretical analysis, Static and dynamic load testing, material properties and relationship to capacity, relationship between bridge deterioration and reduced load capacity. Bridge condition assessment and rating, performance measures and technology used in condition and inventory data collection, Bridge information and management systems, whole of life costing and other economic considerations, maintenance, rehabilitation and replacement, reliability based assessment and management, Bridge deteriorations models under different loading and environmental conditions.

Recommended Books

1. Bridge Engineering: Design, Rehabilitation, and Maintenance of Modern Highway Bridges by Demetrios E. Tonias
2. Building Maintenance Management by Barrie Chanter and Peter Swallow, Wiley-Blackwell; 2 edition (September 4, 2007), ISBN-10: 1405135069

UIE 5804: COMPUTER-AIDED INFRASTRUCTURE DESIGN, CONSTRUCTION AND MANAGEMENT (3)

Introduction to various CAD environments for infrastructure design, construction and maintenance, Application

of building information modeling approach for effective design/ build/operation and maintenance of infrastructure, integrating GPS/total station surveying data in civil engineering design, computer aided hydrological design, graphical presentation of design using multi-color coding schemes, civil infrastructure inspections using 3d computer simulations.

Software Used: AutoCAD Civil 3D

UIE 5805: INTELLIGENT TRANSPORT SYSTEMS (3)

Basic Concepts, background, Application areas of Intelligent Transport Systems (ITS), ITS technologies; Information, communication and sensor technologies; Urban Traffic control, Discrete time optimization, Incident detection and congestion monitoring, dynamic driver information, Advanced Traffic Management Systems, Advanced Traveler Information Systems, Advanced Vehicle Control System, Commercial Vehicle Operations, Advanced Public Transport System, Electronic Payment System, Security and Emergency Response System. Working mechanism or ITS, Data acquisition. ITS architecture and standardization; ITS benefits and cost, myths and realities, implementation strategies, financing and contracts, Public-Private partnerships.Case study of ITS From Transitional economies to developing countries, India China, Brazil, Iran, South Korea, Chili etc.

Recommended Books

1. Ian Catling (1993) Advanced Technology For Road Transport ;IVIHS and ATT, Boston London (ISBN 0-89006-613-2)
2. John C. Miles, Kan Chen (ed.) 2004 The Intelligent Transport Systems Handbook, Thomson Press India.
3. EvangelosBekiaris (ed .et a1) (2004) Economic Impacts of intelligent Transportation system, Elsevier (ISBN 0-7623-0978-4)
4. Intelligent Transportation Realizing the Benefits (proceedings of 1996 Annual Meeting of ITS America.

UIE 5806: URBAN TRAFFIC MANAGEMENT (3)

Traffic Management definition, Basic principles of traffic flow road hierarchy, Key road traffic management issues, Congestion, Supply side remedies, Demand side remedies; Safety, Road accidents detection and prevention, Education, Enforcement and geometric design of various road elements; Traffic management and Environment.

Network optimization principles and tools namely, one-way traffic flows, area wide traffic signal coordination systems and network simulation models; Parking management solutions and techniques; Pedestrian and cycling networks design principles. Light Rail Transit Prospects and Problems:

Arterial roads integrated management solutions;

Public transport priority oriented infrastructure management solutions namely bus lanes etc.; Traffic calming techniques applied both to through roads and to "sensitive" local networks; Reversible lanes solutions; Road pricing, Area Licensing etc.; "Incident" detection and management systems.

Recommended Books

1. Randolph W. Hall (ed.) (2003) Hand book of Transportation Science. Kluwer Academic Publishers
2. Myer Kutz (ed.) 2004, Hand book of Transportation Engineering, McGraw-Hill.
3. Anthon Down (1992) Stuck in Traffic The Lincoln Institute of Land Policy (ISBN 0-8157-1923-X)
4. Georgina Santos (ed.) 2004 Road pricing. Theory And Evidence Elsevier Ltd, ISSBN(0-7623-0968-7)

UIE 5807: URBAN WATERSHED MANAGEMENT (3)

This course is concerned with a basic understanding of watershed management and the underlying associated physical, chemical, and biological systems and processes associated with a watershed. The course will examine watershed management from a scientific/engineering perspective as well as from a policy perspective. The course will briefly touch the hydraulic, hydrologic, and water quality modeling performed in support of watershed management. Other contents include local and international policies and regulations in support of watershed management, watershed assessment, point and non-point sources of pollution, water quality based standards for water bodies, total maximum daily load (TMDL) for water bodies, and development of a watershed management framework for urban watershed.

Recommended Book

1. Watershed: Processes, Assessment, and Management by Paul A. DeBarry, published by Wiley (2004).

UIE 5808: INFRASTRUCTURE CONDITION ASSESSMENT (3)

Types of infrastructure considered will include road pavements, bridges, drainage and sewer systems, and water supply systems. Topics covered will include deterioration through material degradation and effects of the interaction between material properties, traffic loading and environment on pavement deterioration/performance, Pavement distress modes used in performance assessment maintenance and rehabilitation techniques, Technologies/equipment used in condition data collection, multi-laser profiler, non-destructive testing, accelerated load testing, etc; Condition monitoring technologies - indirect and direct, Rehabilitation methods - non-structural, semi-structural and structural.

UIE 5809: INFRASTRUCTURE ASSET MANAGEMENT (3)

Review of the status of civil infrastructure, and analytical methods, tools, data, technologies,

policies and economic/financial frameworks for managing infrastructure systems and facilities as assets. Condition Assessment: Data Needs for Infrastructure Management; Data Collection Technologies for Pavements, Bridges and Sewers. Deterioration Modeling: empirical, mechanistic, deterministic, stochastic, project and network level models. Engineering Economic Analysis: Present worth analysis, Effective interest rates, Perpetual life, Arithmetic and Geometric progressions, Inflation. Project Evaluation: Net Present Value, Benefit/Cost Analysis, Internal Rate of Return, Spreadsheet Financial Functions. Priority Assessment: Ranking Methods Priority Assessment: Mathematical Optimization. Infrastructure and Asset Management Systems/ Softwares. Best Practices in Asset Management.

Recommended Books

1. Infrastructure Management by Hudson, Haas, and WaheedUddin, McGraw Hill, ISBN 0-07-030895-0, 1997
2. International Infrastructure Management Manual, NAMS Group, New Zealand
3. Grigg, Neil, "Infrastructure engineering and management," Wiley, 1988.
4. Water, Wastewater, and Stormwater Infrastructure Management CRC Publishers; 1st edition 2002 Infrastructure Management by Hudson, Haas, and Uddin, McGraw-Hill Publication, N.Y

UIE 5810: TRANSPORTATION PLANNING (3)

Technical and qualitative aspects of the urban transportation planning process, Urban travel characteristics and data collection methods; the urban transportation modeling system, including land use, trip generation, trip distribution, mode choice, and trip assignment models; site traffic impact studies; environmental impacts; project and plan evaluation; and technology options for urban transport. Transportation systems; technological characteristics of transport modes and systems. Land use-transportation inter-relationships. Travel demand forecasting. Planning of public transport systems; Intermediate public transport modes. Traffic flow characteristics; Traffic analyses and design considerations; design of intersections; traffic signals and street lighting; local area traffic management.

Recommended Books

1. Meyer, Michael D. and Eric J. Miller, Urban Transportation, Second Edition, McGraw Hill, New York, 2001.
2. C.S. Papcostas& P.D. Prevedouros, Transportation Engineering and Planning, Prentice-Hall, 2nd Edition
3. Roess, McShane&Prassas, Traffic Engineering, 3rd Edition, Pearson/Prentice-Hall Polytechnic Series, 2004. ISBN # 0-131-42471-8.

UIE 5811: APPLICATION OF GIS/RS FOR URBAN INFRASTRUCTURE PLANNING AND MANAGEMENT (3)

Sources of spatial data and methods of spatial data collection (digital map data, handheld GPS, aerial photography, satellite imagery, etc), processes required to combine various sources of data for spatial analysis; Visualizing urban and regional planning data using GIS, Compiling data using GIS to support Urban, regional and disaster planning, Designing GIS map layouts to support Urban Infrastructure Planning tasks, Analyzing GIS data, Understanding data accuracy issues, understanding key GIS implementation issues.

Recommended Books

1. Juliana Maantay, John Ziegler, and John Pickles (2006) "GIS for the Urban Environment" McGraw Hill
2. AysePamuk (2006)"Mapping Global Cities: GIS Methods in Urban Analysis", ESRI Press

UIE 5812: DISASTER PREPAREDNESS & MANAGEMENT (3)

Visualizing data required for Security/Disaster Planning operations, Preparing disaster scenario maps and warning reports, Preparing, Locating and Protecting Critical Infrastructure, Locate and Protect Impacted Population, Shelter Planning, Preparing Disaster Response and Recovery strategies using GIS and Google Earth, Using vulnerability analysis, multi-hazard mapping, and shelter planning for disaster relief operations, identifying and capturing data necessary for disaster planning and recovery, using of tools such as GIS to support emergency management analysis, Organizing disaster management data.

Recommended Books

1. Introduction to International Disaster Management, by Damon P. Coppola, Butterworth -Heinemann; 1st edition (November 2, 2006) ISBN-10: 0750679824.

UIE 5814: ENERGY AND WATER CONSERVATION PLANNING & MANAGEMENT (3)

This course will reviews the range of energy resources available to humankind, identifies trends in the uses of such resources, examines major problems associated with such trends, and discusses the major policies and organizations that have evolved to address such problems. The course also include the study of energy conservation methods and techniques to reduce environmental pollution problems associated with energy use, including energy auditing, energy management economics, and demand side management. The course will also cover water conservation planning and management including water conservation measures in a watershed management framework, reduction of water losses, and water harvesting.

UIE 5815: DYNAMICS OF URBAN INFRASTRUCTURE SYSTEMS (3)

Introduction to urban dynamics, structure of an urban area, Structure and behaviour of dynamic

systems – basic concepts in System Dynamics, dynamics of stocks and flows; linking feedback with stock and flow structure, Systems Thinking – communicating, learning and acting more effectively in the new Millennium, Tools for Systems Thinking – problem definition and model purpose, building theory with causal loop diagrams, Building the urban growth model – development of infrastructure sector, and the population sector

Recommended Books

1. Urban Dynamics, J. W. Forrester, Pegasus Publications, 2002
2. Business Dynamics – Systems Thinking and Modeling for a Complex World, J. D. Sterman, McGraw-Hill, 2004
3. Modeling the Environment: An Introduction to System Dynamics Models of Environmental Systems, A. Ford, Island Press, 1999

UIE 5816: VEHICULAR TRAFFIC FLOW DYNAMICS (3)

Introduction, Microscopic, Macroscopic, Mesoscopic, Car-Following Model, Traffic Flow Theory, Equilibrium Velocity Distribution(s), Traffic Flow Models, Traffic Flow Theory in one-Dimension, One Equation Model,LWR Model, One Equation Khan-Gulliver model,Two Equation PW Type Models, Zhang Model, Khan-Gulliver model, Numerical Discretization Techniques, Introduction, Formulation of 1-D Numerical Schemes, Numerical Schemes, Lax-Friedrichs Scheme, FORCE Scheme, Roe's Scheme, Godunov's technique, Numerical Discretization, Initial and Boundary Conditions, Ring and Straight Roads, Analysis of One Equation Type Models with Godunov's technique, Simulation Results, PW Type Models Analysis, Conservation Form and Eigenvalues, PW Type Models Description, Simulation Results, and Comparison between the Models

Recommended Books

1. Martin Treiber and Arne Kesting, (2013). Traffic Flow dynamics, Springer-Verlag Berlin Heidelberg, ISBN 978-3-642-32459-8
2. LeVeque, R. J. (1992), “Numerical Methods for Conservation Laws," 2nd. Ed., Lectures in Mathematics, ETH Zurich, BirkhauserVerlag, Basel, Switzerland.
3. Whitham, G. B. (1974), Linear and nonlinear waves, New York: Wiley.
4. Zhang, H. (1998). “A theory of non-equilibrium traffic flow”, Transportation Research Board, 32(7), 485--498.
5. Richards, P. I. (1956). “Shock waves on the highway”, Operations Research, 4(1), 42--51.
6. Harten, A., and Hayman, J. M. (1983). “Self-adjusting grid methods for one dimensional hyperbolic conservation laws”, Journal of Computational Physics, 50, 253-269.

7. Roe, P. L. (1981). “Approximate Riemann solvers, Parameter vectors, and difference schemes.” Journal of Computational Physics, 43(2), 357–-372.

UIE 5817: PEDESTRIAN TRAFFIC FLOW DYNAMICS (3)

Traffic Flow Theory, Introduction, Microscopic, Macroscopic, Mesoscopic, Car-Following Model, Traffic Flow Theory, Flow, Conservation Laws, Velocity–Density Relationship(s), Traffic Flow Models, LWR Model, PW type Models, Zhang Model, Khan-Gulliver models, Crowd Models, Introduction, Traffic Flow Theory in 2-Dimensional, One Equation Crowd Model,, Crowd Dynamic Model, Model Description, Conservation Form and Eigenvalues, PW type Crowd Dynamic Model, Model Description, Conservation Form and Eigenvalues,Derivation of a Macroscopic Model from a Microscopic Model in 2-Dimensional, Conservation Form and Eigenvalues, Comparison between the Models, Linearization, One Equation Crowd Model, PW-Type models, Khan-Gulliver models, Zhang model, Numerical Methods, Introduction, Fundamentals of FVM, Formulation of 2-D Numerical Schemes, Numerical Schemes, Godunov's technique, Lax-Friedrichs Scheme, FORCE Scheme, Roe's Scheme, Simulation, Initial and Boundary Conditions , Simulation Results, One-equation Model, PW-type Model, Khan-Gulliver models

Recommended Books

1. EmilianoCristiani, Benedetto Piccoli, Andrea Tosin, (2014). Multiscale Modeling of Pedestrian Dynamics, Springer, ISBN 978-3-319-06619-6

2. LeVeque, R. J. (1992), “Numerical Methods for Conservation Laws," 2nd. Ed., Lectures in Mathematics, ETH Zurich, BirkhauserVerlag, Basel, Switzerland.

3. Whitham, G. B. (1974), Linear and nonlinear waves, New York: Wiley.

4. Zhang, H. (1998). “A theory of non-equilibrium traffic flow”, Transportation Research Board, 32(7), 485--498.

5. Richards, P. I. (1956). “Shock waves on the highway”, Operations Research, 4(1), 42--51.

6. Harten, A., and Hayman, J. M. (1983). “Self-adjusting grid methods for one dimensional hyperbolic conservation laws”, Journal of Computational Physics, 50, 253-269.

7. Roe, P. L. (1981). “Approximate Riemann solvers, Parameter vectors, and difference schemes.” Journal of Computational Physics, 43(2), 357–-372.

UIE 5818: WATER, SANITATION & HYGIENE IN EMERGENCIES (3)

Introduction to the context and scope of WASH in Emergency, Need for interdisciplinary approach, Principles, tools and skills for coordination in

emergency, Overview of the international legal framework and guiding principles of humanitarian action, Risk management tools, Contingency planning and disaster preparedness, Planning the response – Hygiene, SPHERE and other standards followed by international humanitarian organizations, Emergency planning and management, Decision making, Monitoring and reporting.

Recommended Books

1. Emergency Sanitation: Assessment and Programme Design, P. Harvey, S. Baghri, and B. Reed, WEDC, Loughborough University, United Kingdom, 2002
2. Emergency water sources: Guidelines for selection and treatment. 3rd edition (3rd edn), S. House and B. Reed, WEDC, Loughborough University, United Kingdom, 2004
3. Principles of emergency planning and management. D. Alexander, Terra Publishing, Harpenden, 2002.

UIE 5890: SPECIAL TOPICS (3)

Any subject relevant to Urban Infrastructure Engineering

UIE 5899 MASTER'S THESIS (6)

UIE 6899 PhD THESIS (9)

Urban Infrastructure Planning & Management (Degree Programme)

NIUIP also offers master's degree program in Urban Infrastructure Planning and Management, in addition to the M.Sc degree program in Urban Infrastructure Engineering.

The magnitude and dynamics of urbanization place an enormous burden on organizations responsible for the planning and management of urban regions. The core objectives of urban planning and management are seen as understanding dynamic urban processes and developing effective interventions that contribute to the sustainability of urban development.

The M.Sc. degree program in Urban Infrastructure Planning & Management trains the students in the current practices and research in the field of urban planning and management. Major areas of study and research include:

1. Urban and Regional Planning
2. Environmental Laws in Urban Planning
3. Land Use Regulation and Enforcement
4. Census Data Analysis & Policy Making
5. Urban Housing
6. Urban Economics & Real Estate Markets
7. Sustainable Urban Infrastructure Planning & Management
8. Infrastructure Utilities Planning
9. Urban Development & Design
10. Financing of Infrastructure Projects

ELIGIBILITY CRITERIA FOR M.SC URBAN INFRASTRUCTURE PLANNING & MANAGEMENT DEGREE PROGRAM:

Undergraduate degrees (04 years Bachelors i.e. total of 16 years education) or postgraduate degrees (02 years masters i.e. total of 16 years education) in fields of:

- Architecture
- Town planning
- Urban and regional planning
- Environmental sciences
- Geography

In addition to above mentioned fields the students having Bachelor Degree in any of the following engineering fields are also eligible for M.Sc Urban Infrastructure Planning & Management Degree Program:

- Civil Engineering
- Transportation Engineering
- Water Resource Engineering
- Sanitary Engineering
- Environmental Engineering
- Geoinformatics Engineering
- Agriculture Engineering
- Industrial Engineering
- Engineering Management

LIST OF APPROVED COURSES

S.N	Code	Course Title
1	UIP 5815	Land use Regulation & Enforcement
2	UIP 5816	Census Data Analysis & Policy Making
3	UIP 5817	Urban Housing
4	UIP 5818	Urban Economics & Real Estate Markets
5	UIP 5819	Sustainable Urban Infrastructure Planning & Management
6	UIP 5820	Infrastructure Utilities Planning
7	UIP 5821	Urban Development & Design
8	UIP 5822	Urban & Regional Planning
9	UIP 5823	Environmental Laws & Policy Making
10	UIP 5824	Quantitative Methods & Statistics in Planning
11	UIP 5825	Financing of Infrastructure Projects
12	UIP 5826	Utility Financing & Service Delivery
13	UIP 5827	Urbanization and Urban Sprawl
14	CE 5117	Engineering Contracts & Tendering Process**
15	UIP 5890	Special Topics
16	UIP 5899	Master's Thesis (6)*
17	UIP 6899	PhD Thesis (9)

*Mandatory

**Course contents can be found in the section on Civil Engineering programs

UIP 5815: LAND USE REGULATION AND ENFORCEMENT (3)

The objective of this course is to provide students with the tools that are needed for managing and regulating land use in today's political environment. The roles of planners, citizens, and various units of government will be examined as it relates to regulating land use. The course deals with practical land use planning and regulatory techniques that provide an opportunity for planners to be successful in implementing plans and related ordinances. The course will also provide students with an understanding of the techniques, processes, and strategies of land use planning. Other related topics include land use and urban development regulations and their enforcement, land use zoning regulations, urban land use planning system and infrastructure development system, zoning districts, subdivision control and methods of community building, constitutional and statutory limits on land use regulations, smart growth and other flexible land use strategies and housing and urban redevelopment.

UIP 5816: CENSUS DATA ANALYSIS & POLICY MAKING (3)

This course will focus on the use of census data for growth analysis and related policy making. This course will give students the tools to calculate and compare market-driven growth to vision-driven growth, analyze population projections. Topics covered in the course include census basics, census geography, history of census data in Pakistan, community surveys in support of census, census products, analysis of census data, census data analysis tools, relationship of census

and growth in urban communities both in the past as well as future growth projections. Finally, the course will relate the census data analysis to policy making and how it can be effectively used as a tool to better manage and implement growth and urbanization policies.

UIP 5817: URBAN HOUSING (3)

This course examines the institutional framework within which urban housing services are delivered, and the practical implications of the housing market. It will review the following concepts and examine their application in the production of housing services. Demand factors such as population distribution and household formation, household income, the financial markets and credit, and the impact of these factors on particular groups in the population or categories of households, are included. Supply factors, including land, the organization of the construction industry and efficiency of production will be discussed. Topics such as housing search, pricing, filtering, gentrification, renovation, conservation and market failure will be included. This course will also assess housing policy options and the contributions planners can make to the supply of affordable, adequate and appropriate housing. It presents the many factors influencing the housing market and analyzes public and private initiatives affecting the provision of housing. It shows the interdependence between housing and social service planning and analyzes issues regarding the choices among housing and other social policies.

UIP 5818: URBAN ECONOMICS AND REAL ESTATE MARKETS (3)

This course examines the economic principles involved in land development and planning and other related forces that shape cities. It examines the factors that determine land value and land uses. It presents models of urban spatial structure and discusses issues in land development, planning and taxation. This course is also an introduction to the concepts, planning principles and analytical methods involved in making key decisions regarding real estate markets. This course examines real estate market research, for residential, retail, commercial, and office type real estate. Market analysis and developments are studied through lectures and case study discussions. The course will include evaluation of the investment merits of large, existing income-generating properties and commercial assets of urban areas.

UIP 5819: SUSTAINABLE URBAN INFRASTRUCTURE PLANNING & MANAGEMENT (3)

This course is aimed at an exploration of the interrelationship between land-use planning and infrastructure provision, especially transport, water, sewerage, and solid waste management facilities. It will examine the policy and regulatory frameworks for providing sustainable infrastructure facilities and the associated methodology of

planning and management of such facilities. Focus will be on master planning for such facilities based on land use patterns, population, and long-term planning for urban communities. The course will explore various theories and frameworks used in planning, public affairs, and social sciences for understanding and implementing sustainability as it relates to urban infrastructure.

UIP 5820: INFRASTRUCTURE UTILITIES PLANNING (3)

This course is intended for urban infrastructure planners to study the institutional, management, and policy frameworks for setting up municipal infrastructure utilities that are responsible for providing municipal services for an urban community. These will be studied in the context of improving the efficiency and effectiveness of public works departments and urban municipalities in providing services related to urban infrastructure such as water, sewer, and waste management services. The course will also include an emphasis on public/private partnerships as it relates to planning and setting up such utilities for the provision of urban municipal services. Field visits will be conducted in relevant agencies and authorities of Pakistan such as WASA (water and sewer authority) to study their overall planning and management frameworks.

UIP 5821: URBAN DEVELOPMENT AND DESIGN (3)

This course will introduce basic concepts in urban development and design, nature of urban design with emphasis on the public realm of cities and urban design, urban design processes and procedures. Course also includes the evolving topology of urban design projects, traditional design professions and their products for urban design, architectural design process and its phases including understanding the context, exploring possibilities, and developing the design. Case studies will be carried out to get practical experience of the processes as they relate to urban design.

Recommended Books

1. Urban Design: A Topology of Procedures and Products by Jon Lang (2005)
2. The Urban Design Handbook: Techniques and Working Methods by Urban Design Associates (UDA) (2003)

UIP 5822: URBAN AND REGIONAL PLANNING (3)

Main types of planning tasks including urban management, site selection, impact assessment, and strategic planning, land use theory and land use zoning. Role of urban and regional planning in making decisions about the natural and built environments, Planning techniques and principles to handle important issues such as traffic management, land use controls, and ecologically sustainable development. Reactive and proactive planning, Analysis and presentation of spatial data.

Recommended Books

1. Levy, J.M. (2008) "Contemporary Urban Planning", Prentice Hall, ISBN-10: 0205701116
2. Marshall, T, and Glasson, J. 2007. Regional Planning. Abingdon, Oxfordshire, UK: Routledge.

UIP 5823: ENVIRONMENTAL LAWS & POLICY MAKING (3)

Introduction to Environmental Assessment, Definitions of Environmental Assessment, General Principles and Overview of Environmental Assessment. Introduction to Domestic Environmental Law, pertinent Guidelines of Pakistan Environmental Protection Agency regarding infrastructure projects and National Environmental Quality Standards. Examples of Domestic Environmental Law. Research into Domestic Environmental law. International Environmental Law – Foundations of Environmental Law, Principles of International Environmental Law. Types of Environmental Assessments - Environmental Impact Assessment, Environmental Impact Statement, Risk Assessment/ Risk Analysis, Ecological Risk Assessment, Strategic Environment Assessment, Environmental Audit, Regional Risk Screening, Ecological Impact Assessment, Social Impact Assessments and Statements, Economic and Fiscal Impact Assessment, Health Impact Assessment. The Design and Process of Environmental Assessment – Steps in the Environmental Assessment Process (Scoping, Screening, Alternatives to the Proposal, Collection and Analysis of Information, Public Involvement, Reporting the Findings of the Study, Post Project Analysis) Study design (Baseline Studies, Predicting Impacts, Mitigation Measures), Data Collection and Analysis. Writing Environmental Reports, Examples of Suggested Layouts for Environmental Assessments, Effective Report Writing. Mini Course Project entailing carrying out a small environmental assessment and writing it up as a professional report.

Recommended Books

1. Environmental Assessment in Practice by Owen Harrop and Ashley Nixon, Routledge Publishers, UK, ISBN: 978-0-415-15691-2 2.
2. Environmental Assessment by Ravi K. Jain, L. V. Urban, Gary S. Stacey, Harold E. Balbach, 2 edition (September 13, 2001), ISBN-10: 0071370080

UIP 5824: QUANTITATIVE METHODS AND STATISTICS IN PLANNING (3)

This course introduces students to basic methods of quantitative analysis used by urban and regional planners. It introduces methods for exploring and presenting data, analyzing relationships between variables and testing hypotheses. The course will introduce concepts of fitting data to various statistical models such as linear regression and multiple linear regression models. Students will also become familiar with STATA, statistical analysis software used by planners for such analyses.

UIP 5825: FINANCING OF INFRASTRUCTURE PROJECTS (3)

Fundamentals of Capital Project Financial Planning and Analysis. Concepts of economic and financial returns, cost of capital, discounting, risk and reward, Capital Budgeting in Government and Private Sector. Various Operating and Financing Structures: Government-owned, Privately-owned, and mixed Project Finance Structures. Transportation Finance: Highways and Toll Facilities, Airports, Ports and Terminals. Environmental and Energy Finance: Water supply and sewer, Power Electric/Gas.

Recommended Books

1. Principles of Project Finance by E.R. Yescombe, Academic Press, ISBN-13: 978-0-12-770851-5, June 2002
2. Principles of Project and Infrastructure Finance by Willie Tan ISBN: 978-0-415 41577-4 Published by: Taylor and Francis

UIP 5826: UTILITY FINANCING AND SERVICE DELIVERY (3)

This course is intended for urban infrastructure planners to study the financial and revenue generation frameworks as it relates to utility financing of urban infrastructure utilities that are responsible for providing municipal services for an urban community. Examples of such utilities include those providing water, sewer, and waste management services. These will be studied in the context of improving the efficiency and effectiveness of such utilities and to facilitate the service delivery of such utilities. The course will also include an emphasis on public/private partnerships as it relates to financing such utilities for the provision of urban municipal services and the issues related to the generation of revenues as needed to support the financial sustainability of such utilities. Field visits will be conducted in relevant agencies and authorities of Pakistan such as WASA (water and sewer authority) to study their overall financing and revenue generation frameworks.

UIP 5827: URBANIZATION AND URBAN SPRAWL (3)

Basic concept and definition, Urbanism / Urbanization trends, and its causes; scale & pace of urbanization at national and international level, City and its region; Rural Urban Fringe/Peri-Urban Area, Suburbs, Satellite Town, Metropolitan area, Conurbation, Decentralization/Deconcentration policy in response to urbanization, garden city movement, British new Towns, Planned cities/new towns of Pakistan, Development of Intermediate cities.

Development of slums and squatter settlements and its solutions, Urbanization trends & conditions: Urban growth pattern, components of urban growth, growth of cities. Cities and the environment, Urban Environmental problems, Designing sustainable solution for cities: Lack of co-ordination, land and market information, land use

regulations, Institutional issues, Community participation in plan making, Time horizons & sustainability. Urban problem and challenges, Institution & financial frame work for future development, prospective policy issue with special reference to Pakistan: Future of Pakistani cities

Recommended Books

1. Breese, G. W. (1969). The City in Newly Developing Countries: Readings on Urbanism and Urbanization, Englewood Cliffs, N. J.: Prentice Hall.
2. Brunn, S. D. (2012). Cities of the World: World Regional Urban Development, Rowman& Littlefield Publishers, Inc., Maryland, 5th Edition.

UIP 5890: SPECIAL TOPICS (3)

Any subject relevant to Urban Infrastructure Engineering

UIP 5899 MASTER'S THESIS (6)

UIP 6899 PhD THESIS (9)

Department of
Basic Sciences & Islamiat

The Department of Basic Sciences and Islamiat UET, Peshawar is functioning since 1980, teaching basic sciences and humanities courses to the students in various Engineering and Non-Engineering Departments of the University. The Department launched Postgraduate Degree Programs (MS and PhD) in Applied Mathematics in 2009, since then the Department is producing a high quality of scholars meeting national and international standards who are well versed with the needs of the society. Being a degree awarding and a supporting department, it carries a tremendous amount of teaching and research load simultaneously.

In addition to teach foundation courses to undergraduate students, the Department also offers various courses on postgraduate level, like Mathematical Methods, Numerical Linear Algebra, Applied Functional Analysis, Integral Transforms, Mathematical Modeling, Advanced Fluid Dynamics, Partial Differential Equations, Numerical Solutions of PDEs, Advanced Complex Analysis, Meshless Methods, Mathematical Biology, Non-Linear Dynamics and many more. The Department of Basic Sciences and Islamiat provides opportunities for students to carry out research in different areas of Applied Mathematics. Some of them are: Computational Numerical Analysis, General Relativity & Cosmology, Image Processing, Mathematical Biology, Optimization Techniques, Differential Equations, Fluid Dynamics etc.

The Department of Basic Sciences and Islamiat has highly qualified faculty members, who have got their terminal degrees from national and international prestigious Universities. Mathematical life at the department is very active. It comprises original research, discussions, lectures, and teaching at many levels. Faculty is deeply committed to superior research in mathematics and the scientific excellence of the faculty is well recognized in the mathematical community. Large segments of current mathematical research are represented in the Department by the active research programs and interests of the faculty members. The Department has strengths and pursues original investigations in Computational Mathematics, Numerical Analysis, General Relativity & Cosmology, Image Processing, Mathematical Biology, Modeling and Simulation, Graph Theory, Optimization Techniques, Differential Equations and Fluid Dynamics. The Department has achieved highest productivity in terms of publications in well-reputed international journals, national and international research collaborations, research grants and highest citations among different projects of UET, Peshawar. The Department has research collaborations with many national and international Universities and organizations.

Missions

The basic motive for the mission of the Department of Basic Sciences and Islamiat is, "The discovery of wisdom and transmission of learning".

- The Department aims at providing comprehensive knowledge of basic scientific principles, mathematical tools and developing the personalities of the students in every aspect of life.
- The Department enhances the scientific and critical thinking of the students by providing quality education and making them aware about the fundamental knowledge of core courses of Basic Sciences and humanities.

Dean, Faculty of Architecture, Allied Sciences and Humanities

Prof. Dr. Siraj-ul-Islam

Chairman

Prof. Dr. Amjad Ali	Ph.D. (Pak)

Professors

Prof. Dr. Siraj-ul-Islam	Ph.D. (Pak)
Prof. Dr. Amjad Ali	Ph.D. (Pak)
Prof. Dr. Ali Muhammad	Ph.D. (Pak)

Associate Professors

Dr. Marjan-ud-Din	Ph.D. (Pak)
Dr. Rehan Ali Shah	Ph.D. (Pak)
Dr. Noor Badshah	Ph.D. (UK)

Assistant Professors

Mr. Kifayat Ullah	M.Sc. (Pak)
Mr. Javed Iqbal	M.Phil (Pak)
Dr. Muhammad Humayun	Ph.D. (Pak)
Dr. Iltaf Hussain	Ph.D. (Pak)
Dr. Tufail Ahmed Khan	Ph.D. (Pak)

Lecturers

Dr. Qayyum Shah	Ph.D. (Malaysia)
Mr. Said Anwar Shah	M.Phil (Pak)
Mr. Gul Shed	M.Phil (Pak)
Mr. Atta-ur-Rehman	M.Phil (Pak)
Mr. Jamal Nasir	M.Phil (Pak)
Mr. Iqbal-ud-Din Arif Utman	M.Phil (Pak)
Mr. Haseen Ullah Jan	M.Phil (Pak)
Mr. Ehtram-ul-Haq	M.Phil (Pak)
Miss. Shaista	M.A. (Pak)

Academic Programs

- Master of Science in Mathematics (MS in Mathematics)
- Doctor of Philosophy in Mathematics (PhD in Mathematics)

Laboratories

- Applied Physics
- Applied Mechanics
- Graduate ComputerLaboratory

Research

Faculty is actively involved in research in the areas of Numerical Analysis, General Relativity & Cosmology, Image Processing, Mathematical Biology, Modeling and Simulation, Fluid Dynamics, Applied Physics and Chemistry.

MS DEGREE PROGRAMME IN MATHEMATICS

The MS degree programme in Mathematics at the Department of Basic Sciences & Islamiat, shall extend over a period of atleast two years (4-Semester). A total of 32 credit hours (including 26 credit hours of courses and six credit hours of research) are required to complete the MS (Mathematics) programme. The 26 credit hours from the area of specialization and 2 credit hours of the course "Research Methodology". This course will e registered as credit course.

ELIGIBILITY

1. Candidates seeking admission must have M.Sc in Mathematics (16 years) or BS four years degree from accredited Institutions, securing atleast 60% marks in annual system or atleast CGPA 3 in the semester system.
2. Candidates seeking admission must score atleast 50% minimum marks in ETEA GAT (General) or GRE (General) international.
3. Candidates shall have to pass departmental subject test with 50% minimum marks. Final merit shall be made based on the combined results of ETEA marks and the departmental test.

PH.D. DEGREE PROGRAMME IN MATHEMATICS

Department of Basic Sciences intends to offer Ph.D. programme in the emerging fields of applied/computational mathematics to produce researchers who are competent in terms of research productivity at national and international level.

The general rules and regulations for Ph.D. programme in Mathematics will be as per rules mentioned in the Postgraduate Prospectus.

LIST OF APPROVED COURSES FOR MS PROGRAMME IN MATHEMATICS

The following 12 courses are core courses:

1. BSI-5011 Partial Differential Equations (3)
2. BSI-5025 Mathematical Statistics (3)
3. BSI-5034 Numerical Linear Algebra (3)
4. BSI-5017 Mathematical Modeling and Numerical Simulation
5. BSI-5018 Mathematical Methods (3)
6. BSI-5028 Applied Functional Analysis (3)
7. BSI-5671 Numerical Methods for Partial Differential Equations (3)
8. BSI-5558 Differential Geometry-I (3)
9. BSI-5040 Integral Transform and its Applications (3)
10. BSI-5560 Meshless and other Advanced Numerical Method (3)
11. BSI-5674 Advance Fluid Dynamics (3)
12. BSI-5030 Mathematical Biology (3)

BSI 5011 PARTIAL DIFFERENTIAL EQUATIONS (Core: 3)

Cauchy's Problems for Linear Second Order P.D Equations in n-Independent Variables. Cauchy Kowalewski Theorem. Characteristic surfaces. Adjoint operations, Bicharacteristics. Spherical and Cylindrical Waves. Heat equation, Wave equation, Laplace equation, Maximum-Minimum Principle, Integral Transforms.

