

Postgraduate Prospectus

(2021-22)



University of Engineering and Technology, Mardan

MARDAN

Mardan is the second largest city of Khyber Pakhtunkhwa. It has different population segments and tribes from all over Pakistan, and is the de-facto headquarter of the most hospitable and soft-spoken tribe of Pakhtun: Yousafzai. The city is located at the gateway of Northern Areas of Pakistan and has a great geographical significance. Mardan also happens to be the stopping and refreshment spot for all the tourists around the country as it connects places like Swat, Dir, Chitral, and Gilgit. Furthermore, with its central geographic location, the M1 motorway connects it to Peshawar (65 km approx.) and Islamabad (144 km approx.).

Mardan is located in a region rich in archaeological sites and has a long rich history that can be back dated to thousands of years. The oldest of artefacts like the Sanghao Caves, Ashoka remains, excavation sites like Jamal Garhi and Shahbaz Ghari around Mardan are testaments to the rich culture and historical importance of this region. Furthermore, the UNESCO World Heritage Site of Takht Bhai is also in its close proximity. Besides, The Mardan Museum, a repository and showcase of the artefacts, is just at a walking distance from the University of Engineering and Technology, Mardan.

Additionally, Mardan is a perfect blend of traditional and urban lifestyle with a population of around 2.5 million, it is expanding fast and so are the businesses and markets. On one hand, the people of Mardan get to enjoy the traditional markets like Gajju Khan Market, Ghareeb Market and Bank-Road; on the other hand, it also offers mega-malls and mega-marts for the shopping spree of its people. It has a variety of continental and traditional food and can satiate all types of palates with its traditional restaurants, modern cafes and road-side vendors that serve mouth-watering food.

Recently, the main Nowshera-Mardan road has been transformed into a business hub with large shopping malls, food courts and plazas and is yet in the process of development and growth. It also offers health facilities, sports facilities and world-class education facilities. Mardan city is home to Oil mills, Sugar mills, Textile, Tobacco and Marble industry which makes it an industrial zone also.

Mardan City is home to one of the largest regiments of Pakistan Army, the Punjab Regimental Centre, that lies at the heart of the city. The city is also neighbour to Risalpur, the home of Pakistan Air Force, and forms close proximity with the China-Pakistan Economic Corridor (CPEC) Economic Zone of Rashakai, which can in future, provide industrial opportunities and economic growth.

ABOUT UET MARDAN

UET Mardan is the emerging public sector engineering university in the Khyber Pakhtunkhwa recognised by HEC. It aims to provide quality engineering education to the people of Khyber Pakhtunkhwa. It is an inspiring place to work & study with the continuous flow of new knowledge and ideas.

The key features of the system running at UET Mardan are:

Outcome Based Education System: Outcome Based Education system in line with the Washington Accord in all undergraduate engineering programs.

Quality Enhancement Cell: Quality Enhancement Cell undertakes measures for ensuring academic quality assessment & enhancement and to assist in implementing Internal Quality Assurance (IQA).

Office of Research, Innovation & Commercialisation: Office of Research, Innovation & Commercialisation serves as a pivotal point, encompassing all the research activities-from development of research proposals to commercialisation of research products.

Career Counselling: Dedicated Advisor Postgraduate Studies is nominated in every department, for academic and career counselling of the students.

Internet Access: Dedicated Optical Fibre connection for Internet Access is provided in each department.

Libraries: The central Library is equipped with books that meet the requirements of each discipline. It has digital Library access and a dedicated room for postgraduate research and study. The future plan includes having a separate postgraduate library.

Disciplines: There are three disciplines of engineering offering postgraduate programs: Telecommunication Engineering, Electrical Engineering and Computer Software Engineering. Besides, undergraduate program in Department of Computer Science was introduced in the year 2018, while BSc Mechanical Engineering and BSc Civil Engineering have been introduced in 2021. Furthermore, much more avenues and platforms will be made open for the people who have different engineering potential and interests. We are also working towards launching some new disciplines and programs at UET Mardan in the years to come. In essence, the aim is to work for excellence and finesse, and make a world-class production. A Center of excellence and other programs are approved in Rs. 2.5 Billion PC1.

Laboratories: We have a fleet of 26 plus laboratories, these fully equipped state-of-the-art laboratories include: 9 labs at Department of Telecommunication Engineering, 9 labs at Department of Electrical Engineering, 6 labs at Department of Computer Software Engineering & 2 labs at the Department of Computer Science. These labs include Radar Labs, Solaris Labs, Advance Electronics Labs, Programming Lab, Data Science Lab, System and Design Lab, Final Year Project Labs, Postgraduate Lab, Embedded Systems Lab, Power Generation, Transmission and Distribution Analysis Labs, Advance Machinery Lab, Computer Labs, Communication Labs, Control Systems Labs, Advance Telephony and Various types of experimentation test beds as well as workshops. 23-more state-of-the-art laboratories for the Mechanical Engineering, Civil Engineering and Electrical Power Engineering programs are going to be added soon.

Scholarships and Financial Aid: Limited number of merit-based scholarships are available for MSc and PhD students, in Computer Software and Telecommunication Engineering Departments, under certain terms and conditions, and subject to availability of funds. Limited number of Teaching and Research Assistantships are also available.

Research Groups: Dedicated research groups have been created in departments to ensure research productivity and specialised research themes/areas.

Financial Support for Research Publication: UET Mardan has a generous policy to recognise and contribute towards publication fee of research articles by faculty members and PhD students in journals and conferences.

General: UET Mardan, spreading over an area of 172 Kanals, is providing quality education as well as environment to the masses. There are on-campus residence of staff and faculty, two boys' hostels and one girls hostel, housed in purpose built buildings inside campus, with dedicated official caretakers as well as management staff. Moreover, three more hostels, i.e., one boy's hostel, one girls hostel and one staff hostel, are at the final stage of completion and will soon be handed over to the University. We have football grounds, cricket ground, basketball court, badminton courts besides indoor sports and hostel TV lounges that are necessary for the mental as well as physical health of our students.

Moreover, the institute is surrounded by the agricultural lands of Mardan as well as the developed city and buildings so students have an easy access to most of the outside university facilities as well. We have assured the timely response in emergency situations by providing 24/7 on duty medical staff and a dedicated ambulance. The university is a safe haven that provides engineering knowledge, fresh environment as well as community awareness besides uplifting the province from its geographical centre.

DEPARTMENT OF COMPUTER SOFTWARE ENGINEERING

1. INTRODUCTION

Software Engineering is the discipline that deals with developing and maintaining software applications by applying technologies and practices from computer science, project management, engineering, application domains and other fields. Software engineers have a firm grounding in the concepts of Computer Science. However, this discipline varies widely from computer science as it deals with actual implementation of software through software engineering principles. Software Engineering encompasses the entire software process, i.e., from planning to Design, Development, Testing and Deployment.

The Department of Computer Software Engineering was established in 2002 in the then Mardan Campus of UET Peshawar with undergraduate (B.Sc. Computer Software Engineering) program. The Postgraduate programs i.e., M.Sc. and Ph.D. Computer Software Engineering, were started in 2011 and 2012, respectively. After upgrading to a full-fledged University in 2018, the M.Sc. and Ph.D. programs were relaunched with the permission of Higher Education Commission in Spring 2020 and Fall 2020 semesters, respectively.

The postgraduate program at the Department of Computer Software Engineering is designed to develop the research and development skills, and expertise in management of software technologies. The program is well suited for both working professionals as well as fresh graduates. The department has highly qualified and experienced faculty. Expertise/area of interest of the faculty includes software quality assurance, software testing, application of optimization techniques to software engineering, human computer interaction in the context of software engineering, computer vision, machine learning, artificial intelligence, cloud computing, cyber security and computer networks.

2. DEPARTMENT MISSION

- To equip students with the concepts, techniques, skills and tools for the design & development of medium and large-scale software systems.
- To prepare graduates for professional careers in software industry, academia and research organizations by imparting them life-long learning capabilities.

3. WHY YOU SHOULD STUDY MSc. or PhD in SOFTWARE ENGINEERING?

The following unique features of the postgraduate program of Computer Software Engineering make it the first choice of students:

- Higher employability: There is high employability of the graduates of the department. Graduates of the department are working in various Government, semi-Government, autonomous and private organizations. Some are self-employed and entrepreneurs.
- State of the art laboratories: The department is equipped with the state-of-the-art laboratories and high-speed Internet connectivity.

- Highly qualified and experience faculty: Faculty members of the department have rich experience in academia, research and industry.

4. RESEARCH AREAS

The Department of Computer Software Engineering conducts research in the following areas:

- Machine Learning
- Software Testing
- Software Requirements Engineering
- Software Design & Architecture
- Agile Software Development
- Global Software Development
- Software Outsourcing
- Data Science
- Internet of Things
- Semantic Web
- Software Ontology
- Human Computer Interaction
- Cyber Security
- Cloud Computing

5. FACULTY

Chairman

- Prof. Dr. Ibrar Ali Shah PhD (UK)

Advisor Postgraduate Studies

- Dr. Muhammad Usman PhD (South Korea)

Professors

- Prof. Dr. Sadaqat Jan PhD (UK)
- Prof. Dr. Ibrar Ali Shah PhD (UK)

Associate Professors

- Dr. Muhammad Usman PhD (South Korea)

Assistant Professors

- Dr. Muhammad Sohail Khan PhD (South Korea)
- Engr. Imran Maqsood MSc (Pak)

Lecturers

- Engr. Muhammad Ishaq MSc (Pak)
- Engr. Fahim Ullah Khan MSc (Pak)
- Engr. Zafar Ali Shah MSc (Pak)- On study leave
- Engr. Shaharyar MSc (Pak)
- Engr. Lubna Gul MSc (Pak)
- Engr. Shabir Ahmad MSc (Pak)-On study leave

6. MASTER PROGRAM

The title of Master's degree offered in the Postgraduate Program of the Department is:

- M.Sc. Computer Software Engineering.

6.1. Specific Eligibility Criteria for Admission in M.Sc. Computer Software Engineering

Bachelor's degree (16-years of education) in Computer Software Engineering, Computer Science, Information Technology

OR

Computer Science Conversion course two years degree program (16 years of education) referred to as MCS or M.Sc. Computer Science

OR

Sixteen years education in relevant engineering program*

**NOTE: Under this category, a candidate has to complete the pre-requisite courses prior to the M.Sc. course work. The pre-requisite courses will be determined based on the core courses of B.Sc. Computer Software Engineering by the PREC*

Other eligibility criteria, applicable to all MSc programs, are mentioned in MSc Rules and Regulations Chapter.

6.2. Course Work:

The number and credit hours of mandatory and elective MSc. Courses are mentioned in the Table below:

Type of Courses	Required Courses	No. of Courses	Total Credits
Core/Mandatory	Core Courses	3	9
Electives	Elective Courses*	5	15

* To be selected from Courses within list of elective courses

7. DOCTORATE PROGRAM

Degree title: Ph.D. Computer Software Engineering

7.1. Eligibility Criteria for Admission in Ph.D. Computer Software Engineering

- Masters/MPhil or equivalent degree in the relevant field

Other eligibility criteria, applicable to all PhD programs of UET Mardan, are mentioned in PhD Rules and Regulations Chapter.

8. LIST OF COURSES

A. Core Courses

S. No.	Course Code	Course Title	Credit Hours
1	SE-601	Advanced Requirements Engineering	3
2	SE-602	Advanced Software System Architecture	3
3	SE-603	Software Testing and Quality Assurance	3

B. Elective Courses

S. No.	Course Code	Course Title	Credit Hours
1.	SE-604	Advanced Software Project Management	3
2.	SE-605	Software Measurement and Metrics	3
3.	SE-606	Component Based Software Engineering	3
4.	SE-607	Empirical Software Engineering	3
5.	SE-608	Agile Software Development Methods	3
6.	SE-609	Advanced Formal Methods	3
7.	SE-610	Advanced Human-Computer Interaction	3

8.	SE-611	Software Configuration Management	3
9.	SE-612	Software Design Patterns	3
10.	SE-613	Software Risk Management	3
11.	SE-614	Software Engineering Ontology	3
12.	SE-615	Advanced Web Engineering	3
13.	SE-616	Model Driven Software Development	3
14.	SE-617	Agent Based Modeling	3
15.	SE-618	Bio-Inspired Computation	3
16.	SE-619	Data Mining	3
17.	SE-620	Introduction to Machine Learning	3
18.	SE-621	Advanced Topics in Artificial Intelligence	3
19.	SE-622	Design and Analysis of Network System	3
20.	SE-623	Complex Networks	3
21.	SE-624	Information System Security	3
22.	SE-625	Research Methods	3
23.	SE-626	Software Case Tools & Applications	3
24.	SE-627	Data Warehousing	3
25.	SE-628	Reliability Engineering	3
26.	SE-629	Internet of Things	3
27.	SE-801	Service Oriented Software Architecture	3
28.	SE-802	Advanced Semantic based Software Engineering	3
29.	SE-803	Advanced Software Engineering Ontologies	3
30.	SE-804	Advanced Machine Learning: Theory and Methods	3
31.	SE-805	Mathematical Foundations of Machine Learning	3
32.	SE-806	Probabilistic Graphical Models in Machine Learning	3
33.	SE-807	Machine Learning Applications in Software Engineering	3
34.	SE-808	Deep Learning	3
35.	SE-809	Intelligent System Design	3

36.	SE-810	Advanced Text Analytics	3
37.	SE-811	Advanced Natural Language Processing	3
38.	SE-812	Sensor Networks	3
39.	SE-813	Advanced Computer Networks	3
40.	SE-814	Cyber-Physical Systems	3
41.	SE-815	Cyber Security	3
42.	SE-816	Advanced Information System Security	3
43.	SE-817	Advanced Data Visualization	3
44.	SE-818	Blockchain Technologies	3
45.	SE-819	Advanced Cloud Computing	3
46.	SE-820	Convex Optimization	3
47.	SE-821	Simulation and Modelling	3
48.	SE-822	Special Topics Related to Software Engineering	3

C. Thesis

S. No.	Course Code	Title	Credit Hours
1	SE-799	M.Sc. Thesis	6
2	SE-899	Ph.D. Thesis	36

9. COURSE CONTENTS

SE-601 Advanced Requirements Engineering

Software Requirements Fundamentals: Product and process requirements, Functional and non-functional requirements, Emergent properties, Quantifiable requirements, System and software requirements. Requirements Process: Process models, Process actors, Process support and management, Process quality and improvement. Requirements Analysis: Requirements sources, Elicitation techniques. Requirements Analysis: Requirements classification, Conceptual modeling, Architectural design and requirements allocation, Requirements negotiation, Formal analysis. Requirements Specification: System definition

document, System requirements document, Software requirements specification. Requirements Validation: Requirements reviews, Prototyping, Model validation, Acceptance tests. Practical Considerations: Iterative nature of the requirements process, Change management, Requirements attributes, Requirements tracing, Measuring requirements. Software Requirements Tools. Current research topics in requirement engineering.

SE-602 Advanced Software System Architecture

Quality attributes in the context of architecting. Qualitative and quantitative assessment of architectures. Architectural modeling through Architecture Description Languages. System modeling its relation to software architecting. Architecting for evolution and variability. Partitioned and layered architectures. System-of-Systems and Ultra-Large Scale Systems. Software Product Lines and Configurable Software. Self-Adaptive Software. Architectural Description Languages. Feature Modeling. Architecture and Model-Based Testing. Current research topics in software system architecture.

SE-603 Software Testing and Quality Assurance

Testing techniques. Black Box testing, White Box and Grey Box testing techniques. Quality Assurance planning and execution. Automated testing topics include constructing a framework, scripting techniques, generating a test data, generating test architecture, pre/post-processing, test maintenance, and job specific metrics. Current research topics in Software Testing and Quality Assurance.

SE-604 Advanced Software Project Management

Introduction to project management. Algorithmic cost estimation models. Advanced cost estimation models. Function points estimation Risk assessment. Life cycle models. Prototyping. Management of software reuse. Software maintenance. Software maturity framework. An Overview of Project Planning. Program Management and Project Evaluation. Software Effort Estimation. Activity Planning. Risk Analysis and Management. Resource Allocation. Project tracking and Control. Contract Management. Software Quality Assurance. Configuration Management. Various tools of Software Project Management. Project Cost Management. Project Human Resource Management. Project Communications Management. Project Procurement Management. Case studies, Current research topics in Software Project Management.

SE-605 Software Measurement and Metrics

Introduction to quality control and planning needs (Measurement Concepts, Measurement as a support process, Review Metrics Models and Standards). Measurement goals (Formulating problem and goal statement, prioritize information needs and objectives, Formalize measurement goals). Specify Measures (Identify questions and indicators, Identify data elements, Operational definitions for measures). Specify Data Collection and Storage Procedures. Sources of data. How to collect and store the measurement data? Specify Analysis Procedures. Potential data analyses. Methods and tools for measuring software. Develop software measurement reporting. Current research topics in Software Measurement and Metrics.

SE-606 Component Based Software Engineering

Introduction to Software Component (Component. Definition and Essentials, what is CBSE? Why CBSE? The Anatomy of Components: internals, application interfaces, platform interfaces, middleware, Component Characteristics: Properties of Software Component in CBSE). Basic Concepts in CBSE (Improving SW through Software Process Improvement (SPI)), Component-Based Software Development (CBSD). Approach. Component Patterns & Abstraction. Challenges of CBSE. Technical Issues and Objectives of Component Based Software Engineering. Reuse Dimensions. Software Components Types: open, closed, COTS, in house. Challenges in Software Reuse. Software Component Specification. Specification Techniques. Specifying the Semantics of Components. Specifying Extra-Functional Properties. Architecting component based systems (Software Architecture Parts, The Roles of Software Architecture, Designing Software Architectures, Architectural Styles, Architecture-Driven Component Development, Components and Component Models, Component Model Implementation, Component Frameworks, Black-Box and White-Box Frameworks, how do we use Framework in CBSE? Component Interface Specification). Component Engineering Process: Domain Engineering, Domain Engineering pattern based design. Domain Engineering: Component Repositories, Overview of Existing Component Techniques, Component testing in CBSE. Current research topics in Component Based Software Engineering.

SE-607 Empirical Software Engineering

Quantitative study design. Qualitative study designs. Measurement and data collection. State-of-the practice. Archival data analysis. Human variation & impact of experience. Evidence-based software engineering. Simulation of software process. Current research techniques in Empirical Software Engineering.

SE-608 Agile Software Development Methods

Agile values and principles. Agile Practices. Pair programming Refactoring. Test-driven development. Continuous integration and delivery. Automated build. Coding standards simplicity. SMART user stories and release and deployment. Applying Agile methods: Integration, XP+SCRUM, SCRUM +Kanban, Agile methods +User-Centered Design. Distributed Agile teams. Current research topics in Agile Software Development.

SE-609 Advanced Formal Methods

Introduction to formal methods and specification. State-Based Formal Methods. Transformational systems. Traditional approaches. Z specification. Formal development cycle. Temporal Specification: reactive systems, syntax and semantics of temporal logic, temporal specification of reactive systems (safety, aliveness, fairness). Model Checking: Generating finite models, Analysis of a simple model checking algorithm. Symbolic model checking. Overview of reduction methods. Spin and Promela. Case study and practical verification of properties. Current research topics based on Formal Methods.

SE-610 Advance Human-Computer Interaction

Introduction to HCI. Importance of usable and useful software products. The theories of HCI. How to evaluate/develop software products. How to apply theoretical results from HCI research to software products. How to conduct their own research about aspects of usability and user experience, Concepts of Human Computer Interaction. The psychology of usable things. Usability Engineering. Prototypes. Usability inspection methods. Usability testing methods. Usability in practice. User Experience (UX). Web Usability. Mobile Usability. Mobile User Experience. Site objectives and user needs. Information architecture. Information and navigation design. Implementation and optimization. Experiments and HCI guidelines. Current research topics in Human-Computer Interaction.

SE-611 Software Configuration Management

Management of the SCM Process. Organizational Context for SCM. Constraints and Guidance for the SCM Process. Planning for SCM. SCM Plan. Surveillance of Software Configuration Management. Software Configuration Identification. Identifying Items to Be Controlled. Software Library. Software Configuration Control. Requesting, Evaluating, and Approving Software Changes. Implementing Software Changes. Deviations and Waivers. Software Configuration Status Accounting. Software Configuration Status Information. Software Configuration Status Reporting. Software Configuration Auditing. Software Functional Configuration Audit. Software Physical Configuration Audit. In-process Audits of a Software Baseline. Software Release Management and Delivery. Software Building. Software Release Management. Software Configuration Management Tools. Current research topics in Software Configuration Management.

