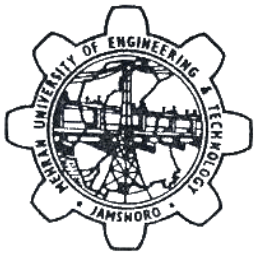

MEHRAN UNIVERSITY OF ENGINEERING & TECHNOLOGY, JAMSHORO

PHD – TELECOMMUNICATION ENGINEERING

SELF ASSESSMENT REPORT

PhD in Telecommunication Engineering

Submitted to,

Quality Enhancement Cell, MUET

January, 2025

PROGRAM TEAM (PT) Department of Telecommunication Engineering:

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Criterion 1: PROGRAM MISSION, OBJECTIVES AND OUTCOMES

1.1 Vision of the University

To become world class educational and research institute and contribute effectively towards building up indigenous and technological capabilities for sustainable socio-economic development.

1.2 Mission of the University

To equip our undergraduate, postgraduate and doctoral students with advance knowledge through collaborative opportunities emerged from linkages with academia, industry and government.

1.3 Mission of the Department

To produce quality telecommunication engineers with in-depth knowledge and skills through collaborative environment who can meet current and future needs of the nation by serving in professional domains and carrying out quality research.

1.4 Standard 1-1:

The program must have documented measurable objectives that support Faculty /College and institution mission statements.

1.5 Vision of Program

The department of Telecommunication, Mehran UET is offering a PhD program with the vision of nurturing highly skilled individuals who can significantly contribute towards strengthening ICT infrastructure and bring about much needed IT revolution. The program aims to encompass a broad area covering advanced digital and analogue electronics communication, signal processing, computer networking, wireless communication, cyber security, multimedia, microwaves, optical communications and advance technologies.

1.6 Mission of Program

To produce quality telecommunication engineers with broad as well as in-depth technical knowledge for information, computer network and mobile industry with the aim of imparting skills to efficiently design, plan, operate and maintain information and communication systems.

1.7 Program Objectives

The goals and objectives of the doctoral program are:

1. Graduates will be skilled researchers capable of conducting and disseminating original, impactful research in telecommunications and related fields, driving innovative solutions and advancements.
2. Graduates should be able to recognize ethical and professional responsibilities and consider the impact of their work on society.
3. Graduates will have a strong foundation in the latest telecommunications technologies, enabling them to adapt to evolving industry trends and pursue lifelong learning opportunities to maintain their professional relevance.

1.8 PEO Assessment Methods

The following document outlines the direct and indirect assessment methods for evaluating graduate outcomes in telecommunications and related fields.

PEO-1

Graduates will be skilled researchers capable of conducting and disseminating original, impactful research in telecommunications and related fields, driving innovative solutions and advancements.

Direct Assessment

- Thesis or Research Project Evaluation: Assess the quality of research through rubrics focused on originality, methodology, analysis, and conclusions.
- Research Papers and Publications: Review the quality of published or conference papers authored by graduates.

Indirect Assessment

- Student/Alumni Surveys: Collect feedback on how prepared students feel for conducting and disseminating research.
- Employer Surveys: Seek feedback from employers on graduates' ability to conduct research and innovation at the workplace.
- Student feedback survey: Survey is conducted to get the students feedback.

PEO-2

Graduates should be able to recognize ethical and professional responsibilities and consider the impact of their work on society.

Direct Assessment

- Ethics in Research Coursework: The students will responsibly use modern AI tools in their research and cite self and other researchers.

Indirect Assessment

- Student/Alumni Surveys: Gather feedback on the perceived relevance of ethical considerations in their coursework and professional practice.
- Employer Surveys: Ask employers whether graduates exhibit ethical responsibility in their professional roles.

PEO-3

Graduates will have a strong foundation in the latest telecommunications technologies, enabling them to adapt to evolving industry trends and pursue lifelong learning opportunities to maintain their professional relevance.

Direct Assessment

- Final Exams: Use exams to test knowledge of telecommunications technologies, tools, and practices.
- Capstone/Design Projects: Evaluate students' use of current and emerging technologies in their final projects.

Indirect Assessment

- Student feedback survey: Use surveys or interviews where students reflect on their readiness to adapt to new technologies.
- Alumni and Employer Surveys: Gather data on how effectively graduates have adapted to industry changes and incorporated new technologies into their work.
- Professional Development Tracking: Review participation in lifelong learning activities such as workshops, certifications, or advanced courses.

Summery Mapping

Outcomes	Direct Assessment	Indirect Assessment
Graduates will be skilled researchers capable of conducting and disseminating original, impactful research in telecommunications and related fields, driving innovative solutions and advancements.	Thesis/project evaluation, publications, capstone projects	Student/alumni surveys, employer surveys, self-reflection
Graduates should be able to recognize ethical and professional responsibilities and consider the impact of their work on society.	Case study analysis, ethics coursework, project evaluation	Student/alumni surveys, employer surveys, exit interviews
Graduates will have a strong foundation in the latest telecommunications technologies, enabling them to adapt to evolving industry trends and pursue lifelong learning opportunities to maintain their professional relevance.	Technical exams, labs/simulations, capstone projects	Self-assessment, alumni/employer surveys, professional development tracking

1.9 Strategic plan to achieve program mission and objectives

The Telecommunication Engineering Department wishes to realize its vision, and accomplish its mission by following the process map of academic activity given below and make continual improvement by strengthening the department's partnerships with its stakeholders through systematic assessments and feedback and integrating emerging fields within the curriculum.

The program mission and objectives will be achieved through

1. Design, monitor, evaluate and revised academic program based on inputs from the industry.
2. Enhance students' learning through extensive course work and applying theoretical knowledge, and encouraging the students to get along with hands on practice on latest information and communication network equipment.

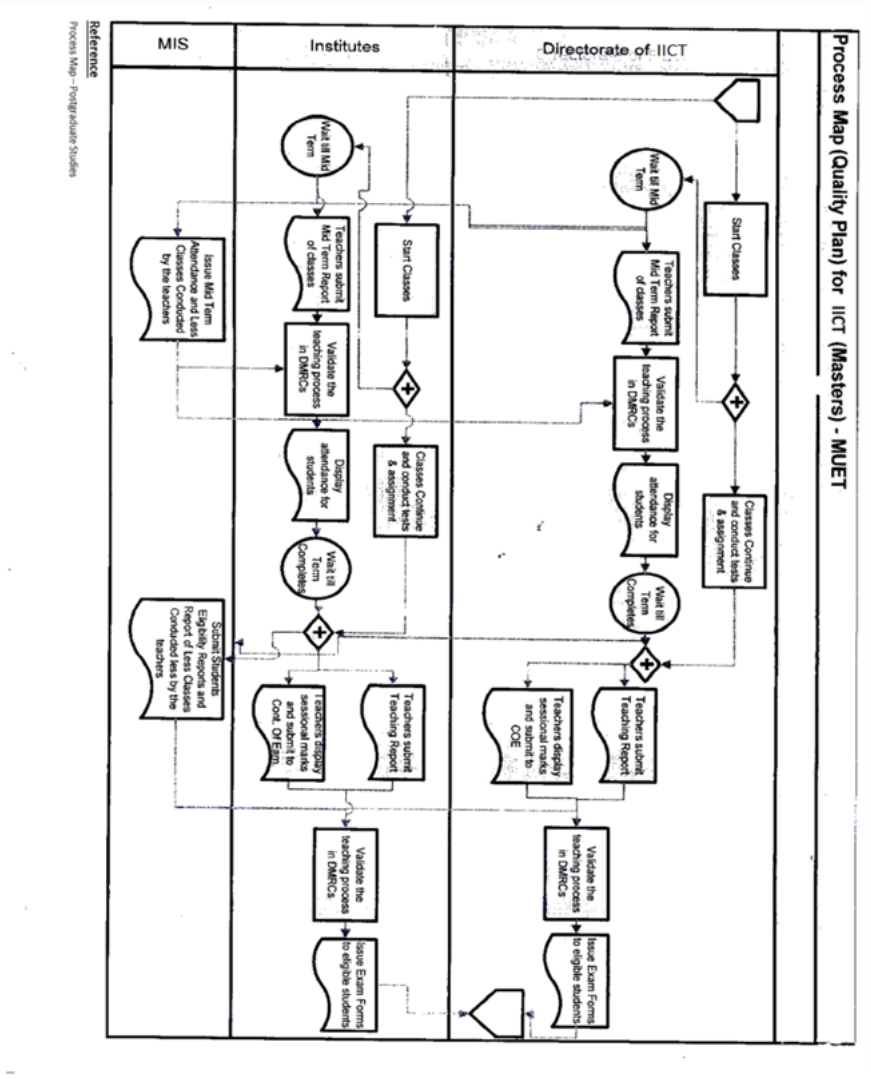

Figure 1.1: Process map of IICT (PhD)

3. Provide professional counseling and support to the students.
4. Arrange co-curricular activities like seminar/workshops and conferences for enhancing research expertise.
5. Successful completion of PhD thesis/project.

1.10 Measurement of objectives

The objectives of the program are measured as described in Table 1.1.

Table 1.1: Program objectives Assessment

Objectives	How measured	When measured	Improvement identified	Improvement made
To prepare scholars with research and design skills	Assessment of scholars regarding the fulfilment of objective in progressive seminar	2022	Scholars require training on Matlab and Python to improve their skills in computational modelling	The department shall organize training courses on Matlab/Python
To prepare scholars to conduct high quality research and disseminate it to scholarly and other audiences	Assessment of scholars regarding the fulfilment of objective in progressive seminar	2022	Elective courses will be adapted such that they are focused towards the needs of students' research	Feedback was conveyed to subject teachers and the supervisory team to liaise with subject teachers
To enable scholars to impart knowledge of the latest technologies in telecommunications and related fields	Assessment of scholars from research seminars and/or research publications	2022	HEC/Industry funded research projects needed to promote research	HEC/industry funded research projects applications shall be made with the help of ORIC

1.11 Standard 1-2:

The program must have documented outcomes for graduating students. It must be demonstrated that the outcomes support the program objectives and that graduating students are capable of performing these outcomes.

1.12 Outcomes and mapping of PhD program

The PhD scholar in Telecommunication engineering shall have following capabilities.

1. Be able to produce high quality research publications in conferences, journals, and books.
2. Compare and contrast latest information and communication network technologies.
3. Be able to maintain and manage the information and communication infrastructure and operations.
4. Be able to plan, design and execute the projects related to future communication networks.
5. Be able to secure career and assume leadership role in academia and telecom related industry.
6. Identify and apply information and communication industry rules and regulations.

Table 1.2 displays the relationship between program objectives and program outcomes:

Table 1.2: Mapping between program objectives and program outcomes

Objectives	Outcomes					
	1	2	3	4	5	6
To prepare scholars with research and design skills.	Direct	Direct	Direct	Indirect	Indirect	Indirect
To prepare scholars to conduct high quality research and disseminate it to scholarly and other audiences	Direct	Direct	-	Indirect	Direct	-
To enable scholars to impart knowledge of the latest technologies in telecommunications and related fields	-	Indirect	Direct	Direct	Indirect	Direct

1.13 Standard 1-3

The results of program's assessment and the extent to which they are used to improve the program must be documented.

This is the first assessment and therefore the program improvement plan will be soon made after the assessment from higher authorities.

Major future program improvements plans based on recent assessments

Though the first assessment is due the department has already planned to increase the equipment for laboratory and related literature.

List strengths and weaknesses of the program

The program is supported by highly qualified full time foreign returned PhD holders, the courses offered are up to date with current state of the art. It is however observed that the research carried out in the department finds it difficult to be transformed into industrial activity.

List significant future development plans for the program

Department intend to increase the number of equipment for laboratory and enhance department- industry linkages.

Table 1.3: Enrollment of Students during last 07 years

S. No.	Name of the Student	Father's Name	Roll No.	Department
1.	Ms. Zarlish Mushtaque	Mr. Mushtaq Ahmed	16PhDIICT03	TL
2.	Mr. Faisal Khan	Mr. Darya Khan	17PhDIICT07	TL
3.	Mr. Yahya Sameen Junejo	Mr. Sameen Afzal Junejo	18PhDIICT05	TL
4.	Ms. Komal Memon	Mr Ghulam Rasool	18PhDIICT13	TL
5.	Mr. Hyder Bux Mangrio	Mr. Muhammad Soomar	18PhDIICT14	TL
6.	Ms. Shanzah Mohsin	Mr. Abdul Sattar Shaikh	18PhDIICT17	TL
7.	Syed Mohsin Ali Shah	Syed Muhammad Ali Shah	18PhDIICT18	TL
8.	Ms. Saima Hafeez	Mr. Abdul Hafeez	19PhDIICT09	TL
9.	Ms. Shadab	Mr. Ali Nawaz Kalhoro	19PhDIICT12	TL
10.	Ms. Sindhu Khadim	Mr. Khadim Hussain	19PhDIICT16	TL
11.	Mr. Muhammad Saleem Khan	Mr. Khan Muhammad	20PhDTL01	TL
12.	Ms. Usira Channa	Mr. Najeeb-ur-Rehman Channa	21PhDTL01	TL
13.	Mr. Shakeel Ahmed	Mr. Muzafar Ali Laghari	21PhDTL02	TL
14.	Mr. Mehran Memon	Mr. Ghulam Shabir Memon	22PhDTL01	TL
15.	Mr. Saqib Hussain	Manzoor Hussain	23PHDTL001	TL

1.14 Standard 1-4

The department must assess its overall performance periodically using quantifiable measures.

1. Student enrollment during the last seven years Table 1.3 lists the details of enrollment of students in this program during last 07 yeas.
2. In order to assess the performance, the student and faculty feedback is received periodically about the department and program. The feedback process is very transparent. After the feedback, MIS department generates the reports which are then followed upon in DMRC and then at the level of Post Graduate Directorate.

The Directorate of Publications of the University is responsible for publishing Quarterly Research Journal "Mehran University of Engineering and Technology". The journal has been recognized as a Research Journal of International repute and is being abstracted at major National and International Abstracting Agencies with ISSN 0254-7821.

2

Criterion 2: CURRICULUM DESIGN AND ORGANIZATION

2.1 Title of degree program

PhD in Telecommunication Engineering

2.2 Major Areas of PhD Program

- Wireless communication
- Wireless systems and networks
- Computer systems and networks
- Electromagnetics
- Antennas and wave propagation
- Photonics
- Optical communication
- Optical networks
- Microwave and THz Communication
- Wireless Sensor Networks
- Internet of Things
- Social Signal Processing
- Human Machine Communication
- Network Security

2.3 Courses Offered

For strengthening student's knowledge in his/her field of research work and for enabling him/her to carry out research properly, he/she is required to complete the course work of at least 18 credit hours followed by a comprehensive examination. Transfer of credits earned in other Institutions may be approved in individual case up to a maximum determined by the Equivalence Committee. Table 2.1 lists mandatory courses offered by the university for PhD programs. The elective courses schemed as given in the table 2.2

Table 2.1: Mandatory courses Offered

S. No.	Course Name	Marks	
		Credit Hours	Marks
1.	Mathematical Modeling and Simulation	3	100
2.	Research Methodology	3	100
Total		**6**	**200**

Table 2.2: Elective courses Offered

S. No.	Course Name	Marks	
		Credit Hours	Marks
1.	Elective course – I	3	100
2.	Elective course –II	3	100
3.	Elective course–III	3	100
4.	Elective course–IV	3	100
Total		**12**	**400**

Considering the background of the student vis-à-vis the field of his research work. The student's supervisor will propose these courses. The courses will be approved by the Board of Studies and Research Board and the Academic Council. The courses taught outside the department are managed and monitored through a clearly defined policy.

All elective courses offered under this program are listed in table 2.3.

Table 2.3: Elective courses offered by Telecommunication Engineering

Sub No.	Course Code	Course Name	Credits	Marks
1.	TL9152	Advanced Digital Signal Processing	3	100
2.	TL9182	Smart Antenna Systems for Wireless Networks	3	100
3.	TL9132	Optical Communication Systems and Networks	3	100
4.	TL9102	Spread Spectrum Communications	3	100
5.	TL9122	Internet of Things	3	100
6.	TL9140	Crowd Sourcing and Big Data Analytic	3	100
7.	TL9160	Software Defined Networks	3	100
8.	TL9112	Wireless Sensor Networks	3	100
9.	TL9200	Vulnerability Assessment & Pentesting in Cybersecurity	3	100
10.	TL9210	Machine Learning for Telecommunication Engineering	3	100
11.	TL9220	Wireless Communication: 5G and Beyond	3	100
12.	TL9230	Photonic Devices	3	100
13.	TL9240	Network Science	3	100
14.	TL9250	Network Security	3	100

The detailed outline of all courses of the PhD TL program are given in Appendix A. These are also available at https://tl.muet.edu.pk/programs/index.php.

2.4 Standard 2-1

The curriculum is in consistence with program's documented objectives.

Table 2.4 presents the mapping of PhD TL courses to the program objectives.

Table 2.4: Mapping of Courses to Program Objectives

Sub No.	Course Code	Course Name	Objectives		
			1	2	3
1.	MTH704	Mathematical Modeling and Simulation	✓		
2.	RM860	Research Methodology	✓	✓	
3.	TL9152	Advanced Digital Signal Processing		✓	
4.	TL9182	Smart Antenna Systems for Wireless Networks		✓	
5.	TL9132	Optical Communication Systems and Netwo		✓	
6.	TL9102	Spread Spectrum Communications		✓	
7.	TL9122	Internet of Things		✓	
8.	TL9140	Crowd Sourcing and Big Data Analytic		✓	
9.	TL9160	Software Defined Networks			✓
10.	TL9112	Wireless Sensor Networks		✓	
11.	TL9200	Vulnerability Assessment & Pentesting in Cybersecurity			✓
12.	TL9210	Machine Learning for Telecommunication Engineering			✓
13.	TL9220	Wireless Communication: 5G and Beyond			✓
14.	TL9230	Photonic Devices		✓	
15.	TL9240	Network Science		✓	
16.	TL9250	Network Security			✓

2.5 Standard 2-2

Theoretical background, problems analysis and solution design must be stressed within the program's core material.

These design attributes are stressed in the curriculum design. Table 2.5

Table 2.5: Break up of design attributes

Elements	Courses
Theoretical background	45%
Problem analysis	35%
Solution design	20%

2.6 Standard 2-3

The curriculum must satisfy the core requirements for the program, as specified by the respective accreditation body.

2.7 Standard 2-4

The curriculum must satisfy the major requirements for the program as specified by HEC, the respective accreditation body / councils.

2.8 Standard 2-5

The curriculum must satisfy general education, arts, and professional and other discipline requirements.

Minimum requirements for each program

The minimum requirement for this program is given in the table 2.6.

Table 2.6: Minimum requirement of PhD in Telecommunication

Program	**Engineering**	**Non-engineering**
PhD in Telecommunication Engineering	100%	0

2.9 Standard 2-6

Information technology component of the curriculum must be integrated throughout the program. Digital Technologies in Energy Systems, Modeling and simulation etc. with the help of software's and E-Book information.

In this program offered by the Telecommunication department, all these things have been integrated in the curriculum and it can be verified the syllabus.

2.10 Standard 2-7

Oral and written communication skills of the student must be developed and applied in the program.