Recommended Books:

1. Dennemyer, R., Introduction to Partial Differential Equations and Boundary Value Problems, McGraw-Hill Book Company, 1968.
2. Chester, C.R., Techniques in Partial Differential Equations, McGraw-Hill Book Company, 1971.

BSI 5017 MATHEMATICAL MODELING AND NUMERICAL SIMULATION (Core: 3)

Prerequisites: Nil

Model and its different types, Deterministic models, Statistical models, Stochastic models, Formulation of a model, Laws and conservation principles, Discrete and continuous models, Manipulation into its most respective form, Evaluation of a model. Case studies, Continuum model, Transport phenomena, Diffusion and air pollution models, Microwave heating, Communication and Information technology.

Software Support: MATHEMATICA, LSODE, GNUPLOT, MATLAB.

Recommended Books:

1. R. Aris, Mathematical Modeling Techniques, Dover, 1994.
2. C. L. Dym and E.S, Ivey, Principles of Mathematical Modeling, Academic Press, 1980.
3. M.S Klamkin, Mathematical Modeling: Classroom Notes in Applied Mathematics, SIAm, 1986.
4. A. Friedman and W.Littman, Industrial Mathematics for Undergraduate, SIAM, 1994.
5. Y. C. Fung, A First Course in Continuum Mechanics,

Prentice Hall, 1969.

6. E. N. Lightofoot, Transport Phenomenon and Living Systems, Wiley, 1974.
7. M. Braun, C.S. Coleman and D.A. Drew, Differential Equation Models, Modules in Applied Mathematics, Volume1, Springer Verlag, 1978.

BSI 5018 MATHEMATICAL METHODS (Core: 3)

General solution of Bessel equation, Recurrence relations, Orthogonality of Bessel functions, Modified Bessel functions, Applications. General solution of Legendre equation, Legendre polynomials, Associated Legendre polynomials, Rodrigues formula, Orthogonality of Legendre polynomials, Application. Concept and calculation of Green's function, Approximate Green's function, Green's function method for differential equations, Fourier Series, Generalized Fourier series, Fourier Cosine series, Fourier Sine series, Fourier integrals. Fourier transform, Laplace transform, Z-transform, Hankel transform, Mellin transform. Solution of differential equation by Laplace and Fourier transform methods.

Recommended Books:

1. G.N. Watson, A Treatise on the Theory of Bessel Function, Cambridge University Press, 1944.
2. G.F Roach, Green's Functions, Cambridge University Press, 1995.
3. A. D, Poularikas, The Transforms and Applications – Handbook, CRC Press, 1996.
4. J.W Brown and R. Churchill, Fourier Series and Boundary value problems, McGraw Hill, 1993.

BSI 5020 STATISTICAL DECISION THEORY (3)

Decision functions, Risk functions, Utility and subjective probability, Randomization, Optimal decision rules, Admissibility and completeness, Existence of Bayes decision rules, Existence of minimal complete class, Essential completeness of the class of nonrandomized rules. The minimax theorem. Invariant statistical decision of problem. Multiple decision problems. Sequential Decision problems.

Recommended Books:

1. J.O. Berger, Statistical Decision Theory: Foundations, Concepts and Methods, Springer Verlag, 1980.
2. T.S Fegguson, Mathematical Statistics, Academic Press, 1967.

BSI 5021 PARALLEL ALGORITHMS (3)

Theoretical models of parallel computation: Variants of the PRAM model. Performance of parallel algorithms.

Basic Techniques: Balanced trees, recursive doubling, divide and conquer, partitioning. Pipe lining, Accelerated cascading, symmetry breaking. List ranking, the euler tour techniques, tree contraction. Algorithms for searching, merging and sorting. Graph algorithms: Connected components, coloring. Parallel algorithms on interconnection networks and other architectures. Limits to parallelizability. P-completeness.

Recommended Books:

1. J. O. Berger, Statistical Decision Theory: Foundations, Concepts and Methods, Springer Verlga, 1980.

2. T.S Ferguson, Mathematical Statistics, Academic year Press, 1967.

BSI 5025 MATHEMATICAL STATISTICS (Core: 3)

Univariate probabilistic and deterministic models, Methods of estimation, Composition of confidence intervals and testing, Optimal tests and confidence intervals, Likelihood ratio tests, Linear models, Regression and correlation, Analysis of variance, Analysis of discrete data, Non-parametric models, Decision theory, Markov processes.

Recommended Books:

1. Weatherburn, C.E., "A first Course in Mathematical Statistics" Cambridge University Press. 1968.
2. Freund, J.E. "Mathematical Statistics" Prentice Hall, 1962.
3. Hogg, R.V. and Criag, A.T. "Introduction of Mathematical Statistics," (Fifth edition) Prentice Hall, 1995.
4. Hoel, P.G. "Introduction to Mathematical Statistics," John Wiley and sons. 1984.
5. A. Papoulis, Probability, Random Variables and Stochastic Processes, McGraw Hill, 1985.
6. H.J. Larson, Introduction to Probability Theory and Statistical Inference, 3rd edition, Wiley, 1969.
7. H. Stark and J.W Woods, Probability, Random Processes and Estimation Theory for Engineers, prentice Hall, 1986.
8. Spiegel, M.R. "Probability and Statistics" Schaum's Outline Series, McGraw-Hill. 1982.

BSI 5028 APPLIED FUNCTIONAL ANALYSIS (Core: 3)

Applications to bounded linear functional, Application to submmability of sequences, Numerical Integration and weak* convergence, Banach fixed point theorem and its applications to linear equations, differential equations and integral equations, Unbounded linear operators in quantum mechanics.

Recommended Books:

1. F. Riesz and Nagy "Functional Analysis", Frederick Ungar Publishing Co.1995.
2. E. Kreyszing "Introductory Functional Analysis With Applications", John, Wiley and Sons, New York. 1989.
3. A.E. Taylor "Introduction to Functional Analysis", Wiley International Edition, New York. 1957.

BSI 5029 MULTIGRID METHOD FOR LINEAR AND NON-LINEAR PDES (3)

Stencil Notations for differential operators, Ingredients of Multigrid, Error smoothing procedure, Two-grid cycle, Multigrid components, Linear Multigrid cycle, Full Multigrid (FMG), Local Fourier Analysis (LFA), Solution of Poisson equation in 2D and 3D, Non-linear Multigrid.

Recommended Books:

1. Ulrich Trottenberg and Anton Schuller, Multigrid. Academic Press, Inc., Orlando, FL, USA, 2001.
2. P. Wesseling. An Introduction to Multigrid Methods. John Wiley and Sons, 1992.
3. Ke Chen. Matrix Preconditioning Techniques and Applications. Cambridge University Press, 2005.

BSI 5034 NUMERICAL LINEAR ALGEBRA (Core: 3)

Matrix-Vector operations, Orthogonal vectors and matrices, Matrix and vector norms, Singular value decomposition (SVD), Projectors and QR factorization, Gram-Schmidt orthogonalization process, Householder triangularization, Least- squares problems, Condition numbers, Gaussian elimination and LU factorization, Pivoting and LUP factorization, Stability of Gaussian elimination, Cholesky Factorization, Overview of eigenvalue problems, Reduction to upper- Hessenberg Tridiagonal form, Power and inverse power iteration, QR algorithm without shifts, QR algorithm with shifts, Arnoldi iteration, GMRES method, Lanczos iteration Orthogonal polynomials and Gauss quadrature, Conjugate gradient (CG) method, Bi-Orthogonalization method.

Recommended Books:

1. Lloyd Trefethen and David Bau, Numerical Linear Algebra, SIAM 1997.

BSI 5058 ADVANCED COMPLEX ANALYSIS (Core: 3)

Contour Integration:

Review of Laurent's Series, Zeros of Analytic Functions, Singularities, Poles, Residues at Poles, Cauchy's Residues Theorem with applications. Expansion of Functions and Analytic Continuation" Mittage Leffler's Theorem with applications, The Weierstrasses' Theorem with applications, The Principle of analytic continuation, Reflection Principle. Elliptic function, Doubly periodic functions, Relation between the zeros and poles of an elliptic function, The Weirestrasse's function P(z), Addition theorem, A differential equation for P(z). The Zeta function, Sigma function and their applications.

Recommended Books:

1. L.L. Pennissi, Introduction to Complex Variables, 1976.
2. J.W. Brown and R.V Churcill, Complex Variables and Application, 7th Edition, 2003.
3. D.G. Zil and M.R Cullen, Differential Equations with Boundary Value Problems, 2000.
4. E. Kreyszig, Advanced Engineering Mathematics, 9th Edition, 2006.
5. E.D Rainvulle, Special functions, Macmillan and Co.

BSI 5043 THEORY OF SPLINES AND ITS APPLICATION (3)

Properties of polynomial and piecewise polynomial, or spline, curves, Bernstein polynomials and B-spline functions, De Casteljau and De Boor algorithms, Bezier and B-spline curves, tensor product surfaces.

Recommended Books:

1. Handbook of Splines (Mathematics and Its Applications), Gheorghe Micula, Sanda Micula, 1st edition (1998)

BSI 5040 INTEGRAL TRANSFORM AND ITS APPLICATION (Core:3)

Fourier Transform, Applications to ODEs, Applications to PDEs, Fourier Cosine and Sine Transforms, Applications to PDEs, Multiple Fourier Transforms and Applications, Laplace Transform- Definition and Properties, Convolution, Differentiation and Integration, Inverse Laplace Transform , Watson's

Lemma, Applications of Laplace Transforms to PDEs Solution of BVPs, Application of Joint Laplace and Fourier Transforms, Hankel Transform, Application of Hankel Transform to PDEs Mellin Transform, Application of Mellin Transform to PDEs.

Recommended Books:

1. Integral Transforms for Engineers, by Larry C., Andrews, Bhimsen K. Shivamoggi, (2004)
2. Integral Transforms and Their Applications by B.Davies, 2nd Sub edition (November 1993)

BSI 5057 SPLINE THEORY AND ITS ANALYSIS (3)

Brief review of polynomial interpolation and its limitations, Piecewise linear approximation and piecewise cubic interpolation, Representation of piecewise polynomial functions, The B-spline basis and stable evaluation of splines and B-splines, B-spline series and local spline approximation methods, Spline Interpolation, smoothing and least squares approximation, Surface interpolation by tensor-product splines, Topics in multi-variate splines, box splines, Other topics depending on topics and interests.

Recommended Books:

1. The Theory of Splines and Their Applications Ahlberg, E.N. Nilson, J.L. Walsh, Academic Presss, 28-Jun-1967-Mathematics.

BSI 5030 MATHEMATICAL BIOLOGY (Core:3)

Population dynamics. Growth and spatial spread of organisms. Fisher's equation. Epidemiology - the spread of plagues. Reaction-Diffusion models: Turing mechanism for pattern formation. How the leopard got his spots (and sometimes stripes). Enzyme Kinetics and chemical reactions: Michaelis-Menten theory. Hormone cycles, neuron-firing. Mass transport; Taylor dispersion.

Recommended Books:

1. James D. Murray, Mathematical Biology: I. An Introduction SIAM (2004).
2. Elizabeth S. Allamn, Mathematical models in Biology: An Introduction.

BSI 5558 DIFFERENTIAL GEOMETRY–I (Core:3)

Manifolds: Definition, examples, importance and applications, Tensor and its basic algebra, Dimension of manifold, Tangent and cotangent vectors, Sub manifolds, Topology of manifolds. Tensors: Definition, examples, importance and applications, Tensor and its basic algebra, Differential forms, Tensors and a point. Tensor components, Order and rank of tensors, Tensor filed. Some fundamental operations with tensors, Cotravariant and covariant tensors. Lie Groups, Geodesics, Curvature, Integration on Manifolds: Orientation of Manifolds, Integrals of forms.

Recommended Books:

1. Introduction to smooth manifolds by John M. Lee.
2. Natural operation in Differential Geometry by Ivan Kolar, Peter W. Michor and Jan Slovak.
3. Differential Geometry by Erwin Kreyszig.

BSI 5559 GENERAL RELATIVITY (3)

Manifold Theory: Manifolds, Maps of manifolds, Lie Derivatives, Vectors (Tangent vectors), vector field

(Tangent field), Vector space (tangent space) at a point, Differentiability of vector fields, Classification of some important tensors: symmetric tensors, Classification of 2 spaces in the tangent space, Bivectors and their classification, Classification of second order symmetric tensors, Classification of the Riemann tensors. Petrov classification of the Weyl tensor, Curvature and curvature Collineations. Derivative operators and parallel transport, curvature of more than 2-dimensional manifolds, geodesics and Geodesics equation, Methods for computing curvature, Symmetries in General Relativity: Killing symmetry, Homothetic symmetry, affine symmetry, conformal symmetry, projective symmetry.

Recommended Books:

1. General Relativity by Robert M. Wald.
2. The Large Scale Structure of Space-time by S.W. Hawking and G.F.R. Ellis.
3. Symmetries and Curvature Structure in General Relatively by G.S. Hall.

BSI 5560 MESHLESS AND OTHER ADVANCED NUMERICAL METHOD (Core:3)

Introduction, Meshless methods in science and engineering, Principle of weak and strong formulations, Local and global meshless methods in strong form, Meshless Galerkin methods, Local collocation and Petrov-Galerkin methods, Point interpolation methods, Meshless methods in fluid dynamics problems, Meshless methods for re-constructions of a function. Meshless methods for shells. Combinations of meshless and other numerical methods as well as numerical implementation.

Recommended Books:

1. G.R. Liu, Mesh free methods, CRC Press, Boca raton, 2003.
2. S.N Atluri, S.Shen, The meshless local Petrov-Galerkin method, Tech. Science Press, 2002.
3. M.A Golberg and C.S Chen, Discrete Projection Methods for Integral Equations, Computational Mechanics Publications, Southampton, Boston, 1997.

LIST OF APPROVED Ph.D COURSES

BSI 5671 NUMERICAL METHODS FOR PARTIAL DIFFERENTIAL EQUATIONS (Core: 3)

Numerical methods for Parabolic PDEs; review of finite difference methods, explicit methods, Crank-Nicolson implicit method, Fourier stability methods, alternating directions implicit method, higher level schemes, nonlinear equations, predictor corrector methods, computer problems. Numerical methods for elliptic PDEs; Guass-Seidel method, successive over-relaxation method, rates of convergence, alternating directions implicit method, conjugate gradient method, Galerkin method, irregular regions, artificial boundaries, computer problems. Numerical methods for hyperbolic PDEs; explicit methods, D'Alembert's exact solution, method of characteristics, Lax-Wondroff method, method of artificial viscosity, higher dimensions, Courant-Friedrichs-Lewy condition, computer implementations.

Recommended Books:

1. K.W. Morton and D.F. Mayers, Numerical Solution of Partial Differential Equations, Cambridge University Press, New York, 1994.
2. A.R. Mitchell and D.F Griffiths, The Finite Difference Methods in Partial Differential Equations, Wiley, 1980.

BSI 5672 NUMERICAL GRID GENERATION & FLUID FLOW COMPUTATIONS

Governing equations of fluid dynamics and their various levels of approximation; Numerical methods like FDM, FVM, Meshless Methods; Introduction to geometrical aspects of simple and complex bodies; grid/mesh generation Methods; Algebraic, PDE based mesh generations with examples; Exercises on flow computations.

BSI 5673 NONLINEAR DYNAMICS AND CHAOS

Implications of nonlinearity, dynamics and chaos, The role of dimensionality, One-dimensional systems, One dimensional flow: visualizing the solution space, Stability and fixed points, Linear stability analysis. Existence and uniqueness, Applications and numerical methods, Bifuercations, Saddle-node, transcritical and pitchfork, Flows on the circle, Uniform and non-uniform oscillator, Two dimensional systems, Beyonds linear systems, Phase portraits, topological consequences, fixed points and linearization, Conservative versus dissipative systems, Reversible systems, Limits cycles in non-conservative systems, Chaos, Lorentz system of equations, Fractals.

Recommended Books:

1. Nonlinear Dynamics And Chaos: With Applications to Physics, Biology, Chemistry, and Engineering, by Steven H. Strogatz, Westview Press; 1st edition (2001)

BSI 5674 ADVANCE FLUID DYNAMICS (Core:3)

Review of gradient divergence and curl. Elementary ideas of tensors. Vorticity of fluid, Streamlines and path lines, Steady and unsteady flows, Velocity potential, Vorticity vector, Conservation of mass, Equation of continuity. Equations of motion, Bernoulli's equation. Singularities of flow, Source, Sink, Doublets, Rectilinear vortices. Complex variable method for two-dimensional problems, Complex potentials for various singularities, Circle theorem, Blasuis theorem, Theory of images and its applications to various singularities. Three dimensional flow, Irrotational motion, Weiss's theorem and its applications. Viscous flow, Vorticity dynamics, Vorticity equation, Reynolds number, Stress and strain analysis, Navier-Stokes equation, Boundary layer Equations.

Recommended Books:

1. N. Curle and H. Davies, Modern Fluid Dynanics, Van Nostrand Reinhold, 1966.
2. L. M. Milne Thomson, Theoretical Hydrodynamics, Macmillan and Co., 1960.
3. G.K. Batchelor, An Introduction to Fluid Dynamics, Cambridge University Press, 1993.
4. F. Chorlton, A Text Book of Fluid Dynamics, Von Nostrand Reinhold/CBS, 1985.
5. A.R Patterson, A First Course in Fluid Dynamics, Cambridge University Press, 1992.

BSI 5675 ADVANCE NUMERICAL METHODS

A review of basic methods for the Poisson Equations on regular domain, The finite difference method, the finite element method, the finite volume method, the meshless methods, second order elliptic boundary value equations, A review of qualitative properties, Maximal principle, Existence and uniqueness (existence of classical and weak solution), Regularity (H2 regularity of the solutions for smooth or convex domain). The finite difference method: Basic finite difference schemes, Discrete maximal principle and M-matrices, Error estimates, Boundary treatments. The method of subspace corrections and its convergence properties: Conjugate gradient methods and preconditioning. Monotone schemes and Godunov theorem. Higher order methods, Nonlinear problems.

Recommended Books:

1. Michael T. Heath: Scientific Computing. An Introductory Survey, 2nd Ed McGraw Hill 2002
2. (Optional) Cleve Moler Numerical Computing with MATLAB SIAM books 2004.
3. (Optional) W. Press, S. Teukolsky, W. Vetterling and B. Flannery. Numerical Recipes in C Cambridge University Press, 1966.
4. Schilling, R. and Harris, S. (2000) Applied Numerical Methods for Engineers.
5. Borse, G. (1997) Numerical Methods with MATLAB, ITP Books.
6. Cheney, W. and Kincaid, D. (1999) Numerical Mathematics and Computing (4th Ed.) ITP Books.
7. Alfio Quarteroni, Ricardo Sacco and Fausto Saleri: Numerical Mathematics Springer Verlag, 2000.

BSI 5676 DIGITAL IMAGE PROCESSING (VARIATIONAL)

Introduction to the theory and applications of 2-D signal and image processing: 2-D signals and system analysis, 2-D sampling and quantization, 2-D signals and image transforms, 2-D FIR filter design: image formation; image enhancement; image restoration; image coding; image reconstruction from projections; image compression; color image processing; current applications.

Recommended Books:

1. Variational Methods in Imaging, by Otmar Scherzer, Harald Grossauer.
2. Geometric Partial Differential Equations And Image Analysis, by Guillermo Sapiro
3. Mathematical Problems in Image processing, by Gilles Aubert.

BSI 5677 COMPUTER VISION (VARIATIONAL)

Introduction to the theory and applications of computer vision. Topics include: image representation, image segmentation, image analysis by mathematical morphology, texture, shape analysis and 3D version.

Recommended Books:

1. Robust Computer Vision: Theory and applications by Nicu Sebe, Michael S. Lew
2. Variational, Geometric and level set methods in computer vision by Nikos Paragios, Olivier Faugeras, Tony Chen.

3. Handbook of Mathematical Models in Computer Vision.

BSI 5678 ADVANCED GENERAL RELATIVITY

Einstein's Field Equations and General Relativity, Einstein's Field Equation, The geometry and physics of universe and their relation, Space-time and 4-dimentional manifold, Space-time and Tetrad. Homogenous and Isotropic Cosmology, Some Special solutions of EFE. The Schwarzschild solution, Schwarzschild Vacuum static space time, Derivation of the Schwarzschild solution, Interior solutions, Birkhoffs theorem, Stationary, Axisymmetric Solutions, Spatially homogeneous Cosmologies, Algebraically Special Solutions Perturbations, Singularity, Singularity theorems. Time like and null geodesics, Congruences, Conjugate points, Existence of Maximum Length Curves, Black holes and the cosmic sensor conjecture, General properties of Black Holes, the Charged Kerr Black Hole.

Recommended Books:

1. General Relativity by Robert M. Wald, University of Chicago Press, 1984.
2. The Large Scale Structure of Space-time by S.W. Hawking and G.F.R. Ellis, Cambridge University Press, 2003.
3. Exploring Black Holes: Introduction to General Relativity by John Archibald wheeler.

BSI 5679 RIEMANNIAN GEOMETRY

Differential geometry lies in the heart of modern theoretical physics. In particular, Riemannian geometry, a natural generalization of the familiar geometry of curves and surfaces to arbitrary dimensions, provides the natural framework within which gravitation and particle physics are studied. So differential geometry is not only a subject of great intrinsic interest, but also one with a multitude of practical applications in various other branches of mathematics. Hence differential geometry would be of wide interest, both to pure and applied postgraduate students. The main aim of the course is to give a thorough grounding in the theory of abstract differentiable manifolds and the geometric structure with which they can be quipped, particularly Riemannian metrics.

Recommended Books:

1. S. Gallot et al, Riemannian Geometry, Springer Verlag 1990.
2. T.J. Willmore, Riemannian Geometry, OUP 1993.
3. Y. Choquet-Bruhat et al, Analysis, Manifolds and Physics Part I, North-Holland 1991
4. V. Guillemin et al, Differential Topology, Prentice-Hall 1974

BSI 5092 APPLIED DATA ANALYSIS TECHNIQUES

Introduction to model building Role of assumption, sharpness of inference, application parameter zing the model, parametric models simple, multiple regression model non linear regression model, ridge regression, robust regression. Logistic regression, probit, regression. Estimation (Model based) maximum likelihood estimation, <-estimation Estimation (Methodology based) classical (parametric, semi-perametric, baysien parametric) non-parametric

model, smoothing spline, kernel regression, estimation (Model based) kernel and smoothing methods.

Recommended Books

1. Basic Econometric, Gujarati, 5th Edition.
2. Econometric Analysis, 5th Edition by Greene
3. Applied Multivariate Statistical Analysis, 2nd Edition, W. Hardle.
4. Regression method in biostatistics, Linear, Logistic, Survival model by Eric Vittinghoff, 3rd Edition.

BSI 5090 SPECIAL STUDIES (3)

BSI 5091 RESEARCH METHODOLOGY (3)

BSI 5099 MASTER'S THESIS (6)

BSI 6099 Ph.D. THESIS (1-9)

Department of Architecture

Department of Architecture was established in April 2004 with the commitment to prepare a bunch/ team of trained professionals in the field of architecture and planning to meet the challenges of rapidly modernizing contemporary building construction market in a more efficient yet sustainable manner. Department has not only been fulfilling the needs of Khyber Pakhtunkhwa, but also paying its share to the capital city of Pakistan in terms of providing highly trained young professionals in the specialized areas of architectural design, construction management, digital graphical presentations, and urban design.

The Department aims at playing a central role in responding to the challenges of contemporary building as well as construction industry in key areas like architecture design, urban landscape planning and design, construction project management and sustainable building services. Equipped with modern computer, GIS and material labs, and, an up-to-date library, the Departmentoffers a Postgraduate Degree Program (M. Arch) in the domain of architecture.

MISSION

Department of Architecture envisions providing highly trained professionals in the field of architecture who will play their role in the development of the Country in a challenging scenario of climate change and sustainable utilization of material resources without comprising the satisfaction of human needs at an optimum level and relevant interests of various stakeholders such as institutions, educators and students, members of the practicing profession (IAP), regulatory and registration body (PCATP), building industry, and last but not the least, the society at large.

OBJECTIVES

1. To fulfill the Country's need for high quality manpower in designing, planning and managing the built environment by generating a pool of highly trained and skilled practitioners, researchers, educators and managers of the building industry.
2. To promote the culture of research in the domains of Architecture and Urban Design.
3. To enhance the intellectuals' capacity of creativity and sensitivity.
4. To help boosting the individual' capabilities required for standardized practice of Architecture.
5. To provide an opportunity for students towards specialized education suited to their interest and needs.

FACULTY STRENGTH AND PROFESSIONAL SERVICES

The Department of Architecture has a strength of fourteen regular faculty members including two foreign qualified Ph.D. degree holders, other four currently pursuing their Ph.D. researches in the Country's leading public and private sector universities, and seven master degree holders in various specialties within the domain of architecture.

In addition to the regular faculty, the Department also invites prominent architects and renowned professionals from the field as visiting faculty. The Department has recently initiated "Architecture and Design Office, UET Consults Peshawar" to provide consultancy and advisory services to various relevant professional departments playing their role in the development of the Country. Recently established Research and Development (R&D) section of the Department aims at strengthening the field of architecture by developing an utmost needed culture of research in the young professionals through practically undertaking various research projects in multiple germane specialties.

Dean, Faculty of Architecture, Allied Sciences and Humanities

Prof. Dr. Siraj-ul-Islam

Chairman

Ar. Shahid Mansoor Khan	MURP (Pak)

Assistant Professors

Dr. Ghousia Saeed	Ph.D. (UK)
Ar. Shabbir Ullah Qureshi	M.Arch (Pak)
Ar. Salman Jamil	M.Arch (USA)
Engr. Akhter Munir	M.Sc. (PaK)
Ar. Waqar Khattak	PGD Env. Design (Pak)
Ar. Muhammad Iqbal	M.Sc. (Pak)
Ar. Muhammad Faisal Rehman	M.Sc. (Pak)

Lecturers

Dr. Ubaid Ullah	Ph.D. (South Korea)
Ar. Azmat Ali Khan	M.Arch (Pak)
Engr. IrumNasim	M.Sc. (UK)
Ar. Habibullah Khan	M.Arch. (Pak)
Ar. Tahir Saeed	M.Arch. (Pak)
Ar. Syed Mazhar Ali Shah	M.Arch. (Pak)

M. ARCH. PROGRAM

Department of Architecture offers Master of Architecture (M. Arch.) degree spanning to a duration of minimum three semesters. First two semesters are dedicated to "Core" and "Optional" courses supported with a range of "Elective" courses, whereas the third semester leads towards the maturation of a specialization, based on either an Advanced Architecture Design Studio or a research based "Thesis" in the domain. A total of 40 credit hours are required to complete the Master Degree Program. 33 credit hours of course work shall include a minimum of 09 courses including two Advanced Architecture Design Studios (I and II) each comprising of 06 credit hours, and an "Advanced Architecture Design Studio III" or a research "Thesis" of 07 credit hours. Table given hereunder provides an overview of credit hours distribution:

Course	Core Courses	Optional (Specialization) Courses	Elective Courses	Advance Architecture Design Studio/ Research Thesis	Total
Number of Courses	03	02	04	01	09
Credit Hours	15	06	12	07	40

SPECIALIZATIONS

The Department offers a range of specialties in the form of optional courses to the students during their M. Arch. Studies. Students can take their research thesis or Advanced Architecture Design Studio III in any of the following area of specialization:

1. Architectural Design
2. History, theory and criticism
3. Heritage and Culture
4. Sustainable Architecture
5. Urban Planning and Design

Or any other specialty offered by the Department.

ELIGIBILITY CRITERIA FOR ADMISSION IN M. ARCH

A candidate seeking admission in the M. Arch. programme must have at least bachelor's degree either in Architecture from a PCATP recognized institution,or in related discipline from HEC recognized institution, considered equivalent to B. Arch. by PCATP.In case of a foreign degree, the candidate must obtain an equivalence certificate from Higher Education Commission and verify the same from PCATP prior to applying for the admission. Persons working in Government/Semi Government or private institutions may also apply. Such candidates shall have to submit "No Objection Certificate" from the Head of the Institution where they are working. A minimum CGPA of 2.5/4.00 (in case of semester system) or 60% marks(in case of annual system) in the relevant bachelor degree is also a pre requisite for admission.

Program	Seats Reserved for Open Merit	Seats Reserved for Rationalized Fee Basis	Seats Reserved for Foreigners	Total
M. Arch.	15	05	05	25

SEMESTER-WISE BREAKUP OF THE COURSES

1ST SEMESTER				
No.	Course Title	Contact Hours		Credit Hours
		Theory	Practical	
ARC6004	Advanced Architectural Research Methods	03	00	03
ARC6001	Advanced Architecture Design Studio-I	01	10	06
ARC	Optional (from list of Specialization)	03	00	03
ARC	Elective – I (related to list of Optional)	03	00	03
ARC	Elective – II (related to list of Optional)	03	00	03
	Semester Total C.H.	**13**	**10**	**18**

2nd SEMESTER				
No.	Course Title	Contact Hours		Credit Hours
		Theory	Practical	
ARC6002	Advanced Architecture Design Studio-II	01	10	06
ARC	Optional II (Minor – from list of Optional)	03	00	03
ARC	Elective – III (related to list of Optional)	03	00	03
ARC	Elective – IV (related to list of Optional)	03	00	03
	Semester Total C.H.	**10**	**10**	**15**

3rd SEMESTER				
No.	Course Title	Contact Hours		Credit Hours
		Theory	Practical	
ARC6003	Advanced Architecture Design Studio-III	01	12	07
ARC6005	Thesis			
	Semester Total C.H.	01	12	**07**
	Total Credit Hours for M. Arch. Programme			**40**

LIST OF COURSES OFFERED

CORE COURSES			
S.No.	Course Code	Course Title	Credit Hours
1	ARC6004	Advanced Architectural Research Methods	03
2	ARC6001	Advanced Architecture Design Studio – I	06
3	ARC 6002	Advanced Architecture Design Studio – II	06

LIST OF OPTIONAL (SPECIALIZATION) COURSES			
S.No.	Course Code	Course Title	Credit Hours
1	ARC6201	Sustainable Architectural Design	03
2	ARC 6301	History, Theory and Criticism	03
3	ARC 6401	Heritage Conservation	03
4	ARC 6501	Urban Design	03
5	ARC 6601	Architectural Project Management	03

In addition to the list given above, courses recommended by the HEC in its guideline will also be offered subject to the availability of expert faculty.

LIST OF ELECTIVE COURSES			
S.No.	Course Code	Course Title	Credit Hours
1	ARC6202	Sustainable Design: Theory and Orientation	03
2	ARC6203	Sustainable Systems and Processes	03
3	ARC6204	Sustainable Development	03
4	ARC6205	Sustainability Management	03
5	ARC6206	Appropriate Technologies	03
6	ARC6207	EIA in Design Projects	03

HISTORY, THEORY AND CRITICISM			
S.No.	Course Code	Course Title	Credit Hours
07	ARC6302	Meaning in the Built Environment	03
08	ARC6303	Contemporary Architectural Historiography	03
09	ARC6304	Techniques in Architectural Analysis	03
10	ARC6305	Key Text and History	03
11	ARC6306	Space and Spatial Syntax	03
12	ARC6307	Semiology of Islamic Architecture	03

HERITAGE CONSERVATION			
S.No.	Course Code	Course Title	Credit Hours
13	ARC6402	Architectural Conservation Techniques	03
14	ARC6403	Laws and Acts of Conservation	03
15	ARC6404	Aging Process of Building Materials	03
16	ARC6405	Restoration of Architectural Heritage	03
17	ARC6406	Survey & Investigation in Arch. Heritage	03
18	ARC6407	Techniq. in Stru. Investigation of Heritage Buildings	03

URBAN DESIGN			
S.No.	Course Code	Course Title	Credit Hours
19	ARC6502	Urban Design Studio	03
20	ARC6503	History and Theory of Urban Design	03
21	ARC6504	Urban Conservation and Renewal	03
22	ARC6505	Urban Economics	03
23	ARC6506	Built Form and Regulation	03
24	ARC6507	Urban Management Systems	03

URBAN DESIGN			
S.No.	Course Code	Course Title	Credit Hours
25	ARC6602	Forecasting and Risk Management	03
26	ARC6603	Professional Communication	03
27	ARC6604	Program and Portfolio Management	03
28	ARC6605	Organizational Project Management	03
29	ARC6606	Agile Project Management	03
30	ARC607	Critical Thinking and System Assessment	03

List of Elective Courses will be updated as per available specialties of the faculty, availability of relevant resources and interest of the enrolled group of students.

Core Courses Details

ARC6004 Advanced Architectural Research Methods

Introduction to fundamentals or research: definition, characteristics, objectives, etc.; Different research methods (such as qualitative, quantitative, mixed); The research process; Selection of an appropriate/ acceptable research topic; Sample and sampling techniques; Literature review; Research conduct issues; Analysis of data and formulation of conclusions; Parts of a technical report; Research communication: academic/ technical writing: Writing a good research paper and get it published in a journal.

Supervising an undergraduate level thesis design research; Formulating research problem, defining research aspects and keywords; Conducting case studies and relating the conclusions with design program, etc.

Recommended Books:

1. Practical Research: Planning and Design. Seventh Edition. Upper Saddle River (NJ): Prentice-Hall, Inc. 2001
2. Inquiry by Design: Tools for Environment-Behavior Research. Monterey: Brooks/ Cole Publishing Co., 1981
3. Blake, G. and Bly, R. W. 1993. "The Elements of Technical Writing." Longman, NY.
4. Fowler, F.J. 2001. "Survey Research Methods." Sage Publications, Inc.
5. Singlet on, R.A. Jr. and Straits, B.C. 2005. "Approaches to Social Research." Oxford University Press, Oxford.
6. Kumar, Ranjit. Research Methodology: A Step by Step Guide for Beginners. 3rd Edition. Sage Publication. 2007.

ARC6001 Advanced Architecture Design Studio – I

ARC6002 Advanced Architecture Design Studio – II

Understanding the explorations within the contemporary design development studies; Inter-relate the architectural texts relevant with the expertise of program within studio learning;

Interlinking theory based learning with spatial articulation; Cohesive integration of multiple architectural pragmatic factors to produce design decisions based on programs ideology; Self evaluatory knowledge of architectural design outcome. Understanding of design analytical techniques.

Intensive studio based learning, where one on one tutor and student interaction is pertinent to functioning of studio.

Exercises/assignments to be designed keeping in view institute's vision and ideology. The exercises will incorporate intricate skill sets in comparison to bachelor program.

Recommended Books/ Reference Material:

Selection from the works of renowned authors and other theoreticians, practitioners will be taken into consideration depending upon the objectives and nature of the studio design project. Works of Aldo Rossi, Christopher Alexander, Keith Crislow, Nader Ardalan, Manfredo Tafuri, Rem Koolhaus, Neil Leach, Hussain Nasr, Laila Bakhtiar, Eba Koch, Bow Wow, Hasan Fathy, GeoffaryBawa, VibhutiChakrabarti, FarshadMoussavi, Andrea Palladio, Denis Scott Brown, and Robert Venturi etc. will be referred.