SE-612 Software Design Patterns

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.

SE-613 Software Risk Management

What is risk and risk management? Motivation for risk management. Reasons we don't do risk management. SEI's Risk Management paradigm. Identifying and recording software risk. Risk Taxonomy. Tools and methods for identifying and recording risks. Analyzing and classifying risks. Complex project management theory. Software Risk Identification. Software Risk Analysis. Software Risk Planning. Software Risk Monitoring. Software Qualitative Risk Analysis. Quantitative Risk Analysis. Risk management and the SDLC. Risk management in CMM. Other useful tools for successful risk management. Current research topics in Software Risk Management.

SE-614 Software Engineering Ontology

Ontology Engineering: Principles, Methods, Tools, and Languages. Using Ontology 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.

SE-615 Advanced Web Engineering

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 PHP and MySQL.

SE-616 Model Driven Software Development

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.

SE-617 Agent Based Modeling

Introduction to agent based modeling. Introduction to Net Logo. Complexity in Social Worlds. Net Logo Commands. Net Logo Procedures. Model properties (Why agent-based objects? Agents, environments, and timescales). Biological systems: fireflies, flocking, slime mold, bees, ants (flocking behavior slime mold). Biological systems: predator/prey, debugging (Verification and validation). Social systems: segregation, Schelling, Micro motives and Macro behavior. A self-forming neighborhood model. Cellular automata. Critical phenomena. Sand piles. Current research topics in Agent Based Modeling.

SE-618 Bio-Inspired Computation

Introduction to bio-inspired computation, Conventional and un-conventional programming, Evolutionary Computation, Evolutionary Strategies and Evolutionary Programming, Genetic Algorithms and Genetic Programming, Genetic Algorithms Methods and implementation, Mutation and Cross Over, Genetic Encoding, Fitness Landscape, Selection Methods, Cartesian Genetic Programming, Ants Colony Optimisation, Swarm Intelligence, Co-evolution, Evolutionary Development.

SE-619 Data Mining

Introduction: Machine Learning and Data Mining, Data Flood, Data Mining Application Examples, Machine Learning and Classification Examples, Input: Concepts, instances, attributes, Preparing the data, Decision tables, Decision trees, Decision rules, Rules involving relations, Instance-based representation. Classification - Basic methods, Decision Trees, Handling Numeric Attributes, Finding Best Split, Dealing with Missing Values, Pruning, Pre-pruning, Post-Pruning, Estimating Error Rates, From Trees to Rules, Regression, Evaluation and Credibility, Data understanding, Discretization, False predictors, Feature reduction, Randomization, Learning with unbalanced data, Clustering, Associations, Visualization, Summarization and Deviation Detection, Predicting Performance, Bootstrap, Choosing a Loss Function.

SE-620 Introduction to Machine Learning

Introduction, Supervised Learning: Deep Networks, Unsupervised Learning: Clustering, K-Means, Mixture of Gaussians, Expectation Maximization, Principal Component Analysis, Kernel Machines: Convex Optimization, SVM, Gaussian Processes, Latent Space Models: Independent Component Analysis, Graphical Models: HMM, Markov Chain, Monte Carlo Methods, Computational Learning theory: Risk Minimization, VC Dimension, Big data and Scalability, Manifold Learning

SE-621 Advanced Topics in Artificial Intelligence

The contents of this course will be developed by the instructor based on emerging trend and active research in the area of Artificial Intelligence.

SE-622 Design and Analysis of Network Systems

Basic Concepts in Networking Protocols and Layers, process to process lifetime of a packet in network, Example Networks and Network Components, Introduction to Network Analysis, Architecture, and Design, Network Requirements Analysis: Concepts, Network Requirements Analysis: Process, Flow Analysis, Network Architecture, Addressing and Routing Architecture, Network Management Architecture, Performance Architecture, Security and Privacy Architecture, Selecting Technology for the Network Design, Interconnecting Technologies with the Network Design.

SE-623 Complex Networks

Introduction to complex networks. What is a complex system? Basic metrics. Degree distribution (DD). Clustering coefficient (CC). Centrality. Page Rank. Hubs and authorities. Bib-coupling. Co-citation index. Edge reciprocity. Rich club phenomenon. Social Network. Homophily. Cohesiveness. Equivalence of ties. Ego-centric networks. Community Structures. Hierarchical Agglomerative. Linear algebra techniques and spectral methods. Citation Networks, Rise and fall of CS fields. Inter-disciplinarily of CS fields. Temporal structures of citation profiles. Citation count prediction. Co-authorship circles. Economic and financial network analytics. Graph mining. Measuring user engagement. Basic definitions and metrics: walks, paths, cycles, connectedness, trees. The clustering coefficient. The World Wide Web. Scale-free networks. Random graphs with a given degree sequence. The Barabasi-Albert model and other models of growing graphs. Degree correlations. The Internet and other assortative and disassortative networks.

Community structures: spectral bisection and hierarchical clustering methods. The modularity and Girvan-Newman algorithm. Current research topics in Complex Networks.

SE-624 Information System Security

Security Introduction, Cryptography, Essential Security Concepts, Trusted Systems and Security Models, Authentication, Kerberos, Availability, DoS Attacks ATM Networks – Performance and Attacks, IP Network Performance – QoS and DoS, Key Management for Secure Networks, Security Protocols, Biometrics, TEMPEST, Student final project “presentations”.

SE-625 Research Methods

Introduction to Research. Objectives of Research. Importance of Research Methodology in Research Study. Types of Research. Steps in Conducting Research. What is Literature Review? Need of Literature Review. Types of Literature Review. Systematic Literature Review Protocol. Problem Statement and Problem formulation. Criteria for selecting a problem. Identifying Types of variables in Research. Types of hypothesis. Identifying Target Population. Types of Sampling. Sampling Techniques. Quantitative Research Methods. Scientific Methods. Design of Quantitative Surveys. Techniques to Conduct Quantitative Methods. Introduction to Qualitative Research. Qualitative Research Methods. Data Analysis and Theory in Qualitative Research Articles. Introduction to Mixed Methods Research. Design of Mixed Methods Research. Evaluation of Mixed Methods Research. Case Study. How to Conduct a Case Study. Case Study Protocol. Importance and Benefits of Case Study. Types of Statistical Tests to Conduct Data Analysis. Data Analysis Tools. Introduction to SPSS. Hands on Practice of SPSS. How to Define variables in SPSS. How to Record Collected Data in SPSS. Types of Tests via SPSS including Regression. Correlation. Cross tabulation and others. How to write Good Research Proposal. Contents of Thesis. Important Elements of Research Thesis.

SE-626 Software Case Tools & Applications

The students will be appraised of; Case tools & techniques, CASE in software development process, Traditional CASE methodologies, Emerging CASE methodologies, OO Design, Specific CASE tools, specialized design tools, Managing CASE methodologies. As part of course, students will be assigned a real life problem for development through CASE tools.

SE-627 Data Warehousing

DW fundamentals, need for a DW, decision support vs. transaction processing, evolution of a DW. Business requirements as the driving force for the DW, matching information to classes of users. Dimensional modeling. Architecture and Infrastructure, data extraction, transformation and loading, data quality. Selected de-normalizations, horizontal and vertical partitioning, materialized views, Physical design, Data mart design, web data warehousing. Current topics in data warehousing.

SE-628 Reliability Engineering

Introduction to Reliability Engineering. The Need for Reliable Software. Software Reliability Engineering Concepts. Basic Definitions. Software Reliability and System Reliability. The Dependability Concept. Reliability Modeling. Availability Modeling. Statistical Reliability Models for Software Reliability. Best Current Practices of software Reliability Engineering. Software Metrics for Reliability Assessment. Software Testing and Reliability. Software Reliability Tools. Review of Reliability Theory. Analytical Techniques and Basic Statistics for Reliability Engineering. Current research topics in Reliability Engineering.

SE-629 Internet of Things

Internet of Things Promises–Definition– Scope–for IoT Applications, Structure of IoT– Introduction to Cloud, Edge and Fog Computing. IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations. M2M and IoT Technology Fundamentals- Basic Electrical and Electronics Concepts, Devices-> Most common Sensors and Actuators. Discussion on current applications of IoT vision, Most common platforms i.e. ThingSpeak, AndroidThings, Xively, Samsara, etc. IoT development platform such as Arduino, Edison & Raspberry Pi. Characteristics, Architecture, Sensing & Actuating devices and Programming tutorials. Implementations using Arduino platform and completion of a term project based on IoT applications.

SE-801 Service Oriented Software Architecture

Introduction to Service-Oriented Architecture, Service Principles, Web Systems Evolution, Web Systems Architecture, HTML / XML / JSON, HTTP, JavaScript, Remote Procedure Call (RPC), Object Brokers. Introduction to Web Services, Service Invocation (SOAP), Service Description (WSDL), Service Publication and Discovery (UDDI), Service Composition (BPEL), RESTful Web Services, Introduction to REST, designing a REST Service, Micro-services, Cloud Services, Security of cloud services, Secure data handling & Avoiding Injection Attacks, Applications of Service Oriented Architecture, Software as a service (SaaS), Infrastructure as a Service (IaaS), Platform as a service (PaaS), IaaS vs PaaS. New trends in Service Oriented Architecture.

SE-802 Advanced Semantic based Software Engineering

Introduction to Semantic Web architecture, knowledge representation techniques, ontology design constraints, Web Ontology Language (OWL), Software Engineering Body of Knowledge (SWEBOK) from semantic web technologies' perspective, analysis of existing implementations in various fields of studies which are related to software design processes.

SE-803 Advanced Software Engineering Ontologies

The technical architecture of the Semantic Web, Web Ontology Language (OWL) and inferencing, Software Engineering Body of Knowledge (SWEBOK), common ontology design patterns, sharing of ontologies, Existing Shared Ontologies (e.g. FOAF, DC, SKOS etc.), enterprise integration, Ontology

alignments, Survey of existing software engineering ontologies and their analysis by integrations/alignments.

SE-804 Advanced Machine Learning: Theory and Methods

Statistical Decision Theory: Decision Theory Principles and Paradigms, Bayesian Analysis, Minimax Analysis, Statistical Complexity: Empirical Risk Minimization and Decision Theory, Tail Bounds, complexity measures, Sparse Linear Models, Computational Complexity: Optimization and Statistical Complexity, Intro to Computational Complexity, Prediction

SE-805 Mathematical Foundations of Machine Learning

Introduction to key mathematical concepts for machine learning, Binary classification, Gradient Descent, matrix methods and statistical models and features real-world applications ranging from classification and clustering to denoising and recommender systems. Mathematical topics covered include linear equations, regression, regularization, the singular value decomposition, iterative optimization algorithms, and probabilistic models. Machine learning topics include the LASSO, support vector machines, kernel methods, clustering, dictionary learning, neural networks, and deep learning.

SE-806 Probabilistic Graphical Models in Machine Learning

Introduction, Bayesian belief networks (directed graphical models), Markov Random Fields (undirected models), Dual decomposition and NLP applications, Conditional random fields, Exact inference, LP relaxations for MAP inference, Variational inference, Learning (Bayesian networks, unobserved data, EM, Markov networks)

SE-807 Machine Learning Applications in Software Engineering

Introduction to Machine Learning and Software Engineering, ML Applications in Prediction and Estimation, ML Applications in Property and Model Discovery ML Applications in Transformation, ML Applications in Generation and Synthesis, ML Applications in Reuse, ML Applications in Requirement Acquisition, ML Applications in Management of Development Knowledge.

SE-808 Deep Learning

The course will cover a range of topics from basic neural networks, convolutional and recurrent network structures, deep unsupervised and reinforcement learning, and applications to problem domains like speech recognition and computer vision.

SE-809 Intelligent System Design

Introduction to Intelligent Systems, Adaptation, Learning, Memory Development, Instinctive Behavior, Artificial Neural Network (ANNs), History of ANN, Mode of Operation, Learning rules, History of ANN, Mode of Operation, Training of ANNs, Back propagation, Types of Neural Networks, Kohonen Self Organizing Maps, Hopfield Networks, Spiking Neural Networks (SNN), Heb's Rule, Spiking time dependent

plasticity networks, Neuro-Evolution, Topology and Weight evolutionary ANNs), Neuro-evolution of Augmented topologies, Neural development.

SE-810 Advanced Text Analytics

Overview of the language processing, sentiment analysis, opinion mining, topic modelling, pre-processing techniques, reviewing NLP techniques, text semantics, semantic tools, evaluation of tools, analysis of text mining tools and their critical review in terms of accuracy, analysis of frameworks, practices of machine learning methods in text mining processes.

SE-811 Advanced Natural Language Processing

Introduction to natural language processing from a computational perspective. Machine learning in NLP, syntactic, syntactic parsing, information retrieval, summarization semantics, lexical semantics, NLP processes and their analysis, NLP tools and their critical review.

SE-812 Sensor Networks

Overview of wireless sensor networks (WSNs), applications of WSNs in various domains, WSNs technologies and systems, MAC protocols design issues, clustering, path finding, routing protocols design issues, transport protocols for WSNs, scalability issues in WSNs, operating systems for WSNs, network management, simulation tools for WSNs protocols design.

SE-813 Advanced Computer Networks

Network design principles, Wireless Networks: Fundamentals, Wireless Networks Technologies: Bluetooth, 802.11, Cellular, Wireless mobility, Wireless TCP, High Performance Networking, Datacenter Fabric, Network Virtualization, Networking Virtual Machines, Datacenter TCP, Switching, Queuing Models, General characteristics of graphs, shortest path problem, efficiency of multicast, hop count to anycast, TCP/IP applications and services, performance analysis, protocol modelling, asymmetric networks and protocol modelling, new TCP/IP standards and flavors.

SE-814 Cyber-Physical Systems

Modeling Cyber-Physical Systems, Discrete-Time Systems Concepts, Continuous-Time Concepts, Continuous-Time Model of Linear Time-Invariant Systems, Modeling Cyber Components: Finite State Machines, Computations, Algorithms, Sample Cyber-Physical System Models, Modeling Interfaces for Cyber-Physical Systems: Conversion, Networks, and Complete CPS Models, Analog to Digital Conversion, Digital to Analog Conversion, Simulation of an Analog to Digital Converter, Modeling an Implemented Finite-State Machine, Simulating an Implemented Finite State Machine, Trajectories in CPS and Simulations: Time Domains, Executions, and Complete CPS Models, CPS and Context aware applications, IoT implementations, RFID systems, Wireless Sensor Network Architecture.

SE-815 Cyber Security

Cyber risk assessment and mitigation strategies, situation analysis, cyber ethics and cyber forensics, penetration testing and ethical hacking, cyberattacks on computer systems, network and cloud infrastructure, generic and protocol-specific cyberattacks, security in IoT, critical infrastructure protection, secure software design, blockchain, cybersecurity of blockchain technology and cryptocurrencies, cyber crimes and law, emerging topics in cyber security.

SE-816 Advanced Information System Security

Course introduction, basic hardware, software, Internet, information security vulnerability and risk management, access control management, software development security, business continuity and disaster recovery planning, cybercrimes and legal aspects of information security, regulations, information warfare, operation security, physical and environmental security, security architecture and design.

SE-817 Advanced Data Visualization

Visualization essentials, visual application, analysis of various types of charts, interactive visualizations, structures, relations, links, state of the art visualization tools, evaluation of the tools in different perspective, automated design.

SE-818 Blockchain Technologies

Bitcoin & Blockchain, Blockchain Structure, Basic Operations, Beyond Bitcoin, Ethereum Blockchain: Smart Contracts, Processing Smart Contracts (Compilation), Deploying Smart Contracts, Best practices in Designing and Evaluating Smart Contracts, Ethereum Structure, Ethereum Operations, Decentralized Applications (Dapps): Blockchain Server, Ethereum APIs, Application Models & Standards: Dapp Models, standard ERC 20 for token Dapps and ERC 721 for non-fungible tokens, Incentive Model, Algorithms & Techniques: Public-Key Cryptography, Hashing, Transaction Integrity, Securing Blockchain Trust Essentials: Decentralized Systems, Consensus Protocol, Decentralized Governance, Robustness, Forks, Blockchain Platforms, Permissioned Blockchains, Hyperledger, Fabric Services, Fabric Model & Functions, Composer, Microsoft Azure. Efforts towards open-source blockchain technologies and its impacts.

SE-819 Advanced Cloud Computing

Cloud computing architecture: infrastructure, platforms and software, cloud platform components for processing and storage, resource management in cloud, virtual machines, scalability issues in cloud, cloud computing case studies, fog and edge computing, simulation tools for cloud and edge computing.

SE-820 Convex Optimization

Convex sets, functions, and optimization problems. Basics of convex analysis. Least-squares, linear and quadratic programs, semidefinite programming, minimax, extremal volume, and other problems. Optimality conditions, duality theory, theorems of alternative, and applications. Interior-point methods. Applications to various fields.

SE-821 Simulation and Modelling

Basic aspects of modelling and simulation, Simulation process / models and systems, statistical problems related to simulation, discrete and continuous simulation modelling, applications of simulation, introduction to ARENA modelling framework, network modelling, Basic process modules, modelling detailed operations, making decision with simulation, process modelling, advanced modelling techniques, OpQuest for ARENA, costing and animation

SE-822 Special Topics Related to Software Engineering

SE-799 M.Sc. Thesis (6 Credit Hours)

SE-899 Ph.D. Thesis (36 Credit Hours)

DEPARTMENT OF TELECOMMUNICATION ENGINEERING

1. INTRODUCTION

The field of Telecommunication Engineering is evolving rapidly with new technological standards introduced with the passage of time. Look back 20 years in the past, when very few of us had a mobile phone, our internet connection, in general, was as powerful as required by the then text based websites and when none of us could be a part of any social networks. However, technological evolution in the field of Telecommunication has unknowingly changed our lifestyle. We now have access to powerful computational machines in the form of mobile, handhelds bundled with user friendly software applications that are designed for any imaginable application scenario. Most of us now spend more time in the world of virtual social networks. Our forms of expressions are just a click away through online blogging and YouTube. We are emerging into an age where we are connected 'Any Time, anywhere' through mobile networks. The demand for high-speed connectivity, live streaming, online video conferencing, e-Learning and distance education, online jobs can be fulfilled after the realization and deployment of next generation of mobile and wireless communication technologies such as 5G and beyond.

Looking at where we are now, from engineering point of view, simply reflects the ground-breaking inventions achieved through research in the field Telecommunication Engineering. Department of Telecommunication Engineering is offering BSc. degree since 2002 while the MSc and PhD programs were started in 2012 and 2013, respectively. Telecommunication Engineering encompasses a wide range of topics in line with the latest curriculum of Higher Education Commission (HEC) of Pakistan and the constantly evolving market trends.

2. DEPARTMENT MISSION

The mission of the telecommunication engineering department is to produce a workforce of outstanding professionals having up-to-date knowledge, technical and interpersonal skills and problem-solving abilities to improve the economic well-being and up-lifting of the society.

3. WHY YOU SHOULD STUDY MSc. Or PhD. in TELECOMMUNICATION ENGINEERING?

Looking ahead in the near foreseeable future, we cannot think of any sector of the society where communication technologies will not have a vital role to play. From healthcare, governance, education, administration to agriculture and finance it is going to be the communication technologies that will define the future modus operandi of those business processes. As a matter of fact, the demand for skilled human resource will increase as the pace and scope of the communication technologies will grow. In line with the foreseeable future requirements of the Telecommunication Industry and all related fields that demand highly skilled Telecommunication Engineers, the Telecommunication Engineering Department provides tailored-fit MSc, and PhD programs. Graduates can expect career opportunities in a wide range of engineering sectors including mobile and telecom industry, telecom regulatory authorities, frequency

allocation board, banking, gas exploration and distribution companies, R & D organisation and education and energy sectors, etc. Telecom engineering graduates are particularly well-suited to work as members or leaders of telecom and multi-disciplinary teams.

The Objectives of Telecommunication Engineering Department are formulated to harness most of these challenges and strategies are formulated to incorporate all the required skills into our program.