For perusing postgraduate studies, it is desired that student must already possess the oral and communication skill. However, University also provides the facilities of improving the oral and written communication skills through ELDC by conducting English grammar and coaching courses in evening.

3

Criterion 3: LABORATORIES AND COMPUTING FACILITIES

Suitable laboratories and computing facilities are available and accessible to all faculty members and students to support teaching and research activities.

3.1 Standard 3-1

Laboratory manuals/documentation/instructions for experiments must be available and readily accessible to faculty and students.

Laboratory manuals/documentation/instructions for work/experiments/manuals are available and readily accessible to faculty and students for the research activities. Details are given as under.

Laboratory Title:	PC-1 Laboratory
Location and area:	In the premises of Telecommunication Department
Objectives:	1. To develop programming skills in the students. 2. To verify theoretical concepts with the help of practical. 3. To give practice on virtual scenarios.
Adequacy for instructions:	Customers' feedback ensures the positive response to the adequacy for instruction.
Software were available if applicable	Matlab and C/C++
Major equipments:	Multimedia projector, High Performance Computers (29) Note: Details are available on the department's webpage http://tl.muet.edu.pk/equipments/

Safety Regulation:	Laboratory instructors, departmental staff, laboratory supervisors, and course coordinators are all responsible for the enforcement of course, departmental and University safety standards. The interpretation of the rules to be followed by everyone is to be the interpretations of the course coordinator and the departmental administration. Any time after the first session of the semester, anyone who does not comply with the safety regulations will, without further warning, be prevented from remaining in the laboratory or laboratory area. **Supervision** Never work in a laboratory without proper supervision. your best protection against accidents is the presence of a trained, conscientious supervisor who is watching for potentially dangerous situations. **Protective Clothing** Proper protective clothing must be worn by all persons in the room at all times that anyone is working with. students and instructors must be protected from their necks to below knees. **Protective Footwear** No sandals, no open-toed shoes, and no foot covering with absorbent soles are allowed. Any foot protection that exposes any part of one's toes is unsuitable for wear in the laboratory. **Food and Drinks in the Labs** Food and drinks are never allowed in the labs. This includes all visible insulated water bottles or mugs, containers of water, or flavored drinks, containers of ice intended for consumption, etc. If a food or drinks container is empty or unopened, it needs to be inside a backpack, etc. and out of sight. **No Unauthorized Experiments** "Simple" chemicals may produce undesired results when mixed. Any experimentation not required by the laboratory manual or approved by your instructor is considered to be unauthorized experimentation.

IN THE EVENT OF A MEDICAL OR PERSONAL EMERGENCY IMMEDIATELY DIAL +92-22-2771351 or dial 2400, 2401 or 2410 from nearest intercom phone of the Department.

Laboratory Title:	Optical Communication Lab
Location and area:	In the premises of Telecommunication Department
Objectives:	1. To provide a practical understanding of fiber optics communication systems and skills required to properly design, install and maintain the fiber optics network. 2. Students will use the latest fiber optic technology and equipment to learn how to splice, connect, test, and troubleshoot optical fiber networks in order to increase efficiency, reliability and on-the-job.
Adequacy for instructions:	Customers' feedback ensures the positive response to the adequacy for instruction.
Major Equipments	OTDR Test Measurement AQ7260 (1), Fusion Splicer FSM17S (1), Basic fiber optic communication training system (EF-970), Optical Power meter AQ2160, Laser source (AQ4270-1), cleaver and Spectrum Analyzer Note: Details are available at on the department's webpage http://tl.muet.edu.pk/equipments/
Safety Regulation:	Safety regulations as indicated above are generic for Labs.

Laboratory Title:	Network and Protocol Design Lab

Location and area:	In the premises of Telecommunication Department
Objectives:	1. To give students a basic understanding of how to set up a personal computer system, including the operating system, interface cards and peripheral devices. 2. To prepare students for how to Plan and install a small business network and connect it to the Internet. 3. To equip students with how to verify and troubleshoot network and Internet connectivity. 4. To learn how to share resources such as files and printers among multiple computers. 5. To provide students with an understanding of identify the important characteristics of common WAN configurations and technologies, and describe the role of a routers in a WAN. 6. To learn the purpose and fundamental operation of the router operating system (IOS). 7. To learn how to identify, analyze, and troubleshoot simple distance vector routing protocols. 8. To learn the use of the commands incorporated within Cisco IOS Software to analyze and rectify network problems.
Adequacy for instructions:	Customers' feedback ensures the positive response to the adequacy for instruction.
Major Equipments	a. Internet Training System Kit (1) b. LAN Trainer Bench-mark Kit (1) c. LAN and Internet Trainer Kit (3) d. Cisco Router 2514 (5) e. Cisco Router 2501 (5) f. Cisco Router 4000 (1) g. Cisco 7170 (1) h. Cisco 5010 (2) i. Cisco 5548 (1) j. Cisco ASA Firewall 5585 (2) k. WAN & Internet-working Trainer (2) Note: Details are available at on the department's webpage http://tl.muet.edu.pk/equipments/
Safety Regulation:	Safety regulations as indicated above are generic for Labs.

Laboratory Title:	**Transmission and Switching Laboratory**
Location and area:	In the premises of Telecommunication Department
Objectives:	1. To train students to have hands on experience of the switching and transmission system. 2. To develop clear understanding of the core digital and switching concept like PCM and ISDN. 3. To provide an environment to the students to grasp the telecommunication concepts from the practical perspective.
Adequacy for instructions:	Customers' feedback ensures the positive response to the adequacy for instruction.
Major Equipments	a. PCM based Transmission and Switching Systems Kits b. Data Tester and Analyzer Kit Note: Details are available at on the department's webpage http://tl.muet.edu.pk/equipments/

Safety Regulation:	Safety regulations as indicated above are generic for Labs.

Laboratory Title:	Project Laboratory
Location and area:	In the premises of Telecommunication Department
Objectives:	To facilitate students to work/solve their projects independently or in a group by providing technical knowledge, skills and tools driven by the established and effective practices of technology, including design, product support and problem analysis.
Adequacy for instructions:	Customers' feedback ensures the positive response to the adequacy for instruction.
Courses taught:	Final year projects and mini semester projects.
Software were available if applicable:	Matlab, OPNET 9.0, Network Simulator, Packet tracer
Major Equipments	SUN Solaris Server and Workstations, High performance PCs Note: Details are available at on the department's webpage http://tl.muet.edu.pk/equipments/
Safety Regulation:	Safety regulations as indicated above are generic for Labs.

Laboratory Title:	Analog and Digital Communication Laboratory
Location and area:	In the premises of Telecommunication Department
Objectives:	1. Impart the concepts of practice in Analog and Digital modulation techniques. 2. Demonstrate the concepts of signals in time domain and the frequency domain. 3. Reinforcing the concepts of signals and systems by analyzing the amplifiers and modulators as systems in time and frequency domain.
Adequacy for instructions:	Customers' feedback ensures the positive response to the adequacy for instruction.
Major Equipments	Modulation and Demod- ulation Kits (8 Workstation) Note: Details are available at on the department's webpage http://tl.muet.edu.pk/equipments/
Safety Regulation:	Safety regulations as indicated above are generic for Labs.

Laboratory Title:	Cellular Communication Laboratory
Location and area:	In the premises of Telecommunication Department
Objectives:	1. To train students about the programming of cellular telephone, its fault diagnosis and audio connection between cellular telephone and test transceiver. 2. To adept students about monitoring of different variables e.g. Atmospheric Pressure, Wind speed and Rainfall measurement analyzed during environmental processes.
Adequacy for instructions:	Customers' feedback ensures the positive response to the adequacy for instruction.

Major Equipments	Cellular GSM trainer (3), System for Environmental and Meteorological Monitoring (2) Note: Details are available at on the department's webpage http://tl.muet.edu.pk/equipments/
Safety Regulation:	Safety regulations as indicated above are generic for Labs.

Laboratory Title:	**Radio Communication Laboratory**
Location and area:	In the premises of Telecommunication Department
Objectives:	1. To build the skills and practice in students to work on RF based equipment. 2. To provide students with an understanding of advances in the RF Engineering field.
Adequacy for instructions:	Customers' feedback ensures the positive response to the adequacy for instruction.
Major Equipments	Satellite Receiver Trainer, Microwave Communication Trainers, TV trainers, TV Antenna System Trainers, Waveguide Antenna System, Antenna Measuring system, Radar Trainer System, Weather Satellite Receiver Trainer. Note: Details are available at on the department's webpage http://tl.muet.edu.pk/equipments/
Safety Regulation:	Safety regulations as indicated above are generic for Labs.

Laboratory Title:	**Advance Computing Laboratory**
Location and area:	In the premises of Telecommunication Department
Objectives:	1. To provide students with an understanding of advances in the engineering technology field, that will enable them to pursue more advances degree. 2. To adept students with fundamental technical knowledge and skills driven by the established and effective practices of technology, including design, product support and problem analysis.
Adequacy for instructions:	Customers' feedback ensures the positive response to the adequacy for instruction.
Courses taught:	Sun Solaris 10 Operating System
Software available if applicable:	Sun Solaris 10 OS
Major Equipments	SUN WORKSTATIONS (ULTRA 25 and ULTRA 45) Note: Details are available at on the department's webpage http://tl.muet.edu.pk/equipments/
Safety Regulation:	Safety regulations as indicated above are generic for Labs.

Laboratory Title:	**PC-2 Laboratory**
Location and area:	In the premises of Telecommunication Department
Objectives:	1. To develop programming skills in students. 2. To verify theoretical concepts with the help of practical. 3. To give practice on virtual scenarios.
Adequacy for instructions:	Customers' feedback ensures the positive response to the adequacy for instruction.

Software available if applicable:	Matlab, C/C++
Major Equipments	Multimedia projector, High performance PCs (29) Note: Details are available at on the department's webpage http://tl.muet.edu.pk/equipments/
Safety Regulation:	Safety regulations as indicated above are generic for Labs.

3.2 Standard 3-2

There must be adequate support personnel for instruction and maintaining the laboratories.

Each laboratory is supervised by Lab In-charge, Lab Supervisor/I.T Assistant and Lab Attendant.

3.3 Standard 3-3

The University computing infrastructure and facilities must be adequate to support program's objectives.

The department has its own computer labs which prepare the students with different skills, workplace maturity and adept students with fundamental technical knowledge driven by effective practices of technology including design, product support and problem analysis. It really takes part in improving students' understanding of advances in the engineering technology field that will enable them to conduct high grade research activities and earn advance degrees.

4

Criterion 4: STUDENT SUPPORT AND ADVISING

4.1 Introduction

Directorate of Students Affairs gives an active support and advice to the students in academic and non-academic matter and indicates the advocacy of other facilities desired by the students. Besides the Director Students Affairs there is an Advisory committee also to make coordination with students and the management to resolve students' matters. At department level class advisers are also appointed to keep in touch with student and help them in academic matter like class attendance, course materials, arranging field visits etc.

4.2 Support Facilities for Students and other Components:

Many facilities have been developed and established in the University to provide assistance to the students in their studies as well as other related activities and leisure. These facilities and establishment are briefly described below.

4.3 Residential Accommodation

One hostel is available for the postgraduate students' accommodation. The hostels can accommodate a total of 100 students. However, the preference is given to neediest students who belong to farther areas of the province.

All the students who are interested in hostel accommodation can apply through a prescribed form which is available in the Provost office. All the residents have to follow strictly the hostel rules and regulations. The hostels are managed by the Provost, Deputy Provost and Wardens.

4.4 Medical Assistance

A part-time dispensary has been established in one of the hostels for the resident students, which is manned by a qualified doctor and a dispenser. Adequate quantity of essential medicine is also available in the dispensary for the minor ailments. Major sickness problems are referred to Liaquat University Hospital, which is quite nearby. An ambulance is also available for the sick students to take them to the hospital in any emergency.

4.5 Transport Facilities

The University has deployed buses for the use of students on various routes between the Campus and Hyderabad/Qasimabad/Latifabad/Kotri. Students have to pay nominal transport charges on yearly basis for the use of this facility.

4.6 Sports Facilities

The Directorate of Sports is responsible to entertain the students of this University by arranging Indoor and Outdoor sports events i.e. Inter Hostel for hostler students and Inter Department for department competitions. The University also organizes and participate Inter-university Sports Events in a large number. The new Gym has been constructed to provide the physical fitness facility with qualified trainers in the campus around the clock.

4.7 Financial Aid

As per directives of Higher Education Commission, Mehran University of Engineering and Technology, Jamshoro has taken initiative to stream line the Scholarship/Financial Aid of our students, in this regard we have established "Student Financial Aid Office" (SFAO) of Mehran University of Engineering and Technology, Jamshoro. Now all Scholarships/financial Aid Cases are routed through Student Financial Aid Office (SFAO). A centralized record of all students getting any Financial Aid will be kept in the Student Financial Aid Office (SFAO).

4.8 Endowment Fund Scheme

With a view to boost the *R&D* in Public Sector Engineering University Sindh Pakistan, the Ministry of Science & Technology has distributed a huge amount, out of which this university has been allocated Rs. 100 million as Endowment Fund. In compliance to the perspectives of IT Policy, this university has come forward to undertake *R&D* in the following major fields of IT & Telecommunication Sector:

- Computer Vision
- Telecommunication Systems & Networks
- Real-Time Application of Microprocessors & Embedded Systems
- Control System Design
- Energy & Power Management
- Artificial Intelligence
- Software Engineering
- Advanced VLSI System
- Industrial Automation
- Biomedical Engineering

This university has adequate infrastructure, state-of-the-art laboratory facilities for research & development, and highly qualified faculty to offer a number of Ph.D. and ME Scholarships in the above broad areas of Research.

Candidates selected for Ph.D. under Endowment Fund will also get a chance to do research work in Technological Developed Countries in Europe up to 12 months under Split/Sandwich Program. Candidates selected for MSE may have a chance to do their Project/Thesis work in Technological Developed Countries in Europe up to 06 months under Split/Sandwich Program.

4.9 Other Scholarships

All the PhD programs are fully funded on Prime Minister's scheme. The tuition fee has been reimbursed to the registered candidate after verifying their eligibility record through Prime minister's office.

4.10 Standard 4-1

Courses must be offered with sufficient frequency and number for students to complete the program in a timely manner.

The department offers courses in light of requirements of Pakistan Engineering Council (PEC) and Higher Education Commission (HEC) and completes in due course of time by following yearly academic calendar.

The details of the elective courses offered to the students in this program are already described in section 2.5.

4.11 Standard 4-2

Courses in the major area of study must be structured to ensure effective interaction between students, faculty and teaching assistants.

Close coordination is observed among student, faculty and teaching assistants during the courses through the steps taken as under.

- Class size is relatively small to ensure the good student/faculty interaction.
- Students are required to attend their classes regularly and well in time.
- Approved Teaching Plans are required to be given to each student before start of the courses.
- Teachers give assignments to the students and guide them to give presentations on various topics.
- Delivery of course material to the student is also ensured by the faculty.
- Teachers entertain students even after the class hours to solve queries related to the course.

4.12 Standard 4-3

Guidance on how to complete the program must be available to all students and access to academic advising must be available to make course decisions and career choices.

Information about program requirements

Students are informed about the program requirements through newspapers, notice board and MUET website.

4.13 Mechanism for providing counseling to students

For newly admitted students in the program, an informal session is conducted on the first day to brief the students about the features of the PhD program, courses, and research directions. They also get to know the practices of the semester system being followed. For academic counseling of students in general and those who are having academic difficulties, the Department assigns “mentoring tasks” to the senior faculty. This practice is specially meant for the students facing problems in academics.

4.14 Advising system

The Directorate of Students Affairs advises students in academic affairs, rules and regulations, adapt university life and studies, explore their interests and goals and work toward meeting departmental mission. The advisor also meets with prospective students and their parents or guardians and welcomes all questions and queries.

4.15 Professional counseling and interaction with practitioners

A Directorate of Industrial Liaison has been established in the University to provide professional counseling and provide platform to interact with practitioners. The Directorate is also facilitating the organization of industrial/field training for the students of the University. In addition to arranging the practical training for the students, the Directorate of Industrial Liaison also performs the following functions.

- To collaborate with the industries for identifying their problems and attempting to solve them through efforts of experienced and qualified professors of the University.
- To arrange exchange of technical staff between the University and industry for the mutual benefit of the both.
- To guide and supply information to the students regarding their possible employment in the industrial/commercial sector.

Effectiveness of program may be observed from raising standard of university at national and international level affiliations with foreign institutions that the recruitment of MUET graduate from the campus at the time of program completion.

5

Criterion 5: PROCESS CONTROL

The processes by which major functions are delivered are in place, controlled, periodically reviewed, evaluated and continuously improved.

5.1 Short Title

These regulations may be called the Mehran University of Engineering and Technology PhD Degree Course Regulations 2017 repealing such regulations framed by the University authorities (if any). These regulations have been deemed to have come into force with effect from the 2018 batch and onwards.

5.2 Standard 5-1

The process by which students are admitted to the program must be based on quantitative and qualitative criteria and clearly documented. This process must be periodically evaluated to ensure that it is meeting its objectives.

5.3 Criteria for Admissions

Admissions to the all postgraduate courses are made according to the policies and rules, framed by the authorities of the university from time to time. The candidates who apply for their admission on the basis of fake certificates/documents (detected before or after their admission) shall be prosecuted under criminal law and their admission shall be canceled. Additionally, they may also be debarred for a period of three years for future admissions.

5.4 Duration of Program

The minimum duration for completing all the requirements for the full time and part time PhD degree program shall be three years and five years, respectively. The maximum duration for completing all the requirements for the full time and part time PhD degree program shall be five years and seven years respectively. However, the ASRB may extend the period up to two years on account of any special circumstances on the recommendation of supervisor.

5.5 Procedure for Admission

A notice for admission in first year is published in daily newspapers for inviting applications. The schedule of issue and submission of application form is given in the advertisement and on MUET website. The Prospectus and Application Forms are sold through branches of an authorized bank. The relevant policy, rules and procedure for admission, information about pre-admission test is published in the prospectus. The University provides information regarding services to the customers through: Advertisement Prospectus Notice Boards MUET Website

5.6 Submission of Admission Forms

The candidates are required to obtain application forms from directorate IICT of post graduate studies and deposit form fee and then the same office within the announced due date. These application forms are then sent to the Mehran University where they are scrutinized. After this scrutiny, all the eligible candidates are sent admission slips for entry to the Pre-Admission Test.

The applicant will submit the application form duly completed in all respects along with the relevant documents by the last date fixed for this purpose. The student may be registered for a full time or part time program. A full time student, if employed, will have to obtain study leave from employer before registration. A part time student, if employed, will have to obtain No Objection Certificate from his/her employer before registration. Each application for admission will be processed separately by the concerned Directorate/Institute. Incomplete application forms or applications not accompanied by the relevant documents and/or processing fee, or applications received after the due date will not be considered.The University reserves the right to refuse admission to any applicant without assigning any reason, or cancel the admission of a student at tiny stage if his/her conduct or progress in studies is not found satisfactory.

Students seeking admission are required to pay the fees at the lime of admission as given in the prospectus duly approved by the University authorities. All fees paid are non-refundable except the library and caution money, which will be refunded at a time when student leaves the Institution.