Optional (Specialization) Courses Details

ARC6201 Sustainable Architectural Design

Ecology as a model; Green design versus sustainable design; Principles for designing sustainability; Regional design and context responsiveness; Regional design process; Site challenges and responsibilities; Site design and environmental analysis; Sustainable design and existing buildings; sustainability in interior and landscape design; Bioclimatic design approaches in buildings; Embedded energy of building materials and the concept of zero-energy buildings; Managing the practice of green architecture; Sustainable construction technologies; Sustainability in design and building management processes

Recommended Books:

1. Introduction to Architectural Science: The Basis of Sustainable Design. (2004). Steven V. Szokolay.
2. Sustainable Architectural Design: An Overview. (2015). KuppaswamyLyengar.
3. Material Revolution: Sustainable Multi-Purpose Materials for Design. (2010). Sascha Peters.
4. Sustainable Design: Ecology, Architecture and Planning. (2007). Daniel E. Williams.

ARC6301 History, Theory and Criticism

Definition of Architecture both as an individual and societal aspiration as well as professionally

disciplined process; Introduction to expanded vocabularies in architectural discourse rooted in the interwoven pursuits of History, Theory and Criticism; Arguments in defense of judgmental cynicism against History, Theory and Criticisms' value as contributors to overall architectural quality both as an educational and/ or as a professional enterprise; Comparative analysis of some of the key developments in historiography, theoretical prepositions, and criticisms offered in voice, word or market reactions; Exercises aimed hypothesizing theories of architecture especially with reference to Pakistan and the region; Scope, nature and purpose of physical planning. Types of theorized constructs about architecture from fiction to measurable physical realities; Architecture and its relationship with other professions impacting upon built urban environment; New trends in architecture and their underlying causalities, aspirations and quality assurance systems especially with reference to Pakistan; Continuous and easy access to role-model work and critically analyzed and communicated case studies of important architects locally, globally and historically.

Recommended Reference Material:

Selections from the works of following authors and other theoreticians, practitioners will be referred for students' assignment as they will be directed/ guided for readings, writings and criticisms:

Nikolaus Pevsner, SigfriedGiedion, Leonardo Benevelo, Reyner Banham, Manfried Tafuri, Le Corbusier, Hans Scharoun, Walter Gropius, Alvar Aalto, D'ArcyW. Thompson, John Ruskin, Bruno Zevi, H-R Hitchcock, Peter Collins, Frank Lloyd Wright, Hugo Haering, Bruno Taut, Mies van der Rohe, GunarAsplund, Antonio Gaudi, Eduardo Torroja, FazlurRehman Khan, Carlo Scarpa, Buckminster Fuller, Klaus Herdig, Walter Netsch, John Summerson, Christian-Norberg Schultz.

ARC6401 Heritage Conservation

Definition of heritage in various contexts; Understanding heritage and types of heritage; Laws and International guidelines for the declaration of heritage and historic buildings; Conservation, preservation, and adaptive reuse; Challenges in conserving architectural heritage; Community participation in heritage conservation; Perceptual and socio-psychological benefits of conserving heritage buildings; Ethics of conservation; Significance and value assessment; Global Conservation movements.

Recommended Books:

1. Microclimate for Cultural Heritage: Conservation, Restoration, and Maintenance of Indoor and Outdoor Monuments. (2014). D. Camuffo
2. Scientific Methods and Cultural Heritage: An Introduction to the Application of Materials Science

to Archaeometry and Conservation Science. (2000). Aylin Orbasli.

3. Authenticity in Architectural Heritage Conservation: Discourse, Opinions, Experiences in Europe, South and East Asia. (2017). Katharina Weiler, Niels Gutschow.

4. Conservation of Historic Buildings. (1982). Bernard Feilden

ARC6501 Urban Design

Introduction to urban design; History, theory and philosophy of urban design; Urban morphology and theories of urban structure; Elements of urban design; Context analysis in urban design assignments; Mapping and analysis tools in neighbourhood studies; Physical, social, perceptual and environmental context of urban settlements; Research methods and techniques in urban design; The concept of ecopolis and living cities; Participatory design approach in urban level project; Sustainable urban infrastructures.

Recommended Books:

1. The Death and Life of Great American Cities. (1961). Jane Jacobs

2. The Image of the City. (1960). Kevin A. Lynch

3. The City in History. (1961). Lewis Mumford

4. Responsive Environments. (1985). Ian Bentley

5. Urban Design: Street and Square. (1992). Cliff Moughtin

6. Urban Design: Green Dimensions. (1996). Cliff Moughtin

7. Urban Design: Method and Techniques. (1999). Cliff Moughtin

8. Urban Design: Health and the Therapeutic Environment. (2009). Cliff Moughtin, Kate McMahon Moughtin, Paola Signoretta

ARC6601 Architectural Project Management

Introduction to project management body of knowledge; SMART Goals; Framework for Project Management; Functions of management; Project planning, scheduling, network diagrams and budgeting; Critical thinking and system assessment; Organizational project management; Design office management; Portfolio and program managements; Risk management; Strategic change implementation; Sustainability management; Management tools/ project manager's toolkit and apps.

Class exercises on critical thinking, brainstorming, network diagrams; SPSS; MS Project etc.

Recommended Books:

1. F. Lawrence Bennett, The Management of Construction: A Project Life Cycle Approach. 2003, Butterworth Heinemann, 1st Edition.

2. George J. Ritz, Total Construction Project Management. 1994, McGraw-Hill
3. Phillip Joseph, Project Management: On Track From Start to Finish. 2004, McGraw-Hill Osborne, 2nd Edition
4. Project Management: The Complete Idiot's Guide
5. Heerkens, Garry R. Project Management. 2002, McGraw-Hill Boston
6. Cotrell, Stella. Critical Thinking Skills: Developing Effective Analysis and Argument. 2011. Pargrave, 2nd Edition.

ELECTIVE COURSES DETAILS

ARC6202 Sustainable Design: Theory and Orientation

History of sustainability; Politics and the concept of sustainability; The role of good governance in sustainable development; Sustainability in complex socio-economic systems; The future of sustainable practices in design; Sustainable thinking and design interventions; Energy and Society; Consumption and consumerism; Risk and resilience; Waste, water and land; Material, energy and building industry.

Recommended Books:

1. Theories of Sustainable Development. (2016). Judith C. Enders, MortizRemig
2. An Introduction to Sustainability: Environmental, Social and Personal Perspectives. (2017). Martin Mulligan
3. Sustainability Principles and Practice. (2017). Margaret Robertson

ARC6203 Sustainable Systems and Processes

Technology and sustainability; Advance mechanical technologies in buildings and their role in achieving sustainability; Electronics and contemporary communication technologies in building management; Application of Geographic Information Systems in achieving sustainable development; Sustainable approaches in building environmental control systems; Sustainable building systems: structural systems, mechanical systems, electrical systems and lighting, plumbing systems, walls, floors, roofs and ceilings, indoor environmental quality, interior building systems etc.

Recommended Books:

1. Advanced Technologies for Sustainable Systems. (2017). Bahi-El-Din, Yehia, Hassan, Maguid (Editors)
2. Sustainable Building Systems and Construction for Designers. (2015). Lisa M. Tucker
3. Sustainable Process Engineering: Concepts, Strategies, Evaluation and Implementation. (2012). David Brennan

ARC6204 Sustainable Development

Individuality versus Collectivity; Tragedy of the Commons; UNDP's Sustainable development goals; Sustainable development, environment and

poverty; Community participation in development and management; Resource conservation and management; Renewable energy resources and sustainability; Indigenous building material and embedded energy.

Recommended Books:

1. Our Common Future. (1987). Brundtland Commission
2. An Introduction to Sustainable Development. (2006). Peter Rogers Atsatt
3. The Age of Sustainable Development. (2015). Jeffrey Sachs
4. Understanding Sustainable Development. (2008). John Blewitt
5. Fundamentals of Sustainable Development. (2012). Niko Roorda
6. Transformative Sustainable Development: Participation, Reflection and Change. (2014). Kei Otsuki
7. Handbook of Sustainable Development. (2007). Eric Neumayer

ARC6205 Sustainability Management

Definition of sustainability management; Corporate social responsibility and reporting; Sustainability in manufacturing and services industry; Supply chain management: Ensuring sustainable supply of energy, water, and food; Sustainable urban services' management; The concept of public ownership and sustainable governance of systems.

Recommended Books:

1. Handbook of Sustainability Management. (2012). Chu-Hua Kuei, Christian N Madu (Editors)
2. Sustainability Management: Lessons from and for New York City, America, and the Planet. (2014). Steven Cohen
3. Corporate Sustainability Management: The Art and Science of Managing Non-Financial Performance. 1st Edition. (2011). Mark W. McElroy, J.M.L. van Engelen

ARC6206 Appropriate Technologies

Suitability of technology to the context; Context and environment responsive design approach; Indigenous and regional techniques in building construction and urban development; Product transfer versus technology transfer; Use of robust building systems; Design intervention for the reduction of machine-dependency; Preparing and managing the local skilled workforce; Exploring alternate building materials to reduce emergy and time;

Recommended Books:

1. Renewable Energy and Sustainable Technologies for Building and Environmental Applications: Options for a Greener Future. (2016). Ahmad,

MardianaIdayu; Ismail, Mazran; Riffat, Saffa (Editors)

2. Green Technologies and Environmental Sustainability. (2017). Ritu Singh, Sanjeev Kumar (Editors)
3. Feasibility Analysis for Sustainable Technologies: An Engineering-Economic Perspective. (2014). Scott R. Herriott
4. Cities and Sustainable Technology Transitions: Leadership, Innovation and Adoption (New Horizons in Regional Science). (2018). Marina Van Geenhuizen et al.

ARC6207 EIA in Design Projects

Environmental impact of design projects: assessment of water, air, land, climate and climate change; Ecology and constructional interventions; Design considerations in coastal and water front projects; Adverse social aspect of design projects: noise, transport, cultural heritage, landscape, and visual pollution; Matrices for measuring socio-economic impacts of design projects; Demographic impacts of design projects: land acquisition and resettlement, neighbourhoods and livelihoods, health and crime rate; Risks and risk assessment; Cumulative impacts and management plans.

Recommended Books:

1. Environmental Impact Assessment Handbook for Pakistan. (2014). Thomas B. Fischer (IUCN)
2. Methods of Environmental and Social Impact Assessment. 4th Edition. (2017). RikiTherivel, Graham Wood (Editors)
3. The Application of Science in Environmental Impact Assessment. (2018). Aaron J. MacKinnon, Peter N. Duinker, Tony R. Walker

ARC6302 Meaning in the Built Environment

Symbolism in architecture; Architecture as signs rather than space; Semiology and iconographic architecture; Metaphorical interpretation of built forms; Perception of the space and the prevailing social norms; Building linguistics; Analogies, metaphors, and similes in architecture; Authoritative and democratic architectural clues;

Recommended Books:

1. The Meaning of the Built Environment: A Nonverbal Communication Approach. (1990). Amos Rapoport
2. Architecture as Signs and Systems: For a Mannerist Time (The William E. Massey Sr. Lectures in the History of American Civilization). (2004). Robert Venturi, Denise Scott Brown.
3. Complexity and Contradiction in Architecture. (1977). Robert Venturi
4. Introduction to Architecture. (1979). James C. Snyder

ARC6303 Contemporary Architectural Historiography

History and historiography in architecture; History of art versus history of architecture; Archaeological evidences of architectural history; Understanding the impact of context on architectural history; Architecture as evidence of history; Fears and prejudices in reporting/ documenting architectural history; Role of virtual reality and digital technology in contemporary historiography; Setting boundaries, ethics, and standards for architectural history.

Recommended Books:

1. The Historiography of Modern Architecture. (1999). PanayotisToumikiotis
2. The Historiography of Persian Architecture. (2015).
3. What is Architectural History? (2010). Andrew Leach
4. Rethinking Architectural Historiography. (2006). Dana Arnold

ARC6304 Techniques in Architectural Analysis

Design strategies and architectural analysis; Identity, context and architecture relationship; Basic and modified elements of architecture; Role of different architectural elements; Architectural elements with multiple roles and meanings; Space, space defining elements and spatial organization; Habitable, inhabitable spaces; Tangible and intangible elements; Relationship between plan, elevation, and section of buildings; Reverse analysis techniques in architecture.

Recommended Books:

1. Precedents in Architecture: Analytic Diagrams, Formative Ideas, and Partis. 4th Edition. (2012). Roger H. Clark, Michael Pause.
2. Conditional Design: An Introduction to Elemental Architecture. (2014). Anthony di Mari
3. Operative Design: A Catalog of Spatial Verbs. (2013). Anthony di Mari
4. Le Corbusier: An Analysis of Form. (1989). Geoffrey H. Baker
5. Analysing Architecture. 4th Edition. (2014). Simon Unwin

ARC6305 Key Text and History

Sources of history; Value of text and manuscripts in history; Authenticity of historical sources; Architecture as a source of history; Interpreting architecture into text and vice versa; Key text in history and its value; Evidences from the past civilizations; Works of Vitruvius; Contribution of Muslim travelers and historians; Significance of Sir Banister Fletcher's book; Historical manuscripts of industrial era; Works of Chicago School of Architecture and contributions to the history of architecture; History of contemporary architecture.

Recommended Books:

1. Vitruvius Ten Books on Architecture. Ingrid D. Rowland, Thomas Noble Howe (Editors)
2. Sir Banister Fletcher's A History of Architecture. (1896). Banister Fletcher
3. A History of Architecture on the Comparative Method, 17th Edition. (1967). Banister Fletcher, R. A. Codingley
4. The Significance of Historical Research in Architectural and Industrial Design. (1963). John Gloag.

ARC6306 Space and Spatial Syntax

Space as a limitless entity; Marking boundaries and limits of the space; Volumetric aspects of the space; Psychological aspect of the space; Space in perceptual context; Forms and types of spatial collision, integration and articulation; Theories of spatial configuration; Impact of spatial configuration on human activity pattern; Spatial configurations and psychological affiliations of users; Analytical, quantitative and descriptive tools for the analysis of spatial formations; Live case studies from the local and international context.

Recommended Books:

1. Space is the Machine: A Configurational Theory of Architecture. (2015). Bill Hillier
2. The Social Logic of Space. (2008). Bill Hillier and Julienne Hanson
3. Decoding Homes and Houses. (2003). Julienne Hanson
4. The Journal of Space Syntax. http://joss.bartlett.ucl.ac.uk/blog/

ARC6307 Semiology of Islamic Architecture

Understanding Islamic system of beliefs; Social structure of Muslim civilizations; Significance and evolution of building elements in Islamic architecture, dome, minaret, mihrab, suq, bazar, maidan, dewan, sehn, serai, etc.; Structural elements as symbol of power and decoration, muqarnas, vaults, niches, etc.; Role of geometry in formal and spatial configurations; Calligraphy and floral patterns instead of murals; Symbolism in various Islamic dynasties; Inspirations from the West and Classical architecture of Greek and Romans; Persian influences; Use of materials as a symbol of dignity, solidarity, and authority;

Recommended Books:

1. Islamic Architecture: Form, Function and Meaning. (1988). Robert Hillenbrand.
2. Dictionary of Islamic Architecture. (1996). Andrew Petersen
3. Islamic Art and Architecture. (1999). Robert Hillenbrand

4. Western Islamic Architecture. (1963). John D. Hoag
5. Understanding Islamic Architecture. (2002). Khalil Pirani
6. Architecture in Pakistan. (1985). Kamil Khan Mumtaz

ARC6402 Architectural Conservation Techniques

Process of conservation; Identifying and involving the stakeholders in the conservation process; Importance of timeline; Sponsoring and budgeting the process; Documentation of decisions and processes; Socio-political pressures in building conservation; Motivating and activating the community; Training the skilled persons for the job; Investment in appropriate technologies; Process monitoring, management and maintenance; Evaluating the conservation process and getting feedback; Setting long term strategies and framing policy recommendations.

Recommended Books:

1. Practical Building Conservation Series.

   https://historicengland.org.uk/advice/technical-advice/buildings/practical-building-conservation/
2. Practical Building Conservation: Conservation Basics. (2013). Historic England
3. Old House Handbook: A Practical Guide to Care and Repair. (2008). Roger Hunt, Marianne Suhr

ARC6403 Laws and Acts of Conservation

Importance of legislation for the conservation of architectural heritage; International history of conservation laws; Role of UNESCO and other international bodies in legislation; Legislation in Pakistan; Role and interests of stakeholders; Implementation procedures and frameworks; Legislation at provincial level; Role of Non-governmental organizations; Collision of public and private interests in conservation process; Benefits of legislation, financial constraints, and socio-political pressures; Motivational aspects of the legislation; Analysis and evaluation of existing laws and acts; Framing policy recommendations based on ground realities.

Recommended Books:

1. Legal and Financial Aspects of Architectural Conservation: The Smolenice Castle Conference Central Europe. (1997). Marc Denhez and Stephen Dennis (Editors)
2. Policy and Law in Heritage Conservation (Conservation of the European Built Heritage Series, 1). (2001). Robert Pickard (Editor).
3. Historic Environment Law: Planning, Listed Buildings, Monuments, Conservation Areas and Objects: 2014 Supplement. (2014). Richard Harwood QC.
4. List of National Cultural Heritage Laws. UNESCO.

https://en.unesco.org/cultnatlaws/list

5. The Antiquities Act, 1976. National Assembly of Pakistan. http://www.na.gov.pk/uploads/documents/1493110980_333.pdf

ARC6404 Ageing Process of Building Materials

Classification of building materials; Climatic factors affecting materials; Erosion, abrasion, and decaying process; The impact of natural and manmade disasters on the pace of ageing; Techniques for estimating the age of historic buildings' materials; Chemical process responsible for decaying, used for the investigation of age, and for the preservation of material.

Recommended Books:

1. The Aging of Materials and Structures: Towards Scientific Solutions for the Ageing of Our Assets. (). Van Breuge, Klaas; Koleva, Dessi; Beek, Ton van (Editors)
2. Ageing and Deterioration of Materials in the Environment – Application of Multivariate Data Analysis. (2012). E. Smidt, M. Schwanninger, J. Tintner, K. Bohm
3. Building Materials. (2008). S. K. Duggal. http://ebooks.bharathuniv.ac.in/gdlc1/gdlc1/Engineering%20Merged%20Library%20v2.7/S.K.%20Duggal/Building%20Materials,%20Third%20Edition%20(371)/Building%20Materials,%20Third%20Edition%20-%20S.K.%20Duggal.pdf
4. The Ecology of Building Materials. (1992). Bjorn Berge

ARC6405 Restoration of Architectural Heritage

Need and philosophy of restoring the historic buildings; Investigating and searching for the original materials; Suitability and appropriateness of alternative materials; Role of workmanship; Programming and budgeting the restoration assignments; Monitoring, evaluation and feedbacks; Live case studies of restoration programs in Lahore Fort, Tomb of Jehangir and other historic buildings; Prospects of restoration in the country.

Recommended Books:

1. The Restoration Manual: An Illustrated Guide to the Preservation and Restoration of Old Buildings. (1983). Jr. Orin M. Bullock
2. Conservation and Restoration of Buildings: Philosophy and Approach. (1978). Clive Lucas
3. A Guide to the Maintenance, Repair, and Alteration of Historic Buildings. (1984). Frederick A. Stahl

ARC6406 Survey and Investigation in Architectural Heritage

Traditional techniques in surveying the heritage buildings; Walk-through surveys for initial investigations; Formulating checklists and schedules; Using contemporary devices (Total

station and GPS) on heritage sites; BIM and Low-cost survey techniques; Documentation process; Ethics in documenting the heritage buildings; Working on timelines, finances, manpower, and implementation strategies; Recording relevant information on heritage sites; Managing socio-political pressures and community participation.

Recommended Books:

1. International Journal of Heritage Architecture. https://www.witpress.com/journals/ha
2. Metric Survey Specifications for Cultural Heritage. 3rd Edition. (2015). David Andrews, Jon Bedford, Paul Bryan
3. Conserving Cultural Heritage: Proceedings of the 3rd International Congress on Science and Technology for the Conservation of Cultural Heritage (TechnoHeritage 2017), May 21-24, 2017, Cadiz, Spain. (2018). Maria Jesus Mosquera, M. L. Almoraima Gil

ARC6407 Techniques in Structural Investigation of Heritage Buildings

Types of building structures; External and internal structural elements; Primary and secondary structural elements; Types of structural failures in heritage buildings; Investigating the causes of failure; Documenting structural aspects; Temporary and permanent supports; Introducing new elements and working on compatibilities of materials; Working out finances and timelines; Training the labour; Managing and supervising the processes; Monitoring and evaluating the activities;

Recommended Books:

1. Structural Aspects of Building Conservation. 2nd Edition. (2004). Poul Beckmann et al.
2. Specifications for Building Conservation: Volume 1: External Structure: Practical Examples v. 2. (2015). Rory Cullen and Rick Meier (Editors)
3. Conservation of Architectural Heritage, Historic Structures and Materials. Ernesto Borrelli. https://www.iccrom.org/publication/conservation-architectural-heritage-historic-structures-and-materials

ARC6502 Urban Design Studio

This studio will be based on practical field work. Students are expected to identify urban settlements facing infrastructural, economic, social and environmental problems. Students will develop their own methodologies for documenting, analyzing and resolving those issues after reviewing the existing literature on selected issues.

Recommended Books/ Material:

Efforts of Ar. Arif Hassan and Ar. ParveenRehman will be referred in this studio in the local context, whereas those of Nabil Hamidi and other famous architects and planners will be studied from the international context.

1. The Historical Quarters of Karachi. Yasmeen Cheema
2. Responsive Environments. Ian Bentley et al.

ARC6503 History and Theory of Urban Design

Origin and concept of urban design; Historical evolution of cities and urban forms; Case studies of London after the great fire and Paris; Urban street layouts, public spaces and landscape through ages; Urban forms in Islamic cities and the concept of Suq, Hujra, Serai, and Maidan; The concept of sustainability and future of cities.

Recommended Material/ Books:

Extensive case studies will be carried out in this particular course to build strong conceptual base in students for undertaking practical urban design assignments.

1. By the City/ For the City. Anne Guiney (Editor), Brendan Crain (Editor)
2. Combinatory Urbanism. Thom Mayne
3. The Death and Life of Great American Cities: 50th Anniversary Edition. Jane Jacobs
4. Ecological Urbanism. Mohsen Mostafavi (Editor), Gareth Doherty (Editor)

ARC6504 Urban Conservation and Renewal

The concept of genius loci in urban settlements; Aspects and prospects of conserving the historical parts of cities; Techniques in urban conservation; Types of failures in urban neighbourhoods: infrastructural, social, administrative, economic, and environmental; Needs for urban renewal; Extent and practice of urban renewal; The process of urban decay and urban rejuvenation; Sustainability and the debate of urban conservation versus urban renewal.

Recommended Books:

1. Urban Renewal Techniques: Conservation, Redevelopment, Organization, Strategy. (1964). Milwaukee (Wis.). Department of Civil Development
2. Introduction to Urban Conservation: The Complete Book. (2013). Ayman G. Abdel Tawab
3. Preserving the World's Great Cities: The Destruction and Renewal of the Historic Metropolis. (2002). Anthony Max Tung
4. The World of Walled Cities: Conservation, Environmental Pollution, urban Renewal and Development Prospects. (1992). I. Mohan

ARC6505 Urban Economics

Reasons for the existence of cities; Urban spatial structure and real estate market; Urban sprawl and land-use control; Land-use policies and freeway congestion; Housing demands, tenure choice and governmental policy frameworks; Economic nuclei and local public goods and services; Pollution, crime, quality of life and urban job market.

Recommended Books:

1. Lectures on Urban Economics. (2011). Jane K. Brueckner
2. The Economy of Cities. (1969). Jane Jacobs
3. Urban Economics and Real Estate: Theory and Policy. (2007). Daniel P. McMillen and John F. McDonald
4. Essentials of Urban Economics. (1990). Arthur O'Sullivan
5. Order Without Design: How Markets Shape Cities. (2018). The MIT Press

ARC6506 Built Form and Building Regulation

Planning control and urban sprawl; The concept of development control, urban skyline, and city-environment relationship; Role of building bylaws in framing perceptual context of the cities; Controlling and regularizing slums and squatter settlement; The language of the city: building facades, streets, public spaces, landscape etc.

Recommended Books/ Reference Material:

Building Code of Pakistan.
https://www.pec.org.pk/building_code_pakistan.aspx

http://urbanpolicyunit.gkp.pk/publications/

Building Bylaws of Various Local Area Development Authorities in Pakistan

ARC6507 Urban Management Systems

Planning, designing and implementing urban infrastructure; Cluster development, ecopolis, green urbanization; Managing and controlling sprawl and slums; Land-use planning and zoning; Administrative control systems of cities; Neighbourhoods and constituencies in cities; Managing and planning systems; Energy crisis, water supply and sanitation systems management; Waste management and revenue generation; GIS and urban land records; Urban land tenure, land transaction and mutation policies; Managing urban densities through effective housing policies

Recommended Books:

1. Big Data Support of Urban Planning and Management: The Experience in China. (2018). Li, Miaoyi, Shen, Zhenjiang
2. Sustainable Water Management in Urban Environments. (2016). TamimYounos, Tammy E. Parece (Editors)
3. Open Design: A Stakeholder-Oriented Approach in Architecture, Urban Planning, and Project Management. Volume 1 Research in Design Series (Research in Design). 2006. R. Binnekamp, L. A., Van Gunsteren and P.-P. Van Loon

ARC6602 Forecasting and Risk Management

Construction projects and risk management

strategies; Project environment: project constitution, project organization, identifying various phases, effect of phases on risk, project appraisal; Importance of human aspect in risk management; Risk and value management; Qualitative methods and soft system methodologies in risk management; Quantitative methods for risk analysis; Mapping techniques in identifying, analyzing and managing risks; Setting specifications and guidelines for managing risks; Financial risks in construction projects; Effective communication and risk management.

Recommended Books:

1. Portfolio Risk Analysis. (2010). Gregory Connor, Lisa R. Goldberg, and Robert A. Korajczyk
2. Managing Risk in Construction Projects. (2006). Nigel J. Smith, Tony Merna, and Paul Jobling
3. Crisis Management in Construction Projects. (2000). Martin Loosemore

ARC6603 Professional Communication

Communication types: verbal and non-verbal; Role of communication in business and various professions; Dyadic and group communications: listening and feedback in organizational relationship; Role of communication in confidence and trust building; Communication skills and bondage between organizational groups and teams; Interpersonal dynamics in organizations; Professional interviews; Professional presentations and audience feedback; Skills in preparing and delivering professional presentations; Role of visual aids and body language in professional presentations; Types of business and professional presentations: Technical presentations, Proposal presentations, Sales communication, Risk and Crisis communication.

Recommended Books:

1. Business and Professional Communication: KEYS for Workplace Excellence. (2010). Kelly M. Quintanilla and Shawn T. Wahl
2. Business and Professional Communication: Principles and Skills for Leadership. (2010). Steven A. Beebe and Timothy P. Mottet
3. Professional Communications: A Handbook for Civil Engineers. (2004). Heather Silyn-Roberts
4. Professional Communication. (2008). KONERU

ARC6604 Program and Portfolio Management

Definition of portfolio management; Link with organizational strategy, organizational governance and organizational management; Portfolio management, program and project management; Role of portfolio manager; Portfolio management metrics; Portfolio management reporting; Portfolio management process and organization; Portfolio stakeholders roles and responsibilities.

Recommended Books:

1. Pioneering Portfolio Management: An Unconventional Approach to Institutional Investment. (2009). David F. Swensen
2. Strategic Project Portfolio Management: Enabling a Productive Organization. (2009). Simon Moore.
3. Portfolio Management Under Stress: A Bayesian-Net Approach to Coherent Asset Allocation. (2013). Alexander Denev and Riccardo Rebonato
4. The Standard for Portfolio Management (4th Edition). 2006.

ARC6605 Organizational Project Management

Definition of OPM; Underlying concepts in OPM; Organization's strategies, project formulation and effective system management; Goals, objectives, projects and timeframe; team management in OPM; Portfolio management, program management and project management; Beneficiaries of OPM.

Recommended Books:

1. Project Management and Risk Management in Complex Projects: Studies in Organizational Semiotics. (2007). Pierre-Jean Charrel, Daniel Galarreta
2. Creating the Project Office: A Manager's Guide to Leading Organizational Change. (2003). Randall L. Englund, Robert Graham, Paul C. Dinsmore
3. Managing without Leadership: Towards a Theory of Organizational Functioning. (2005). Gabriele Lakomski

ARC6606 Agile Project Management

Principles of Agile project management; Early and continuous delivery to customer; Flexibility of scope, changing requirements and system robustness; Characteristics of Agile team members; Team coordination, timelines and project delivery; Role of dialogue in technical excellence; People, communication, productivity and flexibility; Agility and sustainability;

Recommended Books:

1. Lean and agile project management: how to make any project better, faster, and more cost effective. (2017). Terra Vanzant Stern
2. Agile practice guide. (2017). Project Management Institute
3. Agile Project Management: QuickStart Guide A Simplified Beginner's Guide to Agile Project Management. (2017). ClydeBank Business

ARC6607 Critical Thinking and System Assessment

Understanding the links between ideas; importance and relevance of arguments and ideas; recognizing, building and appraising the arguments;

Inconsistencies and errors in reasoning; Consistent and systematic way of approaching problems; Logical reasoning and critical thinking; Accounting and system administration; Project Close-out and Project Kick-off; Project scheduling, progress and management of resources; Scope, services and time tracking.

Recommended Books:

1. Mind Map Mastery: The Complete Guide to Learning and Using the Most Powerful Thinking Tool in the Universe. (2018). Tony Buzan.
2. Critical Thinking Skills: Developing Effective Analysis and Argument. (2005). Stella Cottrell.
3. Construction Project Management. (2015). S. Keoki Sears et al.
4. Cost Accounting and Financial Management for Construction Project Managers. (2018). Len Holm

SPECIAL TOPICS

Students may study the topics of interest related to their research individually. However, the topics must be approved by the faculty supervisor/ board of study prior to registration for this course.

RESEARCH THESIS/ ADVANCED ARCHITECTURE DESIGN STUDIO–III (OPTED BY THE DEPARTMENT AS PER STRENGTH OF THE FACULTY SUPERVISORS AND INTEREST OF THE STUDENTS)

Thesis/Design proposal shall be prepared by the student during the Second Semester as per skills taught and learned in the subject of Advanced Architectural Research Methods. The research topic and proposal shall be considered by the relevant approving body and student shall be informed accordingly. Students may preferably complete their research/ design in the Third Semester and appear for the public defense/ open jury of their research/design as per recommendations of the Department.

U.S.-Pakistan Center for Advanced Studies in Energy

Energy is prime mover of the current global societal and industrial developments. With rapid pace of human development and the modern needs, the competence level of the engineers should also be in accordance with the demand of the day. Continuous efforts are made globally to enhance the understanding, and capability of the professionals working in the field of energy generation as well as conservation. The USPCAS-E was founded with the mission to address the energy issues of Pakistan, specifically, and contribute the global efforts on energy in general. The USPCAS-E aims to focus on applied research relevant to Pakistan's energy needs, undertake sustainable policy formulation, and serves as bridge between the government, industry and academia. The USPCAS-E is a partnership between the University of Engineering and Technology, Peshawar (UET); National University of Science and Technology (NUST), Islamabad; and U.S. partner, Arizona State University (ASU). At the end of project, the centers at NUST and UET Peshawar will be sustainable hubs to address energy related issues. Collaboration between the partner USPCAS-E universities and the Higher Education Commission will help ensure institutionalization and sustainability of the center. New state of the art M.Sc. programs have been introduced which are enlisted as following:

M.Sc. Electrical Energy System Engineering

M.Sc. Renewable Energy Engineering

M.Sc. Thermal System Engineering

M.Sc. Energy Management and Sustainability

Following Ph.D. Degree Programs are also offered at USPCAS-E:

Ph.D. Electrical Energy System Engineering

Ph.D. Renewable Energy Engineering

Vision

To bridge government, industry and academia via credible applied research and sustainable policy formulation for the development of Pakistan's energy sector.

Mission Statement

The USPCAS-E, UET Peshawar supports Pakistan's economic development by strengthening relevance and responsiveness of university product including applied and policy research and skilled graduates, to the needs of public and private sectors. The Center encourages and empowers women engineers and researchers, and promotes gender equity.

Dean, Faculty of Mechanical, Chemical and Industrial Engineering

Prof. Dr. Muhammad Abdul Aziz Irfan

DIRECTOR

Prof. Dr. Rizwan M. Gul	Ph.D (USA)

ASSOCIATE PROFESSORS

Dr. Adnan Daud Khan	Ph.D. (Italy)

ASSISTANT PROFESSORS

Dr. Najeeb Ullah	Ph.D. (Cambridge, UK)
Dr. Abdul Basit	Ph.D. (Denmark)
Dr. Affaq Qamar	Ph.D. (Italy)
Dr. Muhammad Noman	Ph.D. (Italy)
Dr. Muhammad Arif	Ph.D. (France)
Dr. Khurshid Ahmad	Ph.D. (China)
Dr. Muhammad Hassan	Ph.D. (China)
Dr. Zohaib-ur-Rehman Afridi	Ph.D. (China)

LECTURERS

Engr. Kaleem Ullah	M.Sc. (Pak)
Engr. Muhammad Aslam	M.Sc. (Pak)
Engr. Muhammad Shoaib Khan	M.Sc. (UK)
Engr. Zafarullah Khan	M.Sc. (Pak)
Engr. Noor Muhammad	M.Sc. (Pak)
Engr. Amir Naveed	M.Sc. (Pak)
Engr. Atif Sardar Khan	M.Sc. (Pak)

DEGREE PROGRAMS

- M.Sc. Renewable Energy Engineering
- Ph.D. Renewable Energy Engineering
- M.Sc. Electrical Energy Systems Engineering
- Ph.D. Electrical Energy Systems Engineering
- M.Sc. Thermal Systems Engineering
- M.Sc. Energy Management and Sustainability

Objectives

- Help Pakistan unleash its enormous potential for economic growth.
- Become Pakistan's premier energy think tank and engage stakeholders in both industry and government.
- Improve relevance and quality of curricula, strengthen use of effective teaching methods, and upgrade graduate programs.
- Build a nationwide network for energy professionals by establishing and facilitating channels for interaction including networking sessions, workshops, and exchange programs.

M.Sc in Electrical Energy System Engineering

Introduction

It's a harsh reality that Pakistan power system, ranging from production, transmission, distribution and management has many shortcomings. Moreover less work has been done on integrating alternate energy resources with the conventional system.

This specialized energy program will specifically work on how to improve the efficiencies of existing power plants and in helping the integration of various energy sources into and rehabilitation of the present transmission and distribution system. The taught courses will help students in understanding concepts in following focus areas:

Focus Areas

System Design and Regulation, Distributed Generation, Power Systems and High Voltage Plant Technology, Alternative Energy Systems, Power System Control and Protection, Smart Metering, Smart Grids and Active Network Devices.

Eligibility Criteria

- B.Sc. Electrical Engineering

Seat Allocation

Seat allocation (per semester) for Master of Science (M.Sc.) in Electrical Energy System Engineering : 30 seats with 50% allocation for female candidates as per requirement of USAID. Female candidates must fulfill the university criteria for admission in M.Sc. Program.