4. RESEARCH PROJECTS

The Department of Telecommunication Engineering is at the forefront of innovation and excellence in Engineering through consistent and expanding research. Our faculty members have successfully collaborated with the local and international Industry to design Engineering solutions for our local problems. Some of the outstanding projects are discussed below:

- The department received a research grant of Rs. 25.5 million from the ICT R&D Fund Islamabad, for the project called 'Crop Estimation and Geographic Mapping System (CEGMaS). Project CEGMaS focused on identification and classification of tobacco crop and its seven species through the use of advance image processing techniques over Hyperspectral satellite imagery providing tobacco crop yield estimates to various stakeholders of the Tobacco Industry and the Government's regulatory bodies. CEGMaS was a collaborative research project with the Pakistan Space & Upper Atmosphere Research Commission (SUPARCO).
- An MoU was signed in 2018 by the Department and North Western Polytechnic University (NWPU), which provided opportunities for collaborative Postgraduate Research and Student placement/exchange program
- Some projects have matured into commercial applications and products, such as MySmartRemote (<http://pk.mysmartremote.com/>).

5. RESEARCH AVENUES

- Antenna Design
- Radio Propagation & Modelling
- Radio Meteorology
- 5G and MIMO Technologies
- Acoustics
- Laser Ultrasonics & Non-Destructive Testing
- Metamaterials and Metasurfaces
- Mobile and Satellite Communication
- Signal and Information Processing
- Image and Video Processing
- Microwave and Millimeter Wave Engineering
- Plasmonic, Optical and THz Communications
- Cooperative and Cognitive Communication Networks

- Multimedia Forensics & Communication
- Super resolution imaging
- Routing protocols in WSN and Optimization Techniques

6. FACULTY

Chairman

Prof. Dr. Sadiq Ullah PhD (UK)

Advisor Postgraduate Studies (APGS)

Dr. Toufeeq Ahmad PhD (China)

Professors

Dr. Sadiq Ullah PhD (UK)

Assistant Professors

Dr. Naveed Mufti PhD (UK)

Dr. Toufeeq Ahmad PhD (China)

Engr. Jalal Khan MSc (UK)

Engr. Shagufta Naz MSc (Pak)

Engr. Abid Jan MSc (Pak) on Study leave

Lecturers

Dr. Sahib Khan PhD (Italy)

Engr. Sajjad Ali MSc (Pak) on Study leave

Engr. Humaira Rehman MSc (Pak)

Engr. Usman Ali MSc (Pak)

Engr. Wasi Ur Rehman Khan MSc (Pak)

Engr. Latifullah Khan MSc (Pak) on Study leave

7. MASTER'S DEGREE

The title of Masters degree offered in the Postgraduate Program of the Department is:

- M.Sc. Telecommunication Engineering

7.1. Eligibility Criteria for Admission in MSc. Telecommunication Engineering

Candidates seeking admission must have a Bachelor's Degree (16 years of education) in a relevant discipline (i.e. BSc. In Telecommunication or BS Telecommunication or BSc in Electrical, Electronics, Avionics, Computer/Computer Systems Engineering or equivalent) from a program accredited by Pakistan Engineering Council (where necessary) and/or programs recognized by the Higher Education Commission (HEC) of Pakistan.

Other eligibility criteria, applicable to all MSc programs, are mentioned in MSc Rules and Regulations Chapter.

7.2. Details of Courses for MSc. in Telecommunication Engineering

The number and credit hours of mandatory and elective MSc. Courses are mentioned in the Table below:

Type of Courses	Required Courses	No. of Courses	Total Credits
Core/Mandatory	Core Courses	4	12
Electives	Domain Elective Courses*	3	9
	General Elective Course**	1	3

* To be selected from Courses within list of domain elective courses

** To be selected from Courses within list of general elective courses

8. DOCTORATE DEGREE

The title of the ‘Doctor of Philosophy’ degree offered is:

- PhD. Telecommunication Engineering.

8.1. Eligibility Criteria for Admission in PhD. Telecommunication Engineering

For admission into the PhD, minimum Master’s Degree (18 years of Education) in Telecommunication/ Electrical/Electronics/Avionics/Computer/Computer Systems Engineering or equivalent, recognized by the HEC, will be required.

Other eligibility criteria, applicable to all PhD programs, are mentioned in PhD Rules and Regulations Chapter.

9. List of Courses for MSc and PhD in Telecommunication Engineering

9.1. List of Mandatory/Core courses

S.No.	Course Code	Course Title	Credit Hours
1)	TE-600	Advanced Antenna Design	3
2)	TE-620	Advanced Digital Signal Processing	3
3)	TE-640	Advanced Digital Communication	3
4)	TE-660	Advanced Telecommunication Systems & Networks	3

9.2. List of Elective courses

i. List of Domain Elective Courses

S.No.	Course Code	Course Title	Credit Hours
1)	TE-601	Advanced Engineering Electromagnetics	3
2)	TE-602	Advanced Wireless Communications	3
3)	TE-603	Advanced Satellite Communication	3
4)	TE-604	Advanced Mobile Communication	3
5)	TE-605	Advanced Radar Engineering	3
6)	TE-606	Microwave Active Devices	3
7)	TE-607	RF Circuit Design	3
8)	TE-800	Free Space Optical Communication	3
9)	TE-801	Microwave Filters	3
10)	TE-802	Monolithic Microwave Integrated Circuit (MMIC) Technology and Design	3
11)	TE-803	Metamaterials and Nano Photonics	3
12)	TE-804	Adaptive Antennas and Phased Arrays	3
13)	TE-805	Body Centric Communications and Sensing	3
14)	TE-806	RF Energy Harvesting and Wireless Power Transmission	3
15)	TE-621	Transforms in Signal Processing	3
16)	TE-622	Advanced Digital Image Processing	3
17)	TE-623	Speech Processing	3
18)	TE-624	Multimedia Communications	3
19)	TE-625	Compressed Sensing and Applications	3
20)	TE-820	Adaptive Filter Theory	3
21)	TE-821	Real-Time DSP	3
22)	TE-822	Array Signal processing	3
23)	TE-823	Multimedia Forensics and Security	3
24)	TE-641	Detection and Estimation Theory	3
25)	TE-642	Information and Coding Theory	3
26)	TE-643	Advanced Computer Networks	3
27)	TE-840	Advanced Information and Coding Theory	3
28)	TE-841	Advanced Network Security	3
29)	TE-842	Radio Network Planning and Optimization	3

30)	TE-843	Cellular Network Planning and Optimization	3
31)	TE-661	Stochastic Processes	3
32)	TE-662	Broadband Communication	3
33)	TE-663	Advanced Optical Communication Systems	3
34)	TE-664	Optical Networks	3
35)	TE-665	Network Optimization	3
36)	TE-666	Network Planning and Management	3
37)	TE-667	Telecom Management Network	3
38)	TE-860	Optimization Techniques	3
39)	TE-861	Teletraffic Engineering	3
40)	TE-862	Wireless Sensor Networks	3
41)	TE-863	Next Generation Networks	3
42)	TE-864	Mobile Ad-hoc Networks	3
43)	TE-865	QoS in Telecommunication Networks	3
44)	TE-866	Advanced Intelligent Networks	3
45)	TE-867	Smart Grid Networks	3
46)	TE-898	Special Advanced Topics related to Telecommunication Engineering	3

ii. **List of General Elective Courses**

S.No.	Course Code	Course Title	Credit Hours
1)	TE-680	Research Methodology	3
2)	TE-681	Simulation and Modeling	3
3)	TE-682	Telecom Regulation and Standards	3
4)	TE-683	Telecom Planning and Management	3
5)	TE-684	Cloud and Grid Computing	3

9.3. Thesis

S.No.	Course Code	Course Title	Credit Hours
1)	TE-799	M.Sc. Thesis	6
2)	TE-899	Ph.D. Thesis	36

10. COURSE CONTENTS

TE-600 Advanced Antenna Design

Review of fundamentals antennas and their performance matrices, Design of Wired and Aperture Antennas, Design and Analysis of Patch Antennas, High-gain Phase array antennas, design and analysis of multi-band antennas, reconfigurable antennas, Beam-Steering Millimetre Wave (mmW) Antennas, 5G antennas (mmW and Sub-6 GHz), THz and Optical Antennas, Smart Antennas, Antennas with reduced

mutual coupling, Broadband and Frequency Independent Antennas, Metamaterial Based High-Performance Antennas, Wearable and Textile Antenna design, Design and Synthesis of Antennas for Special Applications, Antenna Simulations in CST MWS/HFSS/ADS and Antenna Measurement Techniques.

TE-620 Advanced Digital Signal Processing

Sampling of continuous-time signal and sampling rate conversion, Solution of difference Equations using different time-domain techniques, 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, 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 as a numerical approximation problem, transformation techniques for the design of IIR filters, FIR filter design by windowing, definition and properties of the discrete Fourier series, Discrete Fourier Transform (DFT) and its properties, application to linear convolution. Computation of the DFT: most commonly used Fast Fourier Transform (FFT) algorithms (radix-2, decimation- in- time, decimation in frequency, etc.) , Short-Time Fourier transform, Wavelet transform, Multi-rate signal processing systems

TE-640 Advanced Digital Communication

Introduction, Mathematical models for communication channels, Review of probability theory, Review of stochastic processes, Mathematical models for information sources, Entropy and mutual information, Lossless data compression, Coding for discrete sources, Huffman coding and adaptive Huffman coding, Run-length coding, Arithmetic coding, The context weighting algorithm, The Lempel-Ziv algorithm, Grammar-based coding, Yang-Kieffer algorithms, Lossy data compression, Rate distortion function, Scalar quantization, Vector quantization, Communications with AWGN Interference, Probability of Error for various digital modulation methods, Comparison of digital modulation methods, Channel Capacity and Coded Modulation, Block and Convolutional Channel Codes, Convolutional codes, Trellis Coded Modulation.

TE-660 Advanced Telecommunication Systems & Networks

The rationale behind this course is to provide the student with an understanding of the evolution of telecommunication systems and networks from traditional Public Switched Telephone Network (PSTN), through the emergence of data networks, local area networks, integrated services digital network (ISDN), broadband ISDN, development of fast packet switching, to the Internet. An overview on the Role of Telecommunications in Developing Countries, Telecommunications Organizations, Telecommunication Standardizations and Services is also provided.

TE-601 Advanced Engineering Electromagnetics

Maxwell's Equation & Review of Electromagnetic Theory, circuit field relations, time harmonic electromagnetic fields, material properties, wave equation and solution, reflection and transmission of multiple interfaces, auxiliary vector potential, construction of solution, radiation and scattering equations, electromagnetic theorems and principles, Scattering, Greens Function, Radio wave propagation in stratified media, Analysis of Electromagnetic Behaviour of Fundamental Engineered Materials/devices in CST MWS/HFSS/ADS.

TE-602 Advanced Wireless Communications

Radio wave propagation, Physical modeling for wireless channels, Path loss and Shadowing, outage probability under path loss and shadowing, time and frequency coherence, Statistical multipath channel models, narrowband fading models, wideband fading models, Discrete-time model, Space-time channel models, channel capacity, capacity of flat fading channels, channel distribution Information known at transmitter or receiver and both capacity comparisons, Capacity of frequency selective fading channels-time invariant- time variant, SNR and bit/symbol energy, error probability for BPSK, QPSK, MPSK, MPAM, MQAM, Index Modulation over fading channels. Error probability for FSK and CPFSK, error probability approximation for coherent modulations and differential modulation, Q-function representation, outage probability, average probability of error, inter symbol interference, selection combining (SC), threshold combining, maximal ratio combining (MRC), equal gain combining (EGC), channel known at the transmitter, channel unknown at the transmitter, Alamouti scheme, moment generating functions(MGF) in diversity analysis, diversity analysis using MGF for SC-EGC-MRC, diversity analysis for non-coherent and differentially coherent modulation, equalizer noise enhancement, equalizer types, zero forcing equalizer, MMSE equalizer, maximum likelihood sequence estimation, decision feedback equalization, adaptive equalizers.

TE-603 Advanced Satellite Communication

Review of Electromagnetics & Propagation, Satellite Systems Planning, Link budgets, Coding and error correction, Modulation and demodulation, Access schemes and protocols, Orbitology, Acquisition and tracking, Payload design and advanced Payload Concepts, Deep space missions, Antenna theory, High throughput satellite systems, Radio resource management of Satellites, Satellite Networking fundamentals, IP over satellite, Digital Broadcasting, Cost, schedule, and mission lifetime versus revenue.

TE-604 Advanced Mobile Communications

Introduction to Cellular Mobile Radio Background and History, The Mobile Radio Environment, Diversity Schemes and Combining Techniques, Diversity Schemes and Combining Techniques, Cellular Traffic, The Analog Cellular Environment, Fading Channel Issues in Analog Systems, Existing Analog Cellular Radio Systems, The Digital Cellular Environment, Digital Modulation, Signal Processing and Data Formatting,

Existing Digital Cellular Radio Systems, CDMA Systems, Capacity Analysis of Multiple Access Methods, IS-95 Standard for CDMA Cellular System, 3rd Generation CDMA Systems, 4th Generation Mobile Systems.

TE-605 Advanced Radar Engineering

General Principles and Basic Concepts on Target Detection and Tracking, Principal Applications of Radars, Estimation and Optimum Filtering, Models of Clutter, CFAR Techniques in Clutter, Pulse Compression and Equivalent Technologies, Pulse Doppler Radar, MTI, MTD and Adaptive Clutter Cancellation, Rejection of Active Interference, Architecture and Implementation of Radar Signal Processors, Identification of Radar Target, Phased Array Antennas (Theory, Mutual Coupling Effects, Active Aperture Arrays), Electronically Steered Antennas for Radar Systems, Space-based Radar Systems, Evolution and Future Trends of Radars.

TE-606 Microwave Active Devices

Review of microwave active and passive device technologies, Microwave Semiconductor Materials and devices, PIN Diodes, Schottky Diodes, Special Microwave Diodes, Microwave Bipolar Transistors, Microwave FETs, MMICs, MMIC Circuit Elements, Microwave Circuit Analysis, Microwave Low-Noise Amplifier Design, Microwave Low- Noise Oscillator Design, Microwave Active Mixer Circuits, analysis and characterization.

TE-607 RF Circuit Design

Introduction to RF Circuit Design: Transmission Line Analysis, Smith Chart, Single- and Multi-Port Networks, Active RF Component Modeling, RF Transistor Amplifier Designs. Advanced Principles of RF Circuit Design: A Brief Overview of RF Filter Design, Active RF Components, Active RF Component Modeling, RF Transistor Amplifier Designs, Oscillators and Mixers design

TE-800 Free Space Optical Communication

The purpose of the course is to give students a comprehensive introduction to free-space optical communication principles. This course offers in-depth exposition on: propagation effects in free-space, both outdoor and indoor as well as deep-space; channel impairments in these media including atmospheric turbulence effects and scattering effects; noise sources, channel capacity studies, advanced modulation and multiplexing techniques for free-space applications, advanced detection and channel compensation techniques; diversity techniques, MIMO techniques, adaptive optics techniques to deal with atmospheric turbulence effects; advanced coding and coded modulation techniques; software defined free-space optical communications, physical-layer security, and quantum free-space optical communications.

TE-801 Microwave Filters

Introduction to Microwave Filters, Selection of filters for various applications according to specifications, frequency ranges, trade-offs between performance and size, Filter technologies i.e. planar filters on conventional substrates, multilayer design and packaging techniques (LTCC and LCP) including quasi-lumped element filters, machined waveguide filters and substrate integrated waveguide, and monolithically integrated filters, Design methods for narrow-band, wide-band and multi-band filters, Manufacturing techniques, design-for-manufacture considerations, tolerance analysis and repeatability, Full-wave EM solvers and design tools such as CST MWS, HFSS and ADS for filter design and optimization.

TE-802 Monolithic Microwave Integrated Circuit (MMIC) Technology and Design

Basic concepts in RF Engineering, Integrated circuit (IC) implementation of RF circuits for wireless communications applications. Transceiver architectures for current wireless communications standards; active/passive device technologies for RFIC implementations; low noise amplifiers; frequency synthesizers, mixers; frequency sources; power amplifiers; single-chip radios; and RFIC packaging and testing. Case studies of modern RFIC chip sets for current wireless communications standards. The course involves circuit design at the IC level; modern RF/microwave CAD software will be used in conjunction with the course. Design of a wireless transceiver functional block component RFIC chip.

TE-803 Metamaterials and Nanophotonics

The course covers engineered structures possessing tailored electromagnetic properties, or properties that are difficult or impossible to achieve using conventional materials. The contents of the course include: Background of Metamaterials (MM), Microwave metamaterials, Optical Metamaterials, Retrieval of constituent parameters, Background and applications of Metasurfaces (MS), Microwave MS such as Isotropic metasurfaces, anisotropic metasurfaces, polarisation control MS, Optical MS such as Plasmonic Materials, Applications of Plasmonic metasurfaces. CST MWS/HFSS for the design and analysis of the meta-devices.

TE-804 Adaptive Antennas and Phased Arrays

Overview for Adaptive Antennas and Phased Arrays, Adaptive Antennas and Degrees of Freedom, Array Mutual Coupling Effects on Adaptive Radar Clutter Suppression, Focused Near-Field Techniques for Evaluating Adaptive Phased Arrays, Moment Method Analysis of Focused Near-Field Adaptive Nulling, Focused Near-Field Testing of Multiphase-Center Adaptive Array Radar Systems, Experimental Testing of Focused Near-Field Adaptive Nulling, Experimental Testing of High Resolution Nulling with a Multiple Beam Antenna. Phased Array Antennas - An Introduction, Monopole Phased Array Antenna Design, Analysis, and Measurements, Monopole Phased Array Field Characteristics in the Focused Near-Field Region, Displaced Phase Center Antenna Measurements Using Near-Field Scanning, Low-Sidelobe Phased Array Antenna Measurements Using Near-Field Scanning, Arrays of Horizontally Polarized Omnidirectional

Elements, Finite Arrays of Crossed V-Dipole Elements, Experimental Ultrawideband Dipole Antenna Array, Finite Rectangular Waveguide Phased Arrays

TE-805 Body Centric Communications and Sensing

Overview of body centric communication and sensing, EM properties and modeling of human body, antenna design and channel characterization at microwave frequencies, wearable devices, UWB for body centric communication, wearable antennas: design and characterization, Body Sensor Networks (BSN) and its applications, Antennas for Telemedicine and Telecare on-body systems, Medical implants communication systems.

TE-806 RF Energy Harvesting and Wireless Power Transmission

Overview of wireless energy harvesting and transfer, circuit design for wireless energy harvesting, antennas for wireless energy harvesting and massive MIMO, Architectures, protocols and applications of wireless power communication networks. Technologies for wireless power transfer (WPT), Communication, Mobility, Energy flow and joint operation of wireless power technologies.

TE-621 Transforms in Signal Processing

This course introduces various types of Transforms used in signal processing applications. These includes Laplace Transform, Fourier Transform, Fast Fourier Transform, Short Time Fourier Transform, Discrete Fourier Transform, Z Transform, Wavelet Transform, Integer Wavelet Transform, Curvelets Transform. The course will discuss different applications of these transforms and the recent research activities.

TE-622 Advanced Digital Image Processing

Introduction to image processing, the basic concepts, image acquisition, color representation, Spatial domain processing, intensity transformations, histogram analysis and equalization, image enhancements, filtering, Frequency domain processing, image filtering, image restoration, image compression, transforms, predictive coding, JPEG., introduction to video compression, Morphological operators, Segmentation algorithms.

TE-623 Speech Processing

Fundamentals of speech production; speech analysis: pitch and period extraction, formant estimation, voiced - unvoiced decision, Linear prediction, Inverse filtering; Auditory modelling, auditory masking; Speech enhancement; Clustering, Gaussian mixture modelling, hidden Markov modelling, Implementation of speech and speaker recognition systems.

TE-624 Multimedia Communication

This course introduces technologies for multimedia processing, coding, and communications. We will address how to efficiently represent multimedia data and how to deliver them over a variety of networks. In the coding aspect, state-of-the-art compression technologies images and videos will be presented. Emphasis will be given to state-of-the-art multimedia coding standards, including JPEG/JPEG-2000, H.26x, MPEG, and scalable video coding (SVC). Besides, considerations for constructing a video codec system will also be discussed. In the aspect of multimedia networking, special considerations for sending multi-media over the Internet and wireless networks, such as video adaptation, error resilience, error concealment, quality of service and resource management will be discussed.