5.7 Pre-admission Test

In accordance with the policies adopted by the Federal as well as Provincial Government of Sindh all the eligible candidates applying under any category are now required to appear in the Pre- Admission Test organized by the University. Candidates having secured less than 50% marks in the Pre-Admission Test shall not be eligible for consideration of their names for the purpose of admission in this University.

5.8 Eligibility

The eligible candidates should have: First class (Minimum 3.0 CGPA) Master's degree (06 years university education) in the relevant field from Mehran University of Engineering and Technology or any other university recognized by Mehran University of Engineering and Technology for this purpose. He/She is further required to be proficient in English Language, and be physically and mentally fit for the study.

At least 60% percentile Score in ETS GRE subject test or 60% Cumulative Score in NTS GAT subject test or 70% percentile score in GRE (Subject) type test, in the area of specialization chosen at PhD level, conducted by the university (where ETS GRE subject teat is not available) is required prior to admission in the PhD program.

5.9 Transfer of credits

Transfer of credits earned in other institutions may be approved in individual cases up to a maximum determined by the Equivalence Committee of the University.

Evaluation and Improvement of Admission Criteria

The admission criterion is evaluated every year by Policy Framing Committee. The recommendations of that committee are further reviewed and recommended further by the Academic Council of the University to the Syndicate for approval.

5.10 Standard 5-2

The process by which students are registered in the program and monitoring of students' progress to ensure timely completion of the program must be documented this process must be periodically evaluated to ensure that it is meeting its objectives.

5.11 Students' Registration

When a candidate is provisionally selected for admission in a particular discipline, he/she will be given a letter containing terms and conditions as per rules and advise to report personally to the concerned Director within due date to get Roll Number after submitting tuition and other fees through the Bank challan.

Each student is required to enroll himself/herself in the University after the finalization and obtain Enrolment Card accordingly. In case of failure, he/she will not be allowed to appear in the examination. Every student shall observe all rules & regulations of the Mehran University of Engineering & Technology Students Conduct and Discipline Regulations, 1978 as amended up to 06-07-2006.

5.12 Duration of Studies and Research

The minimum duration for completing all the requirements for the full time and part time PhD Program shall be three years and five years respectively. The duration starts from the date of admission and finishes at date of conduct of Viva Voce. The maximum duration, for completing all the requirements for the full time and part time PhD degree program shall be five years and seven years respectively. However, the ASRB may extend the period up to two years on account of any special circumstances on the recommendation of the supervisor/co- supervisor(s) and the concerned director/co-director. For strengthening student's knowledge in his/her research work, he/she is required to complete the course work. Each PhD Degree Program shall carry a number of approved courses and each course shall be assigned 03 Credit Hours (C.H). A PhD Degree Program shall have minimum 18 C.H of course work including compulsory and elective courses followed by the comprehensive examination. The duration of leaching time in each semester shall be 16 weeks. The number of contact hours for subject of 3 C.H shall be 48.

5.13 Monitoring the Academic Progress

The monitoring of the program is carried out as under:

- The Chairman/Director of the concerned Department/Institute/Directorate reviews the performance of their teachers in the Departmental Management Review Meetings in accordance with the Teaching Plan, which provides a chance to take preventive measures against any potential Non-Conformity.
- The subject teachers are also required to submit the class attendance sheets of the students along with the topic covered in the class to the Directorate of Management Information System (MIS), through the Chairman / Director of the concerned Department / Institute / Directorate. The Chairman / Director or his nominee from within the Departmental Management Review Committee verifies the class attendance sheets, before sending to the Directorate of MIS. A copy of the class attendance sheet duly stamped and signed by the Administrator in MIS is returned to the teacher through the concerned Chairman / Director. Any discrepancy observed in attendance sheet is communicated by the Director MIS to the teacher through the concerned Chairman / Director. The Dean of the faculty concerned is authorized to settle the matter in consultation with the Director MIS and the concerned Chairman / Director if need arises.
- At the mid and end of the semester every subject teacher compiles a report in prescribed form of the syllabus completed with the help of the copies of class attendance sheets and submits it to the concerned Chairman / Director.
- The Chairman / Director then reviews the report submitted by every subject teacher in Departmental Management Review to ensure the completion of prescribed syllabi in the semester.
- copy of Teaching Plan is also provided to the students at the beginning of every semester to prevent non-conformity.

5.14 Review of Non-conformity

The concerned Chairman / Director reviews all the identified Non-Conformities occurred during the semester and investigate the root-cause of the Non-Conformity and reports it to the concern Director/Dean, who reviews

the nature of Non-Conformity and sends it to the Vice-Chancellor. The Vice-Chancellor also reviews the nature of Non-Conformity and sends it to the Registrar to make it a part of the agenda for the up-coming meeting of the Academic Council.

- The Academic Council as one of the supreme authorities of the university is fully authorized and responsible to deal with Non-Conformity as per the nature. The Academic Council can take any action as per statutes to
  - eliminate the detected Non-Conformity
  - acceptance of the services under concessions
  - preclude the services as per Regulations
- The Academic Council is also fully authorized to take action even if the Non-Conformity is detected after the completion of the delivery of the services.

5.15 Verification of the corrective actions taken on a Non-Conformity

As per decisions of the Academic Council, Chairman / Director of the concern Department / Institute / Directorate takes the corrective measures against the Non-Conformity and reviews its status in the next Departmental Management Review to re-verify the status and to demonstrate the conformity to the requirement.

5.16 Evaluation of Registration and Monitoring Process

The admission and monitoring process is evaluated by Policy Framing Committee when required. The recommendations of that committee are further reviewed and recommended further by the Academic Council of the University to the Syndicate for approval.

5.17 Standard 5-3

The process of recruiting and retaining highly qualified faculty members must be in place and clearly documented. Also processes and procedures for faculty evaluation, promotion must be consistent with institution mission statement. These processes must be periodically evaluated to ensure that it is meeting with its objectives.

Process used to ensure that highly qualified faculty is recruited to the program

The University assigns responsibilities defined in the quality management system to personnel ensuring that they are competent on the basis of applicable education, training, skills and experience. Their qualification and experience data are maintained for record purposes.

Faculty Appointment

The faculty is appointed purely on the basis of Approved Rules, Regulations and Statutes fulfilling requirements of PEC and HEC. Following the appointment process the vacant seats are announced through local and national newspapers and MUET website. All received applications are thoroughly scrutinized and short listed candidates are called to appear before the selection board. The selection board conducts interviews and gives recommendations to the syndicate for the approval. After the syndicate approval the offer letters are given to the selected candidates. For the sake of promotion the faculty members can apply for next higher post. They can be appointed for next higher post through the same process of selection board.

Faculty Evaluation

Faculty members' performance is evaluated annually through Annual Confidential Reports prepared by the Chairman and countersigned by the Dean Concerned.

Teacher evaluation through Customer Feedback System

Customer/Student feedback is obtained regularly to monitor the level of satisfaction and to identify the needs and expectations of the students. The Vice-Chancellor or his nominee is responsible for obtaining student feedback. Student feedback is obtained through Student Feedback Form. Student feedback is obtained at the end of each Academic Term. The student feedback is compiled in the Computer Centre and statistically analyzed. The results of the analysis are submitted to the Vice Chancellor who would forward to the Dean QEC to place it in the Management Review Committee. Based on the statistical analysis actions are initiated for improvements towards quality of services. The relevant departments of the University are responsible for handling customer queries. The Chairman / Director /Head of Section is responsible for handling customer complaints related to his department / Institute / Section, in the cases mentioned below and others.

- Improper services or inadequate services
- Non co-operation of personnel
- Issues related to customer feedback

The customer complaint, through written application is received by Chairman / Director / Head of section who enters the complaint in the Customer Complaint Log. The Chairman / Director / Head of Section reviews the complaint, discusses with the customer and takes remedial measures. Any delay in taking remedial measure is the responsibility of concerned chairman / Director / Head of Section.

On the basis of complaints, the concerned Departmental Head fills in the Corrective / Preventive Action Request (CPAR). The CPAR contains a description of the unsatisfactory condition, root cause analysis, the proposed corrective action, person responsible to carry out the corrective action and proposed completion date.

The CPAR is sent to the Dean QEC, who reviews the proposed corrective action with the concerned Departmental Head. After the approval of both the Dean QEC and the concerned Head of the Department, Dean QCE logs in the CPAR in CPAR Log, allots number to the CPAR and returns the CPAR to the concerned Head of the Department to initiate the corrective action. The Vice- Chancellor is the final authority in case of more than one corrective actions suggested. QEC will maintain the Corrective/Preventive Action Log.

Customer complaint data is statistically compiled and analyzed after every 3 months by the Quality Coordinator and brought in the upcoming meeting of Departmental Management Review Committee. On the basis of the decision taken in the meeting of DMRC the Chairman / Director / Head of Section will take appropriate action for improvement.

5.18 Training, Awareness and Competency

The University has established and maintains a procedure to:

1. Identify competency needs for personnel performing activities affecting quality;
2. Provide training or take other actions to address identified needs;
3. Evaluate effectiveness of the training provided
4. Ensure that employees are aware of the relevance and importance of their activities and how they contribute to the achievement of the quality objectives
5. Maintain appropriate records of education, experience, training and qualification.

Methods used to retain excellent faculty members

In order to retain excellent faculty members who are on contact, the University extends his/her contact or he/she may apply for regular post and go through the selection procedure as per rules.

Indicate how evaluation and promotion processes are in line with institution mission statement

Evaluation and promotion processes are as per rules and regulations of the University which each faculty member is evaluated annually on his performance in teaching, research and other university services. These evaluations are based on the teaching performances through Annual Confidence Reports, self- evaluation, and the chairman's evaluation countersigned by the Dean Concerned. The teaching evaluation is based on the students' input and is conducted during the last few weeks of every semester for all the courses offered in the department. The chairman appoints research/graduate assistants to carry out this activity. At the end of the second semester, faculty members are requested to fill out their self-evaluation forms. Once the teaching evaluations and self-evaluations are reviewed by the Chairman, he forwards them along with his input to the Dean of College of Computer Science and Engineering, which are then forwarded to the Dean of Faculty and Personnel Affairs. Following this, the Faculty Affairs Committee, a standing committee of the university appointed each year and chaired by the Dean of Faculty and Personnel Affairs, reviews and finalizes the faculty evaluations. The annual performance evaluation of each faculty member is sent directly to him every academic year. The University realizes that maintaining high standards and continuous improvement of quality of teaching, research, and other services is directly associated with the benefits, incentives, and awards granted to the faculty with their development and achievements. The result of this policy is clearly reflected by the progress observed in teaching and level of the program graduates, increased rate of publications in reputed journals and conferences, in addition to the professional satisfaction level among faculty members. The policy has resulted in a stable educational environment and ensured the continued teaching competence and professional growth of the faculty.

5.19 Standard 5-4

The process and procedures used to ensure that teaching and delivery of course material to the students emphasizes active learning and that course learning outcomes are met. The process must be periodically evaluated to ensure that it is meeting its objectives.

In order achieve excellence in teaching and students' learning the sound process is implemented and regularly evaluated Moreover, the department puts a strong emphasis on utilizing the current modern technologies such as multimedia, audio-visual facilities, computer animations, and models by teachers in order to enhance the quality of course material delivery.

Processes and procedures used to ensure that teaching and delivery of course material are effective and focus on student learning are conducted through implementing the following process.

- The University is adopting the semester system of examinations comprising of two semesters in an academic year. The Academic Calendar is issued every year for undergraduate and postgraduate programs with the approval of the authorities. It is given wide publicity and also issued in the Prospectus each year.
- Subject Allocated by the Chairman/ Director is purely on the basis of expertise of the teachers
- Time table prepared by the time table committee
- The teaching plan for every teaching subject has to be prepared by the concerned teacher and is to be submitted to the Chairman / Director for approval by the Departmental Management Review Committee.
- The concerned Chairman / Director is responsible to ensure the completion of syllabi within prescribed number of lectures during the semester.
- There is a requirement of Academic Council to complete the syllabus within specific time frame, and with a limit of minimum number of lectures to be delivered.
- The subject teachers are required to develop a tentative Teaching Plan for the semester and that includes the syllabus to be completed in minimum number of lectures prescribed by the Academic Council. The Departmental Management Review Committee of the concerned Department approves the Teaching Plan for each subject of the semester.
- If the prescribed syllabus is not covered in the specific time frame then it is considered as a non-conforming service.

- The Chairman / Director of the concerned Department / Institute / Directorate reviews the performance of their teachers in the Departmental Management Review Meetings in accordance with the Teaching Plan, which provides a chance to take preventive measures against any potential Non-Conformity.
- The subject teachers are also required to submit the class attendance sheets of the students along with the topic covered in the class to the Directorate of Management Information System (MIS), through the Chairman / Director of the concerned Department / Institute / Directorate. The Chairman / Director or his nominee from within the Departmental Management Review Committee verifies the class attendance sheets, before sending to the Directorate of MIS. A copy of the class attendance sheet duly stamped and signed by the Administrator in MIS is returned to the teacher through the concerned Chairman / Director. Any discrepancy observed in attendance sheet is communicated by the Director MIS to the teacher through the concerned Chairman / Director. The Dean of the faculty concerned is authorized to settle the matter in consultation with the Director MIS and the concerned Chairman / Director if need arises.
- At the mid and end of the semester every subject teacher compiles a report in prescribed form of the syllabus completed with the help of the copies of class attendance sheets and submits it to the concerned Chairman / Director.
- The Chairman / Director then reviews the report submitted by every subject teacher in Departmental Management Review to ensure the completion of prescribed syllabi in the semester.
- A copy of Teaching Plan is also provided to the students at the beginning of every semester to prevent non-conformity.

5.20 Standard 5-5

The process that ensures that graduates have completed the requirements of the program must be based on standards, effective and clearly documented procedures. This process must be periodically evaluated to ensure that it is meeting its objectives.

The effective and clearly documented procedure is available to ensure that graduates have completed the program requirements. This process is also periodically evaluated to ensure that it is meeting its objectives.

A student shall be awarded degree of Master of Engineering (M.E.) only after he/she has passed the examinations and cleared all the Heads of all the Semesters within the maximum period of 02 (two) academic years for M.E.

The Chairman/ Director reviews the student records and ensures that all requirements for graduation have been met, then recommend the degree application forms. The Controller of examinations office makes a final check and issue degree certificate with signatures of Controller Examinations, Registrar and the Vice Chancellor.

5.21 Research Project / Thesis

The rules regrading the Research project / Thesis are as under:

- Each student shall work on a project individually. Students shall not be allowed to work in groups.
- A student shall be required to select a supervisor for his/her project. He/she may also select co-supervisor(s) if necessary.
- The supervisor should be a faculty member of MUET and his/her minimum qualification should be PhD in the relevant field.
- A qualified faculty member/expert of any other University or Industry may be taken up as a co-supervisor, if necessary.
- Each student shall prepare a research proposal of his/her project in consultation with his/her Supervisor and Co-Supervisor(s), if any. A student may select a supervisor and co-supervisor(s) on his/her own choice. However, the concerned Director/Co-Director reserves the right to change the Supervisor/Co-Supervisor, if necessary.

- A faculty member shall not supervise or co-supervise his/her real son, daughter, brother, sister, husband or wife.
- The supervisor/co-supervisor shall scan the research proposal of the student through Higher Education Commission (HEC) approved software for plagiarism and shall submit the duly signed and stamped hard copy containing similarity index to the concerned Director/Co-Director.
- The Director/Co-Director shall submit the research proposal to the concerned Dean for approval.

5.22 Conduct of Initial Seminar

Rules are as under:

1. After approval of his/her research proposal by the ASRB, the student will be required to deliver initial seminar before theASRB and experts.
2. The student will prepare a presentation of 15-20 minutes duration under the guidance of his/her supervisor/co-supervisor(s).
3. The Initial seminar will be evaluated by the following:
   (a) At least four Advanced Studies and Research Board (ASRB) members.
   (b) One internal expert
   (c) One external expert
4. The evaluations will be submitted to the ASRB for final approval.
5. In case the Initial Seminar is not approved by the ASRB, the student will be asked to deliver another seminar by incorporating the suggestions and observations of theASRB members and experts.
6. After approval of the initial seminar, the research proposal must be evaluated by at least three experts in the relevant field, one from within the country and the two from abroad.
7. The panel of the experts will be proposed by the supervisor and approved by the ASRB.
8. After completing all the formalities, including initial seminar, the student will proceed with his/her research work under the guidance of his/her supervisor in accordance with the approved Regulations of PhD degree program and deliver progress seminars and submit progress reports as required by the ASRB.

5.23 Conduct of Progress-I Seminar

The rules regarding the conduct of initial seminar are:

1. A student will be eligible to deliver Progress – I seminar if his/her course work including comprehensive examination is completed, his/her initial seminar is approved by the ASRB and his/her research proposal is evaluated by the approved experts in the relevant field and approved by the ASRB.
2. The date of the conduct of the Progress – I seminar will be announced by the concerned Director/Co-Director.
3. The student will prepare a presentation of 15 - 20 minutes duration under the guidance of his/her supervisor/Supervisor(s) and discuss about the progress that he/she achieved after his/her initial seminar.
4. The Progress – I seminar will be evaluated by the following:
   (a) At least four Advanced Studies and Research Board (ASRB) members
   (b) One internal expert
   (c) One external expert
5. The evaluations will be submitted to the ASRB for approval.
6. In case the Progress – I seminar is not approved by the ASRB, the student will be asked to deliver another seminar by incorporating suggestions and observations of the ASRB members and experts.

5.24 Conduct of Progress-II Seminar

The rules regarding the conduct of progressive seminar-II are:

1. A student will be eligible to deliver Progress - II seminar if his/her Progress - I seminar is approved by the ASRB and he/she has completed at least 50% objectives.
2. The date of the conduct of the Progress – II seminar will be announced by the concerned Director/Co-Director.
3. The student will prepare a presentation of 15 - 20 minutes duration under the guidance of his/her supervisor/co-supervisor(s) and discuss about the progress that he/she achieved after his/her Progress–I seminar
4. The Progress – II seminar will be evaluated by the following:
   (a) At least four Advanced Studies and Research Board (ASRB) members
   (b) One internal expert
   (c) One external expert
5. The evaluations will be submitted to the ASRB for final approval.
6. In case the Progress – II seminar is not approved by the ASRB, the student will be asked to deliver another seminar by incorporating suggestions and observations of the ASRB members and evaluators.
7. At least two Progress seminars are mandatory to qualify for the final seminar.

5.25 Conduct of Final Seminar

The rules regarding the conduct of final seminar are:

1. A student will be eligible to deliver final seminar if:
   (a) His/her Progress – II seminar has already been approved by the ASRB.
   (b) His /her final version of thesis book (loose bound) has submitted for evaluation.
   (c) He/she has published at least one research paper in the HEC approved journal.
2. The student will prepare a presentation of 30 - 45 minutes duration with the consultation of his/her supervisors.
3. The student will inform the concerned Director/Co-Director in written through his/her supervisor/co-supervisor(s) that he/she is ready for the final seminar.
4. The final seminar will be evaluated by the following:
   (a) The Dean of the concerned Faculty or his/her nominee.
   (b) Four Advanced Studies and Research Board (ASRB) members
   (c) One internal expert
   (d) One external expert
5. The Director/Co-Director will submit the evaluations to ASRB for final approval.
6. If ASRB does not approve the final seminar, the student will be asked, to deliver another final seminar by incorporating suggestions and observations of the ASRB members and experts.
7. The final seminar of PhD should be an open defense.