Degree Requirement

M.Sc. Program comprises of 33 Credit Hours including 3 CH course of Research Methodology:

List of Courses in Electrical Energy Systems Engineering

1. CAS-EESE 501 Transmission and Distribution (3)
2. CAS-EESE 502 Power System Operation and Planning (3)
3. CAS- EESE 503 Power System Stability (3)
4. CAS- EESE 504 Advance Power Electronics (3)
5. CAS-EESE 505 Electrical Energy Market (3)
6. CAS-EESE 506 Renewable Electrical Energy Systems (3)
7. CAS-EESE 507 Distributed Generation (3)
8. CAS-EESE 508 Electrical Energy and Environmental Systems (3)
9. CAS-EP 521 Management of Technology and Innovation (3)

Course No.	Course title	Credits
CAS-EESE 510	Power System Modeling and Analysis	3
CAS-EESE 511	Analysis of Faulted Power System	3
CAS-EESE 512	Power System Protection and Switchgear	3
CAS-EESE 513	HVDC Transmission Systems	3
CAS-EESE 514	HVAC Transmission Systems	3
CAS-EESE 515	Over voltages and Transients	3
CAS-EESE 516	Power System Reliability	3
CAS-EESE 517	Power System Control	3
CAS-EESE 518	Electrical Insulation Engineering	3
CAS-EESE 519	High Voltage Engineering	3
CAS-EESE 520	Power System Transformers	3
CAS-EESE 521	Advanced Electrical Machines	3
CAS-EESE 522	Electrical Power Generation	3
CAS-EESE 523	Smart Grid	3
CAS-EESE 524	Distribution and Utilization	3
CAS-EESE 525	Power Quality	3
CAS-EESE 526	Power System Substation	3
CAS-EESE 527	Generation and Integration of Renewable Energy	3
CAS-EESE 528	Computer Modeling of Electrical Power System	3
CAS-EESE 529	Control of Voltage Source Converter	3
CAS-EESE 530	Communication and Control in Electrical Power Systems	3
CAS-EESE 531	Advanced Topics in Renewable Energy Integration	3
CAS-EESE 532	Advanced Topics in Power Electronics	3
CAS-EESE 534	Network Based Grid System	3
CAS-EESE 535	Automated Distributed Power System Using Data Communication	3
CAS-EESE 533	Engineering Economics and Management of Electrical Power System	3
CAS-REE 526	Risk and Reliability Engineering	3
CAS-REE 527	Energy Quality management and Standards	3
CAS-REE 528	Energy Audit and Planning	3
CAS-REE 529	Environment Impact assessment for Energy Systems	3
CAS-REE 530	Development & Evaluation of Renewable Energy Projects	3

CAS-EESE 501 Transmission and Distribution [3CH]

Distribution systems, Load characteristics, Application of distribution transformers, design of primary feeders, Design of secondary feeders, Voltage drop and power loss, calculation, Capacitor application, Distribution system automation, HV transmission systems, Review the electrical parameters of HV lines, Conductor types, bundle conductor, Corona phenomena on AC and DC lines, Radio and TV interference, Audible noise, Electrical field effect of HV lines, Insulator selection and clearances, Lightning performance, Voltage regulation.

Recommended Book:

1. Electrical Energy conversion and Transport.Karady

and Holbert; John Wiley.

CAS-EESE 502 Power System Operation and Planning [3CH]

System operation and operating tools, economic dispatch/optimal power flow studies (OPF), unit commitment, automatic generation control (AGC), and applications of dynamic programming (DP) and linear programming (LP). role of voltage stability and stability limits in power exchange, Lagrangian relaxation and Mixed Integer Programming, introduction to state estimation applications in power engineering, electric power industry in the World, Free power marketing, role of independent system operators, regional transmission organizations, and other newly formed sectors of deregulated power infrastructure , role of power markets in power engineering.

Recommended Book:

1. Power Generation, Operation and Control, Wallenberg and Wood, John Wiley

CAS-EESE 503 Power System Stability [3CH]

System Dynamic Performance, the Swing Equation, Synchronizing power and natural frequencies of oscillations, equal area criterion; Analytical basis for identifying modes, Synchronous Machine control, The two reaction theory, Development of the complete d and q axes equations in per unit, Formulation of the states-pace equations, Equations of the one machine connected to infinite bus, Transient and sub-transient parameters, Synchronous machine simulation, Steady-state conditions and phasor diagrams, Simulation of Multi-machine Systems

Recommended Book:

1. Power System Control and Stability by Anderson and Fouad, 2nd Edition, Wiley Inter Science

CAS-EESE 504 Advance Power Electronics [3CH]

Basic principles of switch-mode power conversion. Concept of steady state in switching converters, volt-second and ampere-second balance, ideal switches, concept of power pole DC-DC converters Analysis and detailed design of buck, boost, buck-boost, Cuk and SEPIC converters Analysis and detailed design of isolated dc-dc converters including forward, fly-back, push-pull, full bridge and dual active bridge topologies, continuous and discontinuous current modes of operation, linearized, small-signal average models of dc-dc converters, voltage mode and current mode control design methods, design of magnetics for dc-dc converters

Recommended Book:

1. Power Electronics: Converters, Applications and Design, by N. Mohan, T.M. Undeland, W.P. Robbins, Wiley, 3rd ed.

CAS-EESE 505 Electrical Energy Market [3CH]

This course focuses on the market structures that exist within the electric energy industry. The course

will provide a background on basic economic theory that is necessary to understand operational objectives, pricing and incentives, market power, etc. We will discuss the history of the electric power industry, regulation, and deregulation. We will discuss dispatch optimization problems that exist in the electric industry, approaches to solving these problems, and the corresponding markets. We will discuss different pricing methods, non-convex markets, uplift payments, etc. The final part of this class will deal with a discussion on current research problems in this field.

Recommended Book:

1. Fundamentals of Power System Economics by Kirschen and Strbac, John Wiley and Sons,

CAS-EESE 506 Renewable Electrical Energy Systems [3CH]

Due to ultimate energy supply constraints imposed by fossil fuel and ever increasing energy demand from consumers, renewable energy is attaining much more prominent position as a promisingly viable and necessary solution. This course covers the critical technical constituents that advance electrical utilization of renewable energy. The lecture topics are divided into two modules: electric power conversion and grid integration

Recommended Book:

1. Grid integration and dynamic impact of wind energy by V. Vittal, R. Ayyanar, Springer

CAS-EESE 507 Distributed Generation [3CH]

Introduction to Distributed Generation, Definition and types of Distributed Generation technologies with DG capacities, Applications of Distributed Generation (DG), Impact of Distributed Generation on Power System Grids, Voltage Regulation, Losses, Harmonics, and Short Circuit Levels of the Network; Influence of DG, Influence of DG in service and product quality; Location of DG in the Distribution Networks and its Topology, Distributed Power System Reliability, Islanding of a Power Networks, Microgrids.

Recommended Books:

1. Electric Power Distribution Reliability, Second Edition by Richard E. Brown
2. Integration of Distributed Generation in the Power System by Math H. Bollen, Fainan Hassan
3. Electric Power Distribution Handbook, Second Edition by Thomas Allen Short

CAS-EESE 508 Electrical Energy and Environmental Systems [3CH]

Impact of fossil and nuclear Fuel Based Electrical energy System, Role of Renewable Energy based Electrical System, Impact of high voltage transmission lines. Health effects of electricity generation, Energy Conservation, Assessment of cogeneration cycles and demand side management.

Emission Impacts and its control in electric utilities.

Recommended Books:

1. Electric Energy: An Introduction, Third Edition (Power Electronics and Applications Series) by Mohamed A. El-Sharkawi
2. Energy and the Environment by Robert A. Ristinen , Jack P. Kraushaar

CAS-EP 520 Research Methodology [3CH]

Define research; research terms; researchprocess and the principle activities, skills and ethics associated with theresearch process, relationship between theory and research, major quantitative and qualitative research methods, importance of research ethics and integrate research ethics into the research process, assess and critique a published journal article that uses one of the primary research methods in the field; construct an effective questionnaire that employs several types of survey questions.

Recommended Book:

1. Investigating the Social World: The Process and Practice of Research, by Schutt, R. K. (7th edition). Los Angeles: Sage.

CAS-EP 521 Management of Technology& Innovation (MOTI) [3CH]

Technology and Competitiveness, Business Strategy and Technology Strategy, The Role of Technology in Creation of Wealth, Critical Factors in Managing Technology, Management of Technology: The New Paradigms, Technology Life Cycle, The process of Technology Innovation, Technology Planning, The Acquisition and Exploitation of Technology, Technology Transfer.

Recommended Books:

1. Management of Technology (The Key to Competitiveness and Wealth Creation), by Tarek M. Khalil.
2. The Management of Technological Innovation Strategy and Practice, Revised Edition by Mark Dodgson, David M. Gann, and Ammon Salter,Oxford University Press.

CAS-EP 522 Technology Entrepreneurship [3CH]

Entrepreneurship and Entrepreneurial mind-set, Entrepreneurial Intentions and Corporate Entrepreneurship, Entrepreneurial Strategy: (Generating and exploiting new entries), Creativity and the business plan, Identifying and analyzing domestic and International Opportunities, Protecting the Idea and other Legal Issues for the Entrepreneur, The Business Plan, The Marketing Plan, The Organizational Plan, The Financial Plan, Strategies for Growth and Managing the Implication of Growth.

Recommended Book:

1. Entrepreneurship by Robert D-Histrich / Micheal P. Peters / Dean A.Shepherd.

CAS-EESE 588 Advanced Topics in Electrical Energy System [3CH]

Advanced topics of current interest in Electrical Energy System Engineering, especially focusing current energy crises in Pakistan.

CAS-EESE 599 Master's Thesis [6CH]

Ph.D. in Electrical Energy System Engineering

Introduction

Pakistan is facing energy crisis since one decade. The solution to come out of energy crisis is not merely energy generation by traditional means, but in an integrated approach such as demand side management, the conservation and efficiency, lighting transformation and energy generation through renewable energy sources.

The electrical energy system engineering courses are designed to cover the subjects of power systems, power electronics and smart grids to impart both theoretical and practical knowledge through high quality applications-oriented postgraduate education/research based on state-of-the-art technological equipment and software associated with power systems, power electronics and smart grids.

The objective will be achieved through several parameters; such as continuing to update specific courses in the program to ensure relevance to the latest industrial changes, supporting the development of appropriate computer facilities, promoting the integration of advanced technology in all courses, and encouraging professional growth and development of the students, engineers and researchers. The program is designed to satisfy the educational needs of the community by providing a climate that fosters self-awareness, personal growth, and a desire for lifelong learning.

Focus Areas

Distributed Generation, Smart Grid Technologies (Power and

Communication), Renewable Energy System (PV System, Wind Power System etc), HVAC, HVDC, Wide Area Monitoring and Control, Advanced Power System Protection, Power System Stability, Power System Transients Analysis, Power System State Estimation, Blackout Avoidance Strategies, Phasor Measurement Technologies, Joint Time Frequency Analysis.

Eligibility Criteria

MS/M.Sc. in Electrical Energy System Engineering/Electrical Engineering/Electronic Engineering

Seat Allocation

As per USPCAS-E UET policy

Degree Requirements

Ph.D. Program would comprise of at least 54 credit hours, out of which at least 18 credit hours should be in the form of course work with a minimum CGPA of 3.3. This will be followed by a comprehensive examination along with thesis defense. The minimum time for the award of Ph.D. degree will be three years for full time students and four years for part time students, who must register as full time students for at least two years. All other existing rules of UET-Peshawar will be followed in this regard.

The following breakup of credit hours will be used:

Elective Courses:	18 credits
Thesis:	36 credits
Total:	54 Credits

Technical Electives

CAS-EESE-510 Power System Modeling and Analysis: [3CH]

Circuit concepts, Power System Representation, Transfer function, State-space, Transmission Line Model, Power Transformer Model, Synchronous Machine Model, Load modeling, Power and load flow problem, Inter-connected systems, Computer methods in power system analysis.

Recommended Books:

1. Electrical Power Systems Technology, 3rd edition. Stephen W. Fardo and Dale R. Patrick. The Fairmont Press 2009.
2. Power Systems. Edited by Leonard L. Grigsby, Taylor & Francis Group, LLC, CRC Press 2007.
3. Power System Analysis and Design, 5th Edition, J. Duncan Glower, Mulukutla S. Sharma and Thomas J. Overbye. Cengage Learning 2008.
4. Electric Power Systems Edited by Michel Crappe, Wiley 2008.

CAS-EESE-511 Analysis Of Faulted Power System: [3 CH]

Type of faults in power system, open and short-circuit faults, causes, symmetrical components, sequence networks, Balance and Unbalance faults, Fault Analysis by Computer Methods, Faults analysis of different components of power system, Power system stability and faults.

Recommended Books:

1. Analysis of Faulted Power Systems. Paul M. Anderson, Power Math Associates Inc. Taylor and Francis Group, CRC Press 2010.
2. Power Systems Modeling and Fault Analysis Theory and Practice, Nasser D. Tleis and Abdul Nasser Dib Tleis. Elsevier Ltd 2008.

CAS-EESE-512 Power System Protection and Switch Gear: [3 CH]

Detection of System variables, Relays, Fuses and Circuit Breakers, Isolators, Earthing switches, Protection of Power Transformer, Motor, Generator, transmission and distribution lines, Voltage and Current transformers, power system condition monitoring, Protection schemes and zoning, Microprocessor based power system protection.

Recommended Books:

1. POWER SYSTEM PROTECTION Edited by The Electricity Training Association, The Institution of Electrical Engineers 1997.

   Volume 1: Principles and components.

   Volume 2: Systems and methods.

   Volume 3: Application.

   Volume 4: Digital protection and signaling
2. Protective Relay Principles, Anthony F. Sleva. Taylor & Francis Group, CRC Press 2009.
3. Practical Power Systems Protection, Les Hewitson, Mark Brown, Ben Ramesh Series editor: Steve Mackay, IDC Technologies Newnes Imprint of Elsevier 2004.

CAS-EESE-513 HVDC Transmission Systems: [3 CH]

Economics of Transmission, DC links, Rectifier and Converter operation and Design, Controls and Protection, Harmonics and Filters, Stability of DC transmission systems. Power interchange in HVDC links. Load flow and power flow.

Recommended Books:

1. HVDC Power Transmission Systems. K. Padiyar, New Academic Science 1999.
2. HVDC Transmission: Power Conversion Applications in Power Systems, Gil-Soo Jang, Seok-Jin Lee, Seong-Joo Lim, and Vijay K. Sood, Wiley 2009.

CAS-EESE-514 HVAC Transmission Systems [3 CH]

High voltage Transmission Systems, Overhead lines: Electrical and Mechanical design, Electrical characteristics Corona on A.C lines, Radio and Television Interference, Audible Noise and Corona loss, Insulation Design, Electrostatic effects. HV cables, Grid systems, Inter-connections. Effect of high electric and magnetic field of HV lines, Environmental issues.

Recommended Books:

1. EHV AC Transmission Engineering, Rakosh Das

Begamudre, 3rd edition, Newage Publishers New Delhi.

2. Transmission and Distribution Electrical Engineering. C. R. Bayliss, 2nd edition Newnes An imprint of Elsevier 1999.

3. Power Transmission and Distribution. Anthony J. Pansini, 2nd edition, The Fairmont Press Inc 2005.

CAS-EESE-515 Over voltages and Transients [3CH]

Sources of over voltages and transients, Over voltages and Transient performance of Power System, Circuit Interruption, Switching and lightning transients, Travelling waves, Behavior of power system equipment under transient conditions, Protection against transient overvoltage, Arresters, Insulation coordination.

Recommended Books:

1. Transients in Power Systems. Lou Van der Sluis. John Wiley & Sons Ltd, 2001.

2. Power System Transients: Theory and Applications. Akihiro Ametani, Naoto Nagaoka, Yoshihiro Baba and Teruo Ohno. CRC Press 2013.

CAS-EESE-516 Power System Reliability [3 CH]

Concept of Power System Reliability, Reliability indices, Component Reliability, Evaluation of generating capacity, Reliability Evaluation of Transmission and Distribution System, Evaluation of Composite generation/Transmission system failures modes, Parallel and Series system.

Recommended Books:

1. Reliability Evaluation of Power System, Roy Billington and R N Allan. Springer 1983.

2. Assessment of Power System Reliability Methods and Applications Authors: Čepin and Marko, Springer.

CAS-EESE-517 Power System Control [3 CH]

General characteristics of System Control, Computer and Microprocessor applications, Telemetry Channel, Centralized and de-centralized control, Data Acquisition and logging, Man/machine Interface, Automatic voltage and frequency control, Automatic Generation Control, Voltage and Reactive Control, Optimum dispatch, Power Station Controllers.

Recommended Books:

1. Power System Dynamics Stability and Control, Jan Machowski, Janusz W. Bialek and James R. Bumby. 2nd Edition. John Wiley & Sons, Ltd 2008.

2. Power System Dynamics Stability and Control. K. R. Padiyar. 2nd Edition. BS Publications India 2008.

3. Operation and Control in Power Systems P. S. R. Murty. BS Publications India 2008.

CAS-EESE-518: Electrical Insulation Engineering [3 CH]

Insulation parameters, ionization and Dissociation processes, Charge transport mechanism, Thermal processes, Insulation Failure theories, Discharges

and Insulation defects, Polarization and dielectric relaxation, Behavior in high electric and magnetic fields, Classification of insulation in terms of their Dielectric Properties. Special Purpose Insulation: Insulation for cables in nuclear environment and in Cryogenic Temperatures, Insulation for super-conducting magnet coils, Insulation for cables used in space crafts, Insulation Design, Material properties, Capacitance and sheath grading, Composite Design, Determination of Voltage and Electric Field Distribution, Calculation of CFI and BIL, Insulation design for Transformers, Rotating Machinery and Underground Cables, Insulation design for overhead transmission lines.

Recommended Books:

1. High Voltage Engineering Fundamentals. 2nd edition. E. Kuffel, J. Kuffel and W.S. Zaengl. Published by Butterworth-Heinemann. 2000.
2. Insulators for High Voltage, Looms J. S. T, 1988.

CAS-EESE-519 High Voltage Engineering [3 CH]

Testing of Insulation, Insulation testing under lightning and switching surges, Insulation testing under HVAC and HVDC conditions, Wet and Dry Tests, Voltage withstand Tests, Non-destructive testing, Behavior of overhead line insulation under pollution, Testing and measurements plus methods of generation of HV (HVAC, HVDC and Impulse), Overvoltage's and transients.

Recommended Books:

1. High Voltage Engineering, J. R. Lucas, University of Muratowa Sri Lanka 2001.
2. High Voltage Engineering Fundamentals. 2nd edition. E. Kuffel, J. Kuffel and W.S. Zaengl. Published by Butterworth-Heinemann. 2000.

CAS-EESE-520 Power System Transformers [3 CH]

Introduction, Power and Distribution transformers, Installation of transformers, Transformers theory and design, Operation of transformers in power system, Incipient faults in transformers, Transformer protection, Instrument transformers, High voltage testing transformers, Auto transformers, Transformers in HVDC systems, Voltage regulation and phase advancers.

Recommended Books:

1. Power Transformers Principles and Applications. John J. Winders, Jr. PPL Electric Utilities Allentown, Pennsylvania. Marcel Dekker Inc 2002.
2. A Practical Approach of the Power Transformer. Martin J. Heathcote. Reed Educational and Professional Publishing Ltd 1998.
3. Transformer Design Principles. Robert M. Del Vecchio. Taylor and Francis Group, LLC. 2002.
4. Electric Transformers: Design and Construction. Del Vecchio and Robert M. CRC Press 2010.
5. The J & P Transformer Book 12th edition.

CAS-EESE-521 Advanced Electrical Machines [3 CH]

Principles of motors and generators, Types of rotating machines, AC and DC machines, AC machine design, Electrical machines for hybrid vehicles, Application of electrical machines, Special purpose electrical machines, and Industrial applications.

Recommended Books:

1. Power Electronics and Motor Drives Advances and Trends. Bimal K. Bose, Elsevier Inc 2006.
2. Design of Rotating Electrical Machines, Juha Pyrhonen, Tapani Jokinen, and Valeria Hrabovcova. Wiley 2009.

CAS-EESE-522 Electrical Power Generation [3 CH]

Conventional and non-conventional plants, Peak load and base load plants, Thermal power stations, thermodynamics of thermal plants, Nuclear power stations, Types of reactors, Radiation safety and nuclear waste disposal, Hydroelectric power stations, Hydrology and fluid dynamics, Site selection for different power stations, Layout of power station components and installation, Environmental issues, Control of power stations, Station switchyards, Generation mix, Optimum power dispatch.

Recommended Books:

1. Power Generation Technologies. Paul Breeze. Newnes An imprint of Elsevier Linacre House, Jordan Hill 2005.
2. Wind and Solar Power Systems. Mukund R. Patel CRC Press, 2000.
3. Renewable Energy: Sources and Methods. Anne Maczulak, 2010.

CAS-EESE-523 Smart Grid [3 CH]

Introduction, Smart metering and monitoring of power system equipment, Centralized control of load and generation, Load management and communication infrastructure model, NIST models, Smart grid control elements, Energy storage, Smart grid application layer, Sensors, Smart grid application related to deficient and surplus generation, Fault detection and reporting, Integration of new technologies into grid, Smart grid architecture, Economics and energy savings.

Recommended Books:

1. The Smart Grid: Enabling Energy Efficiency and Demand Response. Clark W. Gellings P.E. The Fairmont Press 2009.

CAS-EESE-524 Distribution and Utilization [3 CH]

Load forecasting techniques, Consumers classification, Feeders and distributors, Urban and rural electrification, Micro-girds, Overhead and underground distribution systems, Distribution system components, Design and Analysis of distribution systems, Power factor improvement, Losses and voltage drop calculations in distributors, Demand side load management, Metering, Tariffs,

Protection of distribution system, Operation of distribution system, Utilization of electrical energy, Traction, Illumination.

Recommended Books:

1. Electric Power Distribution Equipment and Systems. Thomas Allen Short CRC Publication 2005.
2. Power Transmission and Distribution. 2nd Edition. Anthony J. Pansini. The Fairmont Press, Inc 2005.
3. Guide to Electrical Power Distribution Systems. 6th edition. Anthony J. Pansini. The Fairmont Press, Inc 2005.

CAS-EESE-525 Power Quality [3 CH]

Introduction to Power Quality, Power Quality Standards, Purpose and Features, Power Quality Surveys, Power quality measurements, Harmonics Theory and distortion, Harmonic Measurements and Standards, Solutions to Harmonic Distortion, Correction of power quality, Unbalance, Voltage Fluctuations, Voltage sag analysis and mitigation, Long duration voltage variations, Grounding, Power factor correction, Monitoring power quality.

Recommended Books:

1. Electrical Power Systems Quality, Book by H. Wayne Beaty, Mark F. McGranaghan, and Roger C. Dugan, Springer 1996.
2. Electric Power Quality, Madhuchhanda Mitra, Samarjit Sengupta, and Surajit Chattopadhyay, Springer 2011.

CAS-EESE-526 Power System Substation

Introduction, Transmission and distribution substations, Outdoor and Indoor substations, Switchyard, Substation equipment, Installation and arrangement, Busbar arrangement, Grounding and Shielding, Telemetry, Power line communication system, GIS substations, Interconnections and Islanding, Substation control, Micro-grids.

Recommended Books:

1. Electric Power Substations Engineering, 2nd edition. John D. McDonald. Taylor & Francis Group, LLC CRC Press 2007.
2. Energy Storage in Electric Power Grids Benoît Robyns, Bruno François, Gauthier Delille, Christophe Saudemont, Wiley-ISTE 2015.

CAS-EESE-527 Generation and Integration of Renewable Energy [3 CH]

Introduction to renewable energy sources, grid codes of Pakistan National Grid, Fault ride through criteria development, High penetration of wind and PV System in low voltage distribution systems and solution to voltage imbalance and improvement, Performance evaluation of grid connected PV Systems with different MPPT Controllers, Optimal siting and sizing of PV Systems and Wind Power Plants, Power Flow Analysis and Reactive power compensation of grid connected wind farms, Contribution of variable speed wind turbines for

frequency regulation and oscillation damping, Integration of Clean energy into distribution networks, Integration of Plug in Hybrid Electric Vehicles (PHEV) into the distribution grid, Coordinating Distributed Generation sources during emergency operations, Energy storage in fly wheels, Pumped storage hydroelectric power plants, Super capacitors, compressed air storage for clean energy sources.

Recommended Books:

1. Renewable Energy Integration Challenges and Solutions by Hossain, Jahangir, Mahmud, Apel (Eds.)
2. Renewable Energy: Sustainable Energy Concepts for the Energy by Roland Wengenmayr, Thomas Bührke, William D. Brewer
3. Renewable Energy Systems by David M. Buchla, Thomas E. Kissell, Thomas L. Floyd

CAS-EESE-528 Computer Modeling of Electrical Power System [3 CH]

This course covers the computer modeling of synchronous machines, transformers, transmission lines, loads, electromagnetic transients, load flow and system stability study under power electronic control.

Recommended Books:

1. Power System Control and Stability by Prabha Kundur

CAS-EESE-529 Control of Voltage Source Converter [3 CH]

Methods for design and analysis of control algorithms applied to grid-connected converters and electric drives, two-level VSCs and their pulse width modulation, current control of VSCs, synchronization of VSCs, active- and reactive-power control of VSCs, DC-bus-voltage control of VSCs, power-synchronization control of MMCs, fault ride through of MMCs, modeling and internal control of the MMC, VSC-fed drives, similarities and differences to grid-connected VSCs.

Recommended Books:

1. Control of Voltage-Source Converters and Variable Speed Drives by L. Hamefors, M. Hinkkanen, och J. Loumi
2. First Course on Power Electronics and Drives by Mnpere and Ned Mohan
3. Power Electronics: Converters, Applications and Design," N. Mohan, T.M. Undeland, W.P. Robbins, Wiley, 3rd ed., 2003
4. Grid Converters for Photovoltaic and Wind Power Systems by Remus Teodorescu, Marco Liserre and Pedro Rodriguez

CAS-EESE-530 Communication and Control in Electrical Power Systems [3 CH]

- Design, implementation and use of information and control systems for protection, automation and operation of restructured power systems.

- ❖ Describe the functions of the primary equipment in the power system that is relevant for protection, automation and control. Analyze substations and simple power systems in terms of reliability protection, automation and control needs.
- ❖ Describe the function and architecture of information and control systems used for protection, automation and control of power systems.
- ❖ Describe the function and architecture of communication systems used for information & control systems for power system control.
- ❖ Describe the importance of information & control systems for the ability to connect large amounts of renewable power sources.
- ❖ Analyze and develop basic systems for substation automation and protection.
- ❖ Analyze and develop basic information & control systems for system-wide control from control rooms, e.g. SCADA systems and EMS applications.
- ❖ Construct a state estimator for power systems.
- ❖ Describe relevant interoperability standards in the field, such as IEC 61850 and IEC 61970.
- ❖ Describe the threats and risks associated with the use of information & control system for controlling the electric power system, known as Cyber Security.

Recommended Books:

1. Real Time Stability Assessment in Modern Power System Control Centers by Savu C. Savulescu
2. Smart Power Grids by Ali Keyhani and Muhammad Marwali

CAS-EESE-531 Advanced Topics in Renewable Energy Integration [3 CH]

Advanced topics of current interest in Renewable Energy Integration. Topics are selected from current technical literature based on PhD study requirement.

Recommended Books:

- ❖ To be decided by the instructor

CAS-EESE-532 Advanced Topics in Power Electronics [3 CH]

Advanced topics of current interest in power electronics. Topics are selected from current technical literature based on PhD study requirement.

Recommended Books:

- ❖ To be decided by the instructor

CAS-EESE-534 Network Based Grid System [3 CH]

Introduction to communication network, smart grid communication network (SGCN), home-area network (HAN), neighbor area network (NAN), Wide area network (WAN), wireless technologies for SGCN, Bluetooth, WPANs, Wireless mesh networks, Cellular networks, WiMAX networks, Power-line communication network for SGCN wireless routing protocols for NANS, performance metrics for routing

protocols, smart grid and smart cities

Recommended Books:

1. The Smart Grid: Enabling Energy Efficiency and Demand Response. Clark W. Gellings P.E. The Fairmont Press 2009.

CAS-EESE-535 Automated Distributed Power System using Data Communication [3 CH]

The Electric Power Systems; Generation, transmission and distribution of power grid systems, Introduction to smart grid and intelligent distribution networks, Distributed Power Generation and Energy Renewable Techniques, Energy Storage Technologies, NIST Framework and Roadmap for Smart Grid for 2020, Demand Side Management, Demand Response and Demand Pricing, FDIR and Volt-VAR Optimization - Asset Health Management, SCADA based system and computer based SCADA network, Network types for smart grid communication, Smart metering technology for smart grid, Substation communication network, IEDs, network topology, IEC61850 smart grid standard for substation automation network, Rapid Spanning tree protocol, Parallel redundancy protocol (PRP), High-availability seamless redundancy (HSR), Wireless communication technologies for substation distribution network, Network security for smart grid.

Recommended Books:

1. Real Time Stability Assessment in Modern Power System Control Centers by Savu C. Savulescu
2. Smart Power Grids by Ali Keyhani and Muhammad Marwali

CAS-EESE 533 Engineering Economics and Management of Electrical Power System [3 CH]

The course presents an in-depth interdisciplinary perspective of electric power systems, with regulation providing the link among the engineering, economic, legal and environmental viewpoints. Generation dispatch, demand response, optimal network flows, risk allocation, reliability of service, renewable energy sources, ancillary services, tariff design, distributed generation, rural electrification, environmental impacts and strategic sustainability issues will be among the topics addressed under both traditional and competitive regulatory frameworks.

The course will make available the engineering, economic and legal basis to critically evaluate the regulatory instruments that are used worldwide for electricity supply activities that are performed as regulated monopolies or under competitive conditions. Most of these regulatory approaches are also of application in other industrial sectors.

The knowledge acquired in the course will provide the comprehensive understanding of electric power

systems that will be needed for research in this field, as well as for future professional activities in the energy sector, whether in industry, government or consulting.

Recommended Books:

1. Smart Meters and the Smart Grid Privacy and Cyber Security Consideration, Energy Policies, Politics and Prices by Irwin E. Reid and Hale A. Stevens.

CAS-REE 526 Risk and Reliability Engineering [3 CH]

Introduction and Fundamentals of Risk and Reliability Engineering, Risk Management Process, Mathematics for risk analysis, Qualitative Reliability Analysis, Systems modeling using Reliability Block Diagrams, Quantitative Reliability Analysis, Reliability, Availability, Maintainability and Safety Analysis, Certification of Engineering Systems, First Order Reliability Method, Risk Control and Decision Support Systems, Failure Consequences, Introduction to Stochastic Modeling Using Risk, Insurance of Engineering Applications, Risk Analysis of Mega-Projects, Introduction to inspection and Structural Health Monitoring, vulnerability and resiliency components.

Recommended Books:

1. Reliability Engineering and Risk Analysis: A Practical Guide, 3rd Edition, Muhammad Modarres, Mark P. Kaminskyi, Wasi Liy Krivtsov
2. Reliability and Risk: A Bayesian Perspective, Nozer D. Singpurwalla, 2006.

CAS-REE 527 Energy Quality Management and Standards [3 CH]

The course includes local and global quality standards in renewable energy technologies such as solar photovoltaic, solar thermal, bioenergy, and wind energy. Quality and efficiency tests, certifications, standardizations, calibration .Performance and efficiency management and sustainability related issues. PV standards. astm international, Australia—standards Australia, Canada—standards council of Canada ,china—standardization administration of china. European committee for electro technical standardization (cenelec), global approval program for photo voltaic (PV gap). International systems for PV system standardization. Testing and Routes to Certification in renewable energy system. Hydrodynamic Testing, overview of facilities and techniques for testing offshore renewable energy technologies, Review of existing facilities worldwide and their capabilities, overview of facilities and techniques for testing wind turbine rotors, Total Quality Management (TQM), ISO 9000, Lean Manufacturing and Six Sigma components.

Recommended Books:

1. Solar Power Generation Problems, Solutions and Monitoring By Peter Gevorkian,Cambridge University Press 2016.
2. Guideline for Certification of Solar Energy Equipment, The Commission, 1978.

3. How to Solar Power Your Home: Everything You Need to Know Explained SimplyBy Martha Maeda, Atlantic Publishing Company, 2011.

4. Solar PV Engineering and Installation: Preparation for the NABCEP PV Installation Professional Certification, Sean White, Routledge, 2015

CAS-REE 528 Energy Audit and Planning [3 CH]

Energy Law &Policy. Energy resource survey and energy data analysis. The energy crises past, present and future, brief history of energy consumption in industry, Energy and industrial process dynamics .Energy economics. Energy environment and society, Energy demand and availability studies. Energy economic analysis for business decisions, Micro and macroeconomic energy planning studies. Waste to energy feasibility studies, Development & Evaluation of Renewable Energy Projects, Energy Efficiency.

Recommended Books:

1. An Introduction to Community Energy Auditing, Wayne P. Pferdehirt, Norman F. Kron, John F. Tschanz, Argonne National Laboratory,1981.

2. Energy Management in Buildings Using Photovoltaics, Elena Papadopoulou,Springer Science & Business Media, 2012.

3. Global Energy Assessment: Toward a Sustainable Future, By GEA Writing Team, Cambridge University Press.(2012).

4. Investment Grade Energy Audit-Making smart energy choices, by Shirley J. Hansen, James W. Brown, The Fairmont Press, Inc.

CAS-REE 529 Environment Impact assessment for Energy Systems [3 CH]

Understand the basic concepts, methodological approaches, and technological components of an Environmental Impact Assessment, Identify all applicable international Norms, National Codes and Standards concerning the environment and energy systems, Exhibit knowledge and understanding of the way that an EIA is conducted within the framework of the energy sector in Pakistan & southeast Asia.

Recommended Books:

1. Our Fragile World: Challenges and Opportunities for Sustainable Development - Volume II,M. K. Tolba, EOLSS Publications, 2001.

2. Energy and the Environment Cost-Benefit Analysis: Proceedings of a Conference Held June 23-27, 1975,R.A. Karam, K.Z. Morgan Elsevier, 2014.

3. Energy, Waste and the Environment: A Geochemical Perspective R. Gieré, Peter Stille Geological Society of London, 2004.

CAS-REE 530 Development & Evaluation of Renewable Energy Projects [3 CH]

Analysis of the local situation to the final energy project: what steps have to be completed in order to implement a successful regenerative energy project

and what factors must be considered, Survey of energy demand; methods to collect the demand for thermal and/or electrical energy until the point of development of an energy master plan, Technology of renewable energy: how to combine the various options for using renewable energy with different supply situation in the most reasonable way?, Feasibility study, requirements and content of a feasibility study, Legal framework for plant construction (including laws pertaining to construction, water and waterways, noise, etc., Company structures; which company structure is the most appropriate for the various applications?, Risk management, Insurance, What requirements must be met in order to obtain certain types of insurance for certain renewable energy projects, Acceptance: how the acceptance of an application for the use of renewable energy can be assessed and improved?, Organization of realization of a project: how the construction phase of a renewable energy system is organized after the end of the planning period?, acceptance: Which are the acceptance steps until the regular continuous operation.