TE-625 Compressed Sensing and Applications

This course covers, Sparsity, L1 minimization, Probabilistic approach to compressed sensing, Deterministic approach to compressed sensing, Robustness vis a vis noise, Sparse regression, Smooth convex optimization: optimal first-order methods (Nesterov's algorithm), complexity analysis, Nonsmooth convex optimization: smooth approximations of nonsmooth functions, prox-functions, Nesterov's algorithm, Mirror-descent algorithms, Applications in magnetic resonance imaging (MRI), Applications in analog-to-digital conversion, Low-rank matrix recovery, Nuclear-norm minimization

TE-820 Adaptive Filter Theory

Review of Random Processes, Eigenvalue Analysis, Wiener Filters, Method of Steepest Descent, Least Mean Square (LMS) Algorithm, Recursive Least Squares (RLS) Algorithm, Affine Projection Algorithm (APA), Subband Adaptive Filtering and Applications of Adaptive Filtering.

TE-821 Real-Time DSP

This course provides an introduction to the principles of real-time digital signal processing (DSP). The focus of this course is hands-on development of real-time signal processing algorithms using audio-based DSP kits in a laboratory environment. Basic concepts of DSP systems including sampling and quantization of continuous time signals are discussed. Trade-offs between fixed-point and floating-point processing are exposed. Real-time considerations are discussed and efficient programming techniques leveraging the pipelined and parallel processing architecture of modern DSPs are developed. Using the DSP kits, students will implement real-time algorithms for various filtering structures e.g., FIR/IIR filtering, and FFT algorithms and compare experimental results to theoretical predictions. We will also cover interrupt-driven programming, frame processing, quantization effects, code optimization, and DSP applications.

TE-822 Array Signal processing

Introduction to the mathematical principles of array signal processing and their applications. Conventional beamformer design, optimum array processing structures; detection and direction of arrival estimation,

modern subspace methods; adaptive array algorithms; implementation issues (matrix processing, subspace tracking, array calibration); selected applications from wireless communications, audio processing, underwater acoustics.

TE-823 Multimedia Forensics and Security

Introduction to forensics and multimedia forensics, problems, and research challenges. Contents authentication: active and passive technique, Data hiding, Steganography: Spatial and transform domain steganographic techniques, Steganalysis, Watermarking: perceptible, imperceptible, fragile, robust, fragile watermarking, Digital Signatures, Forgery detection, Camera identification: source camera identification, device linking.

TE-641 Detection and Estimation Theory

Background material: recap of probability, calculus, linear algebra. Estimation Theory: General Minimum Variance Unbiased Estimation, Cramer-Rao Lower Bound, Linear Models and Unbiased Estimators, Maximum Likelihood Estimation, Least squares estimation, Bayesian Estimation. Finite state Hidden Markov Models: forward-backward algorithm, Viterbi (ML state estimation), parameter estimation (f-b + EM), Graphical Models, Applications: image processing, speech, communications (to be discussed with each topic), Sparse Recovery and Compressive Sensing introduction, Monte Carlo methods: importance sampling, MCMC, particle filtering, applications in numerical integration (MMSE estimation or error probability computation) and in numerical optimization (e.g. annealing). Detection Theory: Statistical Detection Theory, Deterministic Signals, Random Signals, Statistical, Non-parametric and robust detection. Likelihood Ratio testing, Bayes detectors, Minimax detectors, Multiple hypothesis tests, Neyman-Pearson detectors (matched filter, estimator-correlator etc), Wald sequential test, Generalized likelihood ratio tests (GLRTs), Wald and Rao scoring tests and Applications.

TE-642 Information and Coding Theory

Entropy, Relative Entropy, Mutual Information, Entropy Rates of a Stochastic Process, Gambling and Data Compression, Channel Capacity, Shannon's Source Coding Theorem, Approaching the Shannon limit by turbo coding, Other aspects of coding theory, Differential Entropy, Gaussian Channel, Cryptographic Basis

TE-643 Advanced Computer Networks

A high-level top-down view of computer networking, Applications of networking, Network requirements, Network Architecture, Network Software, Network Performance, Hardware building blocks of Network, Encoding, Framing, Error Detection, Reliable Transmission, Ethernet, Token Rings, Wire-less, Network Adapters, Switching and Forwarding, Bridges and LAN Switches, Cell Switching, Implementation and Performance, Internet Protocol, Routing, Global Internet, Multicast, MPLS, UDP, TCP, RPC, Issues in Resource Allocation, Queuing Disciplines, TCP Congestion Control, Congestion Avoidance Mechanism, Quality of Service, IntServ/DiffServ, Data Presentation Formatting, Data Compression, Cryptographic

algorithms, Security Mechanisms, Firewalls, Name Service, Traditional Applications, Multimedia Applications, Overlay Networks, Network Monitoring and Management.

TE-840 Advanced Information and Coding Theory

Course Contents: Rate Distortion Theory, Information Theory and Statistics, Maximum Entropy, Universal Source Coding, Kolmogorov Complexity, Network Information Theory, Information Theory and Portfolio Theory, Inequalities in Information Theory, Distributed Joint Source-Channel Coding on a Multiple Access Channel, Cooperative Diversity Systems for Wireless Communication, Algorithmic Entropy, Reversible Computation, Introduction to Quantum Information and Coding Theory

TE-841 Advanced Network Security

Introduction to the Problem of Security, Introduction to Communication Network Security, Security services - The CIA triad, Network threats and attacks - Spoofing, Denial of Service (DoS), man-in-the-Middle, Theft of service, Eavesdropping, Impersonation, Spam, Spam over Internet Telephony (SPIT), Cryptography, Symmetric crypto primitives, Asymmetric crypto primitives, Hash functions, Encryption notation, The cryptanalyst attack, Times for exhaustive key search, Cipher Systems, Substitution Ciphers, Transposition Ciphers, Important Historical Cipher Systems, Cryptanalysis and Cipher Security, The strength of security systems (unconditionally secure and computationally secure), Entropy and Equivocation, Perfect Secrecy, Unicity Distance, The Data Encryption Standard (DES), Multiple DES, Electronic Code Book Operation, Cipher Block Chaining Mode, Cipher Feedback Mode, Output Feedback Mode, Public Key Cryptography, Rivest–Shamir–Adleman (RSA) Algorithm, Encryption in Networks, Line-level Encryption, Data Link Layer Encipherment, End-to-end Encryption, Node-by-Node Encryption, Security in the Internet, IP Security, Secure Sockets Layer (SSL)/ Transport Layer Security (TLS), Pretty Good Privacy (PGP), Digital Signatures, Firewalls, Electronics Currency, Smart Cards, E-commerce.

TE-842 Radio Network Planning and Optimization

Overview of mobile networks, 2G Network Planning and Optimization, Transmission Network Planning and Optimization, Core Network Planning and optimization, 3G: UMTS network planning and optimization, 3G transmission network planning and optimization, 3G core network planning and optimization, 4G network planning and optimization, 4G transmission and core network planning and optimization, Introduction to 5G, 5G network planning and optimization, Massive MIMO and IoT.

TE-843 Cellular Network Planning & Optimization

Objectives of Radio Network Planning, The Impact of User Environment, Cellular Network Planning Approaches, Phases of The Cellular Network Planning Procedure, Frequency Reuse, Prediction of Offered Traffic, Capacity Planning, Goals of Coverage Planning, Multipath Propagation: Path Loss, Hata Model, Walfish-Ikegami Model, Path Loss Corrections, Slow and Fast Fading, Connection Between Coverage and

Quality of Service, Radio Link Power Budget, Regular Frequency Reuse Patterns, Methods Applied in Frequency Planning, Cellular Network Planning Tools.

TE-661 Stochastic Processes

Review of Probability: Distributions, Expectations, Conditioning, Bayes' Theorem, Independence, Random Variables, Bounds: Markov, Chebychev, Chernov. Borel-Cantelli Lemmas. Discrete-probability– counting arguments, branching processes. Gaussian Random Variables, Conditioning, Conditional Expectation. Stochastic Processes: Classification: Gaussian, Poisson, Markov, Stationarity- Weak and strong laws. CLT, Convergence, Ergodic Theorems. Wide sense stationary processes- L2- Theory of Stochastic Processes: Bochner's Theorem, Spectral Theory, Shannon sampling, Karhunen-Loeve Expansions. AR and MA Approximations. World decomposition and prediction of 2nd. order stationary processes. Independent increment processes: Wiener process, Poisson Processes. Gauss-Markov processes. Introduction to Markov chains: Classification, invariant distributions, ergodicity. Introduction to martingales- the discrete-time case. Martingale convergence theorem. Doob's optional sampling. Wald's lemma.

TE-662 Broadband Communication

Broadband Data Network Architecture, X.25, Frame relay, X.25 v/s Frame relaying, Frame mode protocol architecture, Frame relay and Frame switching, Frame mode call control , Call control protocol, Data Link Connection Identifier (DLCI), Bearer capability, Link layer core parameters, IPV6, Integrated Service Digital Network (ISDN) – Integration of Transmission and Switching, ISDN Architecture, ISDN standards, ISDN: interface and Functions – Transmission structure, User network interface, ISDN protocol architecture, ISDN connections, Addressing, Interworking, B-ISDN architecture and standards, B-ISDN Services – Conversational, Messaging, Retrieval, Distribution, Business and Residential requirements, B-ISDN protocols – User plane, Control plane, Physical layer, Line coding, Transmission structure, SONET, Signal Hierarchy, System Hierarchy, Asynchronous Transfer Mode (ATM), Virtual channels, Virtual paths, VP and VC switching, ATM cells, Transmission of ATM cells, Adaptation layer, ATM Adaptation Layer (AAL) services and protocols, ATM switching, ATM cell processing in a switch, Matrix type switch, Performance aspects of buffering switching networks.

TE-663 Advanced Optical Communication Systems

Advanced chromatic dispersion compensation, PMD compensation and nonlinearity management. Spectral efficiency limits, turbo equalization, forward error correction and coded modulation, multilevel modulations and OFDM, constrained coding techniques, parametric amplification, all-optical regeneration, wave-length conversion and multibanded switching, soliton and dispersion-managed soliton transmission.

TE-664 Optical Networks

Optical networking principles, Optical networking components, Wavelength-division Multiplexing (WDM) line systems, Optical network design, Core Optical Networks, Metro Optical networks, Access Optical Networks, Wavelength Routing and Assignment, Traffic Grooming and Protection, Multilayer Network Structure, Advanced Techniques and Devices for Optical Networking, Techniques for Space and Spectral Signal Processing – Multiple Input Multiple Output (MIMO) and Orthogonal Frequency Division Multiplexing (OFDM), Elastic Modulation Coding as a Networking Tool, Optical Devices for design of Reconfigurable Optical Add-drop Multiplexer (ROADM) and photonic cross-connect (PXC) design, Wavelength Agile Devices, Wavelength Convertors, Optical Network Management and Routing Principles, Functions of Network Control and Management, Impairment Aware Routing, Optical Circuit Switching, Optical Packet Switching, Optical Burst Switching, Energy Awareness in Optical Networking, Network Modelling Tools, Network Design Guidelines

TE-665 Network Optimization

Introduction to network models, Graphs and networks theory, Shortest spanning tree, Shortest path problems, Maximum flow problems, Minimum cost flow problems, Multicommodity flows, Preflow push algorithms, The radix heap algorithm, Mathematical models for graph and network problems, Applications of network flow, Optimal circuits, Hamiltonian circuits, Vehicle routing problems, Surrogate relaxation, Lagrangian relaxation, Reduction techniques, Approximation and heuristic algorithms, Greedy algorithms, Worst-case performance, Metaheuristic algorithms.

TE-666 Network Planning and Management

Basics of Network Design and Management, Network Design, design of wireless networks, optimal design of telecommunications networks, Network Security, Enterprise Networks, Network Management, Telecommunications Management Network (TMN), Network Management Protocols, Broadband Network Management, Network Management Tools and Applications, Enterprise Network Design, Network Operations and Implementation, Network Monitoring and Reporting, Traffic and Event Analysis, Cyber Security.

TE-667 Telecom Management Network

Overview of telecom management network, Functional architecture, Physical architecture, Telecommunications Management Network (TMN) interfaces, Model Fault Configuration Accounting Performance Security (FCAPS), Management Information Base (MIB). Simple Network Management Protocol (SNMP). SNMPv2, SNMPv3, Information architecture, OSI management. Common Management Information Protocol (CMIP)/Common Management Information Service (CMIS). Session Management Function (SMF). Tele-Management Forum (TMF) Frameworks: principles, business process framework, Enhanced Telecom Operations Map (eTOM), Information Framework (SID), Application Framework (TAM), integration framework. IT service management - IT service management (ITSM) / Information

Technology Infrastructure Library (ITIL). Telecommunications Management Network (TMN): Network Management Layer (NML), Service Management Layer (SML). Operations, Administration and Maintenance (OAM) functions of Asynchronous Transfer Mode (ATM), IP, Multiprotocol Label Switching (MPLS), Synchronous Digital Hierarchy (SDH), Optical Transport Hierarchy (OTH), Dense wavelength division multiplexing (DWDM), Provider Backbone Bridge (PBB), Provider Backbone Bridge Traffic Engineering (PBB-TE). Network management security. QoS management. Alternative technologies for TMN.

TE-860 Optimization Techniques

Linear Programming, nonlinear Programming, Integer Programming, Interior Point Methods, Heuristic Methods, Metaheuristics and applications to optimization problems in telecommunications, Network Flow Algorithms, Shortest Path Algorithms, Software tools for telecommunication network planning and optimization, Multicommodity network flow models, algorithms, problems and decomposition in telecommunication, Optimization in Wireless Networks.

TE-861 Teletraffic Engineering

Traffic Units and Parameters, Holding Time and Call Intensity, Offered Traffic and Carried Traffic, Congestion and Delay, Traffic Variations, Subscriber Behavior, Poisson Traffic Model, Erlang's Model, Binomial, and Engset's Models, Limited Availability, and Gradings, PJ Formula, Link Systems in Switching Networks, Dimensioning Tables and Charts, Computerized Aids, Classical Waiting Time Systems, Classification of Queuing Models, Infinite Source Delay-Loss Systems, Limited Source Delay-Loss Systems, Measurements Recommended by ITU-T, Measurement of Holding Times, and Traffic Intensity, Measurement Accuracy, Multidimensional Traffic Models, Overflow Traffic Modelling, ATM Traffic Characteristics and Modelling.

TE-862 Wireless Sensor Networks

Introduction to sensor networks, Sensor Networks Architecture and Protocol Stack, Hardware and software platforms, Factors influencing the design of sensor networks, Sensor data acquisition, Processing and handling, Application Layer, Transport Layer Protocols, Routing Algorithms, Opportunistic Routing Analysis, Clustering, Medium Access Control Protocols, Error Control Algorithms, Physical Layer Solutions, Localization and Target Detection Algorithms, Time Synchronization Algorithms, Sensor and Actor (Actuator) Networks, Coordination and Communication Problems, Simulation and Modelling of sensor networks, Underwater Sensor Networks and various application scenarios.

TE-863 Next Generation Networks

Introduction, The Network Evolution Towards NGN, Definition of NGN, Characteristics, Architecture, NGN Vision, Scenarios and Advances, NGN Functional Architecture, Enabling technologies, Core network Architecture, Access network (Fixed technologies: copper lines and fibre optics and Wireless technologies: 3GPP based technologies and IEEE based technologies), Drivers and motivation behind NGN (End user

requirements, Operator requirements, Competition, Application), Convergence (Drivers for convergence, Fixed mobile convergence, Voice and data convergence), Abstract layering model for NGNs, IP Multimedia Subsystem (IMS), Migration from legacy systems to NGNs and Case studies of present and possible future applications deployed in NGNs.

TE-864 Mobile Ad-hoc Networks

Introduction to Mobile Ad-Hoc Networks, Ad-Hoc networks topologies, Physical and MAC layer specifications and design considerations for MANETs, Physical and MAC layer specifications and design considerations for IEEE 802.11 and IEEE 802.16 family of standards, Mobility in Ad-Hoc networks, Introduction to Mobile IPv4 and IPv6, Fast Mobile IP, Hierarchical Mobile IP, Routing Layer for MANETS – design and performance considerations, Routing protocols for MANETS (Proactive, Reactive, Hybrid, Hierarchical and Location based routing protocols for MANETS), Quality of Service provisions in the IEEE 802.11 and IEEE 802.16 family of standards and relevance to MANET operation. In depth analysis of the various course topics in network simulator.

TE-865 QoS in Telecommunication Networks

Definitions, Measurement and Evaluation, The Analysis Process, Telecommunications Concepts. Quality of service framework, Technical aspects, QoS regulatory framework and role of national regulatory authorities, Quality of service parameters and key performance indicators, Traffic management, QoS of IP Network Services and Broadband, Quality Measurement Tools, Quality Measurement Platforms, Consumer Protection and Privacy, Economic Principles of QoS Regulation, Optimization issues in quality of service, Evaluative Concepts, Measures and Quantifiers Accessibility, Routing Speed, Connection Reliability, Routing Reliability, Connection Quality-Voice, Connection Quality-Data, Connection Continuity, Disconnection Reliability.

TE-866 Advance Intelligent Networks

Course Contents: Introduction to Intelligent Networks (IN), IN Architecture, IN Architecture Evolution, IN services, Introduction to Signalling System 7 (SS7), Message Transfer Part (MTP), Signalling Connection Control Part (SCCP), Transaction Capabilities Application Part (TCAP), ISDN User Part (ISUP), Intelligent Network Application Part (INAP), Mobile Application Part (MAP), IN Conceptual Model, Service Plane, Global Functional Plane, Distributed Functional Plane, Physical Plane, Service Creation and Management, IN Markets, Customized Applications for Mobile network Enhanced Logic (CAMEL), CAMEL Architecture, CAMEL Application Part (CAP), SS7 over IP, Signaling Transport (SIGTRAN) Network.

TE-867 Smart Grid Networks

Introduction to Smart Grid and Intelligent Distribution Networks, Energy storage technologies, Concept of Resilient and Self-healing Grid, Smart Grid Standards, Telecommunication Systems in Smart Grids, Smart Energy Resources, Feeder Automation, Transmission systems: Energy Management System (EMS),

Flexible AC Transmission Systems (FACTS), and High-voltage Direct Current (HVDC), Distribution systems: Distribution Management System (DMS), Volt/Var control, Fault Detection, Isolation, and service Restoration (FDIR) and Volt-Var Optimization, Outage management, Phase shifting transformers, Plug in Hybrid Electric Vehicles (PHEV), Micro Grid, Integration of distributed energy sources, Operation and Control of Micro Grid, Smart Meters, Advance Metering Infrastructure (AMI), AMI protocols, Phasor Measurement Unit (PMU), Web based power quality monitoring, High performance computing for Smart Grid Applications, Broadband over Power Line (BPL), Cloud Computing for Smart Grids.

TE-680 Research Methodology

Introduction to the nature of research process, Types of research (experimental/non-experimental), Steps of research (with emphasis on Engineering related research), Problem Identification, Literature review and information gathering and analysis techniques (simulation models, projections). Report Writers Pyramid, Business Letter Formats, Report Writing, Research Reports and Reference Formats, Resume Development/Cover Letter Writing, Public Speaking Units including emphasis on oral presentations. Steps in writing technical documents including research proposals, research grants applications, publishing research outcomes, finding the right platforms, Technology tools assisting research, bibliography styles, determining impact of research, measuring the impact through various analytical scales including the citations, the impact factor, and performance parameters for evaluating research.

TE-681 Simulation and Modeling

Introduction to Simulation and Modeling, Discrete-Event Simulation, Simulation of a Single-Server Queueing System, Alternative Approaches to Modeling and Simulations; Review of Basic Probability and Statistics; Estimation of Means, Variances, and Correlations, Confidence Intervals and Hypothesis Tests for the Mean, The Laws of Large Numbers; Random number generators; Simulation of discrete, continuous probability distributions and empirical distributions; tests on simulated distributions, rejection method, simulation of multivariate distributions, correlations, and stochastic processes, simulation of models of arrival processes, Poisson Processes, Nonstationary Poisson Processes, Batch Arrivals, tests on generators, Markov- Chain Monte-Carlo simulations; Variance-Reduction Techniques.