5.26 Submission of Thesis Book and Conduct of Viva Voice Examination

The rules are as under:

1. The student shall submit three hard copies (loose bound) and one soft copy of the thesis book to the concerned Director/Co-Director along with the processing fees of the thesis evaluation.
2. Student shall also submit the fees for anti-plagiarism services.
3. The Director/Co-Director shall send the soft copy of the thesis to the focal person of the Anti Plagiarism Cell of the University to scan it for finding authenticity of the Thesis through HEC approved software for plagiarism.
4. If the scanning report has similarity index less than or equal to 19% and no any single source has a similarity index greater than or equal to 5%, the thesis will be accepted for Viva Voce examination. Otherwise it will be returned back to the student. This procedure shall be repeated until minimum similarity index as defined above is met.
5. Director/Co-Director through his/her supervisor for expert evaluators.
6. The thesis will be sent to the experts within the country and abroad who had originally evaluated the research proposal, if any of the evaluators is not available the ASRB shall appoint a new evaluator. The name of any new evaluator will be again proposed by the supervisor.
7. Once satisfactory report is received from the approved evaluators, the student will be allowed by the ASRB to appear in the viva voce examination to defend his/her thesis. However, if the research work is not considered satisfactory by the evaluators the student will incorporate suggestions given by evaluators and resubmit the modified thesis through his/her supervisor.
8. The student will submit two hard copies (loose bound) of the thesis book to the concerned Director/Co-Director through his/her supervisor for viva voce.
9. The supervisor will propose a panel of external and internal experts for the conduct of the viva voce examination.
10. The concerned Director/Co-Director will submit this panel of experts to thecompetent authority for approval of one External and one Internal Examiner.
11. The Director/Co-Director will send the names of the approved examiners to theController of examinations along with two hard copies of the thesis book and the scanning report of the thesis.
12. The Controller of Examinations will send copies of the thesis to the approved examiners for their evaluation and conduct of final viva voce examinations.
13. The final viva voce examination will be conducted by the external and internal examiners in presence of the concerned Director/Co-Director and Supervisor/Co-Supervisor(s).
14. If the examiners recommend that the student is successful at the Viva-Voce examination, he/she may be declared to have passed the Doctor of Philosophy Degree examination. In case of failure, a second examination maybe conducted on the recommendations of examiners. In normal circumstances, no student shall be permitted a third examination. However, the ASRB may allow the third examination under genuine circumstances.
15. The hard bound copies prepared on guidelines and approved by the concerned Director/Co-director and evaluation report of the examiners duly signed by all concerned will be submitted to the Controller of Examination for announcement of the result.
16. The hard and soft copy of the thesis will be submitted to the HEC for PhD country directory.

5.27 Amendment to Regulations

These Regulations may be amended from time to time as deemed fit by the authorities of the Mehran University of Engineering & Technology, and, unless specifically stated otherwise, the amended Regulations shall apply to the already registered students as well as to the new students.

6

Criterion 6: FACULTY

Faculty members must be current and active in their discipline and have the necessary technical depth and breadth to support the program. There must be enough faculty members to provide continuity and stability, to cover the curriculum adequately and effectively and to allow for scholarly activities.

List of current teaching faculty members is given in the table [**?**].

Table 6.1: List of Faculty Members

S. No.	Name of Faculty Member	Designation	Full time / Part time	Utilization Dedicated / Shared
1.	Dr. Aftab Ahmed Memon	Meritorious Professor	Full time	Dedicated
2.	Dr. Abdul Waheed Umrani	Professor	Full time	Dedicated
3.	Dr. Faisal K. Shaikh	Professor	Full time	Dedicated
4.	Dr. Faheem A. Umrani	Associate Professor	Full time	Dedicated
5.	Dr. Abdul Latif	Associate Professor	Full time	Dedicated
6.	Dr. Faheem Yar Khuhawar	Associate Professor	Full time	Dedicated
7.	Dr. Sajjad Ali Memon	Associate Professor	Full time	Dedicated
8.	Dr. Imran Ali Qureshi	Associate Professor	Full time	Dedicated
9.	Dr. Nasrullah Pirzada	Associate Professor	Full time	Dedicated
10.	Dr. Zafi Sherhan Shah	Associate Professor	Full time	Dedicated
11.	Dr. Zulfikar Arain	Assistant Professor	Full time	Dedicated
12.	Dr. Faisal Ahmed Memon	Assistant Professor	Full time	Dedicated
13.	Dr. Umair Ahmed Korai	Assistant Professor	Full time	Dedicated

6.1 Standard 6-1

There must be enough full time faculties who are committed to the program to provide adequate coverage of the program areas/courses with continuity and stability. The interests and qualifications of all faculty members must be sufficient to teach all courses, plan, modify and update

courses and curricula. All faculty members must have a level of competence that would normally be obtained through graduate work in the discipline. The majority of the faculty must hold a Ph.D. in the discipline.

The details of mandatory coursework are already given in Standard 2-1. The qualifications and interests of faculty members match adequately with the coverage areas of offered courses.

The resume of the faculty members prepared on the format provided by the QEC of MUET can be accessed on Telecom webpage https://tl.muet.edu.pk/faculty/.

Table 6.2 contains details of major areas of specialization in PhD in Telecommunication Engineering and number of faculty members in that area.

Table 6.2: Program areas and number of faculty in each area

Program area of Specialization	**Courses in the area**	**Numbers of PhD faculty members in each area.**
Wireless communication	Spread Spectrum Communications beyond	5
Wireless systems and networks	Wireless Communication: 5G and Beyond	5
Computer systems and networks	Advanced Digital Signal Processing	3
Antennas and wave propagation	Smart Antenna Systems for Wireless Networks	3
Photonics	Photonic Devices	3
Optical communication and Networks	Optical Communication Systems and Networks	5
Microwave and THz Communication	Wireless Communication: 5G and Beyond	3
Internet of Things	Internet of Things	2
Wireless Sensor Networks	Wireless Sensor Networks	3
Human Machine Communication	Network Science Machine Learning for Telecommunication Engineering	1
Big Data Analysis	Crowd Sourcing and Big Data Analytic	2
Network Secuirty	Network Security Vulnerability Assessment and Pentesting in Cybersecurity	2

6.2 Standard 6-2

All faculty members must remain current in the discipline and sufficient time must be provided for scholarly activities and professional development. Also, effective programs for faculty development must be in place.

The faculty members are familiar with current advancement of their fields through internet, research journals, e-journal, and latest books. The faculty has been provided many opportunities for professional development such as funds for participating in regional, national and international conferences to present scholarly work.

Full time faculty members have sufficient time for scholarly and professional development, it is described in job description (JD) and work load is displayed in the table 6.3.

Table 6.3: Job description of Faculty

S. No.	Job Title		Workload Hours per week
1.	Professor	Teaching	06
		Research	14
		Student Counseling	06
2.	Associate Professor	Teaching	10
		Research	10
		Student Counseling	06
3.	Assistant Professor	Teaching	12
		Research	08
		Student Counseling	06

6.3 Present performance measures for research activities

The faculty deemed current in the discipline is shown by the number of publications by the faculty members in table 6.4

Table 6.4: Number of publications of Ph.D Faculty

S. No.	Name of Faculty Member	Designation	Number of Journal publication (2019-2024)	Number of Conference publication (2019-2024)	Area of Specialization
1.	Dr. Aftab Ahmed Memon	Meritorious Professor	5	6	
2.	Dr. A. Waheed Umrani	Professor			
3.	Dr. Faisal K. Shaikh	Professor	5	5	
4.	Dr. Faheem A. Umrani	Associate Professor	7		
5.	Dr. Abdul Latif	Associate Professor	8		
6.	Dr. Faheem Yar Khuhawar	Associate Professor	2	4	
7.	Dr. Sajjad Ali Memon	Associate Professor	7	1	
8.	Dr. Imran Ali Qureshi	Associate Professor	3		
9.	Dr. Nasrullah Pirzada	Associate Professor	5		
10.	Dr. Zafi Sherhan	Associate Professor	10	4	
11.	Dr. Zulfiqar Arain	Assistant Professor	5		
12.	Dr. Faisal Ahmed Memon	Assistant Professor	4		
13.	Dr. Umair Ahmed Korai	Assistant Professor	3	4	

The major part of the faculty is foreign qualified and have vast teaching experiences and are also doing research activities in various laboratories of the department, while some are currently pursuing their higher studies abroad. The faculty often receives training concerning modern teaching methods and trends to keep them up-to-date with the current trends. The list of publications of faculty members is given in the table 8.1.

The list can also be accessed on the departmental website https://tl.muet.edu.pk/research/.

Table 6.5: List of publications of faculty (2019-2023)

Year	Type	Publication
2023	Journal	Fayaz Hassan, Jianguo Yu, Zafi Sherhan Syed, Nadeem Ahmed, Mana Saleh Al Reshan, Asadullah Shaikh (2023). Achieving model explainability for intrusion detection in VANETs with LIME. PeerJ Computer Science, 9, pp. e1440.
2023	Journal	Abid Munir, Amjad Ali, Abdul Latif (2023). Mode coupling in mode division multiplexing techniques for futuristic high speed optical networks and exploring optical fiber parameters to control mode coupling. Mehran University Research Journal Of Engineering & Technology, 42(4), pp. 148–154.
2023	Journal	Sehreen Moorat, Ahsan Ahmed Ursani, Aftab Memon, Nashrul Fazli Mohd Nasir, Bhawani S Chowdhry (2023). Simulation of Low-Frequency Sonophoretic Piezoelectric Transducer Applied over Human Skin. Engineering Proceedings, 32(1), pp. 14.
2023	Journal	Arshad Habib Malik, Feroza Arshad, Aftab Ahmed Memon, Raheela Laghari (2023). Design of novel fractional order FPGA based reactor protection and safety controllers for ACP1000 nuclear power plant in LabVIEW. Mehran University Research Journal Of Engineering & Technology, 42(1), pp. 77–87.
2023	Journal	Zaheer Ahmed Dayo, Muhammad Aamir, Ziaur Rahman, Imran A Khoso, Mir Muhammad Lodro, Shoaib Ahmed Dayo, Permanand Soothar, Muhammad Salman Pathan, Ahmed Jamal Abdullah Al-Gburi, Aftab Ahmed Memon, others (2023). A Novel Low-Cost Compact High-Performance Flower-Shaped Radiator Design for Modern Smartphone Applications. Micromachines, 14(2), pp. 463.
2023	Conference	Nimra Tariq, Zafi Sherhan Syed, Erum Saba (2023). Praise or Insult? Identifying Cyberbullying Using Natural Language Processing. In 2023 7th International Multi-Topic ICT Conference (IMTIC), pp. 1–7.
2023	Conference	Sameer Aftab, Zafi Sherhan Shah, Sajjad Ali Memon, Quratulain Shaikh (2023). A machine-learning-based Intrusion detection for IIoT infrastructure. In 2023 7th International Multi-Topic ICT Conference (IMTIC), pp. 1–6.
2023	Conference	Hafsa Talpur, Badar Muneer, Faisal Karim Shaikh, Umair Ahmed Korai (2023). Design of Phased Array Antenna System for LoRa Applications. In 2023 7th International Multi-Topic ICT Conference (IMTIC), pp. 1–4.
2023	Conference	Mirza Ehsan, Umair Ahmed Korai, Abi Waqas Memon, Anayat Ullah, Badar Muneer, Aftab Ahmed Memon (2023). Availability of Free Space Optical links of Hyderabad Pakistan using Climate Data. In 2023 Global Conference on Wireless and Optical Technologies (GCWOT), pp. 1–4.
2023	Conference	Syed Asad Ullah, Syed Muhammad Khalid, Umair Ahmed Korai, Anayat Ullah (2023). An Energy-Efficient Communication Protocol for Power-Constrained IoT Networks: A Deep Reinforcement Learning Approach. In 2023 Global Conference on Wireless and Optical Technologies (GCWOT), pp. 1–6.
2023	Conference	Umair Ahmed Korai, Mirza Ehsan, Lorenzo Luini, Roberto Nebuloni (2023). Performance of Free Space Optical links: a Case Study for Pakistan. In 2023 17th European Conference on Antennas and Propagation (EuCAP), pp. 1–5.
2023	Conference	Ghulam Fiza Mirza, Yahya Sameen Junejo, Faisal Karim Shaikh, Bhawani Shankar Chowdhry, Ali Akbar Shah (2023). Smart Railway Level Crossing System for Avoiding Accidents. In 2023 International Conference on Robotics and Automation in Industry (ICRAI), pp. 1–8.
2023	Conference	K. Memon, F. A. Umrani, A. Baqai and Z. S. Syed, "A Review Based On Comparative Analysis of Techniques Used in Precision Agriculture," 2023 4th International Conference on Computing, Mathematics and Engineering Technologies (iCoMET), Sukkur, Pakistan, 2023, pp. 1-7, doi: 10.1109/iCoMET57998.2023.10099182.

2022	Journal	Yusra Daudpota, Faisal Ahmed Memon, Aftab Ahmed Memon, Bhawani Shankar Chowdhry (2022). Simulation of Silicon Oxycarbide Waveguides for Shorter Band Photonics. Sir Syed University Research Journal of Engineering & Technology, 12(2), pp. 33–38.
2022	Journal	Faisal Karim Shaikh, Mohsin Ali Memon, Naeem Ahmed Mahoto, Sherali Zeadally, Jamel Nebhen (2022). Artificial Intelligence Best Practices in Smart Agriculture. IEEE Micro, 42(1), pp. 17-24.
2022	Journal	Syed Muhammad Shehram Shah, Sajjad Ali Memon, Erum Saba, Abdul Latif Memon, Aqeel Ahmed (2022). Deep Learning based Automated Modulation Recognition for Cognitive Radio Networks. IEEE Micro, 22(5), pp. 393-400.
2022	Journal	Aijaz Patoli, Shehram Syed, Abbas Syed, Zafi Sherhan Syed (2022). Artificial Intelligence in Aid Efficient Mental Healthcare in context of State-of-the-art Sir Cowasjee Mental Health Institute at Hyderabad Sindh Pakistan. LIAQUAT MEDICAL RESEARCH JOURNAL, 4(1), pp. 49–54.
2022	Journal	Shafqat Ali Siyyal, Faheem Yar Khuawar, Erum Saba, Abdul Latif Memon, Muhammad Raza Shaikh (2022). Analyzing ml-based ids over real-traffic. International Journal of Innovations in Science & Technology, 4(3), pp. 621–640.
2022	Journal	Karim, S., Shaikh, F.K. and Chowdhry, B.S., 2022. Simulation-based quantitative analysis of efficient data transfer routing protocols for Internet of Underwater Things. Simulation Modelling Practice and Theory, 121, p.102645.
2022	Journal	Shaikh, F.K., Karim, S., Zeadally, S. and Nebhen, J., 2022. Recent trends in internet-of-things-enabled sensor technologies for smart agriculture. IEEE Internet of Things Journal, 9(23), pp.23583-23598.
2022	Journal	Baloch, Z., Shaikh, F.K. and Unar, M.A., 2022. CNN-LSTM-Based Late Sensor Fusion for Human Activity Recognition in Big Data Networks. Wireless Communications and Mobile Computing, 2022(1), p.3434100.
2022	Journal	Khan, F., Umrani, F., Baqai, A. and Ijaz, M., 2022. A novel double-sided pulse interval modulation (DS-PIM) aided SIM-OFDM for 6G light fidelity (LiFi) networks. Electronics, 11(21), p.3579.
2022	Journal	Soothar, P., Wang, H., Dayo, Z.A., Naz, F., Muneer, B. and Aamir, M., 2022. A Broadband High Gain Planar Vivaldi Antenna for Medical Internet of Things (M-IoT) Healthcare Applications. IJCSNS, 22(12), p.245.
2022	Journal	Malik, A.H., Memon, A.A. and Arshad, F., 2022. Fractional order modelling and robust multi-model intelligent controllers' synthesis for ACP1000 nuclear power plant. Mehran University Research Journal Of Engineering & Technology, 41(3), pp.43-53.
2022	Journal	Abdul Wahab Khokhar, Sundar Ali Khowaja, Syed Zafi Sherhan Shah, Shahnawaz Shah (2022), Deep Inception-based Siamese Network for Active User Detection in Grant-free NOMA System, University of Sindh Journal of Information and Communication Technology (USJICT), 6(4), pp. 19-24.
2022	Journal	Memon, K.A., Umrani, A.W., Unar, M.A. et al. Design and Analysis of High-Speed Bottleneck-Free One-Dimensional OCDMA Based Gigabit Symmetric PON. Wireless Pers Commun 126, 3147–3165 (2022). https://doi.org/10.1007/s11277-022-09857-x
2022	Conference	Tanveer Abbas Gadehi, Faheem Yar Khuhawar, Aftab Ahmed Memon, Kashif Nisar (2022). Smart Phone Sensor Data: Comparative Analysis of Various Classification Methods for Task of Human Activity Recognition. In 2022 Global Conference on Wireless and Optical Technologies (GCWOT), pp. 1–7.
2022	Conference	Uroosa Maqsood, Faheem Yar Khuhawar, Shahnawaz Talpur, Fawad Hassan Jaskani, Aftab Ahmed Memon (2022). Twitter Mining based Forecasting of Cryptocurrency using Sentimental Analysis of Tweets. In 2022 Global Conference on Wireless and Optical Technologies (GCWOT), pp. 1–6.