Recommended Books:

1. Renewable Energy Projects Handbook, by World Energy Council, 2004
2. Developing Renewable Energy Projects Larger Than 10 MWs at Federal Facilities, Federal energy Management Program, 2013.
3. Economic & Financial Evaluation of Renewable Energy Projects, by Gene Owens, Alternative Energy Development, 2002

CAS-EESE 602 Ph.D. Thesis Project [36CH]

M.Sc. Thermal System Engineering (TSE)

Introduction:

The aim of M.Sc. TSE program is train engineers in energy technologies, including a range of thermal-based energy technologies, in order to meet societal and market needs. Efficient use of thermal energy is an increasingly popular area of interest for engineers and technologists. Therefore, this program is aimed at equipping next generation of engineers with the state of the art knowledge of energy conversion, efficiency and conservation. The program will provide students with set of courses that will improve their capacity to analyze and design innovative thermal energy systems. These systems include, but are not limited to, energy conversion systems and their fuels, refrigeration, combustion, and solar energy. The MSc specialization in TSE primarily covers advanced aspects of energy system modelling, heat- and mass transfer, fluid mechanics, thermodynamics, control engineering and experimental work with focus on different components and energy system aspects. The themes for the three semesters are particularly focused on Thermal Energy and Process Engineering and in-depth understanding of the technologies and scientific disciplines involved in energy conversion, utilization and transport.

Program objectives:

- General understanding of the design, modeling and optimization of energy systems used in various energy production applications
- Understanding the detailed operation, functionality and interaction between the various components of key thermal energy conversion technologies
- Fundamentals and applied knowledge of building energy systems, HVAC & R technologies
- Understanding solid-state and other novel thermal energy conversion approaches, including those used for waste heat utilization
- Understanding combustion processes for optimum efficiency and minimum emissions
- Detailed insight into system integration with respect to both system efficiency and control engineering aspects of energy systems
- Developing, constructing and operating thermal energy conversion technologies in the laboratory and in real applications, Insight into the topics related to the practical realization and implementation of thermal energy technologies and systems concerning both innovative aspects, business planning and economic considerations.

Focused Areas:

Thermodynamics, Thermo-Fluid, Power Plants, HVAC & R, Energy Efficiency, Enhanced Heat Transfer, Computational Fluid Dynamics, Micro/NanoFludics.

Eligibility Criteria:

- B.Sc. in Mechanical Engineering
- B.Sc. in Chemical Engineering

- M.Sc./BSc in Mining Engineering
- M.Sc./BSc in Industrial Engineering.

Seats Allocation: Seat allocation (per semester) for Master of Science (M.Sc.) in Thermal Systems Engineering: 25 seats with 50% allocation for female candidates as per requirement of USAID. Female candidates must fulfill the university criteria for admission in M.Sc. program.

Degree Requirement:

M.Sc. program comprises of 33 credit hours including 3 credit hours of Research Methodology.

Core Courses:

15 Core Course credits required by all students enrolled in the Program.

Course No.	Course title	Credits
CAS-TSE 501	Advanced Thermodynamics	3
CAS-TSE 502	Thermal Power Plants design and operation	3
CAS-TSE 503	Fuels and combustion	3
CAS-TSE 508	Energy Engineering Economics and Policy	3
CAS-EP 509	Research Methodology	3
CAS-TSE 514	Thesis Project	6

Elective Courses: 12 Credits

Students to select Thesis: 6 credits.

Elective Courses

Course No.	Course title	Credits
CAS-TSE 504	Advanced Fluid Dynamics	3
CAS-TSE 505	Clean Coal Technologies	3
CAS-TSE 506	Computational Fluid Dynamics for Thermal Energy systems	3
CAS-TSE 507	Fuel Cell and Hydrogen Technology	3
CAS-TSE 509	Rotodynamic Machinery	3
CAS-TSE 510	Advance Heat Transfer	3
CAS-TSE 511	Advanced topics in Thermal Energy	3
CAS-TSE 512	Thermal Desalination Systems	3
CAS-REE 509	Solar Thermal Energy	3
CAS-REE 511	Biomass Technologies	3
CAS-REE 512	Geothermal Engineering	3
CAS-REE 529	Environment Impact assessment for Energy Systems	3

Detail of Courses

CAS-TSE 501 Advanced Thermodynamics [3CH]

Review of first and second law of thermodynamics, Maxwell equations, Joule-Thompson experiment, irreversibility and availability, exergy analysis, phase transition, types of equilibrium and stability, multi-component and multi-phase systems, equations of state, chemical thermodynamics, combustion. Third law of thermodynamics, Kinetic theory of gases-introduction, basic assumption, molecular flux, equation of state for an ideal gas, collisions with a moving wall, principle of equipartition of energy, classical theory of specific heat capacity. Pinch technology.

Recommended Books:

1. Advanced Engineering Thermodynamics by Bejan A
2. Advanced thermodynamics for engineers by D. Winterbone; Ali Turan

CAS-TSE 502 Thermal Power Plants Design & Operation [3]

The advanced Thermal Power Plants that are currently on the market or are under development, and design and to evaluation of system

performance. The study will focus on natural gas combined cycle, alternatively-fueled combined cycle (i.e., coal or biomass in integrated gasification combined cycle), supercritical Rankine cycle, biomass combustion systems, internal combustion engines, and fuel cells. Also CHP systems, Solar thermal power plants and Geothermal power plants will be briefly discussed.

Recommended Books:

1. Power plant technology by M. M. El-Wakil
2. Thermal power plant performance analysis by De Souza, Gilberto Francisco Martha.

CAS-TSE 503 Fuels and Combustion [3]

Fuels and types, combustion process, combustion mechanism, adiabatic flame temperature, flame propagation, stability, kinetics, combustion aerodynamics, gaseous detonations, flame ignition and extinction and condensed phase combustion. Solid burning equipment, stokers, pulverized coal burning systems, cyclone combustors, emissions, types of fluidized beds, fluidized bed combustion, fundamentals bubbling bed, gas and liquid burners types, gas turbine combustion systems, combustion modeling. Design of combustion systems for boilers, furnaces, gas turbines and IC engines, combustion chamber performance. Propellants Types, theory of combustion, energy balance calculations.

Recommended Books:

1. Combustion by Irvin Glassman
2. Principles of combustions by Kenneth Kuan-yun Kuo.

CAS-TSE 512 Thermal Desalination Systems [3]

Seawater composition. The need for water desalination. Classification of desalination processes. Single effect evaporation. Thermal Vapor compression systems. Multiple effect evaporation. Multistage flash distillation. Once through, MSF. Brine mixing and recirculation MSF. Reverse osmosis. Desalination using renewable energy sources. Economic analysis of desalination processes. Solar Thermal Desalination Systems

Recommended Books:

1. El-Desouky H.T and Ettouney H.M (2011) Fundamentals of Salt Water Desalination Elsevier Science. ISBN-13: 978-0444543424
2. Vassilis Belessiotis Sotoris, Kalogirou, Emmy Delyannis (2016) Thermal Solar Desalination: Methods and Systems, First Edition, Academic Press, ISBN-13: 978-0128096567.

CAS-TSE 504 Advanced Fluid Dynamics [3]

This course will cover principles of fluid dynamics: Tensors, model testing, description of flow fields, laws for mass, momentum and energy. Inviscid flow: Euler and Bernoulli equations, potential flow. Viscous flow: Navier-Stokes equations, boundary layers, turbulence. Element of Stability Theory. Turbulent Flows. Compressible Flows and Introduction to CFD.

Recommended Books:

1. Fluid Mechanics: Fundamentals and Applications by Yunus A. Cengel

2. Introduction to Fluid Mechanics by Fox W. Robert, McDonald T. Alan.

CAS-TSE 505 Clean Coal Technologies [3]

Direct coal liquefaction. Indirect coal liquefaction (FT). Hybrid approach to synthesize liquid fuels. Clean coal gasification process description. Integrated gasification combine cycle (IGCC).Under ground coal gasification (UCG). Carbon capture techniques.

Recommended Books:

1. Clean Coal engineering technology by Bruce G. Miller
2. Emerging clean coal technologies by Paul W. Spaite.

CAS-TSE 506 Computational Fluid Dynamics for Thermal Energy systems [3]

This course will focus on obtaining the knowledge of the computational fluid dynamic for power plants. It provides an overview of fundamental mathematical governing for fluid flow and heat transfer and Navier-Stokes equation. The course will develop the concept of turbulence and its characteristics in random fluctuation flows. The course will cover the finite volume method for steady flow and discretization schemes. The course will enlighten the concept of boundary condition and errors in modeling and simulation. The course deliberates the mesh generation strategies, modeling capabilities and CFD post processing.

Recommended Books:

1. An introduction to computational fluid dynamics, 2nd Edition by H. K. Versteeg and W. Malalasekaera.
2. Computational Fluid Dynamics- Principles and Applications by J. Blazek

CAS-TSE 508 Energy Engineering Economics and Policy [3]

Project Cycle, Features of energy projects, project identification and development, cost concepts and financial calculations, economic evaluation of energy projects, financial evaluation of projects, environmental considerations in project evaluation, financing energy projects, risk analysis, life cycle analysis, economic analysis of public utilities, development and evaluation of CDM projects, case studies.

Recommended Books:

1. Contemporary Engineering Economics by Park C.S.
2. Economic Evaluation of Projects in the Electricity Supply Industry by Khatib H.

CAS-TSE 507 Fuel Cell and Hydrogen Technology [3]

This course will cover from fundamentals to system applications of current fuel cell technologies. Following major types of fuel cells will be discussed: polymer electrolyte membrane fuel cell (PEMFC), direct methanol Fuel Cells (DMFC), Alkaline Fuel Cells (AFC), phosphoric acid fuel cell (PAFC), molten carbonate fuel cell (MCFC) and solid oxide fuel cell (SOFC). The emphasis will be the performance behavior, analysis, and modeling. Subsequently, the

balance of the fuel cell power plant, thermal system design and analysis will be discussed that affect the power generation. Finally, the components needed, issues related, and pertinent analysis will be covered to delivering electric power generated from the fuel cell.

Recommended Books:

1. Fuel Cell fundamentals by Ryan O'Hayre, Suk-Won Cha, Whitney Colella.
2. Fuel Cells Principle design and process by Shripad T. Revankar, Pradip Majumdar.

CAS-REE 511 Biomass Technologies

Biomass Resources and Energy Crops, Chemical and physical properties of biomass, characteristics of biomass as a fuel, Comparison to conventional fuels (coal, oil, natural gas), Energy crops for bio-energy production, pre-processing of biomass fuel for pyrolysis/gasification, principles of thermo-chemical conversion processes. Pyrolysis, Gasification, Combustion, Co-firing Energy conversion systems and CHP, Gasification Technologies, Design and Manufacturing of gasifiers, Design Challenges, Batch reactors, Continuos reactors, Multi-stage gasification, Catalytic gasification, steam gasification, Characterization of fresh and spent catalysts, synthesis gas (producer gas) and its characterization, process parameters influencing syngas composition, process optimization, state of the gasification technology, downstream processes and challenges.

Recommended Books:

1. Sergio C.Capareda (2014) Introduction to Biomass Energy Conversion, First Edition, CRC Press. ISBN-13: 978-1466513334.
2. Prabir Basu (2010) Biomass Gasification and Pyrolysis: Practical Design and Theory, First Edition, Academic Press, ISBN-13: 978-0123749888.

CAS-TSE 509 Rotodynamic Machinery [3]

Different aspects of the rotodynamic machines will be discussed. 2D and 3D steady flow phenomena in the machine components. Major rotodynamic machinery blade design philosophies. Appropriate materials for rotodynamic machinery applications and cooling techniques. Operational aspects of thermal rotodynamic machines. Technically today's and tomorrow's challenges related to thermal rotodynamic machines.

Recommended Books:

1. Fluid Mechanics and Thermodynamics of Turbomachinery by S Dixon Cesare Hal
2. Turbomachinery Flow Physics and Dynamic Performance by Meinhard T. Schobeiri

CAS-REE 512 Geothermal Engineering [3]

The course topics include geothermal power generation systems. Geothermal based heating and cooling of buildings. Geothermal exploration techniques and methods. Modeling and simulation of geothermal systems. Overall the broad objective

of this course is to introduce the energy graduates with the geothermal energy systems and how they can use geothermal energy for the power generation, building applications, and other energy related applications. And graduates will be able to display advanced understanding of relevant scientific theories, ideas, methodologies and the newest technologies in geothermal energy, Enhanced geothermal recovery.

Recommended Books:

1. Geothermal Energy: Renewable Energy and the Environment, William E. Glassley/ Taylor and Francis
2. Geothermal Energy: Utilization and Technology: by Mary H. Dickson and Mario Fanelli

CAS-REE 509 Solar Thermal Energy [3]

The Solar Resource, Solar Radiation Data Bases, Analytical Models of Solar Irradiance, Collecting Solar Energy, Solar Energy System Design, The Solar Energy Conversion System, Economic and Environmental Considerations, Thermal collector capture and loss mechanisms, Models of collector performance, Flat-plate collectors, Parabolic troughs, Parabolic dish and central receivers, Photovoltaic collectors, Evacuated tube collectors, Solar ponds, Concentrator Optics, Ray Trace Diagrams, Mirrors, Lenses, Reflection and Antireflection Coatings, Fresnel Lens Optics, Receiver Design, Central Receiver Systems, System Description, System Thermal Performance, Energy Losses, Energy Storage, Sensible Heat Storage, Solar Considerations, Rankine Power Cycles, Stirling Cycle Engines, Brayton Cycle Engines, Solar Combined with Fossil Fuel Power Cycles.

Recommended Books:

1. Power From The Sun, by William B. Stine and Michael Geyer.
2. Solar Energy Engineering: Processes and Systems: by Soteris Kalogirou.

CAS-REE 529 Environment Impact assessment for Energy Systems [3]

Understand the basic concepts, methodological approaches, and technological components of an Environmental Impact Assessment, Identify all applicable international Norms, National Codes and Standards concerning the environment and energy systems, Exhibit knowledge and understanding of the way that an EIA is conducted within the framework of the energy sector in Pakistan & southeast Asia

Recommended Books:

1. Our Fragile World: Challenges and Opportunities for Sustainable Development - Volume II,M. K. Tolba, EOLSS Publications, 2001.
2. Energy and the Environment Cost-Benefit Analysis: Proceedings of a Conference Held June 23-27, 1975,R.A. Karam, K.Z. Morgan Elsevier, 2014.
3. Energy, Waste and the Environment: A Geochemical

PerspectiveR. Gieré, Peter StilleGeological Society of London, 2004.

CAS-TSE 510 Advance Heat Transfer [3]

Conduction: one dimensional and two dimensional, steady state conduction. One dimensional and two dimensional transient conduction.

Convection: Convection boundary layers. Laminar and turbulent flow. External flow. Internal flow. Free convection. Boiling and condensation. Pool boiling, forced convection boiling. Laminar and turbulent film condensation.

Heat Exchangers: Heat exchangers types, log mean temperature. The Effectiveness - NTU Method.

Radiation: Radiation intensity, emission, irradiation, radiosity. Surface absorption, reflection and transmission. Kirchaws law. Radiation exchange between surfaces. Diffusion Mass Transfer (5%) Fick´s law of diffusion. Conservation of species. Evaporation. Numerical methods in heat transfer.

Recommended Books:

1. Heat and Mass Transfer A practical approach. By Yunus A. Çengel.
2. Advanced Heat and Mass Transfer by Amir Faghri, Yuwen Zhang, John Howell
3. Computational Methods for Heat and Mass Transfer by Pradip Majumdar, Pradip Majumdar

CAS-EP 509 Research Methodology [3]

Define research; research terms; research process and the principle activities, skills and ethics associated with the research process, relationship between theory and research, major quantitative and qualitative research methods, importance of research ethics and integrate research ethics into the research process, assess and critique a published journal article that uses one of the primary research methods in the field; construct an effective questionnaire that employs several types of survey questions.

Recommended Books:

1. Investigating the Social World: The Process and Practice of Research, by Schutt, 7th ed., Sage, 2012.

CAS-TSE 511 Advanced Topic in Thermal Energy [3]

As approved

CAS-TSE 514 Thesis Project [6]

As approved synopsis

M.Sc. & Ph.D. in Renewable Energy Engineering

The world is undergoing a smooth but rapid transition from producing power from fossil fuels – which are quickly depleting and pose serious environmental threats – to more abundantly available Renewable Energy resource, to fulfill its ever growing energy demand. These sources are not only interminable, but are also environment friendly. These sources provide opportunity for promoting distributed power generation to avoid power transmission and distribution losses and other associated complexities. Furthermore, these sources are turning out to be more economical, and in many instances the costs of power generation from these sources is cheaper compared to that from the conventional sources. Therefore, it is the need of the hour to develop competent and knowledgeable human resource to take up the transition challenges and fulfill the emerging market demands for skilled workforce in these areas. Pakistan is blessed with abundant solar, wind, hyrdo and biomass resource, and thus it can easily fulfill its growing energy demands if these sources are properly harnessed. With these objectives in mind, USPCAS-E UET Peshawar would like to commence Master and Ph.D. programs in Renewable Energy Engineering as per the course curriculum below.

Objectives:

The objectives of the Renewable Energy Engineering program is to develop capacity building in a rapidly developing knowledge bank for addressing the ever rising demand for energy through modern renewable technologies. This objective is to be achieved through continuously updating the course curriculum of the program to ensure relevance to the latest market demands and generation of new technologies, as well as encouraging professional growth and development of the students and researchers. The program is designed to satisfy the growing market demand for skilled manpower in the new, clean and economical energy sources.

Mode of execution: The courses are offered in regular day classes, conducted at the campus. It will also include industrial visits, seminars, training modules and case studies.

Outcomes:

1. Graduates will be able to apply the knowledge and principles of renewable energy engineering and use appropriate technologies for the betterment of the society.
2. Recognize international and national issues related to global warming and environmental degradation, in respect of energy generation and consumption.
3. Solve problems by thinking critically, creatively and reflectively and communicate solutions in an effective manner.
4. Apply the science and engineering principles for solving the energy related issues specific to Pakistan and other developing countries.
5. Select and apply appropriate techniques, resources and modern engineering tools, including prediction and modeling, to design, analyze and experimentally verify the renewable energy systems and their components output.
6. Apply international standards, practices and conventions appropriate to energy policies, like Kyoto protocol and Paris agreements.

7. Understand the impact of renewable energy solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.

Focus Areas: Solar PV, Solar Thermal, Wind, Biomass, Hydro, Geothermal, Renewable Energy Policy, Electrical Systems, Energy Management, Energy Materials, Environmental Impacts, Fuel Cells, Energy Storage.

Criteria and Requirements

Criteria and Requirements for M.Sc. in Renewable Energy Engineering

Eligibility Criteria:

- B.Sc. in Mechanical Engineering
- B.Sc. in Chemical Engineering
- B.Sc. in Electrical Engineering
- B.Sc. in Mechatronics Engineering
- B.Sc. in Material Engineering
- B.Sc. in Agricultural Engineering
- Or any other relevant B.SC. Engineering degree

Degree Requirement: MS Program would comprise of 32 Credit Hours in both Core and Elective Courses, as well as the thesis,

Seat Allocation: Seat allocation (per semester) for Master of Science (M.Sc.) in Renewable Energy Engineering: 25 seats with 50% allocation for female candidates as per requirement of USAID. Female candidates must fulfill the university criteria for admission in M.Sc. Program.

Eligibility Criteria for Ph.D. in Renewable Energy Engineering

- M.Sc. in Mechanical Engineering
- M.Sc. in Chemical Engineering
- M.Sc. in Electrical Engineering
- M.Sc. in Mechatronics Engineering
- M.Sc. in Material Engineering
- M.Sc. in Renewable Energy Engineering
- M.Sc. in Agricultural Engineering
- Or any other relevant M.S./M.Sc../M.Phil Engineering degree with a minimum CGPA of 3.0

Students will be offered admission as per standard Ph.D. admission policy of UET.

Degree Requirement: Ph.D. Program would comprise of at least 54 credit hours, out of which at least 18 credit hours (including 12 credit hours of core courses) should be in the form of course work with a minimum CGPA of 3.3. All other existing rules of UET-Peshawar will be followed in this regard. The following breakup of credit hours will be used:

Seat Allocation: As per USPCAS-E UET(Peshawar) policy

Core Courses

Course Code	Title	Cr. Hrs
CAS-REE 501	Renewable Energy Technologies	3
CAS-REE 502	National/Provincial Energy Policies, Supply/Demand & Planning	3
CAS-REE 503	Management of Technology & Innovation	3
CAS-REE 504	Power Electronics and Machines	3

Elective Course Options

Course Code	Title	Cr. Hrs
Technical Electives		
CAS-REE 507	CFD for Renewable Energy	3
CAS-REE 508	Wind Energy Engineering	3
CAS-REE 509	Solar Thermal Energy	3
CAS-REE 510	Hydro Power Engineering	3
CAS-REE 511	Biomass Technologies	3
CAS-REE 512	Geothermal Engineering	3
CAS-REE 515	Applied Photovoltaics Engineering	3
CAS-REE 516	Renewable Energy Mega Power plants	3
CAS-REE 517	Advanced topics in Renewable Energy	3
CAS- REE 518	Electrical and Optical Properties of Materials	3
CAS- REE 519	Materials Characterization Techniques	3
CAS- REE 520	Adv. Topics in Energy Storage & Conversion	3
CAS- REE 521	Adv. Materials for Renewable Energy Systems	3
CAS- REE 522	Operation & Maintenance of RE Systems	3
CAS-EP 520	Research Methodology	3
CAS-REE 526	Risk and Reliability Engineering	3
CAS-REE 527	Energy Quality management and Standards	3
CAS-REE 528	Energy Audit and Planning	3
CAS-REE 529	Envir. Impact Assessment for Energy Systems	3
CAS-REE 530	Development & Evaluation of RE Projects	3
Thesis Project		
CAS-REE 599	TBD (for M.S.)	6
CAS-REE 699	TBD (for Ph.D.)	36

Catalog Course Descriptions:

M.Sc. & Ph.D in Renewable Energy Engineering (REE)

Core Courses

CAS-REE 501 Renewable Energy Technologies [3]

Overview of Energy Use and Related Issues, Global Climate Change Issues and Responses, Sustainability, Energy and Clean Technologies in Context, Electric Power Systems and Requirements for Success, Historical Factor and Prospects for Change in the Electrical Power Grid, Carbon Limitation Policy Options, Wind Power, Current Energy Policy, Wind Energy Technology and Offshore Wind Projects, Electricity Generation Alternatives, Geothermal Energy, Solar Photovoltaic Energy, Solar Thermal Energy, Biomass Energy, Biomass Conversion to Liquid Fuels, Hydropower, Lifecycle Analysis Biomass energy Conversion, Electromagnetic energy , Biocatalytic conversion, Electro-chemical Energy Conversion, New energy technologies (Ocean Energy, Ocean Energy Potential against Wind and Solar, Wave Energy Devices, Tidal Energy Technologies, Osmotic Power, Salinity grid Energy, Renewable Energy Generation at all scales.

Recommended Books:

1 Renewable Energy Resources, by John Twidell & Tony Wier; Taylor & Francis.

2. Power From The Sun, by William B. Stine and Michael Geyer

3. Wind Turbine Engineering Design, by David M. Eggleston, Van Nostrand Reinhold Company NY.

CAS-REE 502 National/ Provincial Energy Policies, Supply/Demand & Planning [3]

Topics include (a) demand side planning (methods of demand projection, demand management and fuel substitutions), (b) supply side planning (methods of estimation of energy supplies from indigenous resources, supply side policies and strategies etc.) (c) Financial planning (assessment of quantum of financial resources required and affordability of the investment including (macro and micro economic impacts, mobilization of financial resources including from private sector). New modern approaches like the Shale boom, exploitation of Marginal & low economic resources with ultimate energy sources will be deliberated to bring these into the main stream. Global, regional, national and provincial supply/demand scenarios will be developed. The course shall include Case Study for Provincial Setup, capacity building, infrastructure, status, policy regimes, international geopolitical energy scenario & market covering.

Recommended Books:

1. Global Energy Assessment: Toward a Sustainable Future, By GEA Writing Team, Cambridge University Press.(2012).

2. Power for the World: The Emergence of Electricity from the Sun,Wolfgang PalzPan Stanford Publishing, 2010.

3. Introduction to Energy Analysis,Kornelis Blok, Evert Nieuwlaar, Routledge, 2016.

4. Energy Policy Planning,B. A. Bayraktar, Springer Science & Business Media, 2012.

CAS-REE 503 Management of Technology & Innovation [3]

Project management (Scope definition, Planning and Scheduling, Critical path analysis), People management (Understanding yourself, Understanding other people, Working in teams, Dealing with conflicts), Marketing (Marketing technology, Selling technology, Market segmentation), Negotiation (Preparation for negotiations, Negotiation process, Win-win Solutions), New product development (Commercializing technology, Market drivers, Time to market, Focusing technology, Concerns), Presentation skills (Understanding your audience, Focusing your message, Successful presentations, Getting your message across), Finance (Profit and loss accounts, Balance sheets, Cash flow forecasting, Project appraisal), Business game (Working in teams (companies), students will set up and run a technology company and make decisions on investment, R&D funding, operations, marketing and sales strategy), Innovative Financial & Enterprise

Models for Renewable Energy Systems, Management of innovation Component.

Recommended Text:

1. Management of Technology (The key to Competitiveness and Wealth Creation), by Tarek M. Khaliler
2. The Management of Technological Innovation Strategy and Prcatice, Revised Edition by Mark Dodgson, David M. Gann, and Ammon Salter, Oxford University Press.

CAS-REE 504 Power Electronics and Machines [3]

Fundamentals of Electromagnetism and Electric Power Conversion, Transformer Operations, DC Machines - motors, generators & control, AC Machines - synchronous & asynchronous, Overview of semiconductor switches - Diodes, IGBTs, MOSFETs, Boost/buck converters - operation, control and design, Multi-phase converters - operation, control and design, Switching strategies of converters, Wind generator systems: General types of electric machines. Converter types and configurations, Photovoltaic generators, PV configurations and integration, Generation Control of Isolated Power systems, Protection sys., Stability & dynamics analysis with the application of FACTS devices, Distributed Generation & Micro-Grids.

Recommended Books:

1. Power Electronics: Converters, Applications and Design," N. Mohan, T.M. Undeland, W.P. Robbins, Wiley, 3rd ed., 2003
2. Electric Machinery Fundamentals,",Stephen J. Chapman, McGraw Hill, 5th ed. 2014
3. Renewable and Efficient Electric Power Systems," Gilbert M. Masters, Wiley, 2004
4. Integration of Distributed Generation in the Power System," Math H. Bollen, Fainan Hassan.

Elective Courses

CAS-REE 507 CFD for Renewable Energy [3]

The physics of thermo-fluids. Governing equations (continuity, momentum, and energy and species conservation) and state of the art Computational Fluid Dynamics including modeling, grid generation, simulation, and high performance computing. Specification for a CFD simulation exercise, Requirements for accurate analysis and validation for multi scale problems, Introduction to Turbulence and turbulent flows, Traditional and Advanced Turbulence Modeling, Introduction to Reynolds-averaged Navier Stokes (RANS) simulations and large-eddy simulation (LES), Renewable energy problems will be solved employing the widely-used industrial flow solver software FLUENT.

Recommended Books:

1. Computational Fluid Dynamics- An Introduction: Edited by John Wendt, Springer
2. Computational Fluid Dynamics – The Basics with Applications: by John Anderson, Springer

CAS-REE 508 Wind Energy Engineering [3]

Historical uses of wind, Horizontal and Vertical axis wind turbines, Innovative wind turbines, Wind farms, Wind Characteristics, Meteorology of wind, Weibull statistics model, Wind Measurements, Wind Turbine Power, Energy, Torque, Blade aerodynamics, Transmission and generator efficiencies, Energy production and capacity factor, Turbine shaft power and torque at fixed and variable speeds, Wind turbine mathematical models, Mechanical components of wind turbines - Rotor, Blade, The Hub, Drive train, Couplings, Gearbox, Brakes, Yaw system, Main frame and nacelle, Tower, Mechanical Aerodynamic and Electrical subsystem, Pitch subsystem, Power quality, Turbine modes of operation, Turbine control strategies, Grid Integration of offshore wind farms, HVAC, Economics and Environmental Aspects of Wind Systems.

Recommended Books:

1. Wind Turbine Engineering Design, by David M. Eggleston, Van Nostrand Reinhold Company NY
2. Wind Energy Handbook by Tony Burten Tony Burton, David Sharpe, Nick Jenkins and Ervin Bossanyi / John Wiley & Sons, Ltd.

CAS-REE 509 Solar Thermal Energy [3]

The Solar Resource, Solar Radiation Data Bases, Analytical Models of Solar Irradiance, Collecting Solar Energy, Solar Energy System Design, The Solar Energy Conversion System, Economic and Environmental Considerations, Thermal collector capture and loss mechanisms, Models of collector performance, Flat-plate collectors, Parabolic troughs, Parabolic dish and central receivers, Photovoltaic collectors, Evacuated tube collectors, Solar ponds, Concentrator Optics, Ray Trace Diagrams, Mirrors, Lenses, Reflection and Antireflection Coatings, Fresnel Lens Optics, Receiver Design, Central Receiver Systems, System Description, System Thermal Performance, Energy Losses, Energy Storage, Sensible Heat Storage, Solar Considerations, Rankine Power Cycles, Stirling Cycle Engines, Brayton Cycle Engines, Solar Combined with Fossil Fuel Power Cycles.

Recommended Boks:

1. Power From The Sun, by William B. Stine and Michael Geyer
2. Solar Energy Engineering: Processes and Systems: by Soteris Kalogirou

CAS-REE 510 Hydro Power Engineering [3]

Hydro power potential in Pakistan, The hydrological cycle, Measurement and calculation of hydrological processes, Numerical models, Planning and design of dams in the context of hydropower development, dam engineering including concrete and embankment dams, soil mechanics for dams and concrete technology for dams, Run of the river system design, hydraulics of open channel flow,

hydraulic design of energy dissipation structures, spillways and outlets, turbines and surge tanks, hydraulic steel works and pipe hydraulics, support and lining for tunnels and caverns, engineering geological investigation methods, design approach for tunnels, caverns and pressure shafts, drill and blast tunnels, investment - socio-economic and environmental impact assessment studies with particular reference to small and micro-hydro turbines.

Recommended Books:

1. Hydropower from small and low head hydro technologies: by Amanda E. Niemi and Cory M. Fincher / Nova Science Publishers
2. Hydropower: Types, Development Strategies and Environmental Impacts: by Amanda E. Niemi and Cory M. Fincher / Nova Science Publishers

CAS-REE 511 Biomass Technologies [3]

Biomass Resources and Energy Crops, Chemical and physical properties of biomass, Characteristics of biomass as a fuel, Comparison to conventional fuels (coal, oil, natural gas), Energy crops for bio-energy production, Pre-processing of biomass fuel for pyrolysis/ gasification, Principles of thermo-chemical conversion processes, Pyrolysis, Gasification, Combustion, Co-firing, Energy conversion systems and CHP, Gasification Technologies, Design and Manufacturing of gasifiers, Design Challenges, Batch reactors, Continuous reactors, Multi-stage gasification, Catalytic gasification, Gasification Catalysts, steam gasification, Characterization of fresh and spent catalysts, synthesis gas (producer gas) and its characterization, Process parameters influencing syngas composition, process optimization, state of the gasification technology, downstream processes and challenges.

Recommended Books:

1. Introduction to Biomass Energy Conversion by Sergio C. Capareda (CRC Press) 2014
2. Biomass Gasification and Pyrolysis: Practical Design and Theory by Prabir Basu (Academic Press) 2010
3. Hydrogen and Syngas Production and Purification Technologies by Ke Liu, Chunshan Song, Velu Subramani (John Wiley & Sons) 2009
4. Reaction Pathways and Mechanisms in Thermocatalytic Biomass Conversion (I &II) by Marcel Schlaf, Zonghcao Zhang (Springer) 2015
5. Biomass Power for the world by Wim P. M. van Swaaij, Sascha R. A. Kersten, Wolfgang Palz (Pan Stanford Publishing) 2015 .

CAS-REE 512 Geothermal Engineering [3]

The course topics include geothermal power generation systems. Geothermal based heating and cooling of buildings. Geothermal exploration techniques and methods. Modeling and simulation of geothermal systems. Overall the broad objective

of this course is to introduce the energy graduates with the geothermal energy systems and how they can use geothermal energy for the power generation, building applications, and other energy related applications. And graduates will be able to display advanced understanding of relevant scientific theories, ideas, methodologies and the newest technologies in geothermal energy and enhanced geothermal recovery.

Recommended Books:

1. Geothermal Energy: Renewable Energy and the Environment, William E. Glassley/ Taylor and Francis
2. Geothermal Energy: Utilization and Technology: by Mary H. Dickson and Mario Fanelli

CAS-REE 515 Applied Photovoltaics Engineering [3]

The characteristics of sunlight, the behavior of solar cells, semiconductors and p-n junctions, grid-connected photovoltaic systems, stand-alone photovoltaic system design, system design for PV-powered water pumping, remote area power supply systems. Specific purpose photovoltaic applications, PV cell interconnection and module fabrication, cell properties and design. Production of commercial grade silicon from raw grade silicon, CZ, FZ process of ingot development, different type of semiconductor material and their spectral response, different type of Silicon based solar cells and their detailed study.Degradation of solar silicon based cells, System design, simulation and detailed study of BOS, batteries, Inverters, charge controllers, Applications of PV Systems.

Recommended Books:

1. Applied Photovoltaics, Second Edition by S.R. Wenham M.A. Green M.E. Watt,R. Corkish, ISBN-10: 1-84407-401-3.
2. From Sunlight to Electricity: R.K.Pachauri , 2nd Edition, a practical handbook on solar photovoltaic Applications . The energy and resources institute (TERI).

CAS-REE 516 Renewable Energy Mega Power plants [3]

The course deals with prospects and consequences of large scale production of renewable energy. Electromagnetic, Electrochemical, Photovoltaics, Kinetic and potential energy conversions into mass scale electrical power houses, Scale up potential of various renewable energy technologies such as solar PV, Organic Photovoltaic, CSP, thermal, Biomass energy, biofuel cell systems, and wind power house.

Recommended Books:

1. Large-Scale Solar Power Systems: Construction and Economics.Peter Gevorkian Cambridge University Press, 2012.
2. Reactor and Process Design in Sustainable Energy Technology by Fan Shi ,Elsevier Science, (2014).
3. Power for the World: The Emergence of Electricity from the Sunedited by Wolfgang Palz, Pan Stanford Publishing. Co.

4. Sustainable Energy Conversion for Electricity and Coproducts: Principles technology and equipment ,By Ashok Rao John Wiley & Sons 2015.

CAS-REE 517 Advanced Topics in Renewable Energy [3]

Advanced topics of current interest and trends in renewable energy engineering. Topics are selected from current technical literature: hydro energy, solar photovoltaic, solar thermal energy, biomass energy, fuel cell energy, wind energy, geothermal energy, wave & tidal energy and any other form of renewable energy.

Recommended Books: To be determined by the instructor

CAS- REE 518 Electrical and Optical Properties of Materials [3]

Electron as a Particle, Electron as a wave, The Hydrogen atom, Schrodinger Equation, Quantum Tunneling, Electrical properties of metals, Electrical properties of Semiconductors, Electrical properties of Insulators, Conducting Polymers, Semiconductor Physics, Intrinsic & extrinsic semiconductors, Band Theory, Semiconductor Devices, Super Conductors. Photons, light Spectrum, Snell's law, Reflection, Refraction, Dispersion, Absorption, Scattering, Luminescence. Optical properties of metals, Semiconductors and Dielectric, Ferro-electricity, Piezo-electricity, Resonator, Conductivity, mobility, generation, recombination, lifetime, n and k, Measurement of electrical and optical properties, like Hall, ellipsometry.