TE-682 Telecom Regulation and Standards

Introduction to Telecommunications Regulation, Regulating for Effective Competition, Licensing and Authorizing Services, Managing the Spectrum, Network Access and Interconnection, Universal Access and Service, Regulatory Challenges in a Brave New World, Regulation of Telecom Sector In Pakistan

TE-683 Telecom Planning and Management

Overview of telecommunications management, current and long-range planning, feasibility analysis, and forecasting, selection and management of telecom equipment and services. Management of Internet services, writing and evaluating responses to RFPs, managing long distance services, and more.

Management of a telecom facility, including PBX and key telephone equipment, automatic call distributors, voice processing equipment, local area networks and Internets, wide area networks, convergence, and video and audio conferencing equipment, cost control, benchmarking, contracting, outsourcing, and optimizing voice circuits and data network bandwidth, The development of a telecom operations and disaster prevention plan to project management, quality control, security and fraud prevention, and more, it provides a thorough examination of telecommunications operations planning and execution

TE-684 Cloud and Grid Computing

Concepts of cloud computing including Utility Computing, SaaS (Software as a Service), Paas (Platform as a Service), IaaS (Infrastructure as a Service), Automation, Cloud /Grid middleware, Elastic Computing, Cloud databases, Scalability, Fabric Computing, Green IT, High Performance Computing, Programming Methodology and middleware used for parallel computing in grid and cloud systems. Design and development of application-specific parallel up-to-date software for grid and cloud programming environments. Parallel computing platforms, parallel programming models, programming patterns (such as task and data parallelism), middleware for job and resource management and fault tolerance. Program design theory. Current technology implementation in grid and cloud computing. Grid security. Grid infrastructure. Virtualization technology. Cloud operating systems. Cloud and grid data storage and management. Cloud security.

DEPARTMENT OF ELECTRICAL ENGINEERING

1. INTRODUCTION

Area of Electrical Engineering is one of the most dynamic sectors of local and global economy. Development of this sector is driving fundamental changes in all areas of work and life. Electrical Engineering represents an exceptionally wide and interdisciplinary area of engineering sciences and there is virtually no human activity in which this discipline does not contribute, either directly or indirectly. The area encompasses the scientific field of electrical engineering with sub-branches of power engineering, electromechanical engineering, electronics, computer information systems, radio and satellite communications, automation, and robotics. The area is recognized as an area of strategic importance for social development. Together with the industrial sector, academia is committed to encouraging development of new educational programs in Electrical Engineering, as prerequisites for development of information society.

Electrical Engineering Department of U.E.T Mardan is Well-equipped with state-of-the-art laboratories, dedicated faculty members which has strengthened this department and been able for upbringing better Engineers to innovate contemporary status of common man and society. Details of faculty members is given below:

2. FACULTY

Chairman:

Prof. Dr. Imran Khan PhD (Thailand)

Advisor Postgraduate Studies:

Dr. Ajmal Farooq, PhD (China)

Assistant Professors:

Dr. Sheraz Khan – PhD (Thailand)

Dr. Fazal Muhammad - PhD (Pak)

Dr. Muhammad Ali - PhD (China)

Dr. Ajmal Farooq - PhD (China)

Dr. Salman Khan – PhD (Hong Kong)

Lecturers:

Dr. Gul Rukh - PhD (Pak)

Engr. Jawad Ali – MSc (Pak)

Engr. Sadia Jabeen Siddiqui - MSc (Pak)

Engr. Haseeb Ahmed Khan – MSc (Pak)

Engr. Khadim Ullah Jan – MSc (Pak) On study leave

Engr. Mahum Pervez - MSc (Pak)

3. DEPARTMENT MISSION

The mission of the Master of Science/Doctorate in Electrical Engineering program in the UET Mardan is: “To prepare students for careers in private and public sectors and for advanced level in research that leads to high scholarly achievements, and advanced knowledge”.

4. PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

The Post graduate program in Electrical Engineering is a challenging and rewarding way of study for a higher degree. Graduates of the Master of Science in Electrical Engineering program will be able to fulfill the following program educational objectives (PEOs):

- **PEO-1:** To produce graduates with a strong applied knowledge in the field of Electrical Engineering and who are motivated to become good researchers, entrepreneurs and successful engineers.
- **PEO-2:** To enable graduates to efficiently analyze and solve technical problems.
- **PEO-3:** To produce graduates who practice their profession within the code of ethics, social responsibilities and with commitment to community services.
- **PEO-4:** To produce graduates who exhibit an aptitude for continuous and independent learning, leadership and communication skills in competitive environment.

5. PROGRAM LEARNING OUTCOMES (LOs)

By the time a student completes the requirements for the Post graduate program in Electrical Engineering, the student will have achieved the following Learning Outcomes (LOs).

LO-1: Enable engineers to develop mathematical models and equip them with engineering knowledge to innovate and upgrade engineering products for the betterment of society.

LO-2: Equip engineers with ample knowledge in the specialized fields of Electrical Engineering for problem analysis and design of engineering solutions that are according to the international standards.

LO-3: Develop communication skills to explain systems models, analytical solutions and design to national and international audience.

LO-4: Able to recognize the trends in the specified field through literature review, analyse and identify the current problems in the Electrical Engineering area.

LO-5: Enable engineers with performance and evaluation knowledge to validate their mathematical analytical model by use of Modern tools.

LO-6: Able to draw results from the modern tools' graphs that enable conclusive discussion and highlight future work in the specific field.

LO-7: Enable engineering students to draft technical paper using modern tools with proper bibliography.

6. WHY YOU SHOULD STUDY M.Sc OR Ph.D. IN ELECTRICAL ENGINEERING?

Continuous and rapid development in the field of Electrical Engineering, driven by new findings and achievements, necessarily requires corresponding educational processes. Well educated and competent researchers and professionals are an essential prerequisite for progress and keeping pace with the technologically advanced countries. Development of a major part of economy, public and private sector in the region striving towards production and distribution of Electric power, management and monitoring of intelligent systems, development and application of electronic and computer systems, and communication and information technology is strongly dependent on researchers and trained personnel's in Electrical Engineering. Therefore, dynamic development of the region will most certainly result in increased need for Electrical Engineering professionals.

Research Avenues:

- Power Systems
- Power Generation & Distribution
- Energy Management
- Control Engineering
- Renewable Energy Systems
- Economics of Power Systems
- Instrumentation & Measurement
- Smart Grid Systems
- Embedded Systems
- Radio & Satellite Communication Systems
- Advanced Electronic Circuits
- Artificial intelligence
- Mobile and Satellite Communication
- Digital Signal Processing
- Signal Information Processing
- Digital Image and Video Processing
- Mobile and Computer Networks

7. POSTGRADUATE PROGRAMS OFFERED IN DEPARTMENT OF ELECTRICAL ENGINEERING

The title of degree offered in the Masters Program of the Department is:

- MSc in Electrical Engineering

Following two streams will be offered for M.Sc. Electrical Engineering program.

1. Power Systems and Control Engineering
2. Communication and Electronics Engineering

The department is seeking NOC from HEC for the following postgraduate program, for a tentative start in Spring 2022 semester:

- PhD in Electrical Engineering

7.1 Eligibility of the Postgraduate Programs in Electrical Engineering

7.1.1 Eligibility Criterion for Admission in MSc in Electrical Engineering:

Candidates seeking admission must have a Bachelor's Degree (16 years of education) in a relevant discipline. (i.e. B.Sc/BS/BE in Electrical, Electronics, Telecommunication) from a program accredited by Pakistan Engineering Council and program recognized by the Higher Education Commission of Pakistan.

Other eligibility criteria, applicable to all MSc programs, are mentioned in MSc Rules and Regulations Chapter.

7.1.2 Eligibility Criteria for Admission in PhD. Electrical Engineering

For admission into the PhD, minimum Master's Degree (18 years of Education) in Electrical, Electronics, Telecommunication Engineering or equivalent, recognized by the HEC, will be required.

Other eligibility criteria, applicable to all PhD programs, are mentioned in PhD Rules and Regulations Chapter.

7.2 Course Requirement for MSc and PhD in Electrical Engineering

MSc and PhD students will be required to complete course work of 24 and 18 credit hours respectively. Table 1 shows the number of courses the MSc and PhD students' needs to register and qualify for completion of his course work.

Table 1: Course Requirement for MSc and PhD in Electrical Engineering

MSc in Electrical Engineering			
Type of Courses	Required Courses	No. of Courses	Credit Hours
Core/Mandatory	Core Courses (6XX Level Courses)	03	09
Non-Engineering Core/Mandatory	Research Methodology (6XX Level Courses)	01	03
Electives	To be selected from pool of electives	04	12
PhD. in Electrical Engineering			
Elective Courses	Based on Research Area	6	18

7.3 List of Core Courses for M.Sc and PhD in Electrical Engineering

Table 2 below depicts the list of core courses for M.Sc. students:

Table 2: List of Core Courses

S.No.	Course Code	Course Name	Credit Hours
1.	EE-601	Stochastic Processes	3
2.	EE-602	Optimization Techniques	3
3.	EE-603	Linear System Theory	3
		Total	09

Note: EE-670 Research Methodology (03 credit hours) is Non-Engineering core/Mandatory course for all M.Sc students

7.4 List of Elective courses for M.Sc. & Ph.D. in Electrical Engineering

MSc. Students are required to study and pass a total of **five (05)** courses from the list of electives in proportion mentioned in each specialization.

The PhD. Students are required to study and pass **six (6)** courses from the list of Elective Courses.

Table 3: List of Domain Elective Courses

S.No.	Course Code	Course Title	Credit Hours
<i>Elective courses (for Power Systems and Control Specialization)</i>			
1.	EE-610	Renewable Energy Systems	3
2.	EE-611	Power Electronics Devices and Converters	3
3.	EE-612	Modelling and Simulation of Converters	3
4.	EE-613	Power Quality	3
5.	EE-614	Advanced Control Systems	3
6.	EE-615	Advanced High Voltage Engineering	3
7.	EE-616	Modelling and Simulation of Electrical Machines	3
8.	EE-617	Special Electrical Machines	3
9.	EE-618	Smart Grid Systems Operation	3
10.	EE-619	Power System Reliability	3
11.	EE-620	Power System Distribution	3
12.	EE-621	Insulation Coordination in Power Systems	3
13.	EE-622	Photovoltaic Energy and its Applications	3
14.	EE-623	Advanced Electrical Machine Design	3
15.	EE-624	Power Generation Economics	3
16.	EE-625	Power System Restructuring	3
17.	EE-626	Condition Monitoring Techniques	3
18.	EE-627	Energy Management	3
19.	EE-628	Digital Control System	3
20.	EE-629	Advanced Power Electronics	3
21.	EE-630	Distributed Generation	3
22.	EE-631	Advanced Power System Transmission	3
23.	EE-632	Non - Linear Control Systems	3
24.	EE-633	Advanced Power System Protection	3
25.	EE-634	Power System Modelling and Analysis	3
26.	EE-660	Linear Control Systems	3
27.	EE-670	Research Methodology	3
28.	EE-671	Simulation and Modelling	3
29.	EE-810	Advanced Power System Operation and Control	3
30.	EE-811	Advanced Process Control	3
31.	EE-812	Advanced Power System Stability	3
32.	EE-813	Optimization and Economics of Integration Power Systems	3
33.	EE-814	Control of Electric Machine Drives	3
34.	EE-815	Control of Power Electronic Converters	3
35.	EE-816	Control of DC Machines and Drives	3

36.	EE-817	Control of AC Machines and Drives	3
37.	EE-818	Dynamics and Control of Integrated Power System	3
38.	EE-899	Special Advanced Topics related to Electrical Engineering	3
<i>Elective courses (for Communication and Electronics Specialization)</i>			
1.	EE-604	Advanced Electronics	3
2.	EE-632	Non - Linear Control Systems	3
3.	EE-650	Digital Image Processing	3
4.	EE-651	Advanced Digital Communication	3
5.	EE-652	Digital Integrated Circuit Design	3
6.	EE-653	Antenna Theory and Design	3
7.	EE-654	Advanced Digital Signal Processing	3
8.	EE-655	Cellular and Mobile Communications	3
9.	EE-656	Microwave Devices	3
10.	EE-657	Secure Communications	3
11.	EE-658	Solid State Electronics	3
12.	EE-659	Photonic Devices	3
13.	EE-660	Linear Control Systems	3
14.	EE-661	Advanced Computer Networks	3
15.	EE-662	Speech Processing	3
16.	EE-663	Advanced Wireless Communication	3
17.	EE-664	Semiconductor Device Physics	3
18.	EE-665	Data Communication and Security	3
19.	EE-666	Advanced Communication Systems	3
20.	EE-667	Smart Antennas	3
21.	EE-668	Advanced Microwave Engineering	3
22.	EE-669	Advanced Satellite Communication	3
23.	EE-670	Research Methodology	3
24.	EE-671	Simulation and Modelling	3
25.	EE-819	Design and Analysis of Algorithms	3
26.	EE-820	Real Time Digital Signal Processing	3
27.	EE-821	Spatial Array Processing	3
28.	EE-822	Advanced Information & Coding Theory	3
29.	EE-823	Microwave Filters	3
30.	EE-824	Monolithic Microwave Integrated Circuit (MMIC) Technology and Design	3
31.	EE-825	Metamaterials and Nano photonics	3
32.	EE-826	Mobile Ad Hoc Networks	3
33.	EE-827	Advanced Intelligent Network	3
34.	EE-828	Wireless Sensor Networks	3
35.	EE-829	Internet of Things	3

36.	EE-830	Semiconductor Processing	3
37.	EE-831	Quantum Mechanics	3
38.	EE-832	RF Circuits Design	3
39.	EE-833	Free Space Optical Communications	3
40.	EE-834	Advanced Digital System Design	3
41.	EE-835	Adaptive Filter Theory	3
42.	EE-836	Special Advanced Topics related to Electrical Engineering	3

Thesis

Course Title	Course Code	Credit Hours
M.Sc. Thesis	EE-799	6
Ph.D. Thesis	EE-899	36

7.5 Course Contents

EE-601 Stochastic Processes

Review of Probability: Distributions, Expectations, Conditioning, Bayes' Theorem, Independence, Random Variables, Bounds: Markov, Chebychev, Chernov. Borel-Cantelli Lemmas. Discrete-probability– counting arguments, branching processes. Gaussian Random Variables, Conditioning, Conditional Expectation. Stochastic Processes: Classification: Gaussian, Poisson, Markov, Stationarity- Weak and strong laws. CLT, Convergence, Ergodic Theorems. Wide sense stationary processes- L2- Theory of Stochastic Processes: Bochner's Theorem, Spectral Theory, Shannon sampling, Karhunen-Loeve Expansions. AR and MA Approximations. World decomposition and prediction of 2nd. order stationary processes. Independent increment processes: Wiener process, Poisson Processes. Gauss-Markov processes. Introduction to Markov chains: Classification, invariant distributions, ergodicity. Introduction to martingales- the discrete-time case. Martingale convergence theorem. Doob's optional sampling. Wald's lemma.

EE-602 Optimization Techniques

Numerical optimization techniques; Convex Optimization, constrained and unconstrained optimization, integer linear programming, mixed integer linear programming, mixed integer non-linear programming; artificial; Stochastic optimization methods; (a) Metropolis-Hastings algorithm and Gibbs sampling; (b) Stimulated annealing; (c) Genetic algorithm; (d) Tabu search; (e) Swarm algorithm, (f) Ant Colony Optimization Technique and its variants, (g) Wind Driven Optimization Technique and its variants, (h) Cuckoo Search Optimization Technique and its variants, (i) Whale Optimization Technique and its variants, (j) Bat Optimization Technique and its variants (k) Grasshopper Optimization Technique and its variants,

(l) Grey Wolf Optimization Technique and its variants, (m) Firefly Optimization Technique and its variants, (n) Teaching Learning Optimization Technique and its variants

EE-603 Linear System Theory

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 eigenvectors, 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 transition matrix, discrete-time controller design and implementation.

EE-604 Advanced Electronics

Voltage Amplifier Circuits: Transistor as an amplifier, small signal analysis, large-signal analysis, single stage, multistage amplifiers; Classes of Amplifiers: Class A, B, AB, and C amplifiers, push-pull amplifier, complementary symmetry amplifier; Coupled Amplifiers: RC-coupled, transformer coupled, direct coupled amplifiers; Frequency response of the amplifiers, audio frequency amplifiers, radio frequency amplifiers, tuned amplifiers; feedback in amplifiers, effect of feedback on frequency response; Practical Amplifier Considerations: input and output impedance matching, amplifier loading; Oscillator Circuits: basic theory, tank circuit, damped and undamped oscillations, phase-shift oscillator, Colpitt oscillator, Hartley oscillator, Wein-bridge oscillator, Clapp oscillator, crystal Oscillator; Analogue Filter Circuits

EE-610 Renewable Energy Systems

Fundamentals of Alternative Energy Sources, Energy Demand and Supply, Environmental and Ecological Effects of Energy Production and Consumption, Energy Conversion, Introduction to Nuclear Energy, Nuclear Power Plants, Fusion Energy, Solar Energy, Wind Power, Geothermal Energy, Biomass, Power from the Water, Energy Storage, Economics of Energy Projects.

EE-611 Power Electronics Devices and Converters

Introduction to high-power electronics, power switches, and power-electronic converter systems, Principles of electronic power conversion in switched-mode converters. Averaged modelling of switched-mode converters, input filter design. Line-commutated and pulse-width-modulated rectifiers. Analysis and design of PWM (Pulse-Width-Modulated) converters including the selection of components, design of magnetic components, design of feedback loop, performance measurement.

EE-612 Modelling and Simulation of Converters

Voltage-Source Converter (VSC) and Pulse-Width Modulation (PWM), Switched and averaged models of the half-bridge VSC, Current-mode and voltage-mode control methods, Three-phase VSC, Sinusoidal PWM (SPWM), and SPWM with third harmonic injection. Space-phasors and vectorial representation of three-

wire, three-phase converter systems. $\alpha\beta$ -frame and dq-frame transformation. Synchronization and the Phase-Locked Loop (PLL). Real and reactive power control by the three-phase VSC. DC-link voltage regulation in the VSC, and Controlled DC-Voltage Power Port. State-space modeling and analysis of power-electronic converter systems. Analysis of important applications (wind power system, PV system, HVDC systems, etc.)

EE-613 Power Quality

Power Quality Introduction and Concepts, Terms and Definitions, Voltage Sags and Interruptions, Transient Over voltages, Fundamentals of Harmonics, Applied Harmonics, Long-Duration Voltage Variations, Power Quality Benchmarking, Distributed Generation and Power Quality, Wiring and Grounding, Power Quality Monitoring. Power Frequency Disturbance, Electrical Transients, Harmonics, Grounding and Bonding, Power Factor, Electromagnetic Interference, Static Electricity, Measuring and Solving Power Quality Problems.

EE-614 Advanced Control Systems

State-Space and Multivariable Control, Digital Control & System Identification, Nonlinear and Adaptive Control Systems, Process Control & Automation, Optimal & Robust Control, Intelligent Control & Robotics, Applied Control

EE-615 Advanced High Voltage Engineering

Voltage High voltage transmission systems, Generation of high voltages. Cockroft-Walton cascade rectifier. Transformer cascade. Marx generator for impulse voltages. High voltage dividers. High voltage test technique. Electrical breakdown strength of gaseous, liquid and solid insulation. Dielectric properties of electrical insulation. Complex permittivity and dielectric response functions. Kramers-Kronig relations. Insulation diagnostics. Dielectric spectroscopy. Partial discharges.