2022	Conference	Muhammad Raza Shaikh, Faheem Yar Khuhawar, Kashif Nisar, Aftab Ahmed Memon, Adnan Shahid Khan (2022). Vulnerability Assessment & Analysis of Software-Defined Networking using a Virtual Testbed. In 2022 Global Conference on Wireless and Optical Technologies (GCWOT), pp. 1–7.
2022	Conference	Shameel Syed, Faheem Khuhawar, Shahnawaz Talpur, Aftab Ahmed Memon, Miquel-Angel Luque-Nieto, Sanam Narejo (2022). Analysis of Dynamic Host Control Protocol Implementation to Assess DoS Attacks. In 2022 Global Conference on Wireless and Optical Technologies (GCWOT), pp. 1–7.
2022	Conference	F. Shafique, S. Fatima, F. Y. Khuhawar and Z. A. Arain, An Analysis of Multipath TCP Security Vulnerabilities: A Research Study, 2022 IEEE 19th International Conference on Smart Communities: Improving Quality of Life Using ICT, IoT and AI (HONET), Marietta, GA, USA, 2022, pp. 172-177, doi: 10.1109/HONET56683.2022.10019021.
2022	Conference	E. H. Talpur, B. Muneer, B. Shankar Chowdhry and E. R. Shaikh, "Design of 3-Bit Reflection Type Digital Phase Shifter for Regional ISM Band," 2022 25th International Symposium on Wireless Personal Multimedia Communications (WPMC), Herning, Denmark, 2022, pp. 38-41, doi: 10.1109/WPMC55625.2022.10014728.
2022	Conference	G. H. Palli, B. Muneer, B. S. Chowdhry and F. K. Shaikh, "CovScan: Smart non-contact IR-Temperature scanning and online database system integrated with RFID authentication," 2022 IEEE 16th International Conference on Application of Information and Communication Technologies (AICT), Washington DC, DC, USA, 2022, pp. 1-6, doi: 10.1109/AICT55583.2022.10013563.
2022	Conference	H. Talpur, B. Muneer, B. S. Chowdhry and M. Z. Sheikh, "Development of Software/Hardware platform For Wideband Antenna Measurement," 2022 International Conference on Emerging Technologies in Electronics, Computing and Communication (ICETECC), Jamshoro, Sindh, Pakistan, 2022, pp. 1-4, doi: 10.1109/ICETECC56662.2022.10069072.
2022	Conference	K. Shaikh, A. Waqas, U. A. Korai Baloch, B. Muneer and A. Memon, Cost-Effective Portable Photonic Sensor for Liquid Adulteration Detection, 2022 IEEE 19th International Conference on Smart Communities: Improving Quality of Life Using ICT, IoT and AI (HONET), Marietta, GA, USA, 2022, pp. 063-068, doi: 10.1109/HONET56683.2022.10019183.
2022	Conference	M. Azlan, B. Muneer and B. S. Chowdhry, "Lungs Fluid Accumulation Detection Using Microwave Imaging Technique," 2022 International Conference on Emerging Technologies in Electronics, Computing and Communication (ICETECC), Jamshoro, Sindh, Pakistan, 2022, pp. 1-4, doi: 10.1109/ICETECC56662.2022.10068922.
2022	Conference	H. U. Abro, Z. S. Shah and H. Abbasi, Analysis Of COVID-19 Effects On Well-being - Study Of Reddit Posts Using Natural Language Processing Techniques, 2022 International Conference on Emerging Trends in Electrical, Control, and Telecommunication Engineering (ETECTE), Lahore, Pakistan, 2022, pp. 1-7, doi: 10.1109/ETECTE55893.2022.10007300.
2022	Conference	T. A. Gadehi and F. Y. Khuhawar, Evaluation of human activity recognition using machine learning techniques, 3rd International Conference on Computational Sciences and Technologies (INCCST'22)
2022	Conference	H. Lilaram, S. Talpur, A. M. Bozdar, S. Syed, and F. Y. Khuhawar, Detection of server-side dhcp dos and spoofing attack using machine learning techniques, 3rd International Conference on Computational Sciences and Technologies (INCCST'22)
2021	Journal	Tanveer Ahmed, Sajjad Ali Memon, Saqib Hussain, Amer Tanwani, Ahmed Sadat (2021), Emotion Recognition of Low Resource (Sindhi) Language Using Machine Learning , IJCSNS International Journal of Computer Science and Network Security, VOL.21 No.8, pp. 369, August 2021

2021	Journal	Tabassum Waheed, Faisal Karim, Sayeed Ghani, others (2021). QoS Enhancement of AODV Routing for MBANs. Wireless Personal Communications, 116(2), pp. 1379–1406.
2021	Journal	Zafi Sherhan Syed, Muhammad Shehram Shah Syed, Margaret Lech, Elena Pirogova (2021). Automated recognition of alzheimer's dementia using bag-of-deep-features and model ensembling. IEEE Access, 9, pp. 88377–88390.
2021	Journal	Zulfiqar Arain Arain, Xuesong Qiu, Lujie Zhong, Mu Wang, Xingyan Chen, Yongping Xiong, Kiran Nahida, Changqiao Xu (2021). Stochastic Optimization of Multipath TCP for Energy Minimization and Network Stability over Heterogeneous Wireless Network. KSII Transactions on Internet and Information Systems (TIIS), 15(1), pp. 195–215.
2021	Journal	Mussadiq Abdul Rahim, Muhammad Mushafiq, Salabat Khan, Zulfiqar Ali Arain (2021). RFM-based repurchase behavior for customer classification and segmentation. Journal of Retailing and Consumer Services, 61, pp. 102566.
2021	Journal	Mujeeb Abdullah, Ahsan Altaf, Muhammad Rizwan Anjum, Zulfiqar Ali Arain, Abdul Aleem Jamali, Mohammad Alibakhshikenari, Francisco Falcone, Ernesto Limiti (2021). Future smartphone: MIMO antenna system for 5G mobile terminals. IEEE Access, 9, pp. 91593–91603.
2021	Journal	Permanand Soothar, Hao Wang, Badar Muneer, Zaheer Ahmed Dayo, Bhawani Shankar Chowdhry (2021). A broadband high gain tapered slot antenna for underwater communication in microwave band. Wireless Personal Communications, 116(2), pp. 1025–1042.
2021	Journal	Badar Muneer, Bhawani Shankar Chowdhry, Hima Zafar, Zahid Ali, Faisal Karim Shaikh (2021). Polarization Agile Antenna for Underwater Communication Using Integrated Power Divider and Phase S2021 & Journal & hifter. Wireless Personal Communications, 116(2), pp. 1137–1149.
2021	Journal	Meijun Qu, Yunfei Feng, Jianxun Su, Syed Mohsin Ali Shah (2021). Design of a single-layer frequency selective surface for 5G shielding. IEEE microwave and wireless components letters, 31(3), pp. 249–252.
2021	Journal	Permanand Soothar, Hao Wang, Badar Muneer, Zaheer Ahmed Dayo, Bhawani Shankar Chowdhry (2021). A broadband high gain tapered slot antenna for underwater communication in microwave band. Wireless Personal Communications, 116(2), pp. 1025–1042.
2021	Journal	Badar Muneer, Bhawani Shankar Chowdhry, Hima Zafar, Zahid Ali, Faisal Karim Shaikh (2021). Polarization Agile Antenna for Underwater Communication Using Integrated Power Divider and Phase Shifter. Wireless Personal Communications, 116(2), pp. 1137–1149.
2021	Journal	Zafi Sherhan Syed, Muhammad Zaigham Abbas Shah Syed, Muhammad Shehram Shah Syed, Aunsa Shah (2021). Sequential Modeling for the Recognition of Activities in Logistics. Sukkur IBA Journal of Emerging Technologies, 4(1), pp. 12–21.
2021	Journal	Muhammad Yasir, Zafi Sherhan Shah, Sajjad Ali Memon, Zahid Ali (2021). Machine Learning Based Analysis of Cellular Spectrum. International Journal of Wireless and Microwave Technologies, 11(2), pp. 24–31.
2021	Journal	Saqib Hussain, Nasrullah Pirzada, Erum Saba, Muhammad Aamir Panhwar, Tanveer Ahmed (2021). Evaluating Domain Knowledge and Time Series Features for Automated Detection of Schizophrenia from EEG Signals. International Journal of Advanced Computer Science and Applications, 12(11), pp.530-535.
2021	Journal	Permanand Soothar, Hao Wang, Chunyan Xu, Yu Quan, Zaheer Dayo, Muhammad Aamir, Badar Muneer (2021). A Miniaturized Broadband and High Gain Planar Vivaldi Antenna for Future Wireless Communication Applications. International Journal of Antennas and Propagation, 2021, pp. 11.

2021	Conference	Zafi Sherhan Syed, Muhammad Shehram Shah Syed, Margaret Lech, Elena Pirogova (2021). Tackling the ADRESSO Challenge 2021: The MUET-RMIT System for Alzheimer's Dementia Recognition from Spontaneous Speech. In Interspeech, pp. 3815–3819.
2021	Conference	Syed, S., Khuhawar, F., & Talpur, S. (2021). Machine Learning Approach For Classification of DHCP DoS Attacks in NIDS. 2021 IEEE 18th International Conference on Smart Communities: Improving Quality of Life Using ICT, IoT and AI (HONET), 143-146. https://doi.org/10.1109/HONET53078.2021.9615392.
2021	Conference	Shameel Syed, Faheem Khuhawar, Shahnawaz Talpur (2021). Machine Learning Approach for Classification of DHCP DoS Attacks in NIDS. In 2021 IEEE 18th International Conference on Smart Communities: Improving Quality of Life Using ICT, IoT and AI (HONET), pp. 143–146.
2021	Conference	Mehak Fatima Qureshi, Rizwan Ahmed Kango, Nafeesa Zaki, Faisal Karim Shaikh (2021). Activity monitoring of the potential covid'19 individuals in quarantine facility. In IECON 2021–47th Annual Conference of the IEEE Industrial Electronics Society, pp. 1–6.
2021	Conference	Syed, Z.S., Syed, M.S.S., Lech, M., Pirogova, E. (2021) Tackling the ADRESSO Challenge 2021: The MUET-RMIT System for Alzheimer's Dementia Recognition from Spontaneous Speech. Proc. Interspeech 2021, 3815-3819, doi: 10.21437/Interspeech.2021-1572
2021	Conference	Sarang Karim, Faisal Karim Shaikh, Bhawani Shankar Chowdhry (2021). Void handling in routing protocols for underwater wireless sensor networks: A quantitative analysis. In 2021 IEEE 18th International Conference on Smart Communities: Improving Quality of Life Using ICT, IoT and AI (HONET), pp. 137–142.
2021	Conference	Tabassum Waheed, Faisal Karim Shaikh, others (2021). IEEE 802.15. 6 Relaying Protocol for MBANs. In 2021 Mohammad Ali Jinnah University International Conference on Computing (MAJICC), pp. 1–6.
2020	Journal	Urooba Zaki, Muhammad Zaki, Rizwan Shah (2020). Harmful Effects of 5G On Life with Possible Solution. missing 8, pp. 1 - 13.
2020	Journal	Sherali Zeadally, Faisal Karim Shaikh, Anum Talpur, Quan Z Sheng (2020). Design architectures for energy harvesting in the Internet of Things. Renewable and Sustainable Energy Reviews, 128, pp. 109901.
2020	Journal	Faisal Ahmed Dahri, Fahim Aziz Umrani, Attiya Baqai, Hyder Bux Mangrio (2020). Design and implementation of LED–LED indoor visible light communication system. Physical communication, 38, pp. 100981.
2020	Journal	Muhammad Usman Younus, Muhammad Khurram Khan, Muhammad Rizwan Anjum, Sharjeel Afridi, Zulfiqar Ali Arain, Abdul Aleem Jamali (2020). Optimizing the lifetime of software defined wireless sensor network via reinforcement learning. ieee access, 9, pp. 259–272.
2020	Journal	Zixuan Yi, Meiling Li, Badar Muneer, Guoqiang He, Xue-Xia Yang (2020). Self-Resonant Antisymmetric Planar Coil for Compact Inductive Power Transfer System Avoiding Compensation Circuits. IEEE Transactions on Power Electronics, 36(5), pp. 5121–5134.
2020	Journal	Abi Waqas, Faisal A Memon, Umair A Korai (2020). Experimental validation of a building block of passive devices and stochastic analysis of PICs based on SiOC technology. Optics Express, 28(15), pp. 21420–21431.
2020	Journal	Mohamed Abuhelala, Umair A Korai, Anderson L Sanches, Wing C Kwong, Ivan Glesk (2020). Investigation of 2d-wh/ts ocdma code stability in systems with soa-based device. Applied Sciences, 10(21), pp. 7943.
2020	Journal	Faisal Ahmed Memon, Imran Ali Qureshi, Abdul Latif Memon, Zafi Sherhan Syed, Nasrullah Pirzada, Erum Saba (2020). SiOC-coated silicon nitride platform for efficient phase actuators. Coatings, 10(4), pp. 309.

2020	Journal	Attiya Baqai, Anum Talpur, Fahim Aziz Umrani, Inamullah Lakho (2020). Design, Implementation and Evaluation of IR-Based Tagging System for RTLS. Wireless Personal Communications, 113(2), pp. 1345–1358.
2020	Journal	Faisal Ahmed Dahri, Fahim Aziz Umrani, Attiya Baqai, Hyder Bux Mangrio (2020). Design and implementation of LED–LED indoor visible light communication system. Physical communication, 38, pp. 100981.
2020	Journal	Zaheer Ahmed Dayo, Qunsheng Cao, Yi Wang, Permanand Soothar, Badar Muneer, Bhawani Shankar Chowdhry (2020). A compact broadband high gain antenna using slotted inverted omega shape ground plane and tuning stub loaded radiator. Wireless Personal Communications, 113(1), pp. 499–518.
2020	Journal	Abdullah Memon, Syed Mudassir Kazmi, Attiya Baqai, Fahim Aziz Umrani (2020). Design and Experimental Analysis of Touchless Interactive Mirror using Raspberry Pi. People, 11(5), pp. 478-485
2020	Journal	Abdullah Memon, Syed Mudassir Kazmi, Attiya Baqai, Fahim Aziz Umrani (2020). SA Ratti, FA Umrani, Z Bhutto, N Pirzada, A Mirani, A Hussain (2020). Campus Navigation and Fleet Management Application by Using GPS. INTERNATIONAL JOURNAL OF COMPUTER SCIENCE AND NETWORK SECURITY, 20(9), pp. 228–232.
2020	Journal	SA Ratti, FA Umrani, Z Bhutto, N Pirzada, A Mirani, A Hussain (2020). Campus Navigation and Fleet Management Application by Using GPS. INTERNATIONAL JOURNAL OF COMPUTER SCIENCE AND NETWORK SECURITY, 20(9), pp. 228–232.
2020	Journal	Abdul Hai Faiz, Nasrullah Pirzada, Imran Ali, Abdul Latif, Sajjad Ali (2020). Wi-Fi Network Analysis of University Campus. IJCSNS, 20(10), pp. 40.
2020	Journal	Zafi Sherhan Syed, Sajjad Ali Memon, Abdul Latif Memon (2020). Deep acoustic embeddings for identifying Parkinsonian speech. International Journal of Advanced Computer Science and Applications, 11(10), pp. 726–734.
2020	Journal	KA Memon, SA Khuhro, N Pirzada, MA Panhwar, M Mohd, KK Soothar, N Ain (2020). Analyzing distributed denial of service attacks in cloud computing towards the Pakistan information technol-ogy industry. Indian Journal of Science and Technology, 13(29), pp. 2062–2072.
2020	Journal	Ovase Karim Kazi, Sajjad Ali Memon, Erum Saba, Zahid Ali, Falak Naz (2020). Infrastructure Sharing and Remedies in Next Generation Cellular Networks. IJCSNS, 20(12), pp. 185.
2020	Journal	Ovase Karim Kazi, Sajjad Ali Memon, Erum Saba, Zahid Ali, Falak Naz (2020). Infrastructure Sharing and Remedies in Next Generation Cellular Networks. IJCSNS, 20(12), pp. 185.
2020	Journal	Zafi Syed, Muhammad Shehram Shah Syed, Abbas Syed (2020). Automated Recognition of Sincere Apologies from Acoustics of Speech. International Journal of Advanced Computer Science and Applications, 11(6), pp. 649–654.
2020	Journal	Asif Ali, Muarizio Magarini, Nasrullah Pirzada, Muhammad Aamir Panhwar, Aqeel Ahmed, others (2020). Direction of Arrival and Least Square Error Technique used in Massive MIMO for Channel Estimation. 16(2021, No. 2, pp. 647-657
2020	Journal	Asif Ali, Muarizio Magarini, Nasrullah Pirzada, Muhammad Aamir Panhwar, Aqeel Ahmed, others (2020). Direction of Arrival and Least Square Error Technique used in Massive MIMO for Channel Estimation. 16(2021, No. 2, pp. 647-657
2020	Journal	SA Ratti, FA Umrani, Z Bhutto, N Pirzada, A Mirani, A Hussain (2020). Campus Navigation and Fleet Management Application by Using GPS. INTERNATIONAL JOURNAL OF COMPUTER SCIENCE AND NETWORK SECURITY, 20(9), pp. 228–232.

2020	Journal	Faisal Ahmed Memon, Imran Ali Qureshi, Abdul Latif Memon, Erum Saba (2020). Introducing SiOC as novel dielectric platform for photonic integration. Malaysian Journal of Fundamental and Applied Sciences, 16(1), pp. 81–84.
2020	Journal	Zafi Sherhan Syed, Sajjad Ali Memon, Muhammad Shehram Shah, Abbas Shah Syed (2020). Introducing the Urdu-Sindhi Speech Emotion Corpus: A novel dataset of speech recordings for emotion recognition for two low-resource languages. International Journal of Advanced Computer Science and Applications, 11(4), pp. 1–6.
2020	Journal	Aftab Ahmed Mirani, Sajjad Ali Memon, Saqib Hussain, Muhammad Aamir Panhwar, Syed Rizwan Ali Shah (2020). Spectrum Occupancy Measurement of Cellular Spectrum and Smart Network Sharing in Pakistan. Spectrum, 11(3), pp. 232-243.
2020	Journal	Zafi Syed, Muhammad Shehram Shah Syed, Abbas Syed (2020). Automated Recognition of Sincere Apologies from Acoustics of Speech. International Journal of Advanced Computer Science and Applications, 11(6), pp. 649–654.
2020	Journal	Saqib Ahmed, Fahim Aziz Umrani and Abdul Bassit Surahio (2020), Analysis of Components and Circuit for FMCW Radar System, Gyancity Journal of Electronics and Computer Science, Vol.5, No.1, pp. 1-11
2020	Journal	Asif Ali, Mehran Memon (2020), Acoustic Based Electronic Rodents Repellent System, International Journal of Modern Research in Engineering & Management, 3(1), pp.22-29.
2020	Conference	M. Tanveer, T. Hassan, F. R. Abro, and F. Y. Khuhawar, Machine learning based intrusion detection system using feature engineering and data mining techniques, 2nd International Conference on Computational Sciences and Technologies (INCCST'20).
2020	Conference	S. Syed, K. Arain, Z. Syed, F. Khuhawar, T. Kaimkhani, H. Sheikh, and S. Khan, Case study: Intranet penetration testing of muet, 2nd International Conference on Computational Sciences and Tech- nologies (INCCST'20).
2020	Conference	Muhammad Shehram Shah Syed, Zafi Sherhan Syed, Margaret Lech, Elena Pirogova (2020). Automated Screening for Alzheimer's Dementia Through Spontaneous Speech.. In Interspeech, pp. 2222–6.
2020	Conference	A. B. Surahio, S. Hafeez and N. Bohra, Analyzing Indoor/Outdoor Environmental Effects with Varying Cell Size on 5G Millimeter-Wave Propagation, 2020 3rd International Conference on Computing, Mathematics and Engineering Technologies (iCoMET), Sukkur, Pakistan, 2020, pp. 1-8, doi: 10.1109/iCoMET48670.2020.9073891.
2020	Conference	F. Naz, F. A. Umrani, Z. Ahmed Soomro, Z. Ali and S. Hafeez, Comparative Analysis of Symmetrical and the Asymmetrical Golden ratio U Slot Microstrip Patch Antenna, 2020 , 3rd International Conference on Computing, Mathematics and Engineering Technologies (iCoMET).
2019	Journal	Umair A Korai, Alaine H Bermello, Michael J Strain, Ivan Glesk, Aitor V Velasco (2019). Design of an athermal interferometer based on tailored subwavelength metamaterials for on-chip microspectrometry. IEEE Photonics Journal, 11(6), pp. 1–11.
2019	Journal	Meiling Li, Ruixiang Deng, Badar Muneer, Tao Zhang (2019). Reflection phase modification by metamaterial interface: an understanding of design criteria for ultrathin multispectral absorber. Optics Express, 27(18), pp. 26131–26142.
2019	Journal	Rizwan Qureshi, Mehmood Nawaz, Faheem Yar Khuhawar, Nazish Tunio, Muhammad Uzair, others (2019). Analysis of ECG signal processing and filtering algorithms. International Journal of Advanced Computer Science and Applications, 10(3), pp. 545-550.