Recommended Books:

1. Electrical Properties of Materials by Laszlo Solymer, Donald Walsh, and Richard R. A.syms
2. Physics of Semiconductor Devices by Colinge, J.P, Colinge, C.A.
3. Optical Materials by Simmons and Potter.

CAS- REE 519 Materials Characterization Techniques [3]

Basic principles and applications of the following techniques: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Atomic Force Microscopy (AFM), X-Ray Diffraction (XRD), Ultimate Testing Machine (UTM), Non-Destructive Testing (NDT), Thermal Gravimetric Analysis (TGA), Differential Thermal Analysis (DTA), X-Rays photoelectron spectroscopy (XPS), Solar Simulator, Incident Photon to Electron Conversion Efficiency (IPCE) / Quantum Efficiency Equipment and Energy Conversion and Storage Simulators, Laboratory Ethics, Experimental Setups and Protocols, Chemical Ordering/Storage/Waste disposal, Laboratory Safety Procedures.

Recommended Books:

1. Advanced Techniques for Materials Characterization by A. K. Tyagi, Mainak Roy, S. K. Kulshreshtha and S. Banerjee
2. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Edition by Yang Leng.

CAS- REE 520 Advanced Topics in Energy Storage and Conversion [3]

Advanced topics of current interest and trends in energy storage and conversion. Topics are selected from current technical literature: fundamentals of electrochemistry, fuel cells, solar PV cells, batteries, hydrogen production and storage, super capacitors any other electrochemical devices for energy storage and conversion, wind and hydro turbines, any other electromechanical devices for energy conversion and storage, different types of heat exchangers and their role in energy conservation.

Recommended Books: To be determined by the instructor

CAS-REE 521 Advanced Materials for Renewable Energy Systems [3]

Types of solar cells (1st to 3rd generation), advance materials for solar cells, performance characteristics and market analysis of solar cells, different types of fuel cells, advanced materials for fuel cells, performance characteristics and market analysis of fuel cells, different types of batteries, advanced materials for batteries, performance characteristics and market analysis of batteries, advanced materials for hydro and biomass technology. Smart innovative materials for energy applications.

Recommended Books:

1. Solar Cell Materials by Conibeer & Willoughby
2. Materials for Fuel Cells, M. Gasik , ISBN: 978-1-84569-330-5
3. Rechargeable Batteries Materials, Technologies and New Trends by Zhang, Zhengcheng, Zhang, Sheng Shui

CAS-REE 522 Operation & Maintenance of Renewable Energy Systems [3]

Condition monitoring and maintenance methods in wind turbines, Operation and maintenance methods in solar power plants, Development operation and future prospects for implementing biogas plants, Integration of renewable energy in traditional energy systems, Low cost hybrid systems of renewable energy, Control methods applied in renewable energy systems, Design for reliability of power electronics in renewable energy systems, Renewable energy systems supporting industrial applications, Use of renewable energy for smart cities, Analysis of the impact of increasing share of electric vehicles on the integration of renewable energy systems generation.

Recommended Books:

1. Use, Operation and Maintenance of Renewable Energy Systems, by Sanz Bobi & Miguel, Springer, 2014
2. 5-Step: Project Operations & Maintenance, DOE Office Of Indian Energy.

CAS-EP 520 Research Methodology [3]

Define research, research terms, research process and the principle activities, relationship between

theory and research, skill development to write research thesis, assess and critique a published journal article that uses one of the primary research methods in the field, skill development for oral presentation and publishing short paper in conference proceeding, skill development for proposal writing, case studies and discussion on research trends, design of experiments and statistical analysis methods.

Recommended Books:

1. Investigating the Social World: The Process and Practice of Research, by Schutt, R. K. (7th edition). Los Angeles: Sage.
2. Research Methodology, Methods and Techniques, by C. R. Kothari, New Age International Publishers.
3. Introduction to Research Methods, by Catherine Dawson.

CAS-REE 526 Risk and Reliability Engineering [3]

Introduction and Fundamentals of Risk and Reliability Engineering, Risk Management Process, Mathematics for risk analysis, Qualitative Reliability Analysis, Systems modeling using Reliability Block Diagrams, Quantitative Reliability Analysis, Reliability, Availability, Maintainability and Safety Analysis, Certification of Engineering Systems, First Order Reliability Method, Risk Control and Decision Support Systems, Failure Consequences, Introduction to Stochastic Modeling Using Risk, Insurance of Engineering Applications, Risk Analysis of Mega-Projects, Introduction to inspection and Structural Health Monitoring, vulnerability and resiliency components.

Recommended Books:

1. Reliability Engineering and Risk Analysis: A Practical Guide, Third Edition, Mohammad Modarres, Mark P. Kaminskiy, Vasiliy Krivtsov
2. Reliability and Risk: A Bayesian Perspective, Nozer D. Singpurwalla, 2006.

CAS-REE 527 Energy Quality Management & Standards [3]

The course includes local and global quality standards in renewable energy technologies such as solar photovoltaic, solar thermal, bioenergy, and wind energy. Quality and efficiency tests, certifications, standardizations, calibration .Performance and efficiency management and sustainability related issues, PV standards, astm international, Australia—standards Australia, Canada—standards council of Canada ,china—standardization administration of china, European committee for electro technical standardization (cenelec), global approval program for photovoltaics (PV gap). International systems for PV system standardization. Testing and Routes to Certification in renewable energy system. Hydrodynamic Testing, overview of facilities and techniques for testing offshore renewable energy technologies, Review of existing facilities worldwide

and their capabilities, overview of facilities and techniques for testing wind turbine rotors, Total Quality Management (TQM), ISO 9000, Lean Manufacturing and Six Sigma components.

Recommended Books:

1. Solar Power Generation Problems, Solutions and Monitoring By Peter Gevorkian, Cambridge University Press 2016.
2. Guideline for Certification of Solar Energy Equipment, The Commission, 1978.
3. How to Solar Power Your Home: Everything You Need to Know Explained SimplyBy Martha Maeda, Atlantic Publishing Company, 2011.
4. Solar PV Engineering and Installation: Preparation for the NABCEP PV Installation Professional Certification, Sean White, Routledge, 2015.

CAS-REE 528 Energy Audit and Planning [3]

Energy Law &Policy. Energy resource survey and energy data analysis. The energy crises past, present and future,a brief history of energy consumption in industry, Energy and industrial process dynamics .Energy economics. Energy environment and society, Energy demand and availability studies. Energy economic analysis for business decisions, Micro and macroeconomic energy planning studies. Waste to energy feasibility studies, Development & Evaluation of Renewable Energy Projects, Energy Efficiency.

Recommended Books:

1. An Introduction to Community Energy Auditing,Wayne P. Pferdehirt, Norman F. Kron, John F. Tschanz, Argonne National Laboratory,1981.
2. Energy Management in Buildings Using Photovoltaics, Elena Papadopoulou,Springer Science & Business Media, 2012.
3. Global Energy Assessment: Toward a Sustainable Future, By GEA Writing Team, Cambridge University Press.(2012).
4. Investment Grade Energy Audit-Making smart energy choices, by Shirley J. Hansen, James W. Brown, The Fairmont Press, Inc.

CAS-REE 529 Environment Impact assessment for Energy Systems [3]

Understand the basic concepts, methodological approaches, and technological components of an Environmental Impact Assessment, Identify all applicable international Norms, National Codes and Standards concerning the environment and energy systems, Exhibit knowledge and understanding of the way that an EIA is conducted within the framework of the energy sector in Pakistan & southeast Asia.

Recommended Books

1. Our Fragile World: Challenges and Opportunities for Sustainable Development - Volume II,M. K. Tolba, EOLSS Publications, 2001.

2. Energy and the Environment Cost-Benefit Analysis: Proceedings of a Conference Held June 23-27, 1975,R.A. Karam, K.Z. Morgan Elsevier, 2014.

3. Energy, Waste and the Environment: A Geochemical PerspectiveR. Gieré, Peter StilleGeological Society of London, 2004.

CAS-REE 530 Development & Evaluation of Renewable Energy Projects [3]

Analysis of the local situation to the final energy project: what steps have to be completed in order to implement a successful regenerative energy project and what factors must be considered, Survey of energy demand; methods to collect the demand for thermal and/or electrical energy until the point of development of an energy master plan, Technology of renewable energy: how to combine the various options for using renewable energy with different supply situation in the most reasonable way?, Feasibility study, requirements and content of a feasibility study, Legal framework for plant construction (including laws pertaining to construction, water and waterways, noise, etc., Company structures; which company structure is the most appropriate for the various applications?, Risk management, Insurance, What requirements must be met in order to obtain certain types of insurance for certain renewable energy projects, Acceptance: how the acceptance of an application for the use of renewable energy can be assessed and improved?, Organization of realization of a project: how the construction phase of a renewable energy system is organized after the end of the planning period?, acceptance: Which are the acceptance steps until the regular continuous operation .

Recommended Books:

1. Renewable Energy Projects Handbook, by World Energy Council, 2004

2. Developing Renewable Energy Projects Larger Than 10 MWs at Federal Facilities, Federal energy Management Program, 2013

3. Economic & Financial Evaluation of Renewable Energy Projects, by Gene Owens, Alternative Energy Development, 2002 .

CAS-REE 599 6

CAS-REE 699 36

M.Sc. Energy Management & Sustainability (MSEMS)

The University of Engineering Technology UET, Peshawar, Khyber Pakhtunkhwa Pakistan pioneers a graduate degree program, namely Master of Science in Energy Management & Sustainability (MSEMS) to develop high level managerial skills in holders of professional degrees with special emphasis in Sustainability. The degree comprises of class room lectures, seminars, case studies, industrial visits, off campus professional on site problem solving activities, and optional thesis in innovative fields of power and energy management. In the MS EM & S program, participants will be given an introduction, as well as in-depth of all essential management concepts, processes, tools and techniques relevant to the Energy & Power sectors, as well as practical knowledge where the best practices in the field of energy were imparted. Case studies shall be integral part of the degree courses. Since Khyber Pakhtunkhwa has tremendous oil and gas reserves and over 40,000 MW hydro power potential therefore, the courses are designed to cater for the needs of aforementioned business areas of upstream, mid-stream and downstream. Theme of this program is to groom energy managers to manage mega-projects successfully, turnaround projects and fast track projects. The scholars shall acquire the capability to break new grounds and produce new knowledge by undertaking research work in the field of Energy Management & Sustainability, specifically for Khyber Pakhtunkhwa and generally for Pakistan.

Objectives:

MS in Energy Management & Sustainability is designed to prepare and equip future energy managers with skills to conceptualize, plan, develop, budget, finance, leverage, bid, project management, construct, commission, operate and manage mega-projects in Energy and Power Sectors.

Mode of execution:

The course is offered in evening and weekend classes. Regular as well as professional and executive training program aims at capacity building of public sector and corporate sector for policy planning and operational energy management. The course will be offered on campus instructions, visits, seminars, training modules, and case studies. Each course module may be delivered as delocalized (off campus) and on site executive training program meeting the need of client.

Learning Outcomes:

MS in EM&E is a terminal professional degree aimed to develop energy managers to manage mega-projects, equipped with the knowledge imparted in the Energy Courses, the scholars shall acquire the capability to break new grounds and produce new knowledge by undertaking research work in the field of Energy Management & Sustainability, specifically for Khyber Pakhtunkhwa and generally for Pakistan. MSEMS graduates shall pursue research work leading to the MS degree in form of a project or thesis.

Focus Areas: Energy Entrepreneurship, Planning and management, Public/private policy and practice. Energy audit, Sustainability & political economy of global energy reserves.

Eligibility Criteria:

B.S./B.Sc. Engineering, M.Sc. Natural Sciences (Physics, Chemistry, Biology, Computer Science, Earth Sciences etc.), M.A. Social Sciences (Economics, Political Science), City and Regional Planning, Architecture, Law, Business, Finance and Management.

Degree Requirement: MS Program would comprise of 33 credit hours in both Core and Elective Course as well as thesis.

Seat Allocation: Seat allocation (per semester) for Master of Science (M.Sc.) in Energy Management and Sustainability: 25 seats with 50% allocation for female candidates as per requirement of USAID. Female candidates must fulfill the university criteria for admission in M.Sc. program.

Detail of Core Courses

12 Core Course credits required by all students enrolled in the Program.

Course No.	Course title	Credits
CAS-EMS 501	Strategic Organization Management (Public/Private Sector)	3
CAS-EMS 502	Sustainable energy management and development	3
CAS-EMS 504	Management of Energy Technology & Innovation	3
CAS-REE 516	Energy Quality management and Standards	3
CAS-EMS 601	Thesis Project	

Elective Courses

Elective Courses: 14 credits

Course No.	Course title	Credits
Technical Electives		
CAS-EMS 505	World Energy politics and supply chain analysis	3
CAS-EMS 506	Energy Tariff and Financials risk management	3
CAS-EMS 507	Energy Business Models and Marketing Strategies	3
CAS-EMS 508	Global & Local Energy demand analysis	3
CAS-EMS 509	Energy Service Companies Management	3
CAS-EMS 510	Energy regulatory affairs & Business Laws	3
CAS-EMS 511	Energy Project Management (Public & Private)	3
CAS-EMS 512	Energy modeling, Optimization and decision making	3
CAS-EMS 513	Energy security studies	3
CAS-EMS 514	Global sustainability and international obligations	3
CAS-EMS 515	Energy environment and climate change mitigation	3
CAS-EMS 516	Energy Business Management	3
CAS-REE 519	National/Provincial Energy Planning, Policies & practice.	3
CAS-REE 515	Environmental Impact assessment for Energy Systems.	3
CAS-REE 517	Energy Audit and Planning	3
CAS-EP 520	Research Methodology	3

Detail of Corses

CAS-EMS 501 Strategic Organization Management [3] (Public/Private Sector)

This is one of the Core Courses of MSEMS. The main objective of this Course is to enable the future energy managers to cause growth and manage public sector companies and organizations with state of the art management and solution tools & techniques. The course would have real time case studies of main public sector, change management and on high growth strategies. This course will enable the scholars to identify the key factors and elements that are

influential in the design of an organizations of the 21st Century. This course will equip the scholars with Public Sector Companies Good governance techniques, rules and risks. The course will equip the scholars with PPP mode of business and how to leverage public sector advantages to create mega-projects and investments.

Recommended Books:

1. Karl Mallon (Editor), "Renewable Energy Policy and Politics: A Handbook for Decision-Making" Earthscan Publications Ltd., 2006, 288 pages. Dewey Library, HD9502.A2.R446 2006.
2. Government as Entrepreneur by Albert N. Link, Jamie R. Link.
3. Public/Private Partnerships: Innovation Strategies and Policy Alternatives by Albert N. Link.

CAS-EMS 502 Sustainable Energy management and Development [3]

Sustainable vs unsustainable resource depletion . Sustainable management of natural and human resources. Energy Resources, Energy Scenerio, Issues & Challenges, Vision, Need for an Energy Policy, synopsis of earlier National Energy Policies. Modern management practices and sustainable future planning.

Energy Independence, Energy Security, Sustainable Development of Energy Sector.

The important role of energy in industrial, and economic development .Understand the responsible and sustainable development. Global responsibility as one world global citizen. Post fossil fuel era, ocean as energy reservoir .

Green energy approach. Consequence and prospects of resource depletions and new energy technologies.

Environmental cost of energy mega projects.

Recommended Books:

1. Our Fragile World: Challenges and Opportunities for Sustainable Development - Volume II,M. K. Tolba, EOLSS Publications, 2001.
2. Fanchi, John R. "Energy in the 21st century" Hackensack, N.J. : World Scientific, 2005, 243 pages. Barker Library, TJ163.2.F362 2005.
3. Jefferson W. Tester, Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay, William A. Peters, "Sustainable Energy: Choosing Among Options", The MIT Press, 2005, 870 pages.Hayden & Barker Library, TJ808.S85 2005.

CAS-EMS 504 Management of Energy Technology & innovation [3]

Project management (Scope definition, Planning and Scheduling, Critical path analysis), People management (Understanding yourself, Understanding other people, Working in teams, Dealing with conflicts), Marketing (Marketing technology, Selling technology, Market segmentation), Negotiation (Preparation for negotiations, Negotiation process, Win-win Solutions), New product development (Commercializing technology, Market drivers, Time to market, Focusing technology, Concerns), Presentation skills (Understanding your audience, Focusing your message, Successful presentations, Getting your message

across), Finance (Profit and loss accounts, Balance sheets, Cash flow forecasting, Project appraisal), Business game (Working in teams (companies), students will set up and run a technology company and make decisions on investment, R&D funding, operations, marketing and sales strategy), Innovative Financial & Enterprise Models for Renewable Energy Systems, Management of innovation Component.

Recommended Books:

1. The Management of Technological Innovation: Strategy and Practice by Mark Dodgson, David M. Gann, Ammon Salter

CAS-REE 516 Energy Quality Management & Standards [3]

The course includes local and global quality standards in renewable energy technologies such as solar photovoltaic, solar thermal, bioenergy, and wind energy. Quality and efficiency tests, certifications, standardizations calibration .Performance and efficiency management and sustainability related issues. PV standards. astm international, Australia-standards Australia, Canada-standards council of Canada ,china-standardization administration of china. European committee for electro technical standardization (cenelec), global approval program for photovoltaics (PV gap). International systems for PV system standardization. Testing and Routes to Certification in renewable energy system. Hydrodynamic Testing, overview of facilities and techniques for testing offshore renewable energy technologies, Review of existing facilities worldwide and their capabilities, overview of facilities and techniques for testing wind turbine rotors, Total Quality Management (TQM), ISO 9000, Lean Manufacturing and Six Sigma components.

Recommended Books:

1. Solar Power Generation Problems, Solutions and Monitoring By Peter Gevorkian,Cambridge University Press 2016.
2. Guideline for Certification of Solar Energy Equipment, The Commission, 1975.
3. How to Solar Power Your Home: Everything You Need to Know Explained SimplyBy Martha Maeda, Atlantic Publishing Company, 2011.

   Solar PV Engineering and Installation: Preparation for the NABCEP PV Installation Professional Certification, Sean White, Routledge, 2015.

CAS-EMS 512 Energy modeling, Optimization and decision making [3]

This course is designed to help prepare graduate students to conduct empirical research in energy and environmental economics. The course has two broad objectives. The first is to develop an in-depth understanding of specific empirical methods and research designs that are routinely used in the field of energy and environmental economics. The second is to familiarize students with some of the economic theories and institutions that are most relevant to empirical work in this area.

Recommended Books:

1. Our Fragile World: Challenges and Opportunities for

Sustainable Development - Volume II,M. K. Tolba, EOLSS Publications, 2001.

CAS-EMS 505 World Energy politics and supply chain analysis [3]

This course will review World primary and secondary energy resources, including but not limited to oil, gas and coal resources and location of resources in various countries and regions as well as major demand centers. Various energy markets, trade routes for movement of liquid hydrocarbons (petroleum products, LPG, LNG etc.) and gas pipelines will be discussed. Roles of National Oil companies (NOCs), Provincial Oil companies (POCs) and International Oil Companies (IOC) and major oil and gas producers, including OPEC & non-OPEC will be examined. World oil, gas and coal demand supply and its impact on the fuel prices will be discussed. This course will also review future world energy outlook, the strategies being adopted to meet the future projected requirements and the lessons for the national/ provincial policy makers. Geopolitics and diplomacy will also be referred. Provinces will also be integral part & independent energy strings for both national & international sustainable energy across the globe. This course will introduce the scholars to various forms of energy, classifications of energy reserves, energy measurement units and consumption patterns. Energy balance sheets and input output models would be prepared. Scholars will also be familiarized with various energy production and conversion technologies and their future prospects (oil, gas, coal, electricity, renewable, atomic energy etc. The course will also discuss the issues in energy resources at Pakistan and global level with a view to find solution.

Recommended Books:

1. Fanchi, John R. "Energy in the 21st century" Hackensack, N.J. : World Scientific, 2005, 243 pages. Barker Library, TJ163.2.F362 2005.
2. European Energy Futures 2030: Technology and Social Visions from the European Energy Delphi Survey by Timon Wehnert, et al.
3. Visions for a Sustainable Energy Future by Mark A. Gabriel.

CAS-EMS 506 Energy Tariff and Financials risk management [3]

This course shall get into details of multi-facet tariff in the power sector and oil and gas pricing. The scholars will be challenged to develop new economic concepts to ease tariff burdens on the consumers yet give fair and reasonable return on investment to sponsors. This course consists of detailed discussions on applications of economic concepts for exploitation of energy resources on one hand and delivery of energy products on the other hand at both macro and micro level. These discussions will be based on real life examples of Pakistan economy and global energy dynamics. The topics will include micro economic foundation of energy demands and supply; regression analysis, elasticity of demand curve fitting techniques for future energy projection; economic allocation of energy resources and pricing issues; macro economic linkages of energy delivering system etc. It will also include discussion more so in the context of Pakistan's experience on the energy market structure, vertical

integrated utilities, emerging concepts of unbundled utilities and fair and open competition in the energy market. Some regulatory issues and experience of Pakistan's energy regulatory bodies will be discussed in the context of determination of prices of electricity, oil and gas.

Recommended Text:

1. Electricity Pricing in Transition by Ahmad Faruqui.
2. The Handbook of Research on Energy Entrepreneurship by Rolf W_stenhagen, Robert Wuebker.

CAS-EMS 507 Energy Business Models & Marketing Strategies [3]

The course will enable the scholars to capitalize on the opportunities with limited resources to achieve a sustainable competitive advantage. And also assist them to select a course of action from among several alternatives that involves specific customer groups, communication methods, distribution channels and pricing structures. Great emphasis will be on marketing the oil & gas reserves and Hydro potential of Khyber Pakhtunkhwa to prospective buyers and sponsors in other part of the country. A marginal cost mechanism will be discussed to give fair and reasonable marketing tools to the Government of Khyber Pakhtunkhwa. Various marketing tools and techniques will be examined, as well.

Recommended Books:

1. Alexander Osterwalder, Yves Pigneur
2. The Handbook of Research on Energy Entrepreneurship by Rolf W_stenhagen, Robert Wuebker.
3. Government as Entrepreneur by Albert N. Link, Jamie R. Link.

CAS-EMS 508 Global & Local Energy demand analysis [3]

Importance of supply /demand balance for sustainable energy ecology.

Local need analysis from house hold consumer to corporate energy users.

Global energy demand past ,present and future.

End user energy conservation as global responsibility.

Economic impact of energy conservation and efficiency from domestic to corporate buildings.

Energy conservation and efficiency by green building approach.

Recommended Books:

1. Our Fragile World: Challenges and Opportunities for Sustainable Development - Volume II,M. K. Tolba, EOLSS Publications, 2001.
2. Energy beyond oil by Fraser Armstrong, Katherine Blundell.
3. Oil, Dollars, Debt, and Crises: The Global Curse of Black Gold by Mahmoud A. El-Gamal, Amy Myers Jaffe.Energy Crisis by P.C. Sinha.
4. Jefferson W. Tester, Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay, William.
5. A. Peters, "Sustainable Energy: Choosing Among Options", The MIT Press, 2005, 870pages.Hayden & Barker Library, TJ808.S85 2005.

CAS-EMS 509 Energy service companies management [3]

Energy crises and security issue took a heavy toll on the economy of Pakistan. The objective of this course is economy renaissance, especially in the energy, industrial and services sectors. Revival and turnaround of the economy through energy is one of the most important aspect of Pakistan, especially Khyber Pakhtunkhwa.

Topics will include, the concept of strategic management, building competitive advantage by examining internal and external factors (current and forecast), making functional, corporate and global strategies, vertical integration, diversification, corporate restructuring and unbundling, mergers and acquisitions, organizational development and control, governmental and corporate leadership. The high capex and opex is perhaps one of the largest deterrent that has made IRR of public and private sectors feasibilities below the Discount Rate.

The scholars shall develop ways and means in interactive discussions to achieve the purpose of the course. High profile experts will be invited to interact with the scholars and share their experience in revival. This course will have case studies on how businesses made a turnaround. The purpose of this course is to generate out of the box and innovative ideas amongst the scholars. International research on turnarounds will be examined minutely in the Course.

CAS-EMS 511 Energy Project Magmt. (Public & Private) [3]

This course will present the theory and practices in Energy project management, especially mega-projects. Topics will included but not limited to project EOI, Pre-Qualification, tenders, RFP, bidding, PPRA, KPPRA, PEC, FIDIC, planning, scheduling, execution, budgeting, Working Capital, catch up plan. Case studies will also be included. Major software used in the project management will be discussed. National and international rules governing tenders will also be discussed.

The purpose of the course is to enable the scholars to understand and analyze the project management and organizational processes and strategies. The focus is on scholarly research in the field of management and organizational theory and design. The course emphasizes on the emerging issues of project management, management research, leadership styles, organizational design, policy formulation and strategic thinking. The ultimate goal is to evolve the critical thinking among scholars so that they can analyze the existing literature on project management focused on the indigenous project management organizational problems should significantly contribute to the existing body of scientific knowledge of project management.

Khyber Pakhtunkhwa does need involvement of the public sector to sustain the economy. This course will present the theory and practices in Energy project management, especially public mega-projects. Topics will included but not limited to project EOI, Pre-Qualification, tenders, RFP, bidding, PPRA, KPPRA, PEC, FIDIC, planning, scheduling, execution, budgeting, Working Capital, catch up plan. Case studies will also be included. Major software used in the project

management will be discussed. National and international rules governing tenders will also be discussed.

Recommended Books:

1. Government as Entrepreneur by Albert N. Link, Jamie R. Link.
2. The Management of Technological Innovation: Strategy and Practice by Mark Dodgson, David M. Gann, Ammon Salter.
3. The Handbook of Research on Energy Entrepreneurship by Rolf W_stenhagen, Robert Wuebker.

CAS-EMS 510 Energy regulatory affairs & Business Laws [3]

It is important for the energy managers to know Energy and Business laws, especially those in the Public Sector. The course will give live examples of various Acts and Rules, including Companies Act 1954, Petroleum Policies, Petroleum Rules, Power Policies, KKPRA Rules, PPRA Rules, RFP policies etc. A few case studies will be examined in the class under interactive mode. The scholars will be required to propose changes in various laws and rules to make these efficient and bring these in line with investor friendly environment. Laws and rules of other countries will also be examined and compared with that of Pakistan.

Recommended Books:

Karl Mallon (Editor), "Renewable Energy Policy and Politics: A Handbook for Decision-Making" Earthscan Publications Ltd., 2006, 288 pages.Dewey Library, HD9502.A2.R446 2006.

Paul Komor, "Renewable Energy Policy" iUniverse, Inc., 2004, 194 pages."

CAS-EMS 515 Energy environment & climate change mitigation [3]

Importance of sustainable energy ecology. Assessment of technological options for responding to climate change. Overview of climate-change science; sources, sinks, and atmospheric dynamics of greenhouse gases. Current systems for energy supply and use. Renewable energy resources, transport, storage, and transformation technologies. Technological opportunities for improving end-use energy efficiency. Recovery, sequestration, and disposal of greenhouse gases. Societal context for implementing engineered responses.

Recommended Books:

1. Our Fragile World: Challenges and Opportunities for Sustainable Development - Volume II,M. K. Tolba, EOLSS Publications, 2001.

CAS-EMS 513 Energy security studies [3]

Importance of sustainable energy ecology. Energy scarcity and energy inflation studies.

Energy crises forecasting . Consequences of energy inflation, mitigation of energy inflation.

Preempting and forecasting energy crises.

Notable world energy crises.

Global energy demand past, present and future.

Economic indicators of energy inflation and crises.

Energy crises : Pakistan case study

Recommended Books:

1. Our Fragile World: Challenges and Opportunities for Sustainable Development - Volume II,M. K. Tolba, EOLSS Publications, 2001.
2. California Energy Crisis: Lessons for a Deregulating Industry by Will McNamara.
3. Energy... beyond oil by Fraser Armstrong, Katherine Blundell.
4. Oil, Dollars, Debt, and Crises: The Global Curse of Black Gold by Mahmoud A. El-Gamal, Amy Myers Jaffe Energy Crisis by P.C. Sinha.

CAS-EMS 514 Global sustainability and international obligations [3]

Understand the responsible and sustainable development.

Global responsibility as one world global citizen.

Post fossil fuel era, ocean as energy reservoir .

Green energy approach. Consequence and prospects of resource depletions and new energy technologies.

Identify all applicable international Norms, protocols, UN conventions, environmental cost of energy mega projects.

Recommended Books:

1. Our Fragile World: Challenges and Opportunities for Sustainable Development - Volume II,M. K. Tolba, EOLSS Publications, 2001.
2. Fanchi, John R. "Energy in the 21st century" Hackensack, N.J. : World Scientific, 2005, 243 pages. Barker Library, TJ163.2.F362 2005.
3. Jefferson W. Tester, Elisabeth M. Drake, Michael J. Driscoll, Michael W. Golay, William A. Peters, "Sustainable Energy: Choosing Among Options", The MIT Press, 2005, 870 pages.Hayden & Barker Library, TJ808.S85 2005.

CAS-EMS 516 Energy Business Management [3]

This course is an extension of MSEMS-703. Pakistan's economy is burdens with heavy expenditure on ex-pats not only during the planning and construction phases but also during operation and maintenance phases. The high capex and opex is perhaps one of the largest deterrent that has made IRR of public and private sectors feasibilities below the Discount Rate. This Course is designed to encourage and impart skills, tools and techniques to national scholars to establish their own ESCOs under low risk profile. The mini/mirco hydel is one great example that will be taught in the class and interacted with PEDO so that scholars can do businesses on planning, construction and O&M in remote areas. The scholars can also interact with venture capital markets to sell their knowledge and skills. Case studies will be integral part of the course work.

Recommended Books:

1. Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers by Alexander Osterwalder, Yves Pigneur.

2. Entrepreneurs and Innovation: Creating Value with Emerging Technologies by Keith Herndon.

3. The Handbook of Research on Energy Entrepreneurship by Rolf W_stenhagen, Robert Wuebker.

CAS-REE 517 Energy Audit and Planning [3]

Energy Law &Policy. Energy resource survey and energy data analysis. The energy crises past, present and future,a brief history of energy consumption in industry, Energy and industrial process dynamics .Energy economics. Energy environment and society, Energy demand and availability studies. Energy economic analysis for business decisions, Micro and macroeconomic energy planning studies. Waste to energy feasibility studies, Development & Evaluation of Renewable Energy Projects, Energy Efficiency.

Recommended Books:

1. An Introduction to Community Energy Auditing,Wayne P. Pferdehirt, Norman F. Kron, John F. Tschanz, Argonne National Laboratory,1951.

2. Energy Management in Buildings Using Photovoltaics, Elena Papadopoulou,Springer Science & Business Media, 2012.

3. Global Energy Assessment: Toward a Sustainable Future, By GEA Writing Team, Cambridge University Press.(2012).

4. Investment Grade Energy Audit-Making smart energy choices, by Shirley J. Hansen, James W. Brown, The Fairmont Press, Inc.

CAS-REE 515 Environment Impact assessment for Energy Systems [3]

Understand the basic concepts, methodological approaches, and technological components of an Environmental Impact Assessment, Identify all applicable international Norms, National Codes and Standards concerning the environment and energy systems, Exhibit knowledge and understanding of the way that an EIA is conducted within the framework of the energy sector in Pakistan & southeast Asia

Recommended Text:

1. Our Fragile World: Challenges and Opportunities for Sustainable Development - Volume II,M. K. Tolba, EOLSS Publications, 2001.

2. Energy and the Environment Cost-Benefit Analysis: Proceedings of a Conference Held June 23-27, 1975,R.A. Karam, K.Z. Morgan Elsevier, 2014.

3. Visions for a Sustainable Energy Future by Mark A. Gabriel.

CAS-REE 519 National/Provincial Energy planning, ,Policies & Practice [3]

Topics include (a) demand side planning (methods of demand projection, demand management and fuel substitutions), (b) supply side planning (methods of estimation of energy supplies from indigenous resources, supply side policies and strategies etc.) (c) Financial planning (assessment of quantum of financial resources required and affordability of the investment including (macro and micro economic impacts, mobilization of financial resources including from private sector). New modern approaches like the Shale boom, exploitation of Marginal & low economic resources with ultimate energy sources will be

deliberated to bring these into the main stream. Global, regional, national and provincial supply/demand scenarios will be developed. The course shall include Case Study for Provincial Setup, capacity building, infrastructure, status, policy regimes, international geopolitical energy scenario & market covering.

Recommended Text:

1. Global Energy Assessment: Toward a Sustainable Future, By GEA Writing Team, Cambridge University Press.(2012).
2. Power for the World: The Emergence of Electricity from the Sun,Wolfgang PalzPan Stanford Publishing, 2010.
3. Introduction to Energy Analysis,Kornelis Blok, Evert Nieuwlaar, Routledge, 2016.
4. Energy Policy Planning,B. A. Bayraktar, Springer Science & Business Media, 2012.

CAS-EP 520 Research Methodology [3]

Define research, research terms, research process and the principle activities, relationship between theory and research, skill development to write research thesis, assess and critique a published journal article that uses one of the primary research methods in the field, skill development for oral presentation and publishing short paper in conference proceeding, skill development for proposal writing, case studies and discussion on research trends, design of experiments and statistical analysis methods.

Recommended Text:

1. Investigating the Social World: The Process and Practice of Research, by Schutt, R. K. (7th edition). Los Angeles: Sage.
2. Research Methodology, Methods and Techniques, by C. R. Kothari, New Age International Publishers.
3. Introduction to Research Methods, by Catherine Dawson.

CAS-EMS 601 Thesis Project [6]

M.Sc in Materials for Energy Storage and Conversion

The world is exploring various sources of energy and has successfully identified and exploited novel materials for energy creation and application. There is a big demand throughout the world for making novel materials for energy creation. The fast transformation in the world of materials for fuel cells, solar cells, batteries and photocatalysis compel us for finding and exploiting opportunities of local manufacturing and training facilities. This interdisciplinary M.Sc program will bring engineers from different disciplines under one roof to work together as teams and thus bring technical revolution to meet local energy demands.

Focus Areas

Fuel Cells, Solar cells, Batteries, Photocatalysts

Faculty

Prof. Dr. Rizwan Gul

Ph.D. Mechanical Engineering (MIT, Massachusetts USA)
Director, U.S PCAS-E

Dr. Najeeb Ullah

Ph.D Material Science (University of Cambridge, UK)
Academic Program Developer

Eligibility Criteria

- B.Sc in Mechanical Engineering
- B.Sc in Chemical Engineering
- B.Sc in Electrical Engineering
- B.Sc in Material Engineering
- B.Sc Industrial Engineering
- B.Sc in Mechatronics
- Other related Engineering disciplines

Seat Allocation

Seat allocation (per semester) for Master of Science in Materials for Energy Storage and Conversion: 25 seats.

Degree Requirement

MS Program comprises of 33 Credit Hours including 3 CH course of Research methodology.