EE-616 Modelling and Simulation of Electrical Machines

Voltage Introduction: - Key components - Magnetic principles - Electromagnetic circuits - Use of phasors
Fundamentals: Fundamentals: Transformer - Ideal transformer - Three and two inductor model - With all non-idealities
Fundamentals: Three phase circuits and Power - Star-Delta connections - Space vectors - Application of space vectors for 3-phase analysis - Relationship of space vectors and phasors - Power in 3-phase systems
Fundamentals: Fundamentals: Space vector based Transformer models - Development - 2-phase ITF based generalized model
Fundamentals: Electric machines – Generalized model - IRTF concept - Conditions for constant torque - General machine model
Fundamentals: Synchronous and Induction machines - Machine configuration
Fundamentals: Fundamentals: Lahore University of Management Sciences - Operating principles - Symbolic model - Generalized symbolic model - steady state characteristics, DC machines and Simple Drive System - Symbolic model - Steady State characteristics - Single phase uni-polar drive circuit - Single phase bi-polar drive circuit

EE-617 Special Electrical Machines

Voltage Stepper Motor: Introduction, Variable Reluctance Stepper Motor, Permanent Magnet Stepper Motor, Hybrid Stepper Motor, Other Types of Stepper Motor, Windings in Stepper Motors, Torque Equation, Characteristics of Stepper Motor, Open – loop Control of Stepper Motor, Closed – loop Control of Stepper Motor, Microprocessor – Based Control of Stepper Motor, Applications of Stepper Motor. Switched Reluctance Motor (SRM): Construction, Principle of Working, Basics of SRM Analysis, Constraints on Pole Arc and Tooth Arc, Torque Equation and Characteristics, Power Converter Circuits, Control of SRM, Rotor Position Sensors, Current Regulators, Microprocessor – Based Control of SRM, Sensor less Control of SRM. Permanent Magnet DC Motor and Brushless Permanent Magnet DC Motor: Permanent Magnet DC (PMDC) motor, Brushless Permanent Magnet DC (BLDC) Motors Permanent Magnet Synchronous Motor (PMSM): Construction, Principle of Operation, EMF Equation, Torque Equation, Phasor Diagram, Circle Diagram, Comparison of Conventional and PMSM, Control of PMSM, Applications. Synchronous Reluctance Motor: Construction and, Working, Phasor Diagram and Torque Equation, Control, Advantages and Applications Single Phase Special Electrical Machines: AC series Motor, Repulsion Motor, Hysteresis Motor, Single Phase Reluctance Motor, Universal Motor.

EE-618 Smart Grid Systems Operation

An Overview of the Smart Grid, Renewable Energy Generation, Power Grid, Smart Storage and Electric Vehicles, Smart Energy Consumption, Communications in the Smart Grid, Security and Safety for Standardized Smart Grid Networks, Interoperability, Integration of Variable Renewable Resources, Future of the Smart Grid.

EE-619 Power System Reliability

Power system security, stages of power system security, Voltage Concept of Power System reliability, modelling of generators, modelling of transmission lines, transformers & load, Reliability of multi-node systems: methods for multi-area and composite system analysis; contingency enumeration/ranking; equivalent assistance; stochastic/ probabilistic load flow 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.

EE-620 Power System Distribution

Primary & secondary distribution systems, Types of power distribution systems, radial, ring & interconnected systems, DC & AC distribution, substation bus bar schemes, Voltage Load modelling of distribution networks, Application of distribution transformers, Design of sub-transmission lines, Voltage drop, Power losses, Distribution system voltage regulation, Distribution system protection, Distribution system reliability. Application of capacitors to distribution systems, power factor improvement in distribution systems.

EE-621 Insulation Coordination in Power Systems

Transient over voltages in power systems, Introduction to Insulation Coordination, Temporary over voltages, Switching over voltages, switching of Transmission line, cables, capacitors, reactors, AIS/GIS substation modelling for Insulation coordination, surge arrester selection, Voltage Introduction; lightning

parameters; lightning performance of transmission lines; switching performance of transmission lines; AC performance of transmission lines; modelling breakdown behaviour; insulation co-ordination of substations and distribution networks.

EE-622 Photovoltaic Energy and its Applications

Applications of solar energy, solar radiation, solar cell technology and its properties, photovoltaic engineering, photovoltaic energy applications, environmental impact of photovoltaic, advanced and specialized topics, large PV projects, photovoltaic under concentrated sunlight, storage of energy (including alternative storage, the hydrogen economy), distribution of energy

EE-623 Advanced Electrical Machine Design

Voltage Advanced topics of electric machines, beginning with dynamic modeling and principles of vector control and evolving into new design and control of electric machines for advanced traction motors and renewable energy generator systems. Advanced electromechanics, Dynamic models, Reference frame transformations, Reduced-order models, Mechanical loads and models, Power electronic drives: dc techniques, ac techniques, models, Digital simulation of electric drive systems

EE-624 Power Generation Economics

Voltage Electricity Boards, Production methods of electrical energy, Formation of electrical energy system, Analysis of electrical consumers, Description and basic calculations from electrical point of view of production installations, Criteria of load satisfaction from electrical production systems, Electrical economy elements, Forming of electrical energy price list. Function and control of electrical energy systems, energy control centres, hardware and software of energy control, study and forecast of electric load, load curves, least squares method, the production system, thermic energy plants- characteristic curves, hydroelectric energy plants- characteristic curves, economic load dispatch of thermic energy plants, linear programming, Lagrange method, economic energy dispatch considering production-load equivalence, Newton-Raphson method, economic energy dispatch considering production-load equivalence and the functional limits of production plants, economic energy dispatch considering production-load equivalence, the functional limits of production plants and transmission losses, hydro-thermic energy plant co-operation, economic energy dispatch considering the transmission grid limits, generalized Kuhn-Tucker method, electrical energy exchanges, economic electrical energy exchanges, energy exchanges and plant entry.

EE-625 Power System Restructuring

Voltage Introduction to restructuring of power industry, Fundamentals of Economics., The Philosophy of Market Models, Transmission Congestion Management., Locational Marginal Prices (LMP) and Financial Transmission Rights (FTR), Ancillary Service Management, Pricing of transmission network usage and loss allocation.

EE-626 Condition Monitoring Techniques

Voltage Power quality issues and condition monitoring techniques used in electrical and industrial systems, Power systems and three-phase machines, Power Quality: Electromagnetic interference and interactions in energy systems, types of power quality issues, regulations, standards, prevention techniques, measurements and analysis and real-time tests. Condition Monitoring: Importance, types and features of faults, test methods, sensors and measurement techniques, traditional and advanced diagnostic methods, case studies and real-time tests.

EE-627 Energy Management

Voltage Energy Management Centers and Their Functions, Architectures, recent Developments, Characteristics of Power Generating Units and Economic Dispatch, Unit Commitment (Spinning Reserve, Thermal, Hydro and Fuel Constraints); Solution techniques of Unit Commitment, Generation Scheduling with Limited Energy. Energy Production Cost – Cost Models, Budgeting and Planning, Practical Considerations, Interchange Evaluation for Regional Operations, Types of Interchanges, Exchange Costing Techniques.

EE-628 Digital Control System

Voltage 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)

EE-629 Advanced Power Electronics

Voltage Averaged switch modelling of switched-mode converters, input filter design, current-programmed control of converters, Cascade connection of converters: Buck cascaded by boost, Boost cascaded by boost. Converters producing a unipolar output voltage, Converters producing a bipolar output voltage, suitable as dc-ac inverters, Several members of the class of two-inductor converters, Inverse SEPIC, Obtaining isolation in the Cuk converter, Switch stress and switch utilization, Construction of small-signal equivalent circuit model, Negative feedback: A switching regulator system, Negative feedback, Effect of negative feedback on the network transfer functions, Regulator system small-signal block diagram, Feedback reduces the transfer functions from disturbances to the output Closed-loop output impedance, Construction of the important quantities $1/(1+T)$ and $T/(1+T)$, construction of $T/(1+T)$, Analytical expressions for approximate reference to output transfer function, Interpretation: how the loop rejects disturbances, Terminology: open-loop vs. closed-loop, A loop gain leading to a stable closed-loop system, Closed-loop response, Design of closed loop system for the buck converter, Measurement of loop gains, Power and harmonics in non-sinusoidal Systems. Power and harmonics in non-sinusoidal systems, and line-commutated and pulse-width-modulated rectifiers.

EE-630 Distributed Generation

Voltage Overview of Power Systems and Distributed Generation Systems, Basic models of distribution systems, Introduction to distributed energy sources, Power system control: single- and three-phase systems, per-unit system, Issues related to bidirectional power flow on networks: voltage control, system protection, The basic inverter and interfacing, real and reactive control, Smart grid concepts, HVDC v's HVAC networks: offshore and onshore applications, The energy market: energy pools, bidding, clearing, unit commitment, balancing , capacity and ancillary services, demand-side management.

EE-631 Advanced Power System Transmission

Basic theory of line compensation. FACTS devices, The FACTS optimization problem. Transient and dynamic stability enhancement using FACTS components. Concepts of modern grid.

EE-632 Non - Linear Control Systems

Introduction to nonlinear and time-varying systems. Mathematical background, including vector spaces and norms. Lp norms for signals, induced norms for systems, and the Lebesgue Lp spaces. Existence and uniqueness of solutions to nonlinear differential equations. Techniques for the stability analysis of nonlinear and time-varying systems. Internal stability of feedback systems. Phase plane portraits. Lyapunov stability theorems. Popov and circle. criteria for nonlinear feedback systems. Passivity and small gain for nonlinear operators. Overview of design for nonlinear systems. Jacobian linearization and gain scheduling. Introduction to feedback linearization and extensions of optimal control techniques. Direct design methods.

EE-633 Advanced Power System Protection

Detection of system variables, relays, fuses and circuit breakers, protection of power transformer, motor, generator and lines, voltage and current transformer. Need for power system protection. Types of relays. Protection system terminologies. Current transformer (CT) and Potential Transformer (PT). CT and PT errors. Fuses and their types. Fuse terminologies. Circuit Breakers and related terminologies. Fuse - Fuse coordination. Fuse - Circuit Breaker coordination. Over Current Relays. Three Phase Over current protection. Directional OCR. Differential Protection. Transformer protection. Bus bar protection. Impedance protection. Generator protection. Induction motor protection. Feeder protection.

EE-634 Power System Modelling and Analysis

Basic principles of a.c power flow, Complex power, Power Factor Correction, Complex power flow, Balanced three phase circuits, Y- Δ Loads, Δ -Y Transformations, Per phase analysis, Modelling of power system components, Synchronous generator modelling, Three phase power transformer modelling, Transmission line models, Load modelling, Single line diagram, Impedance diagram, The Per Unit System, Load Flow/Power Flow studies, Types of Bus bars, Formation of Y matrix, Power Flow Equations, Gauss siedel method, Newton Rapson, Fast decoupled, Fault analysis, Types of faults, Short circuit capacity,

Systematic balanced fault analysis, Unbalanced faults, Symmetrical components, Sequence impedances, Sequence networks, Unbalanced fault analysis

EE-810 Advanced Power System Operation and Control

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 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.

EE-811 Advanced Process Control

Introduction to automatic control theory and structures, process systems and process models, process control of common unit processes, process control in large industrial complexes, robust processes control

EE-812 Advanced Power System Stability

General background and overview of power system stability issues (angle and voltage stability, transient, midterm and long-term stability), Synchronous machine theory and modelling, AC transmission components, Power system loads, Excitation systems, Prime movers and energy supply systems, Control of active power and reactive power, Small-signal stability, Transient stability, Voltage stability, Methods for improving stability.

EE-813 Optimization and Economics of Integrated Power Systems

Relevant factors in power system operation, theory of optimization under equality and inequality constraints, computational methods, application to generation scheduling in integrated power systems

EE-814 Control of Electric Machine Drives

Control of DC Motor Drives, AC Machines for Drives, Dynamic Model of a three phase machine, Role of Power Inverters in AC Motor Control, Space Vector PWM, Scalar Control and Vector Control of Induction Motor, Sensor-less control of induction motor, Direct Torque control of Induction Motor, Fuzzy logic based control of three phase induction motor, Expert system and neutral network for motor.

EE-815 Control of Power Electronic Converters

Voltage 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 (Electro Magnetic Interference), Voltage Mode Control, Current Model Control, Dual Loop Control for power electronic converters (dc-dc, ac-dc, dc-ac).

EE-816 Control of DC Machines and Drives

Voltage Electric machines, Power converters, Controllers, Load, Modeling of DC Machines, DC motor operation, Model of DC motors, Operating modes in DC motor drives, Electronically - commutated DC motor drives, Phase controlled DC motor drives, Chopper controlled DC motor drives, Control objective, Control structure, Control design, Example of a controller design, Equivalent circuit, Measurement of parameters of induction motors, Steady-states operation of induction motors, Voltage source inverters, Current source inverters, Cycloconverters, Stator-voltage control, Slip-energy recovery speed control, Frequency-controlled induction motor drives, Vector-controlled induction motor drives, Equivalent circuit, Steady-states operation of synchronous motors, Vector control of synchronous motors, Control strategies, Permanent-magnetic brushless DC motor.

EE-817 Control of AC Machines and Drives

Voltage Review of Basic Induction Motor Theory, Review of Synchronous Machine Theory, Converters for AC Drives, Adjustable Speed Drive Types, Induction Motor Model, Vector Analysis of Induction Machines, Current Regulation in Power Converters, Simulation of AC Machines and Drives, Complex Modeling for Control Design and Analysis, Field Orientation (FO)–Induction Machines, Field Weakening, Flux Observers and Direct Field Orientation (DFO), Field Orientation Control of Synchronous Machines, Permanent Magnet Synchronous Machine Drives, Direct Torque Control, Sensorless Control, Simulation of Field-Oriented Drives, Motor model, Practical Aspects of Drive Control

EE-818 Dynamics and Control of Integrated Power System

Modelling and simulation of synchronous and induction machines; transmission line dynamics and simulation; computer representation of excitation systems, governor and prime mover dynamics, interconnected system dynamics, theory of neglecting electromagnetic transients, time scale separation, transient stability studies, simulation methods, dynamic stability analysis, heroic measures for transient stability enhancement.

EE-650 Digital Image Processing

Introduction to image processing, the basic concepts, image acquisition, color representation, Spatial domain processing, intensity transformations, histogram analysis and equalization, image enhancements, filtering, Frequency domain processing, image filtering, image restoration, image compression, transforms, predictive coding, JPEG., introduction to video compression, Morphological operators, Segmentation algorithms.

EE-651 Advanced Digital Communication

Voltage Basic Elements of a Digital Communication System, , Mathematical Models, Analysis of Communication Signals and Systems , Deterministic Signals and Systems, Bandpass/Lowpass Representations, Signal Space, Random Processes, Bandpass/Lowpass Representations, Series

Expansions, Digital Modulation Schemes , Memoryless Modulations, PAM, PSK, QAM, FSK, Multidimensional Modulations, FSK, Biorthogonal, Simplex, Non-linear Modulations with Memory, CPFSK, CPM, Optimum Receivers for AWGN Channels, Optimal demodulation, Correlator, Matched Filter (MF), Optimal detection, MAP, ML, min distance, max correlation, Band-limited channels, Inter-Symbol Interference (ISI), Eye pattern, Signal Design for zero/controlled ISI, Optimum receivers for bandlimited channels with ISI, , Channel Equalization, Linear Equalizers, Decision Feedback Equalizers (DFE), Adaptive Channel Equalization, Adaptive Linear Equalizer, Zero-Forcing (ZF), min Mean Square Error (MMSE), , LMS algorithm, RLS algorithm, Blind equalizer, Adaptive DFE, Carrier , Symbol Synchronization, Carrier Phase estimation, Symbol timing estimation, Multicarrier Systems & OFDM, Multiuser Communications

EE-652 Digital Integrated Circuit Design

CMOS Logic, Switch Models & Simple RC Models, IC Fabrication, Layout & Design Rules, Device Physics, MOS Models, Device Scaling & Short-channel effects Inverters (CMOS, Pseudo NMOS), Static CMOS & Pseudo NMOS Logic Gates, Pass Transistor Logic, Dynamic Logic & Other CMOS Logic Families, Timing Clock Routing Buffers, Pad-Frames, Static/Dynamic Flip-Flops, Registers, Semiconductor Memory, Counters & Arithmetic Elements, CMOS Logic Families/Dynamic Logic, Design Flow Testing, Basic Economics for Full and Semi-Custom Approaches

EE-653 Antenna Theory and Design

Introduction, definitions, EM radiation, Friis and radar Equations, Basic antenna elements (dipole, monopole, loop, Antenna arrays, Antenna pattern synthesis, Aperture antennas, Integral Equations, Method of Moments, self and mutual impedance, Practical antennas

EE-654 Advanced Digital Signal Processing

Sampling of continuous-time signal and sampling rate conversion, Solution of difference Equations using different time-domain techniques, 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, 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 as a numerical approximation problem, transformation techniques for the design of IIR filters, FIR filter design by windowing, definition and properties of the discrete Fourier series, Discrete Fourier Transform (DFT) and its properties, application to linear convolution. Computation of the DFT: most commonly used Fast Fourier Transform (FFT) algorithms (radix-2, decimation- in- time, decimation in frequency, etc.) , Short-Time Fourier transform, Wavelet transform, Multi-rate signal processing systems

EE-655 Cellular and Mobile Communications

Overview of Mobile Wireless Communications: Background; Motivation; Technology Challenges; Future, Introduction to Mobility and Cellular Concept; Cell Design Philosophies, Physical layer; Mobile Channel; Mobile Transceiver Components (Modulation; Coding; Framing; Receiver Structures), Link Layer (Media

Access Control; TDMA, FDMA, CDMA), Application Layer (Compression, Security, etc.), Mobile Network Control, Mobile Network Management, Case study of GSM/WLL Networks, Topics in 3G+ Mobile Wireless Network: Conference Paper Presentations.

EE-656 Microwave Devices

Voltage RF and Microwave frequencies and technology, Passive microwave components: resistors, capacitors and inductors at RF and microwave frequencies; Transmission lines: coaxial lines, strip line, Slot line, coplanar line, and suspended-substrate strip line; Waveguides and its types (rectangular and circular etc.), Analysis and optimization of transmission lines: Impedance matching, Standing Wave Ratio (SWR), reflection loss, impedance matching on Smith chart, Passive microwave devices and circuits: directional couplers, isolators, circulators, resonant circuits, passive filter design, Active microwave components; Diodes, Transistor at RF frequencies, Small signal RF amplifier design, RF power amplifier, Quantum electron devices, microwave mixers and detectors, principle of RADAR.

EE-657 Secure Communications

Voltage Network Security Principles Authentication overview, Biometric authentication, Passwords and password-based authentication, Symmetric- and public-key authentication. Mutual authentication and key exchange, Authenticated key exchange. Mediated authentication and key exchange, PKI and certification authorities System Security: General principles of system security, Authorization and access control, ACLs and capabilities, Access control models, Programming-Language Security, Buffer-overflow attacks, defenses and counterattacks, SQL injection, web security (XSS/CSRF attacks), Web attacks and defenses, Privacy/Anonymity: Database privacy. Network security protocols in practice, SSL, Control-flow integrity, taint tracking, IPsec and IKE, Intrusion detection.

EE-658 Solid State Electronics

Voltage The course presents fundamentals of the solid-state electronics. The topics include electronic band structure of semiconductors, basic concepts such as Fermi level, band gap, mobility, carrier recombination. The main emphasis will be on principles of the solid-state device operation. The devices that will be considered in detail include field-effect transistors, bipolar and metal-oxide-semiconductor transistors. The course will also cover device fabrication issues, particularly overview of the molecular beam epitaxy, manufacturing of contacts and p-n junctions.

EE-659 Photonic Devices

Theory, design, fabrication and applications of photonic materials and devices. Survey of optical materials design for semiconductors, dielectrics and polymers, the course examines ray optics, electromagnetic optics and guided wave optics; physics of light-matter interactions; and device design principles of LEDs, lasers, photodetectors, modulators, fiber and waveguide interconnects, optical filters, and photonic crystals. Device processing topics include crystal growth, substrate engineering, thin film deposition,

etching and process integration for dielectric, silicon and compound semiconductor materials. Microphotonic integrated circuits and applications in telecom/datacom systems.

EE-660 Linear Control Systems

Model Based Controller Design, Control structures and performance measures, Design of controller for SISO system, Controller design for TITO processes, Limitations of PID controllers, Effects of measurement noise and load. Frequency Domain Based Identification, Identification of dynamic models of plants, Relay control system for identification, Off-line identification of process dynamics, On-line identification of plant dynamics. Time Domain Based Identification, State space based identification, State space analysis of systems, State space based identification of systems-1, State space based identification of systems-2, identification of simple systems, Identification of FOPDT model, Identification of second order plus dead time model, Improved identification using Fourier series and wavelet transform, DF based analytical expressions for on-line identification, Reviews of DF based identification. Design of Controllers, Advanced Smith predictor controller, Design of controllers for the advanced Smith predictor, Model-free controller design, Model based PID controller design, Model based PI-PD controller design, Tuning of reconfigurable PID controllers.