2019	Journal	Nazish Tunio, Abdul Latif Memon, Faheem Yar Khuhawar, Ghulam Mustafa Abro (2019). Detection of infected leaves and botanical diseases using Curvelet transform. International Journal of Advanced Computer Science and Applications (IJACSA), 10(1), pp. 2019.
2019	Journal	Shadab Kalhoro, Fahim Aziz Umrani, Mustahsan Ali Khanzada, Liaquat Ali Rahoo (2019). Matched filter based spectrum sensing technique for 4G cellular network. Mehran University Research Journal of Engineering & Technology, 38(4), pp. 973–978.
2019	Journal	Muhammad Aamir Panhwar, Sijjad Ali Khuhro, Nasrallah Pirzada, Kamran Ali Memon, Deng ZhongLiang, N Ain (2019). Security Solutions for Classified Attacks in WSNs. IJCSNS, 19(6), pp. 42.
2019	Journal	Abdul Razaque Kalhoro, Faheem Khuhawar, Nafeesa Bohra, Shazia Abbassi (2019). Survey based assessment of qos deliverance from user's perspective towards muet's internet service, International Journal of Engineering Research and Applications (IJERA), 9(7), pp. 88.
2019	Conference	T. K. Khani, H. B. Mangrio and F. A. Umrani, Performance Analysis of VLC system using Commercially Available Components, 2019 22nd International Multitopic Conference (INMIC), Islamabad, Pakistan, 2019, pp. 1-4, doi: 10.1109/INMIC48123.2019.9022768.
2019	Conference	U. A. Korai, A. H. Bermello, M. J. Strain, I. Glesk and A. V. Velasco, Temperature Insensitive Waveguide Interferometer based on Subwavelength Gratings, 2019 IEEE 2nd British and Irish Conference on Optics and Photonics (BICOP), London, UK, 2019, pp. 1-4, doi: 10.1109/BICOP48819.2019.9059587.

6.4 Standard 6-3

All faculty members should be motivated and have job satisfaction to excel in their profession.

Faculty survey was conducted to obtain their input using on programs for faculty motivation and job satisfaction. Results are as under.

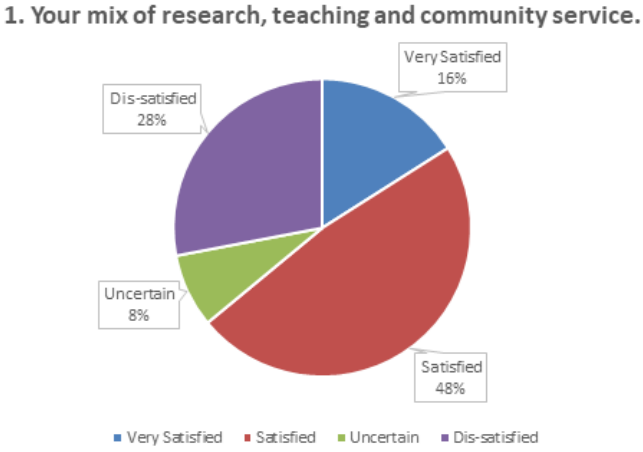

Figure 6.1: Your mix of research, teaching and community service

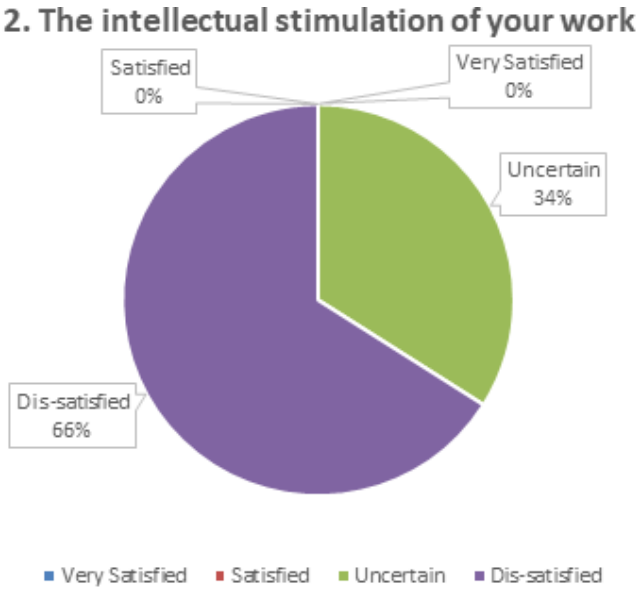

Figure 6.2: The intellectual simulation of work

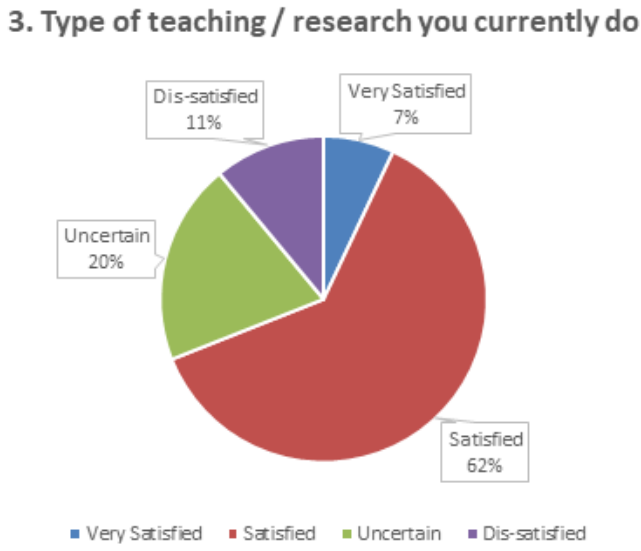

Figure 6.3: Type of teaching / research you currently do

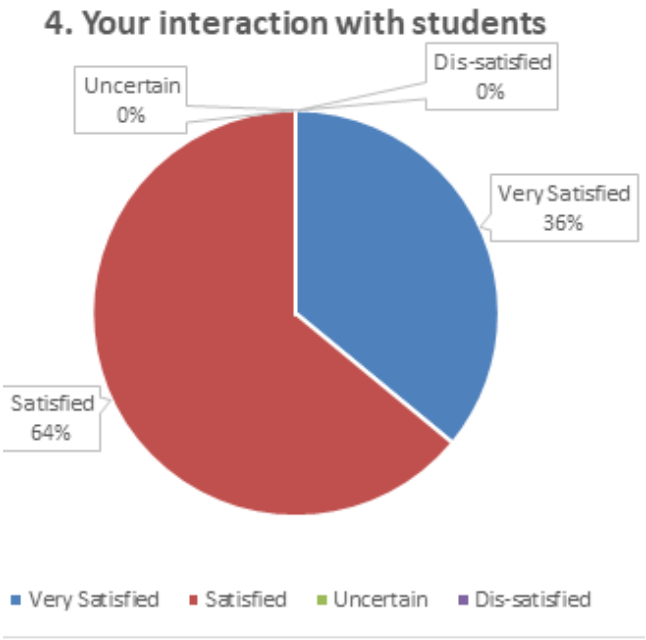

Figure 6.4: Your interaction with students

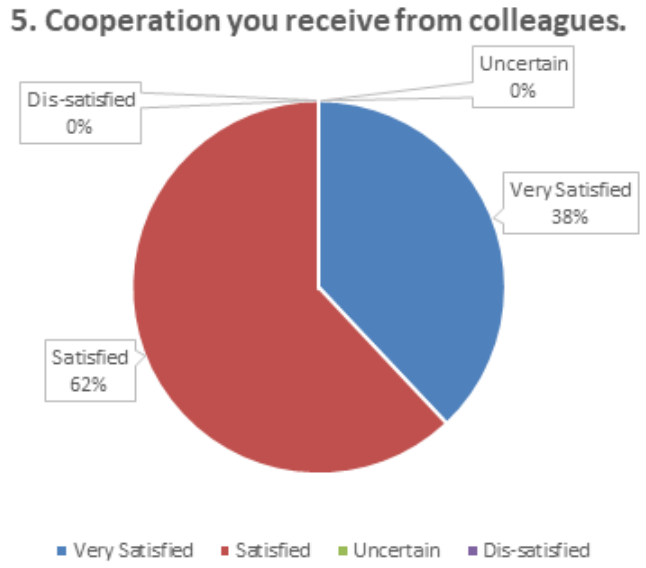

Figure 6.5: Cooperation you receive from colleagues

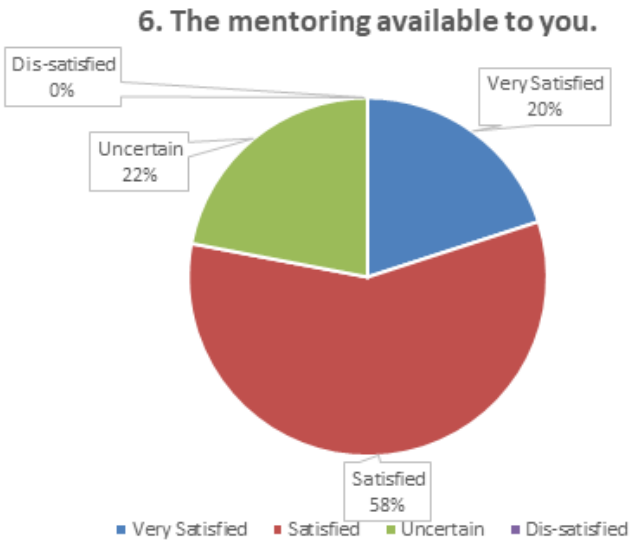

Figure 6.6: The mentoring available to you

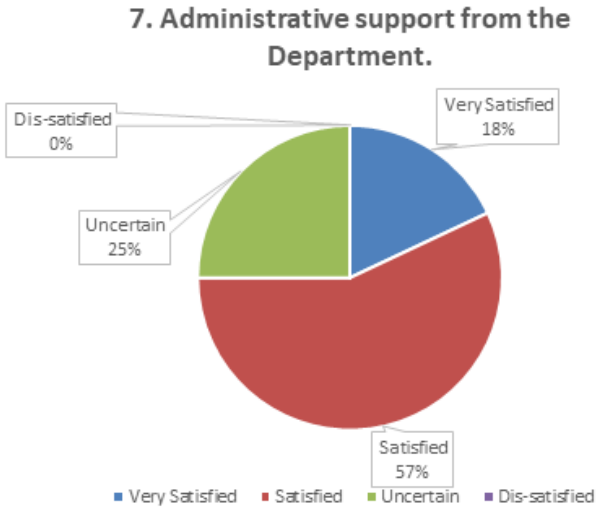

Figure 6.7: Administrative support from the deaprtment

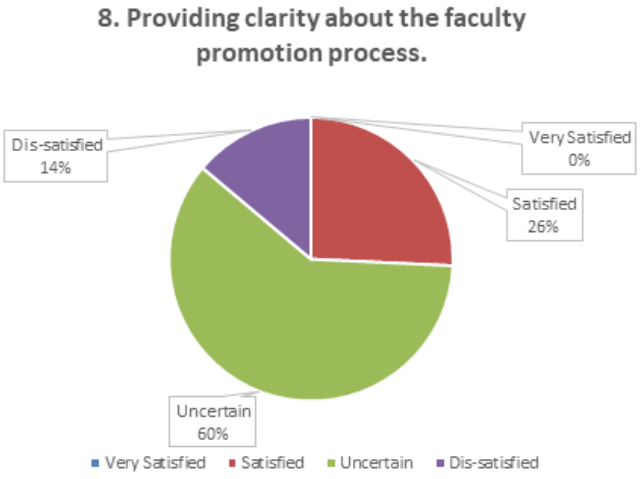

Figure 6.8: Providing clarity about faculty promotion

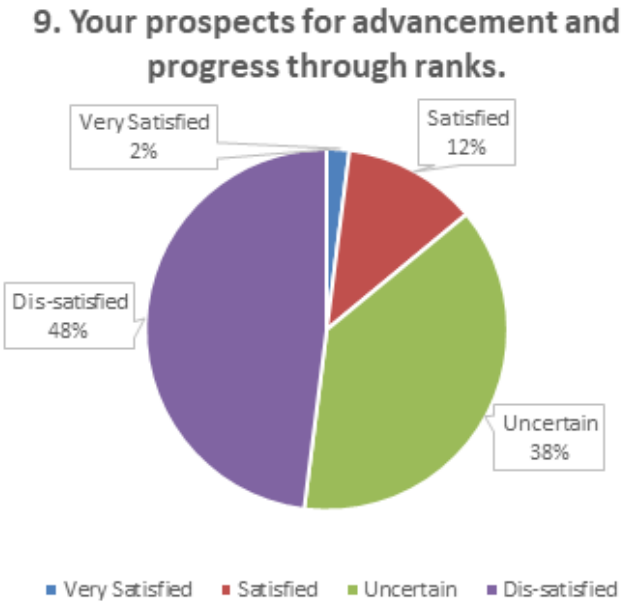

Figure 6.9: Your prospects for advancement and progress through ranks

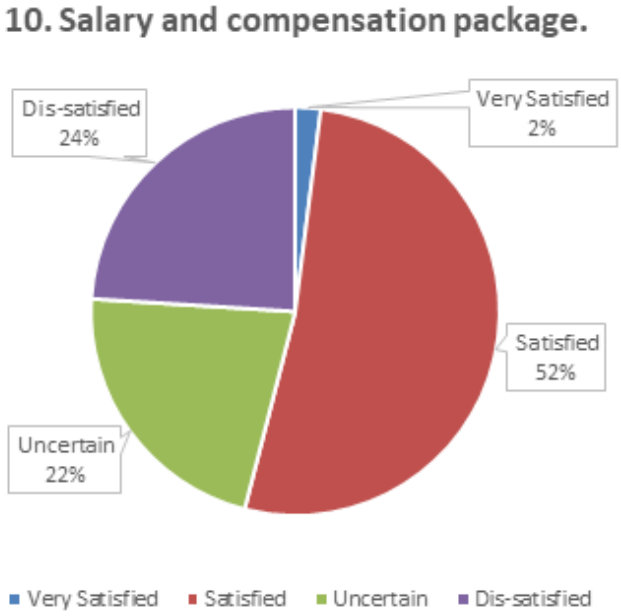

Figure 6.10: Salary and compensation package

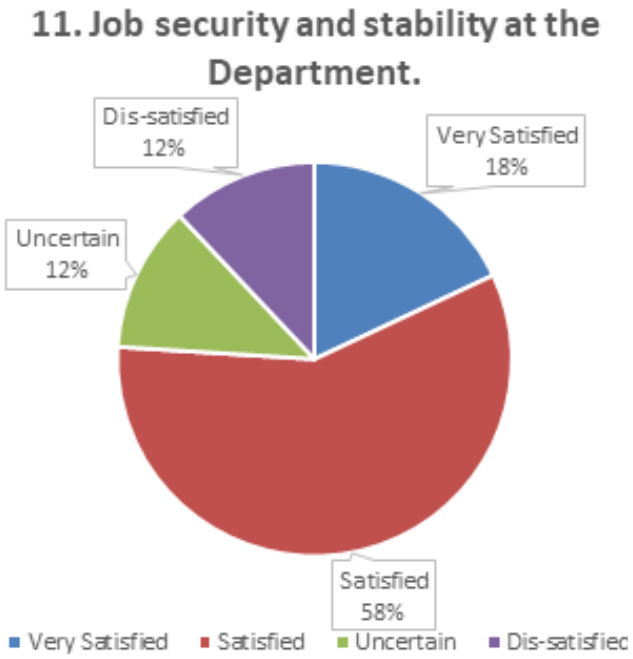

Figure 6.11: Job security and stability at the department

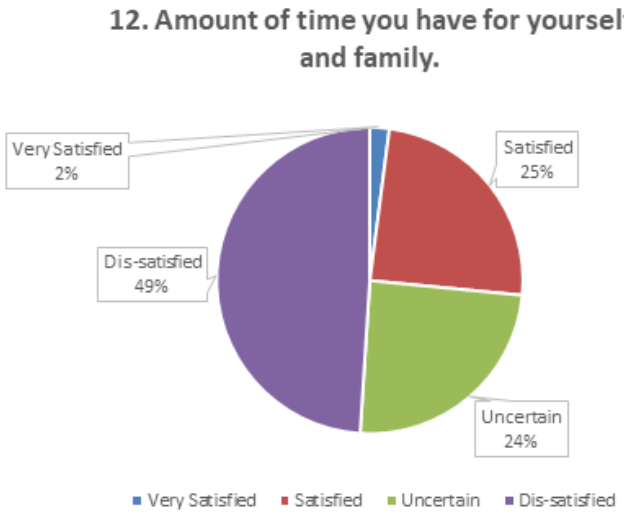

Figure 6.12: Amount of the time you have for yourself and family

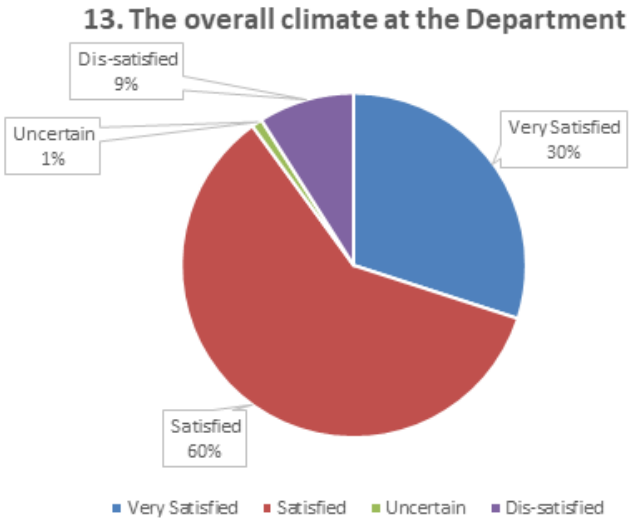

Figure 6.13: Overall climate at the department

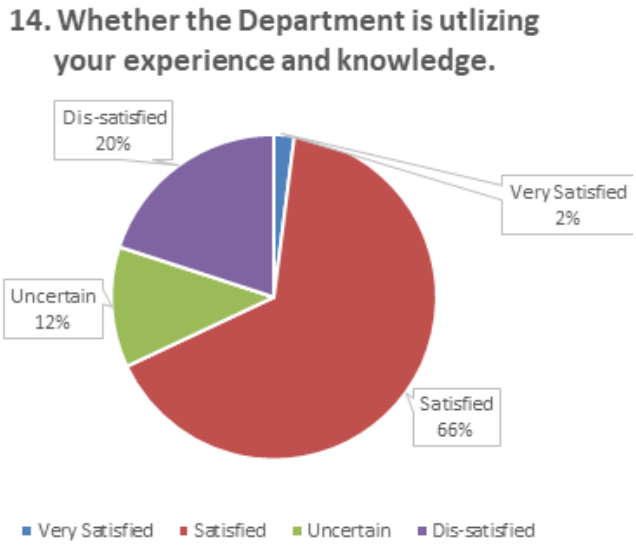

Figure 6.14: Whether the department is utilizing your experience and knowledge

7

Criterion 7: INSTITUTIONAL FACILITIES

Institutional facilities, including library, classrooms and offices must be adequate to support the objective of the program. To satisfy this criterion, a number of standards must be met.