Course Code	Title	Credit Hours
CAS-ME 501	Materials Sciences and Properties of Materials	3
CAS-ME 502	Electrochemistry	3
CAS-ME 503	Electrical and Optical Properties of Materials	3
CAS-ME 504	Materials Characterization Techniques	3
CAS-ME 505	Nanofabrication Techniques	3
CAS-ME 506	Advanced Materials for Energy Application	3
CAS-ME 507	Survey for Energy Technologies	3
CAS-ME 508	Thin Films Technology	3
CAS-ME 511	Materials Thermodynamics	3
CAS-EP 521	Management of Technology and Innovation	3

Note: 6 core courses must be taken from the above list while the following four are compulsory.

i. CAS-ME 501 Materials Sciences and Properties of Materials
ii. CAS-ME 502 Electrochemistry
iii. CAS-ME 503 Electrical and Optical Properties of Materials
iv. CAS-EP 521 Management of Technology and Innovation

CAS-ME 501 Material Sciences and Properties of Materials [3CH]

Basic material properties and materials selection charts. Selection of materials and shape. Case studies in materials selection (focus on modulus, strength, toughness, etc of metals, ceramics, polymers, etc. examples from solar module materials (which must have a 25-year lifetime), batteries (where weight is an issue for, e.g., cars). Multiple constraints and compound objectives. Mechanical properties of Nano composites, CNTs and graphene. Interaction of materials, processing and design. Design process and materials selection methodology. Economics of materials and manufacturing processes.

Recommended Books:

1 Materials Selection in Mechanical Design, 3rd Edition, by Michael F. Ashby, Butterworth and Heinemann,

2 Selection and Use of Engineering Materials, 3rd Edition, by J A Charles, F A A Crane and J A G Furness, Butterworth and Heinemann,

CAS-ME 502 Electrochemistry [3CH]

Thermodynamic fundamentals – Enthalpy, entropy, free energy, chemical equilibrium

Electrolytes – conduction in different medium i.e Aqueous, molten, ionic liquids and solid ionic conductors.

Electrodes – EO and Ecell, Effect of Concentration, Nernst equation

Electrical double layer – surface potential, stability of micro- and nano-particles

Electrode kinetics – the rate of electron transfer between the metal and species in solution, The transport of material to and from the electrode interface

Technology – Electrochemistry in Fuel cells, primary and secondary batteries, flow batteries, supercapacitors, third generation solar cell, electrolysis

Photo-electrochemistry –H2 production from water, reduction of carbon dioxide to useful chemicals, photodegradation of hazardous chemicals,

Recommended Books:

1 Electrochemistry, 2nd, Completely Revised and Updated Edition, by Carl H Hamann, Andrew Hamnett, WolfVielstich.

2 Physical Electrochemistry, Fundamentals , Techniques and Applications by EliezerGileadi,

3 Electrochemical Methods, Fundamentals and Applications by Allen J Bard and Larry R Faulkener

4 Electroanalytical Methods, Guide to Experiments and Applications by Scholz, Fritz

CAS-ME 503 Electrical and Optical Properties of Materials [3CH]

Electrical properties of metals. Semiconductors and dielectrics. Band structure of electron states, band-structure calculation and transport properties of selected semiconductors, band tuning, quantum dots, quantum well. LEDS, Conducting polymers, Electrons in strong magnetic fields, ohmic contacts, Fermi surface determination, semiconductors (Intrinsic, Extrinsic),

The physics of semiconductor devices, superconductors,

Recommended Books:

1 Physics of Semiconductor Devices by Colinge, J. P, Colinge, C.A.

2 Electrical Properties of materials Ninth Edition by Laszlo Solymar, Donald Walsh, and Richard R. A. Syms

3 Optical Materials by Simmons and Potter .

CAS-ME 504 Materials Characterization Techniques [3CH]

Basic principles and application of the following instruments: Scanning Electron Microscope and Transmission Electron Microscope, atomic force microscopy (AFM) and x-ray diffraction (XRD), Ultimate tensile machine(UTM), Nondestructive Test (NDT), Inductive couple plasma, thermal gravimetric analysis and differential thermal analysis, Differential scanning calorimetry (DSC) and XRays photoelectron spectroscopy (XPS) , Electron energy Loss spectroscopy (EELS). Raman, FTIR, spectrophotometry

Recommended Books:

1 Advanced Techniques for Materials Characterization by A. K. Tyagi, Mainak Roy, S. K. Kulshreshtha and S. Banerjee

2 Materials Characterization: Introduction to Microscopic and Spectroscopic Methods, 2nd Edition by Yang Leng

CAS-ME 505 Nanofabrication Techniques [3CH]

Introduction to device application. Shift in Device application from macro-scale to nano-scales. Basic patterning techniques (lithography, and etching), thin film deposition processes, growth and microstructure. Comparison of classical methods vs emerging technologies. Classic methods: Photolithography, electron beam lithography and their limitations, Emerging technologies: focused ion beam lithography, scanning probe lithography, soft lithography and bio-molecular patterning.

Recommended Book:

1 The Science and Engineering of Microelectronic Fabrication by Campbell.

CAS-ME 506 Advanced Materials for Energy Applications [3CH]

Advance materials for fuel cells, solar cells and batteries. Advanced materials for cathodes, anodes and electrolyte for fuel cells and batteries. Materials for solar cells (first to third generation).

Recommended Books:

1 Energy Production and Storage: Inorganic Chemical Strategies for a Warming World by Robret H Crabtree

2 Rechargeable Batteries by Zhang, Zhengcheng, Zhang, Shengshui

3 Solar Cell Materials: Developing Technologies by Gavin Conibeer, Arthur Willoughby

4 Fuel Cell Fundamentals by Ryan O' Hayre, Suk WonMaterials for Fuel Cells by M Gasik

CAS-ME 507 Survey of Energy Technologies

Principles governing energy generation, Energy Conversion, Historic Energy Conversion Sequences, Modern Energy Conversion Sequences, Energy Sources, Energy Supply- Pakistan sources, Conversion Efficiencies, Overall Efficiency includes Steps Upstream

& Downstream of the Energy Conversion System, Rate Processes in Energy Conversion, Special current and anticipated future technologies for energy production, interconversion, storage, exemplified by Gasification to Syngas, Fischer-Tropsch Reaction, Hydrogen economy, Hybrid cars, Renewable energy technologies. Common Conversion Efficiency Challenges.

Recommended Books:

1 Energy Technology and Directions for the Future by John R. Fanchi.

2 Enhancing the Market Deployment of Energy Technology: A Survey of Eight Technologies by Lea

CAS-ME 508 Thin Films [3CH]

Crystal structures and defects in thin films, the basic nucleation and growth mechanisms of thin films (growth models, lattice matching epitaxy and domain matching epitaxy), thin film processing techniques (CVD, MOCVD, MBE, PLD, Laser-MBE, sputtering, and evaporation etc.), thin film growth instrumentation aspect (energy source, chamber configurations, vacuum systems and growth controllers), and several advanced topics related to electrical and optical devices. Clean room technology.

Recommended Books:

1 Electronic Thin Film Science for Electrical Engineers and Materials Scientists by K-N Tu, J. W. Mayer and L. C.

2 Materials Science of Thin Films, Deposition and Structure by M. Ohring

CAS-ME 511 Materials Thermodynamics [3CH]

Concepts of Helmholtz Free Energy and Gibbs Free Energy, Energy-Property relationships, Thermal Equilibria, Chemical Equilibria, Ellingham Diagrams, 1st order and 2nd order Transformations, Gibbs Helmholtz Relationships, Fugacity and Chemical activity, Equilibrium constant and its variation with temperature, Vant Hoff's equation, Effect of temperature and pressure on phase transformations, Clapeyron equation, Thermodynamics of solutions using examples of molten salt (for storage).

Recommended Books:

1 Introduction to Thermodynamics of Materials by D. R. Gaskell

2 Amendments in Thermodynamics, an Advanced Text for Material Scientists by J. Hudson

CAS-EP 520 Research Methodology [3CH]

Define research; research terms; research process and the principle activities, skills and ethics associated with the research process, relationship between theory and research, major quantitative and qualitative research methods , importance of research ethics and integrate research ethics into the research process, assess and

critique a published journal article that uses one of the primary research methods in the field. construct an effective questionnaire that employs several types of survey questions.

Recommended Book:

Investigating the Social World: The Process and Practice of Research, Schutt, R. K. (7th edition). Los Angeles: Sage.

CAS-EP 521 Management of Technology & Innovation (MOTI) [3CH]

Technology and Competitiveness, Business Strategy and Technology Strategy, The Role of Technology in Creation of Wealth, Critical factors in managing Technology, Management of Technology: The New Paradigms, Technology Life Cycle, The Process of Technology Innovation, Technology Planning, The Acquisition and Exploitation of Technology, Technology Transfer.

Recommended Books:

1 Management of Technology (The Key to Competitiveness and Wealth Creation), By Tarek M. Khalil.

2 The Management of Technological Innovation Strategy and Practice, Revised Edition, Mark Dodgson, David M. Gann, and Ammon Salter, Oxford University Press.

CAS-ME 588 Advanced Topics in Energy Storage and Conversion

CAS-ME 599 Master's Thesis [6CH]

Board of Advanced Studies and Research (BOASAR)

The Board of Advanced Studies and Research (BOASAR) was instituted as one of the authorities of the University under section 13(V) of the university ordinance. Its functions include:

- To advise the authorities on all matters connected with the promotion of advanced studies and research in the University.
- To consider and report to the authorities on the institution of research degrees in the university.
- To propose regulations regarding the award of research degrees.
- To appoint supervisors for research students and to determine the subject of their thesis.
- To receive research projects from university teachers.
- To sanction research grants against specific research projects.
- To coordinate and approve research programme and budget.
- To monitor faculty research.
- To utilize research results.

Masters and Ph.D. degree programmes in selected departments are being run under the umbrella of BOASAR. Funds are provided for both faculty research and student research. Postgraduate Advisors have been appointed for each specialization to provide guidance and assistance to researchers. BOASAR also maintains regular contact with local industry and the government to help solve their technological problems.

Best Applied Research Project Award

To support and encourage faculty research in the university, an award has been instituted for the best applied research project. Principal Investigators of approved projects may apply for the award, which includes a cash award as well as a certificate and shield. Full details, including eligibility, application procedure, award criteria and details of award are available at the BOASAR office for reference.

Master Degree Programme

GENERAL

The Master's degree programme at University of Engineering and Technology shall extend over a period of at least four semesters. A total of 33 credit hours (including 27 credit hours of courses and 6 credit hours of research) are required to complete the Master's Degree Programme. The 27 credit hours of course work shall include a minimum of 18 credit hours from the core area of specialization and 3 credit hours of the course "Research Methodology". This course will be registered as credit course.

RULES

1.1 Admission

a) Master's degree programme shall commence in Spring and Fall semesters i.e, twice in an academic year.

b) Candidates seeking admission must have a Bachelor's Degree in a relevant Engineering discipline from an institution accredited by Pakistan Engineering Council or Sixteen (16) years of education for Non-Engineering disciplines from an institution recognized by HEC.

c) Candidates seeking admission must score 50% minimum marks in GRE International type test or GAT (General) organized by University Appointed Testing Authority (UATA).

d) Applications on the prescribed form shall be made to the Director Admissions, on the date advertised in newspapers, after which no application shall be entertained.

e) Seats for Pakistani students are given in Table-1 page-233. 50% of the total allocated seats in each category (i.e Open/Rationalized) will be filled during Fall semester, and remaining will be filled during Spring semester.

f) Candidates shall have to pass departmental subject and UATA test with at least 50% marks. Final merit shall be made based on the combined results of UATA marks and the departmental test in the following manner:

GRE International / GAT (General) Test conducted by UATA = 50% weightage.

Departmental Subject Test = 50 % Weightage

g) The UATA (GAT General)/UATA (UET GAT Special) tests shall be valid for one academic year (two semesters i.e Spring & Fall or Fall & Spring) while subject test shall be conducted each time admission is offered.

Table 1: Seat allocation for Pakistani students for Fall 2020 Semester and Spring 2021 Semester

Department	Seats Reserved for Open Merit	Seats Reserved for Rationalized Fees Basis	Total
Electrical Engineering			
Power Engineering	30	10	40
Communication and Electronic Engineering	35	10	45
Civil Engineering			
Water Resources Engineering	22	10	32
Environmental Engineering	22	10	32
Structural Engineering	25	10	35
Geo-Technical Engineering	23	10	33
Transportation Engineering	23	10	33
Earthquake Engineering	20	10	30
Mechanical Engineering			
Dynamics & Control	25	10	35
Mechanical Engineering Design	30	10	40
Materials Engineering	20	20	40
Computer Systems Engineering	35	10	45
Mining Engineering	20	10	30
Agricultural Engineering			
Soil & Water Engineering	20	10	30
Farm Machinery & Power Engineering	15	10	25
Chemical Engineering	25	10	35
Industrial Engineering	35	10	45
National Institute of Urban Infrastructure Planning (NIUIP)			
Urban Infrastructure Engineering Degree Programme	30	10	40
Urban Infrastructure Planning & Management	25	10	35
Mathematics	35	10	45
Computer Science & Information Technology (CS&IT)	35	10	45
Mechatronics Engineering	35	20	55
TOTAL	585	240	825

Note: Exact number of open merit seats as per semester quota will be offered in each semester. Furthermore if an open merit seat remains vacant in Fall semester then it shall be added to the quota of open merit seats to be offered in Spring semester.

h) On the recommendations of the Admission Committee, the vice-chancellor shall approve the names of candidates selected for admission.

i) A candidate's admission shall be confirmed after he/she has deposited the prescribed fees with the University within the period specified for this purpose.

j) No student shall be admitted after two weeks of the start of classes.

k) The Director Postgraduate Studies shall forward the particulars of each student admitted for the first time, within one month of the completion of admission to the Controller of Examinations. The Controller shall assign a registration number to student not already registered with UETP within one month, and shall share the same with the relevant Heads of the Teaching Departments and the Director Postgraduate Studies.

l) Admission of any student is liable to be cancelled if his/her academic progress or conduct at any stage is found unsatisfactory.

m) Students registered for Master's programme shall not be allowed to participate in various students' organizations.

n) The facility of hostel accommodation for Master's students shall be provided on need basis, subject to availability.

o) If any of the particulars given by the candidate in his/her application are found incorrect or facts are suppressed, he/she shall be denied admission. If any incorrect or false statement or suppression of facts is detected after a candidate has been granted admission, his/her admission shall be cancelled and he/she shall be expelled from the University at any time during the course of his/her studies.

p) A candidate who is already a bonafide, full time student of some other institution, is ineligible to take admission in this University. He/She will have to cancel admission in other University before taking admission in UET, Peshawar. A student may take admission in other university subject to cancellation and clearance of his/her dues. If a case is detected where a student enrolled in this University is also a student of some other institution, his/her admission in the University shall be cancelled

q) At the time of admission, selected candidates shall submit an undertaking to abide by the Rules and Regulations prevailing in the University. This shall be according to the prescribed proforma on non-judicial Stamp Paper worth Rs.50/-, and duly attested by an Oath Commissioner.

r) In the event of a tie of aggregate marks

(UATA+Departmental Subject Test) between two or more candidates seeking admission in the Master's Programme, the subject test marks will be considered. In case these are equal then older candidate shall be considered.

1.1.1 Admission of Foreign Students

a) The applications of foreign students must be routed through the Director, Academics, Higher Education Commission, Sector H-9, Islamabad (www.hec.gov.pk). All applicants of this category should submit, along with their application forms:

(i) A certificate showing proficiency in English language, e.g. TOEFL or IELTS with a minimum score of 50%.

(ii) A financial statement confirming the availability of funds for completing the Master's Degree programme.

b) Foreign students seeking residential accommodation at the University Campus may apply to the Provost, University Hostels.

c) Foreign students are exempted from entrance test for admission.

d) Twenty Four (24) seats (floating) are reserved for foreign students in the Postgraduate Programme.

e) Two (02) seats (floating) are reserved for the students of least developed countries of Organization of Islamic Countries (OIC) under Higher Education Commission scholarship programme: “Academic and Research Linkages Bilateral Agreement”.

1.1.2 Admission of Affiliated Universities/Institutes

a) Admission to engineering programmes in affiliated universities/institutes shall be advertised alongwith other postgraduate programmes of UET, Peshawar. Applications for admission should be submitted to the Directorate of Admissions, at UET Main Campus on or before the last date announced for the purpose alongwith all the required documents.

b) Affiliated Engineering Universities/Institutions shall follow the University rules and regulations for admission mentioned in the Prospectus.

c) The Affiliated Institute shall forward the particulars of each student admitted for the first time, within 15 days of the completion of admission to the Controller of Examinations and shall deposit the prescribed fee for obtaining registration card of their students.The Controller shall assign a registration number to each student.

d) Institute of Communication Technologies (ICT), Islamabad

Institute of Communication Technologies, Islamabad offers the following Master's Degree Programs in affiliation with University of Engineering and Technology Peshawar:

i. M.Sc Telecom Engineering 30 seats

ii. M.Sc Telecom Engineering Management 30 seats

Candidates seeking admission in the above programs must have aBachelor's Degree in Electrical / Electronics / Computers / Telecom / Information Systems Engineering or any other related engineering disciplines recognized by HEC and Pakistan Engineering Council.

1.2 Academic Advisor

Any faculty member with at least Master's degree in the relevant field shall be appointed as the Academic Advisor.

1.3 Postgraduate Advisors

Each specialization of the Department concerned will have a Postgraduate Advisor having Ph.D. Degree, who will work under the direct supervision of the Chairman. The advisor will monitor the implementation of the postgraduate programme in his/her department, and maintain liaison with the BOASAR (Board of Advance Studies and Research) Secretariat. His duties will include:-

a) Providing guidance to students on rules and regulations of the Master's Degree Programme.

b) Providing guidance to students on selection of research projects.

c) Organizing field trips of Master's students.

d) Promoting links with industries and other outside organizations.

e) Promoting faculty research.

f) Organizing extension lectures, seminars, workshops and training courses in the departments.

g) Supervising reference library in the department.

h) Coordinating with the Academic Advisor of Master's students on various issues, such as registration, selection of courses and general programme of study.

1.4 University Fee

University fees for postgraduate students enrolled on open merit seats are shown in Table 2.

Table 2: University Fee for Postgraduate Students on Open Merit.

S. No.	Item	Pakistani Nationals (Rs.)
1	Registration Fee (per semester)	2000.00
2	Tuition Fee (per credit hours)	3000.00
3	Computer Fund (per semester)	750.00
4	Library Fund Non Refundable (per semester)	1000.00
5	Library & Lab. Security (on first registration) Refundable	4000.00
6	Field Trips (Charged when a field Trip organize)	1000.00
7	Thesis Evaluation Charges (on submission of Thesis)	4000.00
8	Course Completion Certificate	200.00
9	Interim Transcript	200.00
10	Final Transcript	500.00
11	Lab. Charges (per Semester)	2000.00
12	Internet Charges (per semester)	1000.00
13	CMS/PERN Charges (per semester)	2000.00
14	Utility charges (per semester)	2000.00

Three subjects (9 credit hours) tuition fee will be paid at the time of admission in addition to registration fee in first semester.

Fees for a semester are payable at the beginning of each semester, on the date of registration. In case of Admission Cancellation the refund policy is as under:

% of Tuition Fee	Time Line for Semester System
Full (100%) Fee refund	Upto 7th day of commencement of classes
Half (50%) Fee refund	From 8th-15th day of commencement of classes
No Fee (0%) refund	From 16th day of commencement of classes

Late fee @ 0.025% will be charged per day from the students who failed to deposit the University dues/funds within due date for any reason.

1.5 Registration

a) At the beginning of each semester, students shall register for courses in consultation with the departmental Academic Advisors.

b) List of courses offered in a Department shall be finalized by Postgraduate Advisor of the relevant field of specialization, in consultation with Academic Advisors, and this shall be displayed on the postgraduate notice board, one week before registration, to facilitate students in choosing courses.

c) Minimum number of students to register for a course shall be five for all the Departments, otherwise, the course shall be dropped for that semester. In case a course is dropped by the Department, the fees shall be refunded to the students or adjusted in the coming semesters. However, the departments can offer course(s) to a class having less than five students in exceptional cases with the approval of Dean. A department can also offer course(s) to students relevant to M.Sc Thesis in the area of research.

d) To ensure quality of teaching the maximum number of students in each section of Postgraduate course should not be more than 20. If the number of registered students in any subject exceeds 20, then they shall be accommodated in more than one section.

e) A student who wants to freeze a semester shall have to register in a "Zero Semester" subject to the following conditions:

i. He/She will pay registration fee for the "Zero Semester"

ii. He/She will apply within 15 days of start of the classes

iii. He/She will be allowed to clear his/her subjects prior to "Zero Semester"

iv. He/She can resume his/her studies in a given semester subject to the approval of the Chairman.

1.6 Work Study Load

A student shall not be allowed to take more than three courses per semester.

1.7 Addition of Courses/Withdrawal from Courses

a) A student may be allowed to add/drop courses within two weeks of the beginning of classes on the prescribed proforma available at DPGS office.

b) A student may be allowed to withdraw from courses within six weeks of commencement of classes by applying on the prescribed proforma. A grade of 'W' will be reported in that case.

c) Fees shall not be refunded to a student who withdraws from a course. However, if a course is dropped by UET, fees shall be refunded to student(s).

d) In case a student fails to apply for withdrawal from a course and remains absent, F Grade will be awarded.

1.8 Class Work and Attendance

A student shall attend the classes regularly, submit assignments in time, and appear for tests and examinations when announced by the teacher. Candidates with less than 75% attendance in a course shall not be allowed to appear in the final examination of the course.

1.9 Examination

1.9.1 Course Work

a) For all taught courses of M.Sc Programme, a final term examination having 50% weightage must be carried out. The remaining 50% marks can be distributed over quizzes, home assignments, mid term examination, mini projects etc, or any other appropriate way, as it suits the requirement of the course. However, such distribution should be clearly spelt out in writing before the commencement of the course and be submitted to the Postgraduate Advisor of the respective departments.

1.9.2 Research work

a) The M.Sc research proposal (submitted by a student at the end of second semester of his/her Postgraduate Studies) shall be initially vetted by Project Research Evaluation Committee (PREC), formally constituted for each specialization in each discipline before recommending it to the BOASAR office for final approval. The chairman of the department concerned will recommend the names of three faculty members (including Postgraduate Advisor) holding Ph.D. degrees for constitution of PREC for approval of the Vice Chancellor through Secretary (BOASAR). The Chairman of the concerned department will act as a convenor of the PREC. The PREC will be reconstituted after a period of one year. The Chairman of the concerned department may recommend a Ph.D faculty member, expert in the relevant area, to act as member (co-opted) for the PREC.

b) Any subsequent changes in the proposal, title or the topic shall also be routed through the same channel.

c) The candidate may request for change in MS supervisor or a supervisor may opt to withdraw from supervision of a candidate. The candidate or the supervisor shall submit their request to the chairperson concerned. Recommendation for change of supervisor will be made by PREC of the department through Dean concerned for approval by BOASAR. No relaxation in maximum allowable time for completion of MS degree would be granted to the candidate on the basis that his supervisor has changed.

d) All M.Sc students working on their research will give at least one seminar to PREC at the end of each semester.

e) Before a student is allowed to defend his/her thesis, it will be vetted by the university against plagiarism. For the award of M.Sc degree, at least one paper should be presented / accepted / published from the M.Sc research thesis in a refereed national/international conference or journal.

f) The maximum number of postgraduate students under a Research Supervisor shall be twelve (12) which will include maximum five (05) Ph.D students.

g) A relevant faculty member may be assigned as co-supervisor from the student parent or any other related department.

1.9.2.1 Examination of Research Work

The examination of the research work of the candidate shall be conducted by an Examination Committee comprising (1) Internal Examiner, (2) Student's Research Supervisor and (3) External Examiner from outside the University. The Examination Committee will be appointed by the vice-chancellor on the recommendation of the Dean. The Supervisor shall act as the Chairman of the Examination Committee. The examination shall include:

(i) Evaluation of thesis

(ii) Viva-voce examination

If the thesis is judged as adequate, the candidate shall appear in the viva-voce examination to be conducted by the Examination Committee on a specific date. The thesis supervisor must inform the Director Postgraduate Studies about the Thesis Defense Examination Result on the official form T-3. If the thesis is found inadequate, it may be referred back for revision and resubmission within a specified period as detailed by the Examination Committee. Only one chance of resubmission shall be allowed to a candidate and if the revised thesis is not approved under the aforesaid procedure, the thesis shall be rejected. In a case of revised thesis resubmitted for evaluation, the student has to pay thesis evaluation charges again. If in the opinion of the majority of the examiners, the candidate fails in the oral examination, he/she may be permitted to reappear in the viva-voce re-examination within a period of three months. In such a case the candidate shall be given only one chance to re-appear in the oral examination.

1.10 Quality of Work (Grades)

a) To be eligible for graduation, a student must have a CGPA of at least 2.67 (B-) in course work and

satisfactory grade (S) in research. Grade Points are assigned as shown in Table 3.

Table 3: Grade Points

A	4.00
A-	3.67
B+	3.33
B	3.00
B-	2.67
C+	2.33
C	2.00
C-	1.67
D+	1.33
D	1.00
F	0.00
I	Incomplete
W	Withdrawn
N	Audit
S	Satisfactory (for thesis only)
U	Unsatisfactory (for thesis only)

b) A student who has been awarded "F" grade in a course may be allowed one chance to improve the grade by repeating the course within the prescribed time limit (see.1.13-e). This facility may be availed for a maximum of two courses during the entire Master's programme. Only the higher grade will be used in computing the GPA.

c) Grade "I" (incomplete) is awarded to a student only if he/she has missed the Final Examination, Project Report, etc. due to genuine reasons, but has completed all the other work of the course successfully. Grade "I" should be converted to an appropriate letter grade within two consecutive semesters, otherwise it would be converted into Grade "F" permanently.

d) The requirement of a "N" grade would be laid down by the teacher of a course at the beginning of the semester.

e) The Grade Point Average (GPA) will be calculated as follows:

Quality Points of each course = Grade Points of grade awarded x Course credit hours.

GPA = Sum of Quality Points of all courses / Total credit hours

f) Improvement of grade "C" and below:

Students taking grade "C" or a lower grade than "C" will get only one chance to improve the grade by repeating the course. Tuition fees will be charged for repeating the course. The student will get no additional credit for repeating the course. After repeating the course and fulfilling all its requirements including exams, the instructor concerned will award the student a fresh grade.

1.11 Medium of Instruction

The medium of instruction in all Postgraduate Courses shall be English. Foreign students will be required to satisfy the

concerned department about their proficiency in English before registration.

1.12 Duration of Courses

a) There will be two semesters in an academic year. Each semester will be of eighteen weeks duration, including classes and conduct of examinations.

b) The Fall semester, will start in the first week of September and the Spring semester will begin in the first week of February.

1.13 Degree Requirements

a) **Research-based Master degree program**

Total of 33 credit hours (including 6 credit hours of research) are required to complete the Master's Degree Programme. The 27 credit hours of course work shall include a minimum of 18 credit hours from the core area of specialization and 3 credit hours of the course "Research Methodology". This course will be registered as credit course.

OR

Course-based Master degree program

A total of 36 credit hours (including 3 credit hours of Mini Project) are required for completion of Master degree. The 33 credit hours of course work shall include 18 credit hours of core courses. 3 credit hours of research methodology, and 12 credit hours from the relevant area of specialization.

The student may be permitted by the Head of the Department to register not more than 6 credit hours of courses within the University.

b) A student can take up to two courses being offered by Teaching Departments other than his own if so advised by the Academic Advisor/Chairman. The student shall be entitled for the credit of such courses.

c) On the completion of course and research work, the student shall apply for defence of thesis on a prescribed proforma available from the Directorate of Postgraduate Studies/ Departmental Postgraduate Advisor and University website (www.uetpeshawar.edu.pk). The final script of the thesis must be certified against plagiarism by the Quality Enhancement Cell (QEC) of the University before the thesis defence.

d) After successful defence of research work, the student shall submit three hard-bound copies of the final script of thesis to the Director Postgraduate Studies within fifteen days of defence as per format approved by the statutory bodies of the University. The format of the thesis will be checked by Supervisor. The copies shall be kept in the Departmental

Seminar Library, Central Liberary of the University and the Directorate of Postgraduate studies.

e) The student must complete all the requirements of the M.Sc Degree within forty-eight months (8 semesters) of the first registration for the programme.

f) The degree of Master of Science (M.Sc) shall be awarded to a student who has satisfactorily completed the courses of study and research and has passed the required examinations.

g) The student shall apply for the award of M.Sc degree on a prescribed proforma available from Directorate of Postgraduate studies/ Departmental Postgraduate Advisor and University website (www.uetpeshawar.edu.pk). The proforma shall be used to verify all the requirements of the degree, i.e. passing of core courses, total courses and thesis defence examination.

h) The admission of the student will be cancelled if he/she remains absent continuously for two semesters without freezing the semester. The student will be issued attended semesters transcript.

1.14 Residency Requirements

a) The student shall earn all the credits of course work and complete the research at the University.

b) In special circumstances, the BOASAR may permit the research to be carried out in another organization/ institution. In such an event the student will be assigned a co-supervisor with at least MS qualification working in that institution, who will be paid honorarium equal to half of honorarium paid to the main supervisor. However, the student shall maintain a supervisor from parent department or relevant department of the University with consent of the chairman of parent department in consultation with PREC members.

1.15 Transfer of Credits

In case of change of MS stream/admission in another stream of engineering or readmission, a maximum of six credits of the previous stream/admission may also be allowed if approved by the concerned PREC.

1.16 Scholastic Record

The scholastic record of graduate students shall be maintained by the Controller of Examinations. Departments offering Postgraduate courses shall send award list of grades to the Controller of Examinations, within one week of final examination. The students shall be notified about their final grades by the Postgraduate Advisor of the department.

1.17 Discipline

Students enrolled in the Postgraduate Programme shall observe the rules and regulations of the University. Any infringement shall be dealt with under the University Discipline Rules.

1.18 Assistantships and Free ships

Subject to the availability of funds in the budget, limited number of teaching and tuition free ships are granted to Postgraduate students who are willing to perform academic duties during working hours of the University.

a) Teaching Assistantship: teaching under-graduates. Rs. 5000/- per month with tuition free ship.

b) Research Assistantship: assignment on project work. Rs.5000/- per month with tuition free ship

c) Other fellowship/financial assistance shall be announced when available.

1.19 Admission on Rationalized Fee Basis

a) Eligibility criteria for "Rationalized Fee Based" applicants are the same as for open merit applicants.

b) Fees for Rationalized Fee Based Students are shown in Table 4. In case of Admission Cancellation the refund policy is as under:

% of Tuition Fee	Time Line for Semester System
Full (100%) Fee refund	Upto 7th day of commencement of classes
Half (50%) Fee refund	From 8th-15th day of commencement of classes
No Fee (0%) refund	From 16th day of commencement of classes

Late fee @ 0.025% will be charged per day from the students who failed to deposit the University dues/funds within due date for any reason.

c) A private student who wishes to take a course without taking admission in the Master's Programme, should formally submit an application to the Chairman of the Department concerned. After permission of the Chairman concerned, he/she will be allowed to enroll subject to the availability of space after payment of Rs. 20,000/- per course. Further he/she will not be allowed to take more than two courses without taking admission in Master's Programme. He/she will be awarded a Certificate by the Chairman of the Department concerned for attending the course(s) without claiming any credit.

Table 4: Fees and other Charges for Rationalized Fees Students

S. No.	Item	Pakistani Nationals (Rs.)	Foreign Students (US$)
1	Registration Fees (per semester)	2500.00	90.00
2	Tuition Fee (per credit hours)	6500.00	180.00
3	Computer Fund (per semester)	1500.00	90.00
4	Library Fund Non Refundable (per semester)	2000.00	90.00
5	Library & Lab. Security (on first registration) Refundable	5000.00	400.00
6	Field Trips (Charged when a field Trip organize)	1500.00	90.00
7	Thesis Evaluation Charges (on submission of Thesis)	4000.00	550.00
8	Course Completion Certificate	250.00	10.00
9	Interim Transcript	250.00	10.00
10	Final Transcript	600.00	20.00
11	Lab. Charges (per Semester)	2500.00	21.00
12	Internet Charges (per Semester)	1500.00	21.00
13	CMS/PERN Charges (per semester)	2500.00	21.00
14	Utility charges (per semester)	2500.00	21.00

1.20 Special Provisions

a) In all cases where regulations are silent, the decisions of the vice-chancellor shall be final.

b) All other regulations and instructions relating to Master's Engineering courses issued here-to-fore stand repealed.

c) The University authorities reserve the rights to make any change in the rules, regulations, fees structure and courses of study that may be considered necessary at any time without prior notice.

d) Interpretation of these rules and regulations by the authorized officers of the University shall be final.

Ph.D Degree Programme

GENERAL

These rules apply on all Ph.D. Programmes in which UET Peshawar will be sole degree awarding authority. The Ph.D. programme shall extend over a period of at least three years from the date of first registration for a full-time, and at least four years for a part-time student. The Ph.D. Programme is task-oriented rather than time-oriented. The Ph.D. work will be considered complete only when the supervisor and the Research Evaluation Committee (REC) are satisfied.

The student must register for at least 54 credit hours. While undertaking research work, the candidate shall be encouraged to attend seminars, conferences, symposia and publish papers in journals of national or international repute. Upon recommendation of the Supervisor, BOASAR will provide funding to the candidate for presenting a paper at a relevant Seminar/Conference/ Symposium at least once every year during his/her research.

All research work will be carried out at UET, Peshawar, unless otherwise advised by the Supervisor. Part-time students must also fulfill the residency requirement by registering as full-time students for at least two years. In case of joint research proposal with industry or another university, residency requirement will be established by supervisor and co-supervisor (member from Industry/another university).

RULES

2.1 Admission

a) Ph.D. programme shall be open to applicants who have Master's/M.Phil degrees with a minimum CGPA of 3.0 in a relevant discipline so recognized by the University. For details on area of specialization, the chairman of respective department should be contacted.

b) The DPGS in consultation with the heads of departments will invite applications for admission to the Ph.D. programme at the same time as Master's admissions. The application should include a brief proposal of research to be carried out by the applicant, along with CV and a list of any previous research publications. The candidates must fulfill the criteria for admission as mentioned in clause 2.1 (k).

c) The Chairman, in consultation with the Departmental Project Research Evaluation Committee (PREC) will scrutinize the applications and forward it to the Director Postgraduate Studies with his recommendations (including the name of the proposed Supervisor).

d) The Director Postgraduate Studies will present the credentials to the University Admission Committee for recommendation and to the Vice-Chancellor for final approval.

e) Applicants selected for admission will be so informed by the Head of the Department concerned and their names shall also be notified on the Notice Board of the Department and of the Directorate of Postgraduate Studies.

f) The applicant will have to register within one

month of the notification or the beginning of the forthcoming semester, whichever is later, by paying the prescribed fees for the first semester.

g) A Ph.D. candidate must complete at least 18 credit hours Ph.D. level course work with a minimum CGPA of 3.0, followed by a comprehensive examination along with thesis defense, which will be essential for the award of Ph.D. degree.

h) The student must register for a minimum total of 54 credit hours (18 credit hours of course work and 36 credit hours of research work).

I) A Ph.D. student may be allowed to register in an advanced Postgraduate course as a single participant in his core area of research with the approval of the Dean. However, he/she can only take maximum one course as a single participant.

j) No supervisor shall have more than five (05) candidates for Ph.D. simultaneously, unless authorized by a committee comprising the Dean, the Head of Department and the Secretary BOASAR.

k) The candidates seeking admission in Ph.D. Programme must have:

(i) A Masters/M.Phil/ equivalent degree in the related field with minimum CGPA 3.0 out of 4.0 or 3.75 out of 5.0 or First Division in annual system. The percentage will be valid only if the CGPA is not mentioned in the degree/transcript.