EE-661 Advanced Computer Networks

Resource management, Congestion control techniques in TCP, Intra-domain and Inter-domain routing protocols, IPv6, Software-defined networks, Content-aware networks, Wireless and data-centric networks, Network performance modelling and estimation, Queuing analysis, Markov chains, Integrated and Differentiated Services, Protocol support for QoS (RSVP, MPLS), Selected issues in unicast routing, Multicast routing, Internet of Things, Switch/router architectures, Basic interconnection networks, Wavelength Division Multiplexing (WDM), Optical networks beyond point-to-point

EE-662 Speech Processing

Fundamentals of speech production; speech analysis: pitch and period extraction, formant estimation, voiced - unvoiced decision, Linear prediction, Inverse filtering; Auditory modelling, auditory masking; Speech enhancement; Clustering, Gaussian mixture modelling, hidden Markov modelling, Implementation of speech and speaker recognition systems.

EE-663 Advanced Wireless Communication

Radio wave propagation, Physical modelling for wireless channels, Path loss and Shadowing, outage probability under path loss and shadowing, time and frequency coherence, Statistical multipath channel models, narrowband fading models, wideband fading models, Discrete-time model, Space-time channel models, channel capacity, capacity of flat fading channels, channel distribution Information known at transmitter or receiver and both capacity comparisons, Capacity of frequency selective fading channels- time invariant- time variant, SNR and bit/symbol energy, error probability for BPSK, QPSK, MPSK, MPAM, MQAM, Index Modulation over fading channels. Error probability for FSK and CPFSK, error probability

approximation for coherent modulations and differential modulation, Q-function representation, outage probability, average probability of error, inter symbol interference, selection combining (SC), threshold combining, maximal ratio combining (MRC), equal gain combining (EGC), channel known at the transmitter, channel unknown at the transmitter, Alamouti scheme, moment generating functions(MGF) in diversity analysis ,diversity analysis using MGF for SC-EGC-MRC, diversity analysis for non-coherent and differentially coherent modulation, equalizer noise enhancement, equalizer types, zero forcing equalizer, MMSE equalizer, maximum likelihood sequence estimation, decision feedback equalization, adaptive equalizers.

EE-664 Semiconductor Device Physics

The course will focus on the physics of semiconductor devices and the principals of their operation. The initial parts of the courses will be used to establish a solid understanding of aspects of electrical conduction in semiconductors. The major part of the course will be focused on different types of metal oxide semiconductor field effect transistors (MOSFETS) and MOSFET devices which are the dominant type of devices in the semiconductor device market. The use of transistor devices and their design and optimization for integrated circuit applications will be presented in detail. Nanoscale transistor dimensions and the effect of such dimensions on transistor behaviour will be presented. The physical limits to the scaling of CMOS devices will be discussed in detail.

EE-665 Data Communication and Security

Communication between computers on an intranet and the Internet, models that facilitate an understanding of communication in computer networks, the protocols HTTP, SMTP, TCP, IP, UDP, BGP, RIP, ARP, CSMA/CD & OSPF facilitate data communication, security risks associated with computer networks and implement mitigation strategies, desirable attributes in a communication protocol for a variety of different network applications.

EE-666 Advanced Communication Systems

Microwave Radio Communications, Diversity, protection switching arrangements, Digital TV, Satellite communication systems, Satellite sub systems, Evolution of mobile radio communications, Introduction to Modern Wireless Communication Systems, wireless networks, Over view of WIMAX technologies, Cellular concept, Wireless propagation mechanism, Introduction to Multiple Access GSM system architecture, Introduction to new data services

EE-667 Smart Antennas

Statistical signal processing concepts, Basics of mobile wireless communications. Radiofrequency signal modeling and channel characterization. Smart antennas and generalized array signal processing. Source localization problem. Joint angle and delay estimation. Smart antenna array configurations. Mobile communication systems with smart antennas.

EE-668 Advanced Microwave Engineering

Review of Transmission-line Theory: Lumped element model, Field theory of transmission-lines, TEM/TE/TM modes, Terminated lines, SWR, impedance mismatches, The Smith chart and impedance matching, Transient Analysis. Planar Transmission-lines: Stripline, Microstrip, Coplanar-line, and discontinuities. Waveguides: Rectangular waveguide, Circular and Dielectric waveguide concepts, Waveguide excitation. Matching Networks for Distributed Networks: Stub tuning, Quarter-wave transformers, Multi-section and tapered transformers. Microwave Network Analysis: Scattering parameters, multi-port networks, Signal flow graphs Resonators, Couplers, Power Dividers, and Filters. Q, Transmission-line resonators, Cavity resonators, Dielectric resonators, T-junctions, Magic Tees, and Wilkinson power dividers, Hybrid couplers, Coupled line and Lange couplers, Circulators, Isolators. Periodic structures, Filter design by the insertion loss method, Planar filter circuit implementations, Microwave Amplifier Design, Intro. to sources, detectors, and active circuits, Microwave Integrated Circuits (MIC): RF Microelectromechanical System (MEMS) Components, Microwave Systems, RF Components for Wireless Systems, RF Components for Ultra Wideband Systems.

EE-669 Advanced Satellite Communications

Basic Principles of Satellite Communications (GEO, MEO and LEO satellites. Launching and orbits. Frequency bands and polarization. Satellite footprints. Multibeam coverage. Power spectra. Link budgets. Modulation and coding. Access technologies. Earth station components. Space segment components. Satellite system services. Satellite operators.), Earth and Space Segments and the link (Earth station antennae. Transponders. Antennae sub systems. Power supplies. Link budgets. System noise. System losses. Interference. Satellite switching.), Ground Communications Equipment (Baseband signals. Analogue and Digital systems. Overview of modulation – AM, FM, PM. Digital Modulation. Frequency conversion –up and down conversion. Filters, mixers, local oscillators, IF amplifiers and group delay equalizers. Access methods – single and multiple access systems. Data networks. Television transmission – analogue and digital. Digital signal compression. MPEG processing.), Satellite Navigation (Longitude, latitude, altitude, GPS, How GPS works, timing, alternatives to GPS.), Mobile satellite services (Voice and Phones, BGAN, TV, GPS to program aerial, VSAT.), Error Control Coding (The need for coding. Linear block codes. Cyclic codes. Convolution codes. Interleaving and concatenated codes. Coding gain. Turbo codes.), Test and measurement (Theory and practice of Spectrum Analyzers)

EE-670 Research Methodology

Introduction to the nature of research process, Types of research (experimental/non-experimental), Steps of research (with emphasis on Engineering related research), Problem Identification, Literature review and information gathering and analysis techniques (simulation models, projections). Report Writers Pyramid, Business Letter Formats, Report Writing, Research Reports and Reference Formats, Resume Development/Cover Letter Writing, Public Speaking Units including emphasis on oral presentations. Steps in writing technical documents including research proposals, research grants applications, publishing research outcomes, finding the right platforms, Technology tools assisting research, bibliography styles,

determining impact of research, measuring the impact through various analytical scales including the citations, the impact factor, and performance parameters for evaluating research.

EE-671 Simulation and Modelling

Introduction to Simulation and Modelling, Discrete-Event Simulation, Simulation of a Single-Server Queueing System, Alternative Approaches to Modelling and Simulations; Review of Basic Probability and Statistics; Estimation of Means, Variances, and Correlations, Confidence Intervals and Hypothesis Tests for the Mean, The Laws of Large Numbers; Random number generators; Simulation of discrete, continuous probability distributions and empirical distributions; tests on simulated distributions, rejection method, simulation of multivariate distributions, correlations, and stochastic processes, simulation of models of arrival processes, Poisson Processes, Nonstationary Poisson Processes, Batch Arrivals, tests on generators, Markov- Chain Monte-Carlo simulations; Variance-Reduction Techniques.

EE-819 Design and Analysis of Algorithms

Asymptotic Notation and Performance of Algorithms, Searching and Sorting, Divide and Conquer Algorithms, Graphs, Dynamic Programming, Greedy Algorithms, Randomized, Algorithms, P and NP and NP-Hard Problems and Reductions, Unsolvable Problems, Approximation Algorithms

EE-820 Real time DSP

This course introduces the principles of real-time digital signal processing (DSP). The focus of this course is hands-on development of real-time signal processing algorithms using audio-based DSP kits in a laboratory environment. Basic concepts of DSP systems including sampling and quantization of continuous time signals are discussed. Trade-offs between fixed-point and floating-point processing are exposed. Real-time considerations are discussed and efficient programming techniques leveraging the pipelined and parallel processing architecture of modern DSPs are developed. Using the DSP kits, students will implement real-time algorithms for various filtering structures e.g., FIR/IIR filtering, and FFT algorithms and compare experimental results to theoretical predictions. We will also cover interrupt-driven programming, frame pro-cessing, quantization effects, code optimization, and DSP applications.

EE-821 Spatial Array Processing

Voltage Introduction, Sensor Arrays, Angle-of-Arrival, and Digital Beam forming, Linear Algebra via MATLAB. Space-Time Signals, Multi-Dimensional Fourier Transform, Plane Wave Decomposition; Resolution, Spatial Aliasing, Beam Pattern Synthesis via FIR Filter Design, Spatial Spectrum Analysis: f-k Domain Velocity Analysis, Phase Velocity, Group Velocity, Dispersion, Fan Filter Design via Multi-Dimensional Filter Design, Beam forming, Time-Domain: Delay-and-Sum, Interpolation, Frequency Domain: Phase Steer, Maximizing Array Gain, DFT Beam forming: ``Beam' Space, Optimal (Least-Squares) Array Processing, Spatial Spectral Correlation Matrix, MVE: Minimum Variance Estimation, Coherent Interference, Sub-array Averaging, Array Geometry: Sparse Arrays, Modelling Plane Waves in Noise: Prony, IQML, Signal and Noise Sub-Spaces; Eigenvector Techniques, Singular Value Decomposition, Adaptive (Antenna) Arrays, LMS: Least Mean-Square Iteration, Adaptive Nulling, Constrained LMS, Generalized Side lobe Canceller, Blocking Matrix, Partially Adaptive Arrays, Beam-Space Adaptation, RLS:

Recursive Least-Squares, Array Imaging, Reconstruction from Projections, Synthetic Aperture (Radar or Sonar), Spotlight & Strip map, Migration. Wideband Beam forming: Space-Time Adaptive Processing

EE-822 Advanced Information & Coding Theory

This course introduces the theory of error-correcting codes to computer scientists. This theory, dating back to the works of Shannon and Hamming from the late 40's, overflows with theorems, techniques, and notions of interest to theoretical computer scientists. The course will focus on results of asymptotic and algorithmic significance. Principal topics include: Construction and existence results for error-correcting codes. Limitations on the combinatorial performance of error-correcting codes and Decoding algorithms.

EE-823 Microwave Filters

Introduction to Microwave Filters, Selection of filters for various applications according to specifications, frequency ranges, trade-offs between performance and size, Filter technologies i.e. planar filters on conventional substrates, multilayer design and packaging techniques (LTCC and LCP) including quasi-lumped element filters, machined waveguide filters and substrate integrated waveguide, and monolithically integrated filters, Design methods for narrow-band, wide-band and multi-band filters, Manufacturing techniques, design-for-manufacture considerations, tolerance analysis and repeatability, Full-wave EM solvers and design tools such as CST MWS, HFSS and ADS for filter design and optimization.

EE-824 Monolithic Microwave Integrated Circuit (MMIC) Technology and Design

Basic concepts in RF Engineering, Integrated circuit (IC) implementation of RF circuits for wireless communications applications. Transceiver architectures for current wireless communications standards; active/passive device technologies for RFIC implementations; low noise amplifiers; frequency synthesizers, mixers; frequency sources; power amplifiers; single-chip radios; and RFIC packaging and testing. Case studies of modern RFIC chip sets for current wireless communications standards. The course involves circuit design at the IC level; modern RF/microwave CAD software will be used in conjunction with the course. Design of a wireless transceiver functional block component RFIC chip.

EE-825 Metamaterials and Nanophotonics

The course covers engineered structures possessing tailored electromagnetic properties, or properties that are difficult or impossible to achieve using conventional materials. The contents of the course include: Background of Metamaterials (MM), Microwave metamaterials, Optical Metamaterials, Retrieval of constituent parameters, Background and applications of Metasurfaces (MS), Microwave MS such as Isotropic metasurfaces, anisotropic metasurfaces, polarisation control MS, Optical MS such as Plasmonic Materials, Applications of Plasmonic metasurfaces. CST MWS/HFSS for the design and analysis of the meta-devices.

EE-826 Mobile Ad-hoc Networks

Introduction to Mobile Ad-Hoc Networks, Ad-Hoc networks topologies, Physical and MAC layer specifications and design considerations for MANETs, Physical and MAC layer specifications and design considerations for IEEE 802.11 and IEEE 802.16 family of standards, Mobility in Ad-Hoc networks,

Introduction to Mobile IPv4 and IPv6, Fast Mobile IP, Hierarchical Mobile IP, Routing Layer for MANETS – design and performance considerations, Routing protocols for MANETS (Proactive, Reactive, Hybrid, Hierarchical and Location based routing protocols for MANETS), Quality of Service provisions in the IEEE 802.11 and IEEE 802.16 family of standards and relevance to MANET operation. In depth analysis of the various course topics in network simulator.

EE-827 Advance Intelligent Networks

Introduction to Intelligent Networks (IN), IN Architecture, IN Architecture Evolution, IN services, Introduction to Signalling System 7 (SS7), Message Transfer Part (MTP), Signalling Connection Control Part (SCCP), Transaction Capabilities Application Part (TCAP), ISDN User Part (ISUP), Intelligent Network Application Part (INAP), Mobile Application Part (MAP), IN Conceptual Model, Service Plane, Global Functional Plane, Distributed Functional Plane, Physical Plane, Service Creation and Management, IN Markets, Customized Applications for Mobile network Enhanced Logic (CAMEL), CAMEL Architecture, CAMEL Application Part (CAP), SS7 over IP, Signaling Transport (SIGTRAN) Network.

EE-828 Wireless Sensor Networks

Introduction to Wireless Sensor Networks, Network Architecture, Hardware Platforms, Introduction to ns-3, ns-3 core, Medium Access Control Protocol design, Introduction to Markov Chain, MAC Protocol Analysis, Routing protocols, Routing protocols for WSN, Opportunistic Routing Analysis, Clustering, QoS management, Localization, Time Synchronization, Security, Programming in WSNs, Energy Harvesting WSNs.

EE-829 Internet of Things

Describe what IoT is and how it works today, Recognise the factors that contributed to the emergence of IoT, Design and program IoT devices, Use real IoT protocols for communication, Secure the elements of an IoT device, Design an IoT device to work with a Cloud Computing infrastructure, Transfer IoT data to the cloud and in between cloud providers, Define the infrastructure for supporting IoT deployments

EE-830 Semiconductor Processing

Provide an introduction into the operating principles of electronic and optical devices, and present the relevant material science issues in the principles of semiconductor processing. Present the relevant materials science issues in semiconductor processing. Outline Review of electronic structure and band structure of semiconductors; intrinsic and extrinsic semiconductors; transport properties of semiconductors; semiconductor devices and their applications; defects in semiconductors; semiconductor characterization techniques: structural, electrical and optical techniques; Bulk semiconductor crystal growth : techniques, defects and properties; thin film growth : chemical and physical vapor processes; heteroepitaxy and defects; substrates and substrate engineering; device fabrication fundamentals: diffusion, ion implantation, metallization; lithography and etching. Recent advances in semiconductor nanostructures research will also be introduced.

EE-831 Quantum Mechanics

photoelectric effect, Compton scattering, photons, Franck-Hertz experiment, the Bohr atom, electron diffraction, de Broglie waves, and the wave-particle duality of matter and light. Introduction to wave mechanics: Schrödinger's equation, wave functions, wave packets, probability amplitudes, stationary states, the Heisenberg uncertainty principle, and zero-point energies. Solutions to Schrödinger's equation in one dimension: transmission and reflection at a barrier, barrier penetration, potential wells, the simple harmonic oscillator. Schrödinger's equation in three dimensions: central potentials and introduction to hydrogenic systems.

EE-832 RF Circuits Design

Introduction to communication electronics, general signal transmission theory, communication network, overview receiver/transmitter architectures, noise in RF-systems, modulation techniques, analogue and digital modulation, baseband and bandpass signals, introduction to antenna theory, RF-circuits, design of RF circuits and systems, Communication circuit or system design. System or circuit design in communication electronics.

EE-833 Free Space Optical Communications

Topics include optical/RF comparison, applications, laser sources, link equation, modulation/detection, receivers, advanced spatial acquisition/pointing/tracking techniques from air and space, atmospheric effects, networking, and terrestrial links.

EE-834 Advanced Digital System Design

Review of Combinational Logic, Review of Synchronous Sequential Design Fundamentals, VHDL: VHSIC (Very High-Speed Integrated Circuit) Hardware Description Language, Introduction to Programmable Logic Devices (PLDs), Algorithmic State Machine (ASM) Charts, Hardware Testing and Design for Testability.

EE-835 Adaptive Filter Theory

Introduction to Adaptive Filtering Concept, Review of Random Processes, Eigenvalue Analysis, Wiener Filters, Method of Steepest Descent, Least Mean Square (LMS) Algorithm, Recursive Least Squares (RLS) Algorithm, Affine Projection Algorithm (APA), Subband Adaptive Filtering, Some Applications of Adaptive Filtering

EE-836 Special Advanced Topics related to Electrical Engineering

To be selected based research area of student(s).

UNIVERSITY RULES AND REGULATIONS

MASTER'S DEGREE PROGRAM

GENERAL

The Master's degree program at the University of Engineering and Technology Mardan shall extend over a period of at least four semesters. The M.Sc. Program spans over 2 to 4 years, i.e. for a maximum duration of eight semesters.

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.

MSc students will study 6XX Level core courses, as specified by the respective departments. For domain elective courses, they can also enroll in 8XX level courses.

RULES

1.1 Admission

- a) Master's degree program shall commence in Spring and Fall semesters, i.e., twice annually.
- b) Candidates seeking admission must have a Bachelor's Degree (16 years of education) in a relevant discipline from a program accredited by Pakistan Engineering Council (where necessary) and/or programs recognized by the Higher education Commission (HEC) of Pakistan. *(Department-Specific requirements are mentioned in relevant chapter/section)*
- c) Minimum CGPA 2.0 out of 4.0 or First Division (at least 60% Marks) in Annual System in Bachelor's Degree. The percentage will be valid only if the CGPA is not mentioned in the degree/transcript.
- d) The GRE- General Type Test administered by the Educational Testing Service, with a minimum 50% cumulative score

OR

The Graduate Admission Test (GAT)-General conducted by the Education Testing Council/ University Authorized Testing Agency (UATA) with a minimum 50% cumulative score

Furthermore, the GRE-General and GAT-General test shall be valid for a period as per HEC guidelines.

- e) The final merit list will be calculated based on the percentage weightage distribution as:
 - GAT/GRE General Test = 70%
 - Education (terminal degree) = 30%
- f) Applications on the prescribed form shall be submitted to the Director Admissions, within due date advertised in newspapers, after which no application shall be entertained.
- g) Seats for Pakistani students are given in Table-1.

Table 1: Seat Allocation for Pakistani Students for Fall-2021 and Spring-2022 Semester

Department	Seat Reserved for Open Merit	Seat Reserves for Rationalized Fees Basis	Total
Computer Software Engineering	35	10	45
Telecommunication Engineering	35	10	45
Electrical Engineering	35	10	45
Total	105	30	135

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 15 days of the completion of admission to the Controller of Examinations. The Controller shall assign a registration number to each student.

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 program 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 in some other institution, is ineligible to apply for admission in this University. 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 UET Mardan 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+CGPA or %age marks in terminal degree) between two or more candidates seeking admission in the Master's Program, the higher CGPA/%age 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 program.
- 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) Six (06) floating seats are reserved for foreign students in the Postgraduate Program of UET Mardan.
- e) The fee for foreign students is mentioned in Table 3.