7.1 Standard 7-1

The institution must have the infrastructure to support new trends in learning such as e-learning.

The institution must have the infrastructure to support new trends in learning such as e-learning. Infrastructure and facilities that support new trends in learning are described in this section.

Infrastructure and facilities includes neat and clean offices provided with computer, intranet and internet, intercom and telephone facilities along with adequate security measures available to the faculty to enable them to be get connected with global world. Moreover, ICPC (Information and Communication Processing Centre) is a most recent development under Computer Centre. High Speed Fiber Optics Network for connecting all Teaching Departments, Academic Blocks and Hostels for providing high speed Internet, email facility etc. Computer Centre has been chosen a place as a Communication HUB where all Academic, Administrative, Hostels, etc., of the University will establish Network connectivity and latest and state of art equipment i.e. Routers, Core Switches, SDH, Firewall, and EPABX etc., have been installed to impart Data and Voice Services throughout Campus.

7.2 E-learning Facilities

Due to the COVID pandemic starting in 2019, the university moved towards the e-learning mode. The university had the license of Office 365 and the real use of it started after the COVID situation. First, the university authority conducted a seminar for the faculty with complete guidelines to conduct online classes via MS teams. Then accounts of Office 365 were given to all the faculty and students. According to the Government notifications combination of online and on-campus classes were conducted and continued as per university policy.

7.3 Adequacy of Teaching and Learning Facilities

The adequacy of teaching and learning facilities that include classrooms, learning support facilities, study areas, information resources, library, computing and information technology, laboratories and workshops, etc. is described in the following sections.

7.4 Infrastructure and facilities available that support new trends in learning

The aim of ICPC development is to establish and deploy a high speed Information Communication Network within Campus over Fiber Optic Back Bone and to connect it to PERN (Pakistan Educational Research Network) community to get maximum benefits of *R&D* and uplift MUET at National level. It will provide University Community with information, resources and services in support of its teaching, Research and Office Automation missions. High Speed Internet Services over Fiber Optic for Students and Faculty Staff and Students will become authorized and registered users of ICPC network services under MUET domain. Each staff member and student will get a User ID and e-mail ID under MUET domain. Members will get services of MUET Web Portal. Digital Library Services through PERN. HEC online journals access through PERN. Multimedia development services for Faculty and Students. Online Courseware / Material and Presentations.

Hardware and Software resources sharing. OTS 2004 (Online testing System of MUET). Computerized Attendance System for Students.

Video Conferencing System (Lectures and Presentations sharing between all Universities of Pakistan through PERN). E-Discussion Forums for Faculty and Students. IT short courses ICPC E-Help Desk. All these services in the university have been realized.

7.5 Standard 7-2

The library must possess an up-to-date technical collection relevant to the program and must be adequately staffed with professional personnel.

7.6 Central Library

The Central Library of the University contains more than 80,000 books related to Engineering Science and Technology. Access to 15,000 plus electronics journals is available on-line within the university campus under Digital Library Program; a Project of Higher Education Commission, most of these resources are available full text. There are more than 15,000 (approx.) text books in the Book Bank, which are loaned to students for one term on nominal rent. The collection of books is

updated continuously and new books are acquired on the recommendations of experienced faculty members, which makes collection most suited and beneficial to graduate and under-graduate students. In addition, latest reference and other books are also acquired every year to keep the users of the library abreast with the latest information on Science & Technology especially on Engineering and its allied subjects. In addition to providing the readers with in-house collection, services are also provided for inter- library loan and photocopying of literature including technical articles from other national and international libraries. Literature search services are also provided on request in cooperation with technical information centers within and outside Pakistan. This service is further enhanced by cooperation among Muslim Countries under COMSTECH. Students and faculty members are also provided with Internet facility in the Library. Students are encouraged to use computer for their project work for which PCs are installed in the Internet section of the library with a network printer and photocopier. The Catalog of books is computerized and accessible through library of congress get way serving one-point access interface for books catalog, full-text electronic journals and other electronic resources on the web. Subject bibliographies can be produced on request. The library is heavily used by the students, faculty members and researchers and is open from 8:00 am to 9:00 p.m. throughout the year with professional staff available at service points to meet needs of the readers. Besides the central Library, individual departments have established their own seminar libraries, which cater to the specific needs of the departments. A union catalogue of books available on Campus is also functional. Library is connected to all departments through fiber optic network/internet giving access to databases available in the Library also.

7.7 Departmental Seminar Library

Also, the Seminar Library of the department maintains a close contact with the Central Library and on-line information center of MUET on a regular basis to update new arrivals of books and journals. There are 104 books available in the seminar library of the department.

7.8 Standard 7-3

Class-rooms must be adequately equipped and offices must be adequate to enable faculty to carry out their responsibilities.

Adequate class rooms equipped with Multimedia and Public addressing systems are available and offices with furniture and fixture and computing facility available to most of the faculty members to carry out their responsibilities.

Adequacy of the classrooms

Total two (02) class rooms are provided which are equipped with Multimedia Projectors and adequate teaching environment.

8

Criterion 8: INSTITUTIONAL SUPPORT

The institution's support and the financial resources for the program must be sufficient to provide an environment in which the program can achieve its objectives and retain its strength.

8.1 Standard 8-1

There must be sufficient support and financial resources to attract and retain high quality faculty and provide the means for them to maintain competence as teachers and scholars.

8.2 Faculty Motivation

MUET has been successful in securing sufficient support and financial resources to attract excellent faculty members and to provide all possible means to maintain competence in teaching and scholarly work. However, there is always need for improvement and more financial resources are envisaged for improvement of laboratories, computing facilities, and furnishing library with books and all types of professional magazines.

Faculty members of department of Telecommunication Engineering enjoy competitive salary and pension according to their grades of BPS Scale. Mehran University provides hostel accommodation to bachelor and bungalows for families of faculty and staff of University with very nominal charges. In addition, the University also gives the plots with ownership for faculty and staff to build their own houses for permanent accommodation. Mehran University has also established baby day care center to support working women/faculty members and to provide learning environment for toddlers.

Faculty is encouraged to dedicate their time for research work and submit research proposals to national and international agencies. The University provides travel grant for attending national workshop or conferences and has also comprehensive policy for commercial research work.

The department of Telecommunication Engineering possesses state of art laboratories, classes equipped with multimedia, seminar library and computing facilities. The resources are provided by Mehran University on regular basis to maintain each facility. University has also Main library located in the centre of university, possesses huge collection of books, research journals. Mehran University is subscribed and has access to HEC digital library which provides to large number of research journals, books, thesis and other resources.

8.3 University's Income & Expenses

Table 8.1 lists the sources of income for the university and table 8.2 details the expenses incurred by the university under different heads.

Table 8.1: University's Financial Health (in Million PKR)

S. No.	Source of Income	Current Fiscal Year (2022-23)	1st Previous Fiscal Year (2021-22)		2nd Previous Fiscal Year (2020-21)	
			Budgeted	Actual	Budgeted	Actual
1.	Govt. Grant	1067.459	1067.459	1067.459	1045.903	1045.903
2.	Grant from HEC	56.900	2.919	2.976	55.525	55.525
3.	Investment &; Internal resource generation	1204.310	1015.752	1041.374	884.372	980.873
4.	Provincial Grant	974.000	370.000	370.000	355.026	355.028
5.	Others (Internal Borrowings/ Shortfall)	-	971.411	483.544	839.295	605.324
Total		**3302.669**	**3427.541**	**2965.353**	**3180.121**	**3042.653**

Table 8.2: University's Annual Expenditure (in Million PKR)

S. No.	EXPENDITURE HEAD	Current Fiscal Year (2022-23)	1st Previous Fiscal Year (2021-22)		2nd Previous Fiscal Year (2020-21)	
			Budgeted	Actual	Budgeted	Actual
1.	Faculty and support staff facilities	2559.598	1960.768	1831.859	1974.171	1923.225
2.	Non-Salary Expenditure	1154.948	786.928	669.024	635.665	583.32
3.	Research and Development Expenditure	85.735	49.330	40.248	28.193	28.841
4.	Others	696.070	629.655	616.871	538.801	507.010
Total		**4496.351**	**3426.681**	**3158.002**	**3176.830**	**3042.396**
* Internal borrowings from previous reserves / Investment encashment to meet out the shortfall.						

8.4 Standard 8-2

There must be an adequate number of high quality graduate students, research assistants and PhD. students.

The list of students enrolled in this program is already given in section 1. 10.

8.5 Funding for R&D

There is no university budget allocated specifically to R&D activities. However, there are various means through which R&D pursuits are made sure; such as, Rs. 25,000 is allocated for each master of engineering thesis and Rs. 2 Million for each Ph.D. research in order to arrange raw material and resources, competition based students and faculty startups and provision of hunting research grants such as HEC's National Research Program for Universities (NRPU), Technology Development Fund (TDF) and Pakistan Science Foundation (PSF) research grants.

8.6 Standard 8-3

Financial resources must be provided to acquire and maintain Library holdings, laboratories and computing facilities.

Sufficient resource allocation is done on year bases for library and laboratories. Table 8.3 gives the details.

Table 8.3: Consolidate budget for promotion of Education, Research and Extension (in Million PKR)

S. No.	HEAD OF EXPENDITURE	PhD (2019-2020)		Annual Budget (2015-2016)
		Original	Revised	
1.	Book, Journal, Periodicals and General Library Development (IICT)	0.3	0.358	0.358
2.	i- library development (for whole university)	8.0	8.0	8.0
3.	ii- promotion in education and research (for whole university)	90.31	85.561	85.561
4.	Chemicals and Raw Materials of Laboratories / W shops use (for whole unviersity)	34.5	22.8	22.8
Grand Total		**133.11**	**116.72**	**116.72**

8.7 Office of Research, Innovation, and Commercialization (ORIC)

Office of Research, Innovation, and Commercialization (ORIC) is operational in MUET. ORIC was established at the University according to the prescribed guidelines of the Higher Education Commission (HEC), Islamabad for all Universities of Pakistan to establish "Offices of Research, Innovation, and Commercialization (ORIC)". To make research top precedence among faculty members of MUET, ORIC aims to promote and enhance research activities in a way that helps the industry to meet the latest and state-of-the-art innovations. And help the university to generate more resources for advanced research in the latest areas. ORIC provides a complete platform to the researchers and augments their research skills from a working bench to a furnished product. For this, it welcomes the industries to collaborate on R&D projects. ORIC provides end-to-end services for all matters about research & development, innovation, inventions, commercialization, patents, collaborations, arranging seminars/ conferences/ workshops, etc., and/or research publication honorarium. By and large, ORIC is the focal point for all research-related activities of the University. It facilitates the University researchers (faculty members and scholars) to promote their research work both nationally and internationally. To this effect, this office aims to facilitate several researchers to present their research papers at international conferences, hold seminars/conferences/ workshops, etc. as well as allow the submission and approval of different research & development projects both nationally and internationally.

Appendix A

Curriculum of PhD in Telecommunication Engineering

Advanced Digital Signal Processing

Title of Subject:	Advanced Digital Signal Processing
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9152
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

This course is designed to provide an advanced level of understanding and the concepts of digital signal processing.

Outcomes

After completion of this course, the students should be able to:

1. Apply core concepts of digital signal processing, such as analog to digital conversion, convolution, correlation, and system stability analysis using z-transforms
2. Analyze discrete-time signals and systems using time- and frequency-domain techniques
3. Design and analyze the performance of digital filters
4. Develop an understanding of machine learning pipelines for advanced signal processing operations for audio, image, and textual data

Contents

I. Introduction

- Review of discrete-time signals and systems along with their representation, analog-to-digital conversion, uniform sampling theorem, quantization, and its effects, quantisation noise to signal ratio.

II. Core Concepts of DSP

- Characterization of a discrete-time system using difference equation and pulse transfer function, convolution sum and its use in DT systems, correlation, and normalized correlation, the concept of self-similarity and autocorrelation.

III. Frequency-domain Analysis for Discrete-time Signals

- Discrete-Time Fourier transform, periodicity of DTFT, discrete Fourier transform (DFT), properties of DFT, introduction to fast Fourier transform (radix-2, decimation in time, decimation in frequency), magnitude and phase response using DFT.

IV. Z Transforms for Discrete-time Systems

- Z-transform for the analyses of discrete-time systems, inverse Z-transform, obtaining the pulse transfer function from the difference equation, pole-zero maps in the Z-domain, stability of discrete-time systems.

V. Digital Filters Design and Analysis

- Concepts of FIR and IIR digital systems, design of digital filters using discrete-time Fourier transform - window method, introduction to window functions, comparison of the properties of the window functions.

VI. Advanced Signal Processing in the Machine Learning Era and Modern Era

- Computer Vision, Computer Audition, and Natural Language Processing. Convolutional Neural Networks.

Learning Resources

1. Digital Signal Processing: A Practical Approach, "2nd" Edition Barrie Jervis and Emmanuel C. Ifeachor
2. Discrete-Time Signal Processing - Alan V. Oppenheim, Ronald W. Schafer (Latest Edition "3rd", ISBN-10: 0131988425 or ISBN-13: 978-0131988422)
3. Documents for DSP System Toolbox (MATLAB) (https://www.mathworks.com/products/dsp-system.html)
4. https://librosa.org/doc/latest/index.html

Approval:	Board of Studies of Telecom. Engg:	Res. No. BoS-PhD-TL-4.2	Dated: 04-09-2023
	Board of Faculty of EEC Engineering	Res. No. 21.3	Dated: 07-12-2023
	Advance Studies & Research Board	Res. No. -	Dated: -
	Academic Council	Res. No. 106.3(xxvi)	Dated: 14-12-2023

Smart Antenna Systems for Wireless Networks

Title of Subject:	Smart Antenna Systems for Wireless Networks
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9182
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

This course is designed to provide an advanced level of understanding and the concepts of microwave engineering and antennae design.

Outcomes

After completion of this course, the students should be able to:

1. Underline the functions and types of antennas
2. Identify the atmospheric and terrestrial effects on radio wave propagation
3. Evaluate the fundamental parameters of antennas and arrays operating at various frequencies from LF to microwave applications

Contents

I. Review:

- Maxwell's equation, electromagnetic waves (radio), the speed of light, resonance, index of refraction, Poynting vector, oscillating charges, polarization, refraction and dispersion, polarizers, malus's law, brewster angle, and polarization by reflection/scattering, doppler effect, traveling waves, and standing waves.

II. Uniform Plane Wave Propagation

- Uniform plane wave propagation, uniform plane waves, the wave equations for conducting medium, sinusoidal time variations, phase, and group velocity, conductors and dielectrics, Poynting theorem and flow of power, reflection and refraction of waves at the boundary of two dielectrics, application of boundary value problems and their solutions, surface impedance.

III. Guided Waves

- Waves between parallel planes, TE (transverse electric), waves, TM (transverse magnetic) waves, TEM (traverse electromagnetic) waves, attenuation in parallel plane guides, and wave impedance.

IV. Ground Wave Propagation

- Plane earth reflection, space and surface waves, spherical earth propagation, tropospheric waves.

V. Ionospheric Waves

- Introduction to the ionosphere, wave propagation in the ionosphere, reflection and refraction by the ionosphere, regular and irregular variations of the ionosphere, and attenuation factor.

VI. Antennas

- Introduction, network theorems, directional properties of dipole antennas, two-element array, horizontal patterns in broadcast arrays, linear arrays, multiplication patterns, binomial array, antenna gain and effective area, antenna terminal impedance, transmission loss between antennas resistance and reciprocity theorem.

Learning Resources

1. Electromagnetic Waves and Radiating Systems - Edward Conrad Jordan, Keith George Balmain (2nd Edition, ISBN-10: 8120300548 or ISBN-13: 978-8120300548)
2. Engineering Electromagnetics - William Hayt, John Buck (8th Edition, ISBN-10: 0073380660 or ISBN-13: 978-0073380667)
3. Electromagnetics - John Daniel Kraus, John D. Kraus (4th Edition, ISBN-10: 0070356211 or ISBN-13: 978-0070356214)
4. Electromagnetic Concepts and Applications - Richard E. Dubroff, S. V. Marshall, G. G. Skitek (4th Edition, ISBN-10: 0133011518 or ISBN-13: 978-0133011517)

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Optical Communication Systems and Networks

Title of Subject:	Optical Communication Systems and Networks
Discipline(s):	PhD Telecommunication Engineering
Effective	22 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9132
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

To provide a detailed elementary knowledge of optical communication systems and networks.

Outcomes

After completion of this course, the students should be able to:

1. To learn to develop infrared-based communication systems
2. To learn about optical modulation formats and routing protocols
3. To become familiar with how fiber optic sensors may be used to measure strain, temperature, pressure, humidity, rotation, chemicals, acoustics, electric and magnetic fields

Contents

I. Characteristics of optical transmission

- Introduction to optical transmission and its historical evolution, Optical fibers, and cables, Couplers, and splitters, Dispersion: mathematical model and system impact, Chirping in optical sources and its interaction with dispersion, Coherency, and polarization, Propagation in free space, Guided propagation: dielectric guides, Polarizers, and interferometers.

II. Modulation techniques in optical communication

- Intensity Modulation Direct Detection (IMDD), Quantum limit for unrepeated systems. On-off keying, pulse position modulation, sequence inverse keying, frequency modulation, polarization modulation, phase modulation.

III. Performance analysis of Optical communication systems

- Receiver optimization, Quantum limit for amplified systems, Performance evaluation of receivers, System behavior of a cascade of an optical amplifier (amplifier chain).

IV. Fiber Optical Sensors

- Sensing Principles, Extrinsic sensors, intrinsic sensors, sensor types, Intensity-based fiber sensors, spectrally based fiber sensors, interferometers, fiber etalons, and fiber gratings, review a wide range of sensor types and the biomedical parameters/features they detect, Applications.

V. Design and Implementation of a Simulator

- Implementation of WDM/DWDM and PON systems in a simulator (e,g., Optiwave).

Learning Resources

1. John Senior, 'Optical Fiber Communications' second edition, Prentice Hall, latest edition.
2. S. O. Kasap, 'Optoelectronics and Photonics: Principles and practices' Prentice Hall. latest edition.
3. William B. Jones, 'Introduction to Optical Fiber Communication Systems' Oxford University Press, New York, latest edition.
4. Francis T.S. Yu, Shizhuo Yin, 'Fiber Optic Sensors (Optical Science and Engineering)', Marcell, Deker Inc., New York, latest edition.
5. IEEE and OSA, 'Journal of Lightwave Technology'
6. IEEE LEOS, 'Photonic Technology Letters'

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Spread Spectrum Communications

Title of Subject:	Spread Spectrum Communications
Discipline(s):	PhD Telecommunication Engineering
Effective	22 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9102
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

This course is designed to provide an advanced level of understanding and the concepts of wireless communication systems, in particular those based on spread spectrum communications.

Outcomes

After completion of this course, the students should be able to:

1. Understand the principles of spread-spectrum communications
2. Appreciate the characteristics of pseudorandom noise-like (PN) sequences
3. Design and use PN sequence for spread spectrum communications

Contents

I. Introduction to Spread Spectrum (SS) Communications

- Concept and definitions of SS communications as compared with conventional types of communications, the origin of SS communications, implementations of SS communications, spreading sequences, orthogonal and semi-orthogonal sequences.