(ii) 18 years of education with Masters / MS/M.Sc or equivalent degree from abroad or 17 years of education with MS/M.Sc from abroad.

(iii) GRE Subject Test (International) Score (score >= 60%), Subject Test Score (score >= 60%) conducted by University Appointed Testing Authority (UATA) or the Subject Test (score >= 70%) conducted by the Department concerned will be considered.

l) Interpretation of these rules and regulations by the authorized officers of the University shall be final.

2.2 Ph.D. Candidature

a) The student will become a candidate for Ph.D degree after passing the Qualifying Examination and on the recommendation of the Supervisor concerned.

b) Within two months of passing the Qualifying Examination, the Supervisor, with the approval of the Head of the Department, shall constitute a REC for each candidate comprising qualified persons and shall send it to the office of BOASAR for approval of the Board. All committee members must have Ph.D. degree except possibly No. (v).

(i) The Supervisor (expert in the subject) from the department concerned.

(ii) One member from the department concerned.

(iii) One member from a department other than the concerned department.

(iv) One member from a university other than UET, Peshawar.

(v) One member from a Research Institute/ Industry.

Any member from the above may be appointed as

a Co-Supervisor for the candidate, if required. The names shall be submitted for approval of the vice-chancellor through Director Postgraduate Studies. The Supervisor shall act as the Chairman of the REC.

c) In the Ph.D. degree programme, a minimum of three REC meetings shall be conducted. The REC shall meet once a year (i.e Fall to Fall or Spring to Spring) and monitor the research work of the candidate. There shall be a gap of one year between two consecutive RECs. The supervisor shall submit the yearly progress report of the student to the Director Postgraduate studies.

d) If Supervisor is unable to continue, the Head of Department in consultation with REC shall appoint a new Supervisor (preferably a REC member) of the student's research. The new Supervisor may associate a Co-supervisor from the faculty available within the University or outside the University.

e) The REC, shall also act as an Examination Committee. The quorum for the REC shall be at least three members and for Examination Committee at least four members including at least one member from outside the University. The Supervisor shall act as the head of the committee. The REC may advise the student to go ahead if it is satisfied with the annual progress of the work or to continue on the improving of his/her research findings if it is not satisfied.

2.3 Examination

2.3.1 Ph.D. Qualifying Examination

a) Each department shall conduct Ph.D. qualifying examination once each semester. It will be a written exam on pass/fail basis and will include two parts;a general section and a specialized section. The general section will assess student on the core areas of the discipline (as notified by the Department), whereas thespecialized section may assess the student on the area of his/her research interest. Each part should be scheduled for at least two hours. The qualifying examination shall be designed to ascertain in-depth knowledge, analytical abilities and aptitude of the student in his area of PhD research.

b) A Ph.D. student must appear in the qualifying examination within six months of the date of his course completion. Students who fail will be allowed to repeat the examination once only within six months of the declaration of qualifying examination result.

c) Students who fail the Qualifying examination twice will not be allowed to continue their Ph.D.

d) The Qualifying Examination Committee should comprise of 3 members including concerned Ph.D. Supervisor. The members of Qualifying Examination Committee will be nominated by the concerned supervisor and appointed by the Chairman of the respective department by taking into consideration the core areas of the research. All the members will assess and evaluate the potential of the student independently with regard to the initiative of Ph.D. research in the relevant field. The Qualifying Examination Committee shall declare the result of the student on pass/fail.

2.3.2 Ph.D. Preliminary (or Proposal Defense) Examination

a) Within six months of passing the qualifying Examination, candidate should appear in a preliminary examination conducted by the REC. The candidate will submit his/her research proposal on the approved format along with literature survey and research plan in written form to the REC at least two weeks prior to the examination. In this examination, the candidate will make an oral presentation and defend his/her proposal in front of the REC. The candidate will incorporate necessary changes if suggested by the REC in the proposal and submit to the office of BOASAR through his/her supervisor for approval of the Board.

b) The purpose of preliminary examination is to confirm that the candidate understands the problem, is aware of the associated literature, has a realistic research plan and schedule, and the research problem is of Ph.D. standard. If the REC is satisfied, the candidate will be allowed to proceed. If not, he/she may be given one more chance to pass the preliminary examination.

2.3.3 Foreign Thesis Evaluators

a) Two Foreign Thesis Evaluators from technologically advanced countries will be nominated by the supervisor concerned for a Ph.D. student within six months of passing the qualifying examination. The supervisor will submit nomination to the Director Postgraduate Studies who will recommend these names to Dean for final approval of vice-chancellor.

b) The Foreign Thesis Evaluators will be required to review the research proposal and progress report of the Ph.D. student on regular basis, and their comments will be incorporated in the research accordingly.

2.3.4 Evaluation of Thesis

The foreign evaluators and REC shall first evaluate the thesis to ascertain that:

Thesis makes a distinct contribution in the area of specialization of the candidate, and it shows the ability of the candidate for original investigation and for understanding the relationship of his /her research with a wider field of knowledge.

Thesis evaluation by the foreign evaluators andREC will be on following basis:

a) Each member shall submit his report independently to the Director Postgraduate Studies on prescribed Proforma recommending:-

(i) That thesis is satisfactory, Viva-voce examination may be held to enable the candidate to defend his thesis, (No correction), OR

(ii) That the thesis may be resubmitted by the candidate after revision on the proposals suggested by the members, OR

(iii) That the thesis be rejected as it is not of merit and candidate be declared ineligible.

b) Evaluation report by the two foreign evaluators has to be positive before the student can be asked to carry out final defence.

c) The recommendations made by a majority of the members of the REC shall be implemented. In case of a tie of difference of opinions, the BOASAR shall recommend to the vice-chancellor for appointing a neutral examiner whose opinion shall be final.

d) Re-submission of thesis shall be allowed only once. In case the resubmitted thesis is not of merit, the candidate shall be declared ineligible for the Ph.D. degree.

2.3.5 Ph.D. Thesis Defence Examination

a) A candidate ready for Ph.D. thesis defence examination shall apply to the Director Postgraduate Studies on the prescribed proforma along with six copies of his/her hard-bound thesis and a certificate from his/her Supervisor duly countersigned by the Head of Department about the satisfactory completion of his/her research and thesis in accordance with the prescribed format of thesis. In addition, the final script of the thesis must be certified against plagiarism by the Quality Enhancement Cell (QEC) of the university before the thesis defence.

b) The thesis may be submitted within a maximum period of five years from the date of candidature in case of regular candidates and six years in case of part-time students provided that in exceptional cases, on the recommendations of the Supervisor/the Director Postgraduate Studies, the vice-chancellor may extend the period by a maximum of two years.

c) After the expiry of duration mentioned above, the candidate may be allowed to register as a fresh candidate, if he/she so desires.

2.3.6 Viva-Voce

a) After the thesis has been evaluated as satisfactory, Viva-Voce Examination shall be held at a place and date as may be determined by the Dean on the recommendations of the Director Postgraduate Studies.

b) Such places and dates shall be made public by the Director Post Graduate Studies through at least two national dailies of repute and also by invitation to such other institutions of learning and research as may be related to the area of specialization of the candidate.

c) The Viva-Voce Exam shall be conducted by the Examination Committee,

d) Each member shall submit his report recommending:-

(i) That the candidate be declared to have passed the examination, OR

(ii) That the candidate should appear for viva-

voce, after a period stipulated by the Examination Committee, OR

(iii) That the candidate be declared to have failed and ineligible for the award of the Ph.D. degree.

(iv) The recommendation made by the majority of the examiners shall be implemented. In case of a tie, the BOASAR shall recommend to the vice-chancellor for appointing a neutral examiner whose opinion shall be final.

e) Publication of at least one research paper, as per requirement of HEC, is essential for the award of Ph.D. degree.

(f) The candidate shall be admitted to a Ph.D. degree in the relevant branch, provided that he/she has been declared to have passed the viva-voce examination in accordance with these regulations.

2.4 Funding

a) All students must be available for a minimum period of two years as full time regular student taking leave from their jobs, if necessary. In case of financial need, a student may be awarded a teaching assistantship of up to Rs. 8000/- per month on the recommendation of the supervisor concerned.

b) The matter of study leave and scholarship (for paying fees) of faculty members getting admission in Ph.D. will be decided as per existing rules of the University for leave and scholarship.

c) Students funded by the University should give an undertaking to pay back the University all expenses incurred on their Ph.D. in case of willful abandoning of the Ph.D. programme as ascertained/notified by the Supervisor.

d) Funding for each Ph.D. student will be released annually by BOASAR on the recommendation of the REC. However, funds for the first year will be released upon first registration of the student, since REC is not yet constituted.

2.5 UNIVERSITY FEE

University fee will be charged at rates prescribed in Table-2 (Page-251) for Open Merit Master's students.

2.6 CHANGE OF SUPERVISOR

The candidate may request for change in PhD supervisor or a supervisor may opt to withdraw from supervision of a candidate. The candidate or the supervisor shall submit their request to the chairperson concerned. Recommendation for change of supervisor will be made by PREC of the department through Dean concerned for approval by BOASAR. No relaxation in maximum allowable time for completion of PhD degree would be granted to the candidate on the basis that his supervisor has changed.

Conduct & Discipline Regulations

1. TITLE

These regulations are framed under "UNIVERSITY OF ENGINEERING & TECHNOLOGY, PESHAWAR CONSTITUTION, FUNCTIONS AND POWERS OF AUTHORITIES OF THE UNIVERSITY STATUTES, 2016".

The University discipline Committee constituted under Clause-22.13 of "UET Peshawar Constitution, Functions and Powers of Authorities of the University Statutes, 2016" shall have the authority and jurisdiction to deal with and decide all cases of indiscipline, in accordance with University Students Conduct and Discipline Regulations.

2. APPLICABILITY AND COMMENCEMENT

These regulations shall apply to all students on the rolls of the University and the affiliated Colleges of the University.

3. STUDENTS CODE OF HONOUR

Every student shall observe the following code of conduct:-

(a) Faithfulness in his religious duties, and respect for convictions of others in matters of religion, conscience and customs.

(b) Loyalty of Pakistan, and refraining from doing anything which might lower its honour and prestige in any way.

(c) Truthfulness and honesty in dealing with others.

(d) Respect for elders, and politeness to all, especially to women, children, old people, weak, deformed and the helpless.

(e) Respect for teachers and others in authority in the University.

(f) Cleanliness of body, mind, speech and habits.

(g) Helpfulness to fellow-beings.

(h) Devotion to studies and sports.

(i) Protection of Government property.

4. PROHIBITED ACTS

The students should refrain from:-

(a) Smoking in class-rooms, laboratories, workshops, examination halls, or Convocation Hall, and during study or academic functions.

(b) Using or carrying of alcoholic drinks or other intoxicating drugs, within the University Campus or University Hostels or during instruction, sports or cultural tours or survey camps or entering such places or attending any such tour of camp while under the influence of such intoxicants, or any other University/ College functions outside the Campus.

(c) Organizing or taking part in any function within the University campus or hostel, or organizing any club or society of students or students associations, unions and federations, except in accordance with the prescribed rules and regulations.

(d) Collecting any money, receiving funds or pecuniary assistance for, or on behalf, of the

University, except with the written permission of the vice-chancellor /Principal.

(e) Staging, inciting or participating in any walk-out, strike, or other form of agitation against the University or its teachers or officers, inciting any one to violence, disruption of the peaceful atmospheres of the University in any way, making provocative speeches or gestures which may cause resentment, issuing of pamphlets or cartoons casting aspersions on the teachers or staff of the University or the University bodies, or doing anything in anyway likely to promote rift and hatred among the various groups or castes of students community, issuing statements in the press making false accusations or lowering the prestige of the University or writing and pasting posters on the walls.

(f) Bringing, carrying and keeping of fire arms or any other weapon (of any nature/type) forbidden by law, within the University Campus, class-rooms, hostels and offices.

(g) Causing damage to University property or government public property.

(h) Use of loud speakers, mega-phones, "decks" in the University hostels and on campus.

5. ACTS OF INDISCIPLINE

A student will be deemed to have committed an act

of indiscipline if he/she:

(a) Commits a breach of rules of conduct specified above, or

(b) Disobeys the lawful order or a teacher or other person in authority in the University, or

(c) Habitually neglects his work or habitually absents himself from his class without valid reason; or

(d) Wilfully damages University (or) public property or the property of a fellow student or any teacher or any employee of the University or

(e) Does not pay the fees, fines, or, other dues payable, under the University Regulations and Rules; or

(f) Does not comply with the rules relating to residence in hostels, or uses indecent language, wears immodest clothes, makes indecent remarks or gestures, or behaves in a disorderly manner, or commits any criminal immoral or dishonorable act (whether committed within the University Campus or outside) or any act which is detrimental to the interest of the University. False personification or giving false information or willful suppression of facts, information cheating or deceiving the University

(g) Forging, mutilating, altering erasing or otherwise tampering with any document connected with examination, receipt of University fees / dues or making undue use of such documents.

6. PROCEDURE IN CASE OF BREACH OF DISCIPLINE

The vice-chancellor , if in his opinion an act of indiscipline can more appropriately be dealt with by the University Discipline Committee, may refer it to the University Discipline Committee for necessary action under the Rules/Regulations.

7. RUSTICATION AND EXPULSION

(i) Rustication

(a) Rustication, whenever imposed on a College/University student, shall always mean the loss of one semester or one academic year so far his appearance in a University examination is concerned. The rusticated student may be admitted in the University on the expiry of the rustication period.

(b) No fee will be charged from a rusticated student for the month or months during which his name is struck off the rolls.

(ii) Expulsion

(a) The period of expulsion will be counted from the date of issue of such a notice by the University. Expulsion period can vary.

(b) Name of the expelled student will immediately be removed from the Department's rolls, and no fee will be charged from him/her for subsequent months.

(c) A student expelled from a Department may be re-admitted into that Department or another affiliated College after the expiry of the period of expulsion.

(d) Cases of expulsion will be registered in the University and notified to all Departments and Universities.

8. GENERAL

(i) The authority, which has the power to rusticate could also withdraw the same order before the expiry of the period.

(ii) No student shall be rusticated/expelled from the University unless he has been served with the Show Cause Notice, and allowed a reasonable time for explan-ation and replying to the charges framed against him.

(iii) When in the opinion of the Discipline Committee the rustication or expulsion is not called for in a case referred to it, may impose any other penalty or penalties mentioned in the above Regulations.

9. APPEAL

(i) An appeal against the punishment awarded by the University Discipline Committee can be made to the Appellate Committee.

(ii) No appeal by a student against the decision

of the University Discipline Committee shall be entertained unless it is presented within thirty days from the date on which the decision is communicated to him.

This code of conduct will repeal all previous Regulations relating to Expulsion and Rustication or any other instructions relating to the maintenance of discipline among the students.

UNIVERSITY CONDUCT & DISCIPLINE REGULATIONS 2002 (Amended in 2006)

Penalties which may be imposed by the University authorities
for various offences committed are given below:

S.No	OFFENCE	PENALTY
1.	Using/carrying of alcoholic drinks or other intoxicating drugs within the University Campus or University Hostels or during Study Tour or Cultural Tours or Survey Camps, any such tours of any other University/College or outside the campus under the influence of such intoxicants or misbehaving with others, especially females, during tours etc.	Debar from classes for one week or fine not exceeding Rs. 10,000/- OR Expulsion from the University.
2.	Organizing or taking part in any function within the University Campus or hostel or organizing any club or society of students or students association, unions or federation, except in accordance with the prescribed rules and regulations.	Stern warning and / or Fine not exceeding Rs. 20,000/-, AND / OR Expulsion from hostel accommodation, if relevant.
3.	Collecting any money or receiving funds or pecuniary assistance for or on behalf of the University, except with the written permission of the vice-chancellor .	All money supposed to have collected shall be confiscated in favour of the University. AND/OR Fine not exceeding Rs. 10,000/-
4.	Staging or inciting or forcing fellow students to a walkout from classes or examination halls or organizing, conducting or participating in strikes or agitation or violence against the University authorities or members of teaching or administrative staff or disrupting the classes or any other academic activity of the University being held inside or outside the campus.	Expulsion from the University for one to four semesters/two academic years, depending on the nature and gravity of the crime. AND / OR Fine not exceeding Rs. 20,000/-

5.	Casting aspersions or using abusive and derogatory language in speeches, pamphlets or posters against the University authorities or members of teaching or administrative staff of the University or physically manhandling, beating or disgracing the University authorities or members of the teaching or administrative staff of the University or committing an act of moral turpitude against fellow students.	Expulsion from the University for one to six semesters/ three years, depending on the nature and gravity of the crime. AND / OR Fine not exceeding Rs. 30,000/-
6.	Conducting or inciting or participating in a violent attack on the offices of the University authorities, Chairmen, faculty members or other officers of the University.	Permanent expulsion from the University. AND / OR Fine not exceeding Rs. 50,000/-
7.	Damaging/destroying or trying to damage/ destroy the property (movable or immovable) of the University or University employees or Government or any other Public Organization or stealing or taking away by force any item of University property.	Recovery of the amount equal to the value of the damage caused; and / or fine not exceeding Rs. 20,000/- AND / OR Rustication from the University.
8.	Bringing, carrying or keeping or firing of arms or any other weapon (of any nature/type) within the University campus or class rooms or hostels or examination halls or offices of the University.	Fine not exceeding Rs. 20,000/- AND / OR Expulsion from the hostel. Expulsion from the University for a maximum period of two semesters / one year.

9.	Using loudspeakers or mega-phones in the University hostels or on the University campus or making provocative speeches or gestures which may cause resentment or doing anything in anyway which is likely to promote rift and hatred among various groups or castes of students community or issuing statements in the press, making false accusations against the University or University Authorities or members of teaching staff.	Fine not exceeding Rs. 20,000/-; expulsion from the hostel. AND / OR Expulsion from the University for maximum period of two semesters / one year.
10.	Misbehaving and not cooperating with faculty members, University proctors, Hostel Wardens, and other authorities.	Fine not exceeding Rs. 20,000/-; expulsion from the hostel. AND / OR Expulsion from the University for maximum period of two semesters / one year.
11.	Forming political wing of any political party, student union, student federation, or associations based on linguistic, ethnical, territorial, religions affiliation, or any other platform.	Fine not less than Rs. 5,000/- AND / OR Stern warning. Rustication / expulsion from University.
12.	Holding "Dars" or "Waaz-o-Naseehat" and collection of funds for political, religious party or group within the campus without permission of the University authorities.	Rustication / expulsion from University. AND / OR Fine not exceeding Rs. 30,000/-
13.	Carrying any activity of what-so-ever nature that does not come under the definition of curricular and co-curricular activities that is not allowed and organized by the University authorities.	Rustication / expulsion from University. AND / OR Fine not exceeding Rs. 20,000/-

Where acts of indiscipline need a prompt resolution or are minor in nature, the Chief Proctor may impose a fine not exceeding Rupees one thousand (Rs. 1000/-) and the proctors may impose a fine not exceeding Rupees five hundred (Rs. 500/-), whereas students will have the right to appeal against the fine to the University Discipline Committee.


JALAL BABA HOSTEL

GENERAL

Accommodation in hostels is a privilege and cannot be claimed as a matter of right. Accommodation being limited in hostels may not be provided to all the applicants and will be provided only on the availability of seats in Researchers Hostel. The residential accommodation is an equal and merit based opportunity and preference is given only to those applicants who hail from far-off places.

Researchers Hostel Peshawar:
45 Rooms, 90 Seats (2-Seater)

The hostel is looked after by a resident warden, who is responsible for the implementation of hostels rules, maintenance of order and discipline in the hostel. The Resident Warden is the first point of contact between the Resident students and university administration.

All complaints regarding any student or member of hostel staff, any queries and any problems relating to hostel shall be brought forth before the Resident Warden. Students must never take matters into their own hands. Bearers and other staff have been provided in the hostel to facilitate resident students. The Provost serves as the overall in-charge of the hostels and sets policy guidelines for the hostel administration.

Security officer will supervise a team of highly trained security guards recruited from retired Pakistan Army personnel. Security guards will perform duty on the gates of the hostels who will only allow lawful residence into hostels. Security officer will be overall incharge of security of hostel. He can pay surprise visits to rooms of the hostel at any time for check of any weapon, drugs, intoxicant, rods, daggers and harmful materials etc. The residents of hostel are required to abide by the rules and regulations of the university hostel as laid down in this prospectus and notified from time to time by the hostel and university administration. Misconduct by any resident student may be punished directly by the Resident warden with a fine of up to Rs. 10000/- or it may be reported by the Resident Warden to the Convener Hostel Disciplinary Committee through the Warden for further action. The Hostel Discipline Committee may forward any case to University Discipline Committee (UDC), if it deems fit.

1 ADMISSION

1.1 Hostel admission will be granted only to those students who are on regular rolls of the University. The facility of hostel accommodation to full time postgraduate students may be provided subject to availability.

1.2 Students desirous of hostel accommodation are required to apply on the prescribed hostel admission form on or before the last date announced for the purpose. Students shall submit duly completed forms, alongwith five Passport size photographs duly attested by the head of the concerned department, to the office of the Head of their respective department. The forms after necessary scrutiny will then be forwarded to office of the Provost.

1.3 Seats in the hostel will be allocated on first come first serve basis while preference will be given to those students who belong to far flung areas. Seniority will be maintained from the date of application for hostel accommodation. Local students (Peshawar district) will not be provided hostel facility in any case.

1.4 The hostel authority has the right to refuse/cancel hostel admission of students who misuse their privilege.

1.5 A student can request the cancellation of his/her hostel admission and eligible to receive funds/hostel charges as under:

a. Full charges will be refundable upto 15 days of the allotment of hostel accommodation after necessary adjustments if any.

b. 50% hostel charges alongwith refundable amount i.e. Hostel & Mess Security, will be refundable till one month of the allotment of hostel accommodation after necessary deduction if any.

c. No refund will be entertained after one month of hostel allotment except refundable/ adjustable hostel charges i.e. Hostel & Mess Security.

1.6 A student whose admission is cancelled by the hostel authorities on disciplinary grounds shall not be entitled to receive his hostel security.

2 ALLOTMENT

The warden of a hostel shall provide room/seat to a student within three days of the submission of his/her hostel card. However, handing over/possession may take longer depending upon the time required to complete the process of shifting by ex-room holders.

3 HOSTEL DISCIPLINE & ORDER

3.1 The Residents students must submit an undertaking of good conduct as provided by the university on judicial stamp paper before they can be issued hostel admission cards. The affidavits must be duly signed by the parent/guardian of the concerned student. A student, who fails to submit the duly filled affidavit, shall not be allowed to enter the hostel. The following must also be

ensured with regards to the guardian of a student:

(a) A guardian can only be a Blood Relative i.e. elder sibling, paternal or maternal uncle.

(b) The parent/guardian must accompany the student to the hostel and he/she would be required to submit a copy of his/her CNIC along with the affidavit.

(c) Any student, who fails to furnish the above, shall not be allowed to enter the hostel premises.

(d) Every resident student shall be issued a boarder card, after due verification and collection of duly filled affidavits. The students must keep these cards at all times with them and they will be allowed entry into their hostels only after presenting this card to the security guard.

(e) Residents shall abide by hostel rules and regulations in letter and spirit. Violation of hostel rules and regulations or any order issued by the hostel administration shall render a resident liable for imposition of fine and/or expulsion from the hostel and to such other actions as deemed fit by the University authorities.

3.2 Anybody (be it a student of the university) who is not a resident of the hostel is not allowed to enter or stay in the hostel premises.

3.3 Resident students can entertain their guests within the prescribed visiting hours only in the guest rooms prescribed for the said purpose in each hostel. No resident can entertain a guest in his room.

3.4 Residents are strictly forbidden of keeping any arms, intoxicants, drugs, rods or daggers, and harmful materials etc in the hostel. Any violation of this rule will result in serious disciplinary against the violator and may lead to imposition of heavy fines and expulsion from the hostel. The hostel administration may initiate criminal proceedings against the violator and refer the matter to the police.

3.5 Every Resident student is responsible for the peace and tranquility of hostel environment. Resident students are not allowed to play music or any instrument loudly.

3.6 Residents are not allowed to participate in any political activity.

3.7 Residents are not allowed to invite any political figure, scholar or any individual for any speech, lecture or sermon or to circulate any unpublished or published material for this purpose.

3.8 Residents are not allowed to assemble crowds or congregations within the hostel premises for any purpose e.g lunch, dinner, iftaar, political etc.

3.9 Entry of females into boys' hostels is strictly prohibited & vice versa.

3.10 Residents shall keep their rooms clean and tidy. They shall also be responsible to keep their rooms

properly locked in case they leave the room. Residents shall not keep expensive items (cost of which exceeds Rs. 1000/-) or cash in their rooms. The hostel authorities will not be responsible for any loss.

3.11 Residents are not allowed to park bicycles, motorcycles or cars within the hostel premises. The hostel authorities would not be responsible for any loss or damage incurred by the student.

3.12 Residents are not allowed to ride bicycles or motorbikes inside the hostel premises. Any violation will be dealt with seriously.

3.13 Resident students shall not use and shall not allow the use of their accommodation for any purpose other than that prescribed and allowed by the hostel administration.

3.14 Resident students who in the view of the hostel authorities are not residing in their rooms shall have their hostel admissions cancelled.

3.15 Any complaints against the hostel staff may be brought into the notice of the hostel warden or the provost. Residents are not allowed to deal with the hostel staff directly on their own.

3.16 Resident students shall not insist on the hostel bearers to bring contraband goods for them. Residents shall not insist on the hostel staff to indulge in activities other than their prescribed job responsibilities.

3.17 The Warden of the hostel may impose a fine of up to Rs. 5000/- on any resident student who violates the hostel rules and regulations or orders of the hostel authorities. Prior to imposing any penalty on the Resident Student the Warden may serve him with a show cause notice to which student must respond in writing within the specified timeframe. The Warden may decide to do away with any penalty if he finds the response of the student satisfactory or may decide otherwise. The Warden may forward the case to the Hostel Discipline Committee through the Senior Warden for further action. The Hostel Discipline Committee can report a case of indiscipline to the University Discipline Committee if it deems fit.

3.18 Appeal

An appeal against the punishment awarded by the Resident Warden shall be forwarded to the Hostel Discipline Committee within fifteen days.

4 HOSTEL DISCIPLINE COMMITTEE

4.1 The Hostel Discipline Committee (HDC) will be formed by the Provost under clause 8 of Khyber Pakhtunkhwa, UET Ordinance No. XIII of 1980 and (amended) Ordinance No. IX of 1981.

4.2 Cases of indiscipline by the resident students may be forwarded to the Hostel Discipline Committee by the Resident Warden. The Convener of HDC in consultation with the Provost will call a meeting of HDC, at a place and time convenient to the committee members, to conduct hearings in the case.

4.3 The Hostel Discipline Committee will decide the cases according to hostel conduct and discipline regulations.

4.4 The Hostel Discipline Committee may forward the cases needing severe penalties (such as imposition of a fine of more than Rs. 40,000/- and or expulsion/rustications from the university) to the University Discipline Committee.

4.5 The decision of the HDC will be communicated in writing and will be duly signed by all members. The Assistant Provost will be responsible for recording the minutes and decisions of the committee, keeping proper record of all cases, and communication of decisions to all members, concerned students and wardens.

5 APPEAL

5.1 An appeal against the punishment awarded by the Hostel Discipline Committee shall be forwarded to the University Discipline Committee.

5.2 No appeal by student against the decision of the Hostel Discipline Committee shall be entertained unless it is presented within 15 days of the date on which the decision is communicated to him/her.

6. HOSTEL CHARGES

Hostel charges can be changed from time to time by the University authorities. Hostel charges are given as follow:

S.No.	Description of Charges	Amount (Rs.)
1.	University Funds (Non-Refundable / Non-Adjustable)	25,000.00
2.	Hostel Funds (Non-Refundable / Non-Adjustable)	20,000.00
3.	Hostel Security (Refundable / Adjustable)	5,000.00
	Total	**50,000.00**

7 HOSTEL GATES TIMINGS

7.1 Following timings will be observed for boys hostels.

Season	Opening gate Time	Closing gate Time
Winter	7:00 A.M	10:00 P.M
Summer	6:00 A.M	11:00 P.M

7.2 A Boarder card will be issued by the provost office to the residents. All the students are subject to keep the Boarder card with them in the hostel and university premises. This card will serve as a proof of a student's identity as a Boarder. No student will be allowed entry into the hostel without his Boarder Card.

8 NOTICES & WALL CHALKING

No resident will be allowed to paste or exhibit any notice printed/hand written or other material, in writing anywhere in the hostel except those duly signed by the hostel warden; no resident student is allowed to engage in wall chalking inside the hostel premises. Any violation of this rule is subject to strict disciplinary action.

9 COMPLAINTS

All complaints about matters relating to the hostels shall be reported to the warden of the hostels. Students must never take matters into their own hands, otherwise they'll be held liable for strict disciplinary action.

10 UTENSILS, FURNITURE AND ELECTRIC INSTALLATIONS.

10.1 Residents are not allowed to take utensils from the dining hall/hostel mess and furniture from common room to their rooms or other hostels. Residents are not allowed to move any hostel furniture or other items from their designated places. Any violation will be subject to strict disciplinary action.

10.2 Every Resident of the hostel will be provided with a bed. A table and a chair will be provided on room basis. He/she will be responsible for any loss or breakage thereof. Residents who willfully destroy or damage any hostel property shall pay for damages and will be heavily fined.

10.3 All rooms of hostels have necessary electric fittings. Student/s residing in these rooms shall be responsible for the proper use and safety of these fittings.

11 COMMON ROOM

11.1 This hostel shall have a Common Room Committee comprising of three to five resident students of that hostel and shall be appointed by the concerned Warden. The Committee will look after the affairs of the Common Room under the supervision of the hostel warden.

11.2 The Resident Warden shall take actions to provide residents with newspapers, magazines, material for indoor games and fulfill other

maintenance requirements of the hostel. These needs shall be met through the contingency fund of the hostel. The Resident Warden shall determine the appropriation of contingency funds for these purposes.

11.3 Film shows are not allowed inside the hostels. Special permission of the Provost must be sought for the arrangement and use of microphones in any function whatsoever inside the hostel premises. Non residents shall not be allowed to enter and participate in any activity inside the hostel premises without the prior permission of the warden. No professional artist shall be invited to perform inside the hostel premises.

11.4 Social and cultural activities like indoor games, dramas, debates etc. can be arranged by resident students in the hostel from time to time with the permission of the Resident Warden. The Resident Warden shall decide the fate of such requests through consultation with the Senior Warden and the Provost.

12 HOSTEL STAFF

12.1 Private/personal servants are not allowed in hostels. Every hostel is manned with designated staff to look after the needs of resident students e.g. bearers, water carriers, sweepers and gardener etc. The hostel staff is answerable to the warden of the hostel. Any complaint against the staff should be communicated to the warden of the hostel in writing. Staff is required to serve the resident students inside the hostel premises according to the duties assigned to them by the hostel administration.

12.2 Misbehavior by the resident students with the hostel staff is subject to strict disciplinary action against the perpetrators.

13 PROHIBITION OF VALUABLES

13.1 The resident students are not allowed to keep valuable items like car, motorcycle, VCR, VCP, Video Camera, T.V Set, gold, expensive mobile phones, large sum of money etc. The hostel administration shall bear no responsibility in case of any loss or theft.

13.2 Resident students are allowed to keep computers, Laptops without external speakers/woofers in their rooms at their own risk for educational purposes only. The hostel administration shall bear no responsibility in case of any loss or theft.

14 REGULATIONS FOR POSTGRADUATE STUDENTS

M.Sc students can avail hostel boarding facility for maximum of three (03) years from date of admission in University or completion of degree whichever is earlier.

Ph.D. students can avail hostel boarding facility for maximum period of four (04) years from date of admission in University or completion of degree whichever is earlier.

15 CLOSURE OF HOSTELS

The university hostels shall remain closed during the vacations. All resident students shall be required to vacate the hostels except those who are in examination or have enrolled in summer semester. The administration may provide an alternate arrangement for those who are in examination or enrolled in summer semester. Foreign students may be allowed to stay in their hostel during vacations.

16 Guests

Boarder students will not be allowed to invite female guests for casual meals or for night stay without the prior permission of the hostel warden/Provost.

A: REGULATIONS FOR HOSTEL WARDEN

1.	Violation of Hostel Rules or Disobeying the orders of Hostel Administration	First time: Fine upto a maximum of Rs. 5000/- Second time: Cancellation of Hostel Privilege for next sessions and/ or expulsion from hostel.
2.	Using Electric Heaters/Air Conditioners	First time: Fine upto a maximum of Rs. 5000/- and recovery of estimated electricity charges alongwith confiscation of the appliances Second time: Cancellation of Hostel Privilege for next sessions and/ or expulsion from hostel.
3.	Installing internal locks in the allotted rooms	Fine upto a maximum of Rs. 5000/-
4.	Playing games in hostel lawns or corridors	Fine upto a maximum of Rs. 5000/-
5.	Smoking in hostel premises, sleeping in prayer hall or common room/study room and any matter of this nature	Fine upto a maximum of Rs. 5000/-
6.	Keeping non-residents in the room	Fine upto a maximum of Rs. 5000/-and cancellation of hostel privilege for next sessions and/or expulsion from hostel.

B: REGULATIONS FOR HOSTEL DISCIPLINE COMMITTEE

1.	Keeping non-residents in hostel room	First time: Fine upto a maximum of Rs. 40,000/- Second time: Cancellation of Hostel Privilege for next sessions and/or expulsion from Hostel.
2.	Keeping arms, explosives, intoxicants, and drugs or anything alike.	Fine upto a maximum of Rs.40,000/- and cancellation of hostel privilege for next session and/or expulsion from hostel.
3.	Playing games in hostel lawns and corridors.	Fine upto a maximum of Rs. 20,000/-
4.	Misbehavior with Hostel Staff or Administration or fellow students.	Fine upto a maximum of Rs. 40,000/- and/or expulsion from Hostel and/or cancellation of hostel privilege for next sessions.
5.	Invitation to any political figures, scholar or any individual for any speech, lecture, sermon or to circulate any unpublished or published material for this purpose inside or outside the hostel. Pasting posters/notices etc. without the written permission of hostel administration and/or wall chalking and such other activities.	Fine upto a maximum of Rs. 40,000/- and/or expulsion from hostel and/or cancellation of hostel privilege for next sessions.
6.	Damaging/theft or misuse of hostel property and hostel card	Recovery of loss and Fine upto a maximum of Rs. 40,000/- and/or expulsion from hostel and/or cancellation of hostel privilege for next sessions.
7.	Subletting of one seat or room to outsiders	Cancellation of Hostel seat and fine of Rs. 10,000/- to 20,000/- for subletting a seat and fine of Rs. 20,000/- to 40,000/- for subletting a room.
8.	Willful absence from HDC meeting by a Student	A fine of upto Rs. 10,000/- for the first time and cancellation of hostel seat and exparte action.

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2	Assistant Provost, University Hostels	Mr. Abdul Ghafar Khan	091-9222223
3	**Researchers Hostel Hayatabad** Warden Caretaker	Dr. Zubair Ahamd Khan Mr. Tariq Amin	091-9219010

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MISSION STATEMENT

To produce highly qualified, well-rounded professionals through education who play a leading role in the society by powering and driving knowledge-based economy and offer research services and innovation for sustainable development.

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