1.2 Advisor Postgraduate Studies

Each specialization of the Department concerned will have an Advisor Postgraduate Studies, having Ph.D. Degree, who will work under the direct supervision of the Chairman. The advisor will monitor the implementation of the postgraduate program in his/her department and maintain liaison with the ASARB (Advance Studies and Research Board) Secretariat. The duties of the Postgraduate advisor will include:

- a) Providing guidance to students on rules and regulations of the Postgraduate Programs.
- 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 PG students on various issues, such as registration, selection of courses and general program of study

1.3 University Fees

University fees for postgraduate students enrolled on open merit seats are shown in Table 2. Fees for Rationalized Fees Based Students are shown in Table 3.

Fees for a semester are payable at the beginning of each semester, on the date of registration. Late fee of Rs.200/- per day (maximum upto Rs.1,800/-) will be charged from the students who failed to deposit the University dues/funds within due date for any reason.

In case of Admission Cancellation, the refund policy is as under:

%age of Tuition Fee	Timeline for Semester System
Full (100%) Fee Refund	Up to 7 th day of commencement of classes
Half (50%) Fee refund	From 8 -15 th day of commencement of classes
No Fee (0%) refund	From 16 th day of commencement of classes

Table 2: University Fees for Postgraduate Students on Open Merit

S. No	Item	Pakistani Nationals (Rs)
1	Registration Fees (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

Table 3: Fees and other Charges for Rationalized Fees Students

S.No	Item	Pakistani Students (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

1.4 Registration

- a) At the beginning of each semester, students shall register for courses in consultation with the Advisor Postgraduate Studies (APGS) of the Department.
- b) List of courses offered in a Department shall be finalized by APGS of the relevant field of specialization, in consultation with Chairman, and this shall be displayed on the postgraduate notice board 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.
- 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 do so according to the following conditions:
 - i. He/She will apply 15 days prior to the start of the classes.
 - ii. He/She will pay registration fee of Rs. 3000 for the “Freeze Semester”
 - iii. He/She cannot freeze the first semester.
 - iv. Any student can freeze upto a maximum of 2 semesters, which should not be consecutive.
 - v. He/She can resume his/her studies in the semester after the “Freeze Semester”, subject to the approval of the Chairman.
- f). If a student neither freezes nor registers a semester and then wants to register in a subsequent semester, he/she shall pay a penalty, equal to non-tuition fee component of the semester fee.

1.5 Work Study Load

A student shall not be allowed to take more than three courses per semester.

1.6 Addition of Courses/Withdrawal from Courses

- a) A student may be allowed to add/drop courses within two weeks of the beginning of classes.
- b) A student may be allowed to withdraw from courses within nine 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 Mardan, 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.

1.7 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.

1.8 Examination

1.8.1 Course Work

a) For all taught courses of MSc Program, 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 APGS of the respective departments.

1.8.2 Research work

a) The M.Sc research proposal (expected at the end of second semester of 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 ASARB office for final approval. The Chairman of the department concerned will recommend the names of three faculty members holding Ph.D. degrees (including Advisor Postgraduate Studies) for constitution of PREC, for approval of the Vice Chancellor through Convener ASARB. The Chairman of the concerned department will act as the Convener of the PREC. The PREC will be reconstituted after a period of one year. The Chairman of the concerned department may recommend a PhD faculty member, expert in the relevant area, to act as member (co-opted) for the PREC.

b) All MSc students working on their research will give at least one seminar to PREC at the end of each semester.

c) Before a student is allowed to defend his/her thesis, it will be vetted by the university against plagiarism. For the award of MSc degree, at least one paper should be published from the MSc research thesis in a refereed national/ international conference or journal.

d) The maximum number of postgraduate students under a Research Supervisor shall be twelve (12) which will include maximum of five (05) PhD students.

1.8.3 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 pre-circulated 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 needs revisions, it may be referred back for revision and resubmission within a specified period as detailed by the Examination Committee. If minor revisions are required in the thesis, it shall be submitted within two weeks of thesis defense. In case of major revisions, maximum time limit for resubmission shall

be six weeks. If the thesis is found inadequate, it will be considered as failed. 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.

1.9 Quality of Work (Grades)

- a) To be eligible for graduation, a student must have a CGPA of at least 2.67 in course work and satisfactory grade (S) in research thesis. Grade Points are assigned as shown in Table 4.

Table 4: 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
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 to improve the grade by repeating the course within the prescribed time limit. Only the higher grade will be used in computing the GPA. In case a student has "F" grade in an elective course which is not offered in a subsequent semester, the student may enroll in a different elective course in lieu of failed course.
- c) Grade "I" (incomplete) is awarded to a student only if he/she has missed the Final Examination 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 Semester Grade Point Average (SGPA) will be calculated as follows:
 Quality Points of each course = Grade Points of grade awarded x Course credit hours.
 SGPA = Sum of Quality Points of all courses / Total credit hours
- e) Improvement of grade "C+" and below:

Students taking grade "C+" or a lower grade than "C+" will get a maximum of two chances 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.

1.10 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.

1.11 Duration of Courses

There will be two semesters in an academic year. Each semester will be of eighteen weeks duration, including classes and conduct of examinations.

1.12 Degree Requirements

- a) The course and research work should be completed within maximum of 4 years, as per HEC guidelines. The student must complete all the requirements of the MSc Degree within forty eight months (08 semesters) of the first registration for the program.
- b) Total of 30 credit hours (including 6 credit hours of research and 24 credit hours of course work) are required to complete the Master's Degree Program.
- c) A student can take up to two courses being offered by Teaching Departments other than his own, if so advised by the APGS/Chairman. The student shall be entitled for the credit of such courses.
- d) On the completion of course and research work, the student shall apply for defense of thesis on a prescribed proforma available from the Directorate of Postgraduate Studies/ Departmental Postgraduate Advisor and University website (www.uetmardan.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 defense.
- e) After successful defense 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 defense 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 Library, Central Library of the University and the Directorate of Postgraduate studies.
- f) The degree of Master of Science (MSc) 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 MSc degree on a prescribed proforma available from Directorate of Postgraduate studies/ Advisor Postgraduate Studies and/or University website (www.uetmardan.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 defense examination.
- h) The admission of the student will be cancelled if he/she remains absent continuously for two semesters without freezing the semester.
- i) The student will be issued transcript for the semesters attended/registered, upon request.

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 ASARB on the recommendation of the PREC 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 M.Sc. 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 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 M.Sc. stream/admission in another stream of engineering, a maximum of six credits of the previous stream 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 Advisor Postgraduate Studies of the department.

1.17 Discipline

Students enrolled in the Postgraduate Program 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: Assisting teacher in conduct of theory/lab course to the under-graduates students only, with a financial assistantship of Rs. 5000/- per month along 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 Registering in Individual Courses

A private student who wishes to take a course without taking admission in the M.Sc. Program, 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 M.Sc. Program. He/she will be awarded a Certificate by the Chairman of the Department concerned for attending the course(s) without claiming any credit.

1.20 Special Provisions

1. In all cases where regulations are silent, the decisions of the Vice-Chancellor shall be final.
2. All other regulations and instructions relating to Master's Engineering courses issued here-to-fore stand repealed.
3. 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.
4. Interpretation of these rules and regulations by the authorized officers of the University shall be final.

1.21 Cancellation of Admission

1. A bona-fide student of the University may apply in person, or through parents/ guardians for cancellation of admission on a non-judicial stamp paper worth Rs.50/- duly attested by an Oath Commissioner. The Chairman of the concerned department shall cancel the admission of the student and notify the same.
2. In case, the admission of 1st semester student is cancelled due to any reason, the rules regarding University fee/dues chargeable/refundable mentioned in the university fee section of the postgraduate prospectus 2021-22 will be applicable. Whereas in all other cases, all outstanding dues/fees etc. till date must be paid.
3. A bona-fide student of the University who joins any other Department/Intuition or Academy for the purpose of study shall be liable for immediate cancellation of his/her admission. In such case only the Library & Lab. Security (on first registration) will be refundable.

PH.D DEGREE PROGRAM

General

These rules apply on all Ph.D. Programs in which the UET Mardan will be sole degree awarding authority. The Ph.D. program shall extend over a period of 03 to 08 years as specified by Higher Education Commission of Pakistan. 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, University 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, as per university policy.

All research work will be carried out at UET Mardan, unless otherwise advised by the Supervisor. Part-time students must also fulfil 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).

2.1 RULES

Admission

- a) Ph.D. program 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.
- b) The Director Admission in consultation with the heads of departments will invite applications for admission to the Ph.D. program 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 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.

Registration

- 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) A PhD student will register in 8xx Level Courses to complete the course work. However, maximum of two courses can be studied from the 6XX elective courses, on recommendation of the PREC, provided that such course(s) has/have not been studied in the prior degree.
- i) The student must register for a minimum total of 54 credit hours.
- j) No supervisor shall have more than five (05) candidates for Ph.D. simultaneously
- k) The candidates seeking admission in Ph.D. Program must have:
 - (i) A M.Sc./M.Phil/Equivalent degree (18 years of education) 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) Subject Test (score $\geq 60\%$) conducted by University Appointed Testing Authority (UATA) or the Subject Test (score $\geq 70\%$) conducted by a University Committee consisting of at least 3 PhD faculty members in the subject area and approved by the HEC, 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) All students must be available for a minimum period of two years as full time regular student taking leave from their jobs.
- c) 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 ASARB for approval of the Board. All committee members must have Ph.D. degree except possibly No. (v). The composition is as follows:
 - (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 Mardan.
 - (v) One member from a Research Institute/ Industry.
 - (vi) Advisor Postgraduate Studies of the Department (Secretary)

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. The REC shall meet at least once a year, starting from 1st REC Meeting, with no more than two meetings in a year, and monitor the research work of the candidate. 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.

The REC shall also act as an Examination Committee. The quorum for the REC shall be at least three members (excluding APGS) 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 recommend that the student may continue his PhD if it is satisfied with the annual progress of his/her work or to discontinue his PhD at any stage if it is not satisfied. In any case the report on satisfactory or un-satisfactory annual progress of the student will be submitted by the chairman of the REC (i.e. supervisor) to the university authorities through director postgraduate studies.

2.3 Examination

2.3.1 Ph.D. Qualifying Examination

- a) Each department shall conduct Ph.D. qualifying examination on a regular basis. It will be a written exam on pass/fail basis designed to test knowledge of basic principles in core areas relevant to the candidate's research field.
- 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 one year 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 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 it to the office of ASARB 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 Evaluation of Thesis

The 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 REC 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) 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 ASARB shall recommend to the vice-chancellor for appointing a neutral examiner whose opinion shall be final.

c) 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.

2.3.4 Foreign Thesis Evaluation

a) Two Foreign Thesis Evaluators from technologically advanced countries will be nominated by the supervisor concerned for a Ph.D. student. The supervisor will submit nomination to the Director Postgraduate Studies who will recommend these names to Dean for final approval of vice-chancellor.

b) Thesis evaluation by the foreign evaluators will be on the following basis:

(i) That thesis is satisfactory, Viva-voce examination may be held to enable the candidate to defend his/her thesis, (No correction),

OR

(ii) That the thesis may be resubmitted by the candidate after revision on the proposals suggested by the members,

OR

That the thesis be rejected as it is not of merit and candidate be declared ineligible

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) Open defense of PhD dissertation will be arranged. The date and time shall be made public by the Director Post Graduate Studies
- 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 ASARB shall recommend to the vice-chancellor for appointing a neutral examiner whose opinion shall be final.
- e) Publication of at least one research paper in an HEC approved journal (W or X Category) 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/Assistantships

Subject to the availability of funds in the budget, limited number of teaching assistantships can be granted to PhD students, as follows:

- a) 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 to the University all expenses incurred on their Ph.D. in case of wilful abandoning of the Ph.D. program as ascertained/notified by the PhD Supervisor of the funded student.
- d) Funding for each funded Ph.D. student will be released annually by the University on the recommendation of the ASARB.
- e) The student availing such Assistantship shall be bound to terms and conditions pertaining to such Assistantships

2.5 University Fees

University fees will be charged at rates prescribed in Table 3 for Rationalized Master's students.

2.6 Ph.D. Split Program

The Ph.D.Split Program will include those Ph.D. Programs which involve joint supervision from the two universities participating in the program. The student will be registered with both the institutions. The student will abide by the rules and regulations of the degree awarding institution and additionally will follow all those terms and conditions having mutually agreed upon by the two institutions in the Split Ph.D. Program.

2.7 Cancellation of Admission

1. A bona-fide student of the University may apply in person, or through parents/ guardians for cancellation of admission on a non-judicial stamp paper worth Rs.50/- duly attested by an Oath Commissioner. The Chairman of the concerned department shall cancel the admission of the student and notify the same.
2. In case, the admission of 1st semester student is cancelled due to any reason, the rules regarding University fee/dues chargeable/refundable mentioned in the university fee section

of the postgraduate prospectus 2021-22 will be applicable. Whereas in all other cases, all outstanding dues/fees etc. till date must be paid.

3. A bona-fide student of the University who joins any other Department/Intuition or Academy for the purpose of study shall be liable for immediate cancellation of his/her admission. In such case only the Library & Lab. Security (on first registration) will be refundable.

CONDUCT AND DISCIPLINE RULES AND REGULATIONS

1. RULES AND REGULATIONS

The University Discipline Committee (UDC) shall have the authority and power to deal with, and decide all cases of indiscipline, in accordance with these Conduct and Discipline Rules and Regulations.

2. APPLICABILITY AND COMMENCEMENT

These rules shall be applicable to all the students of UET Mardan and shall commence w.e.f. their admission in the university.

3. STUDENTS CODE OF HONOR

Each and every individual student shall:

(a) show loyalty in their religious duties and respect the opinions of others in matters of religion, integrity and customs.

(b) be truly loyal to Pakistan, and stay away from doing anything that can reduce its honor and reputation in any way.

(c) be honest and trustworthy in dealing.

(d) show respect and care for seniors and show politeness to all, especially to women, children, old people, weak, deformed and the helpless.

(e) respect their teachers and staff in the University.

(f) be conscious of cleanliness of body, mind, speech and habits.

(g) assist their colleagues.

(h) show dedication to studies and extra-curricular activities.

(i) protect government's property.

4. FORBIDDEN AND INDISCIPLINE ACTS

Students should refrain from:

(a) Smoking within the University premises.

(b) Using, carrying or facilitating prohibited drugs and drinks within the University Campus or University Hostels or during training, sports or cultural tours, survey camps or entering such places or attending any such tour of camp while under the influence of such intoxicants, or any other University functions outside the Campus.

(c) Organizing or taking part in any function within the University Campus or hostels or organizing any club or society of students or students' associations, unions and federations, except in accordance with the prescribed rules and regulations.

(d) Gathering money, receiving funds for, or on behalf of the University, except with the written approval of the Vice-Chancellor.

(e) Performing, inciting or contributing in any walk-out, strike, or other form of agitation against the University or its teachers or officers, inciting anyone to violence, or disrupting the peaceful atmospheres of the University in any way. Moreover, making of offensive speeches or gestures which may cause hatred shall be avoided. Issuing of pamphlets or cartoons casting criticisms 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 or social media platforms, making false accusations or lowering the prestige of the University or writing and pasting posters on the walls.

f) Carrying firearms or any other weapon (of any nature/type) forbidden by law, within the University Campus, classrooms, hostels and offices.

g) Violates the lawful instructions of a teacher or other person in authority in the University

h) Causing damage to the property of the University or public or a fellow student or any teacher or any employee of the University.

i) Using of loud speakers in the University Campus or hostels.

j) Not obeying the rules concerning to residence in hostels, or using offensive language, wearing immodest clothes, making indecent remarks or gestures, or behaving in a disorderly manner, or committing any criminal immoral or shameful act (whether committed within the University Campus or outside) or any act which is detrimental to the interest of the University. Doing false representation or giving false information or willfully suppressing facts, cheating or deceives the University.

k) Falsifying, damaging, altering or erasing or otherwise meddling with any document connected with examination, receipt of University fees / dues or making undue use of such documents.

5. PROCEDURE IN CASE OF BREACH OF DISCIPLINE

a) Cases of indiscipline shall be reported to the Vice-Chancellor through the concerned head of department/section.

b) The Vice-Chancellor may refer the case to the University Discipline Committee (UDC) for necessary action under the Rules/Regulations.

c) The UDC may impose, with the approval of Vice-Chancellor, minor/major penalties including to fine, suspend, expel or rusticate students on the basis of the enquiry conducted in response to violation of rules and regulations of the University.

d) The appellate authority for the decisions of UDC shall be the Vice-Chancellor.

6. RUSTICATION AND EXPULSION

a) Rustication

- i. Rustication, whenever forced on a University student, shall always mean the loss of one semester or one academic year of the student.
- ii. During the rustication period, the student shall not be allowed to register any course in the University or sit in any examination.
- iii. No fee will be charged from a rusticated student for the duration in which his/her name is struck off the rolls.
- iv. If a student is rusticated during a running semester and has paid the University fee for that semester, he/she will have to repeat that semester upon expiry of the rustication period. However, he/she shall not be required to pay the University fee for that semester again.

b) Expulsion

- i. The expiration period will be counted from the date of the issue of such notice from the University.
- ii. Expulsion period can vary.
- iii. 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.
- iv. A student expelled from a Department may be re-enrolled into that Department after the expiry of the period of expulsion.
- v. Cases of expulsion will be registered in the University and notified to all Departments and Universities.

7. GENERAL

- a) The authority, which has the power to rusticate could also withdraw the same order before the expiry of the period.
- b) No student shall be rusticated/expelled from the University unless he has been served with the Show Cause Notice, and shall be allowed a reasonable time for clarification and reply to the charges framed against him.
- c) When in the view 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.

8. APPEAL

- a) An appeal in contradiction of the punishment awarded by the University Discipline Committee (UDC) can be made to the Appellate Committee.

- b) No appeal by a student against the decision of the University Discipline Committee (UDC) 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.

9. OFFENCES AND PENALTIES

University authorities can impose the following Penalties for various violations committed:

Table 1: Offences and Penalties

S.No	OFFENCE	PENALTY
1.	Using alcoholic drinks or carrying 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 or outside the campus under the influence of such intoxicants or disobedience with others, especially females, during tours etc.	Expel from classes for one week or fine not above Rs. 10,000/OR Discharge from the University
2.	Taking part in or organizing any function within the University Campus or hostel or organizing any society of students or student's association, unions or federation, except in accordance with the prescribed rules and regulations.	Strict warning and / or Fine not beyond Rs. 20,000/-, AND / OR Expulsion from hostel accommodation, if relevant.
3.	Assembling any money or collecting funds for or on behalf of the University, except with the written permission of the Vice-Chancellor.	All the collected money shall be confiscated in favor of the University. AND/OR Fine not exceeding Rs. 10,000/
4.	Forcing fellow students to a walkout from classes or examination halls or organizing, leading 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.	Using abusive and derogatory language or aspersion remarks in speeches, brochures or posters against the University authorities or members of teaching or administrative staff of the University or substantially 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.	Discharge from the University for one to six semesters/ three years, depending on the nature of the crime. AND / OR Fine not exceeding Rs. 30,000/
6.	Participating or conducting a violent attack on the offices of the University authorities, Chairmen, faculty members or other officers/staff of the University.	Permanent expulsion from the University. AND / OR Fine not exceeding Rs. 50,000/
7.	Damaging/destroying or attempting to damage/destroy the property (movable or immovable) of the University or University employees or Government or any other Public	Recovery of the amount equal to the value of the damage caused; and / or fine not exceeding Rs.

	Organization or stealing or taking away by force any item of University property.	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 classrooms 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 student communities 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/staff members.	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, religious affiliation, or any other platform.	Fine not less than Rs. 5,000/- AND / OR Stern warning. Rustication / expulsion from University.
12	Holding “Dars” or “Waz-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/-
14	The University does not tolerate discrimination or harassment on the basis of gender. When the University becomes aware of gender-based harassment or discrimination, the University will take steps to end the conduct, prevent its recurrence, and address its effects on the individual and community. The University proctorial board is authorized with reviewing and evaluating conduct and harassment processes and outcomes and making recommendations to the University Discipline Committee (UDC) for onward action.	As per recommendations of the UDC

10. STUDENTS’ GRIEVANCES REDRESSAL

If a student has grievances against any department/section/center/directorate/office or employee of the University, he/she can submit a complaint to the Director Quality Enhancement Cell (QEC) on prescribed form available at the Directorate of QEC and/or download section of the University website.