II. PN sequences

- Pseudo-noise (PN) sequence generation and its properties (balance, run, and correlation properties).

III. M-sequences

- Generation of M-sequence using shift registers (Fibonacci and Galois feedback generators), characteristics of M-sequence (near balance, correlation, and security, etc.), polynomial representation of M-sequences, gold sequences: why gold codes, generation of gold codes, finding preferred pair of M-sequences, correlation properties of gold sequences.

IV. Orthogonal sequences

- Walsh codes, motivation, generation, and its properties, application of Walsh codes, variable length orthogonal codes (motivation, generation, and properties).

V. Spread Spectrum Communication Systems

- Fundamental of spread spectrum:: concept of spectrum and bandwidth, the definition of SS signals, types of SS signals, benefits of SS techniques.

VI. Analysis of SS systems

- Direct sequence SS systems, frequency-hopped SS systems, synchronization of SS communication system (acquisition and tracking).

VII. Application of spread spectrum

- Anti-jamming, ranging, multipath suppression, code-division multiple access, recent commercial applications.

VIII. CDMA systems

- Introduction to 2G/3G standards, CDMA 2000 systems, and architecture, WCDMA system, and architecture.

Learning Resources

1. Introduction to Spread Spectrum Communications - Rodger E. Ziemer, Roger L. Peterson, David E. Borth (1st Edition, ISBN-10: 0024316237 or ISBN-13: 978-0024316233).
2. Spread Spectrum Systems with Commercial Applications - Robert C. Dixon (3rd Edition, ISBN-10: 8126527862 or ISBN-13: 978-8126527861).
3. CDMA: Principles of Spread Spectrum Communication - Andrew J. Viterbi (1st Edition, ISBN-10: 0201633744 or ISBN-13: 978-0201633740).

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Internet of Things

Title of Subject:	Internet of Things
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9122
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

This course is designed to provide an understanding of the principles and components of the internet of things.

Outcomes

After completion of this course, the students should be able to:

1. Understand the fundamental concepts of the internet of things
2. Understand various types of communication technologies which enable the internet of things
3. The architecture, operation, power management, and constraints of an IoT system

Contents

I. Introduction

- What is the IoT and why is it important? Introduction to the Elements of an IoT ecosystem. Understanding of Technology and business drivers. Description of IoT applications, trends, and implications. Analysis of Sensing components and devices, Sensor modules, nodes, and systems.

II. Communication technologies

- Communication technologies for the IoT as well as Edge connectivity and protocols. For example, Zigbee, BLE, WiFi, LoRAWAN, NBIoT, 5GB etc.

III. Microcontrollers

- Peripherals, buses, and DMA. Operating systems and multiprogramming concepts.

IV. IoT and Big Data overlap

- Stream processing and data aggregation. Real-time and local analytics, databases, cloud analytics.

V. Energy Management

- Analysis of an energy budget, energy management, and sleep states.

VI. IoT and Future Technologies

- IoT Security and future research and development opportunities in IoT.

Learning Resources

1. Greengard, Samuel. "The internet of things". MIT Press, latest edition.
2. Schwab, Klaus, and Nicholas Davis. "Shaping the future of the fourth industrial revolution", latest edition.
3. Pfister, Cuno. "Getting started with the Internet of Things: connecting sensors and microcontrollers to the cloud", O'Reilly Media, Inc., latest edition.
4. Waher, Peter, "Learning internet of things", Packt Publishing Ltd, latest edition.

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Crowd Sourcing and Big Data Analytic

Title of Subject:	Crowd Sourcing and Big Data Analytic
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Advance Computer Networks
Co-requisite	Nil
Course Code	TL9140
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

The course has been designed to enable students to have a better perspective of big data and its importance.

Outcomes

At the end of the course, the students will have the knowledge to analyze and discover new information from huge distributed datasets.

Contents

I. Introduction to big data
II. Big data challenges
III. Big data characteristics
IV. Solving big data problems
V. Challenges of relational databases
VI. Introduction to MapReduce and Hadoop

Learning Resources

1. IBM: What is big data? Bringing big data to the enterprise - http://www.ibm.com/big-data/us/en/.
2. Big Data: Principles and Best Practices of Scalable Real-time Data Systems - Nathan Marz, James Warren (1st Edition, ISBN-13: 978-1617290343).
3. Introduction to Big Data: An Overview of Fundamental Big Data Concepts, Tools, Techniques and Practices - Vladimir Bacvanski (Video Tutorial).
4. Big Data: Understanding How Data Powers Big Business - Bill Schmarzo (1st Edition, ISBN-13: 978-1-4871-6077-6).

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Software Defined Networks

Title of Subject:	Software Defined Networks
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9160
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

The course has been designed to enable students to design and analyze software-defined networking (SDN) and how it is redefining the way communications networks are managed, maintained, and secured.

Outcomes

At the end of the course, the students will know to know how software-defined networks have been the key component in reducing the CAPEX and OPEX by separating the control plane from the data plane. The knowledge gained through this course will also enable the students to know about emerging challenges and various solutions to them through discussion on the latest research papers.

Contents

I. Introduction

- Introduction to SDN and its fundamentals - why SDN, architecture, working principle, etc.

II. SDN using OpenFlow

- Overview of OpenFlow basics and limitations.

III. The drawbacks of Open SDN, SDN via APIs, Hypervisor-based Overlays

IV. Network Functions Virtualization, SDN in Data Centers

V. SDN vs P2P/Overlay Networks

VI. SDN Applications and its Future

Learning Resources

1. OpenFlow - https://www.opennetworking.org/sdn-resources/openflow.
2. OpenState SDN - http://openstate-sdn.org/.
3. Open vSwitch - http://openvswitch.org/.
4. Ryu - https://osrg.github.io/ryu/.

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Wireless Sensor Networks

Title of Subject:	Wireless Sensor Networks
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9112
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

The course aims to provide doctoral students in Telecommunication Engineering with advanced knowledge and skills in the field of Wireless Sensor Networks (WSNs).

Outcomes

After completion of this course, the students should be able to:

1. Describe the key characteristics and components of Wireless Sensor Networks (WSNs)
2. Analyze and compare different communication protocols, including MAC, routing, and transport protocols, used in WSNs
3. Evaluate energy-efficient strategies for prolonging the lifetime of WSN nodes
4. Investigate real-world case studies and research challenges in WSN deployments

Contents

I. Module 1: Introduction to Wireless Sensor Networks

- Definition, characteristics, and applications of WSNs. WSN architecture and components. Challenges and contemporary research trends in WSNs.

II. Module 2: Communication Protocols in WSNs

- MAC (Medium Access Control) protocols in WSNs. Routing protocols for data dissemination. Transport protocols for reliable communication.

III. Module 3: Energy Efficiency in WSNs

- Power consumption analysis in WSN nodes. Energy-efficient routing algorithms. Energy harvesting and management techniques.

IV. Module 4: Advanced Topics and Research Challenges

- Localization and time synchronization in WSNs. Cross-layer design and optimization. Emerging trends: IoT integration and edge computing in WSNs.

Learning Resources

1. Wireless Sensor Networks: A Networking Perspective by Jun Zheng and Abbas Jamalipour. Wiley-IEEE Press. ISBN: 978-0-470-16763-2.
2. Wireless Sensor Networks From Theory to Applications by Ibrahiem M. M. El Emary and S. Ramakrishnan. CRC Press. ISBN 9781138198821.
3. Research articles as per discussion between student and instructor.

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Vulnerability Assessment & Pentesting in Cybersecurity

Title of Subject:	Vulnerability Assessment & Pentesting in Cybersecurity
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9200
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

This course aims to equip students with a deep understanding of cyber security threats, risk assessment strategies, governance, incident response, emerging technologies, and industry best practices to effectively manage cyber security risks in a dynamic digital landscape.

Outcomes

After completion of this course, the students should be able to:

1. Develop advanced proficiency in performing vulnerability assessments and penetration testing, including techniques such as information gathering, vulnerability scanning, web application assessment, and exploitation of web-based vulnerabilities
2. Gain a deep understanding of key concepts and mitigation strategies related to cyber security risks, such as buffer overflows, client-side attacks, exploits, and fixing vulnerabilities
3. Acquire practical skills in privilege escalation, password attacks, and network security techniques like port redirection and tunneling, enabling effective management of cyber security risks in dynamic digital landscapes

Contents

I. Information Gathering Frameworks:

- OSINT Framework, Maltego

II. Vulnerability Scanning:

- Port Scanning, SMB / NFS / SMTP /SNMP Enumeration

III. Web Application Assessment:

- Inspecting URLs / Page Content / Response Headers / Sitemaps, Tools: DIRB, Burp Suite, Nikto.

IV. Exploiting Web-based Vulnerabilities:

- Exploit Admin Consoles, Cross-Site Scripting (XSS), Identify and Exploit Directory Traversals, Identify and Exploit Local / Remote File Inclusion, and SQL Injection.

V. Buffer Overflows:

- Memory Corruption Exploits, Mitigation: Data Execution Prevention (DEP), Address Space Layout Randomization (ASLR), and Control Flow Guard (CFG).

VI. Client-Side Attacks:

- HTML Application Attack, Microsoft Office Attacks: Macros in Visual Basic for Applications (VBA), and Object Linking and Embedding (OLE).

VII. Exploits and Fixing Exploits:

- Searching Public Exploit Database, Exploit Socket Information and Return Address, Change the Payload, Connectivity Information, Bypass Antivirus Detection using On-Disk and In-Memory Evasion.

VIII. Privilege Escalation and Password Attacks:

- Understand Windows / Linux Privileges, Integrity Levels, User Account Control, Windows and Linux Kernel Vulnerabilities, Brute Force Wordlists, Common Network Service Attack Methods, Leverage Password Hashes and Password Cracking.

IX. Port Redirection and Tunneling

Learning Resources

1. The Web Application Hacker's Handbook: Finding and Exploiting Security Flaws – Dafydd Stuttard, Marcus Pinto (Latest Edition "2nd", ISBN-13: 978-1118026472).
2. Nmap Network Scanning: The Official Nmap Project Guide to Network Discovery and Security Scanning – Gordon Fyodor Lyon (Latest Edition "1st", ISBN-13: 978-0979958717).
3. Hacking: The Art of Exploitation - Jon Erickson (Latest Edition "2nd", ISBN-13: 978-1593271442).
4. Black Hat Python: Python Programming for Hackers and Pentesters – Justin Seitz, Tim Arnold (Latest Edition "2nd", ISBN-13: 978-1718501126).

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Machine Learning for Telecommunication Engineering

Title of Subject:	Machine Learning for Telecommunication Engineering
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9210
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

This course aims to equip students with the machine learning skills and knowledge required to solve problems in telecommunication engineering domains. Students will learn both traditional machine learning algorithms and deep learning techniques, with a focus on applications relevant to areas modern telecommunication systems.

Outcomes

After completion of this course, the students should be able to:

1. Gain a strong foundation in machine learning techniques and algorithms, and apply them effectively to solve problems specific to telecommunication engineering domains
2. Develop practical skills in implementing machine learning models using Python and popular libraries, enabling them to analyze telecommunication data and extract valuable insights
3. Acquire the ability to tackle real-world challenges in telecommunication engineering through case studies, such as time series forecasting, network security, modulation technique classification, and IoT applications, using machine learning approaches

Contents

I. Fundamentals of Machine Learning:

- Introduction to Machine Learning, Classification, Classification Metrics, Regression, Regression Metrics, Cross-Validation, Data Preprocessing, and Hyper-Parameter Optimization. Fundamentals of Machine Learning using Python.

II. Classification:

- Logistic Regression, Support Vector Machine, Decision Trees, and Random Forests.

III. Regression:

- Linear Regression, Support Vector Regressors, and Partial Least Square Regressors.

IV. Dimensionality Reduction:

- Principal Component Analysis, Feature Selection using t-test, mRMR, and correlation.

V. Deep Learning:

- Fundamentals of Neural Networks and Deep Learning, Densely Connected Neural Networks, Convolutional Neural Networks, and Long-Short Term Memory networks for temporal modeling.

VI. Case Studies:

1. Time Series Forecasting in Telecommunication Engineering (such as Traffic Prediction and Frequency Spectrum Usage Prediction).

2. Machine Learning for Intrusion Detection in Telecommunication Network Security.
3. Machine Learning for Automated Modulation Technique Classification.
4. Machine Learning in the Internet of Things Domain.

VII. Practical Machine Learning using Python:

- Guided tutorials for various tools such as Spyder IDE, Scikit-learn, Tensorflow, and Keras toolkits.

Learning Resources

1. Russell, S. J., & Norvig, P. (2010). Artificial intelligence: A modern approach (3rd ed.). Upper Saddle River, NJ: Prentice-Hall.
2. Understanding Machine Learning: From Theory to Algorithms, by Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press; 1st edition, ISBN-13: 978-1107057135.
3. https://scikit-learn.org/.
4. https://www.tensorflow.org/.

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Wireless Communication: 5G and Beyond

Title of Subject:	Wireless Communication: 5G and Beyond
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9220
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

This course aims to discuss in detail the current and future upcoming technologies and present the research challenges in implementing those technologies.

Outcomes

After completion of this course, the students should be able to:

1. Gain a comprehensive understanding of key technologies in 5G and beyond, including Massive MIMO, full duplex, device-centric architecture, millimeter waves, small cells, NOMA, and 6G.
2. Identify and analyze research challenges in implementing advanced wireless technologies, and propose potential solutions or directions for future research.
3. Apply knowledge of enabling technologies to solve practical problems in telecommunications, considering factors such as capacity, energy efficiency, spectral efficiency, hardware impairments, and interference management.

Contents

I. Massive MIMO

- Introduction, uplink and downlink transmission, FDD & TDD modes, uplink pilot training, channel estimation, precoding, pilot contamination, user scheduling, signal detection, hardware impairments, beamforming, capacity, energy and spectral efficiencies.

II. Full Duplex and green communications

- Introduction, difference between in-band full duplex and out-of band full duplex, self-interference and self-interference cancellation methods.

III. Device Centric Architecture

- Introduction and different device centric architectures based on the application.

IV. Millimeter Waves

- Introduction, Advantages and disadvantages, Deployment challenges and integration with future enabled technologies.

V. Small Cells

- Introduction, Architecture, Deployment with previous generations, Evolution in cellular RAN, Multi-tier RAN and C-RAN.

VI. NOMA

- Introduction, How it works, advantages, challenges and capacity calculations.

VII. 6G

- Network architecture, development trends, Key technologies, new spectrum, enhanced air interface, new physical dimensions, testbeds, Pervasive Channel model (6GPCM) and future research directions and challenges.

Learning Resources

1. Usman, M., Wajid, M., & Ansari, M. D. (Eds.). (2020). Enabling Technologies for Next Generation Wireless Communications. CRC Press, ISBN 9780367422493.
2. Henrique, P. S. R., & Prasad, R. (2022). 6G: The Road to the Future Wireless Technologies 2030. CRC Press. ISBN-13: 978-8770224390.

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Photonic Devices

Title of Subject:	Photonic Devices
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9230
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

This course aims to give the practicing engineers and researcher in this field the in-depth knowledge of modern Photonic devices and systems. Moreover, enabling them to work on their implementation and analyzing the effectiveness of use of photonics in applications such as telecommunication, Datacom and sensing.

Outcomes

After completion of this course, the students should be able to:

1. Enable the students to design and analyze integrated photonic devices.
2. Apply integrated photonics in field of telecommunication and sensing.

Contents

Review of optical communication and integrated photonics, applications of photonics, Comparison of photonic integrated circuits with electronic integrated circuits, waveguide and its theory, planar waveguides, rectangular waveguides, optical modes, technologies for photonic waveguides, losses of waveguides, scattering losses, absorption losses, radiation losses, measurement of waveguide losses, coupling of photonic waveguides, butt-coupling, prism coupling, coupling with tapers, tapered mode size converters, advanced photonic devices, MMI, MZI, ring-resonators, mathematical modelling of photonic devices, thermo-optic effect, electro-optic effect and reconfigurable photonic systems. Design and analysis of photonic integrated devices and circuits using simulators.

Learning Resources

1. Robert G. Husperger, Integrtaed Optics, Theory and Technology, 2009, Sixth Edition, Springer, ISBN-978-0-387-89774-5.
2. Theodor Tamir, Guided-Wave Optoelectronics - Springer Series in Electronics and Photonics, Springer-Verlag Berlin Heidelberg, e-ISBN- 978-3-642-97074-0.

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Network Science

Title of Subject:	Network Science
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9240
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

The course has been designed to enable students to have knowledge of the emerging science of complex networks and their applications.

Outcomes

At the end of the course, the students will have the knowledge to analyze complex networks and ongoing research in the field of network science.

Contents

1. Network science basics and its characteristics
2. Graph theory and random graphs
3. Scale-free networks, clustering versus randomness, random network model
4. Two-mode networks, network virtualization and analysis
5. Applications of network science (biological networks, transportation networks, dark networks, social networks, etc.)

Learning Resources

1. Network Science - Albert-Laszlo Barabasi (Latest Edition, ISBN-13: 978-1107076266).
2. Linked: The New Science of Networks - Albert-Laszlo Barabasi (Latest Edition, ISBN-13: 978-0738206677).
3. Networks: An Introduction - Mark Newman (Latest Edition, ISBN-13: 978-0199206650).
4. Networks, Crowds, and Markets: Reasoning about a Highly Connected World - David Easley, Jon Kleinberg (Latest Edition, ISBN-13: 978-0521195331).

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Network Security

Title of Subject:	Network Security
Discipline(s):	PhD Telecommunication Engineering
Effective	23 PhD-TL Batch to Onwards
Pre-requisites	Nil
Co-requisite	Nil
Course Code	TL9250
Assessment:	20% Sessional, 20% Mid-semester exam, and 60% final exam
Marks:	100
Credit Hours:	3
Minimum Contact Hours:	48

Aims

The course has been designed to enable students apply security concepts to design and implement security policies and perform risk analysis.

Outcomes

At the end of the course, the students will have the knowledge to apply effective solution to protect data from intrusion and respond to threats.

Contents

1. Types of cyber attacks
2. Cyber security concepts such as cryptography, digital forensics, intrusion detection
3. Strategic security planning
4. Security standards and controls
5. Risk management framework
6. Security metrics and key performance indicators

Learning Resources

1. Cyber Security: Threats and Responses for Government and Business - Jack Caravelli and Nigel Jones (Latest Edition, ISBN-10: 1440861730, ISBN-13: 978-1440861734).
2. Computer Security - Principles and Practice - William Stallings and Lawrie Brown (Latest Edition, ISBN-13: 978-0134794105).
3. Social Engineering: The Science of Human Hacking - Christopher Hadnagy (Latest Edition, ISBN-13: 978-1119433385).
4. Cryptography and Network Security – Principles and Practice – William Stallings (Latest Edition, ISBN-13: 978-1-292-15858-1)x.

Approval:	Board of Studies of Telecom. Engg:	Res. No. BoS-PhD-TL-4.3	Dated: 04-09-2023
	Board of Faculty of EEC Engineering	Res. No. 21.3	Dated: 07-12-2023
	Advance Studies & Research Board	Res. No. -	Dated: -
	Academic Council	Res. No. 106.3(xxvi)	Dated: 14-12-2023