Curriculum for

# Telecom Engineering/ Electrical Engineering (Telecom)

**Bachelor of Engineering Program**

# 2020

Pakistan Engineering Council
&
Higher Education Commission
Islamabad

# CURRICULUM

# OF

# TELECOM ENGINEERING / ELECTRICAL ENGINEERING (TELECOM)

## Bachelor of Engineering Program

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**Pakistan Engineering Council**
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**Higher Education Commission**
**Islamabad**

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# PREFCE

The curriculum, with varying definitions, is said to be a roadmap or plan of teaching-learning process that students of an academic program are required to undergo. It includes objectives and learning outcomes, course contents, scheme of studies, teaching approaches, and assessment methodologies. Since knowledge in all fields and sectors is expanding at a faster pace and new disciplines are also emerging; it is imperative that curricula should be dynamic having regular review and updation.

The University Grants Commission (UGC) was the designated authority to develop, review and revise curricula beyond Class-XII vide Section 3, Sub-Section 2 (ii), Act of Parliament No. X of 1976 titled "Supervision of Curricula and Textbooks and Maintenance of Standard of Education". With the repeal of UGC Act, the same function was assigned to the Higher Education Commission (HEC) under its Ordinance of 2002, Section 10, Sub-Section 1 (v). In compliance with the above provisions, the HEC has been undertaking the development of curricula for new/ emerging fields and revision of curricula after regular intervals through respective National Curriculum Revision Committees (NCRCs) until 2018.

As a policy change and expanding higher education base under HEC, the curriculum review and development task has been shifted to the respective regulators and HEIs. PEC also having mandate under its Act of Parliament and especially after attaining Washington Accord full signatory status and IPEA licensing authority, took up the challenge to review and develop the curricula for engineering programs based on Outcome-Based Education (OBE) System. PEC has therefore constituted an Engineering Curriculum Review and Development (ECRDC) and also subject ECRDCs comprising of eminent engineers and professionals from academia and industry to take up the task of curricula review and updation. Nevertheless, the basic templates developed by HEC NCRCs have been followed as guidelines.

Under OBE based curriculum review and development framework, PEC held national and regional levels stakeholders and industrial consultation workshops engaging HEIs, industry, technical and consulting organizations. The experts' feedback and suggestions were translated into the curriculum review process taking into consideration of the dynamics of technological advancement, industrial needs and management-cum-soft skills for engineering graduates.

This curriculum document would therefore serve as a guideline whereas allowing HEIs to tame/ change within the framework by introducing courses in support of local/ required industrial demand as well as satisfying 12 GAs (Graduate Attributes) covering core and elective courses, considered as beauty of OBE system in the international environment. At the same time, this curriculum framework would fulfill our national, social and economic needs leading towards attainment of Sustainable Development Goals (SDGs-2030). It would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards.

# 1. Engineering Curriculum Review & Development Committee (ECRDC)

PEC in its efforts towards quality engineering education, took up the challenge of curriculum review and development for engineering programs after due consent of HEC. A high level Engineering Curriculum Review and Development Committee (ECRDC), led by Prof Engr Dr Fazal Ahmad Khalid, Chairman Punjab HEC/ Vice Chairman PEC, was constituted whereas other eminent members are from industry and academia to take up the task of curricula review and updation, besides developing curriculum for new/ emerging fields. The main responsibility of ECRDC is to oversee the entire curriculum review and development process while setting policies and guidelines for the subject ECRDCs working in their respective domains. The 1st meeting of main ECRDC was held on 29th June, 2018 at PEC HQ, Islamabad, wherein the Convener briefed the scope, objective and ToRs of the Committee and also formulated the subject ECRDCs comprising of eminent engineers and professionals from academia and industry.

1. Engr Prof Dr Fazal Ahmed Khalid          Convener
   Convener, Metallurgy, Materials, Mining Engg & Allied Disciplines

2. Engr Prof Dr M. Younus Javed          Member
   Convener Electrical Engg & Allied Disciplines

3. Engr Malik Saleem Ullah Saeed          Member
   Convener Chemical Engg & Allied Disciplines

4. Engr Dr Wasim Khaliq          Member
   Convener, Civil Engg & Allied Discipline

5. Engr. Prof. Dr. Iftikhar Hussain          Member
   Convener, Mechanical and Allied Engineering

6. Engr Dr Muhammad Ashraf          Member
   Convener, Agricultural Engg & Allied Disciplines

7. Engr Prof Dr Jameel Ahmed          Member
   Convener, Common to All (Non-Engg Component)

8.  Engr Muhammad Raza Chohan                                    Member
    Director General, HEC

9.  Engr Dr Nasir Mahmood Khan                                   Member
    Additional Registrar (Accreditation), PEC

10. Engr Dr Ashfaq Ahmed Sheikh                                  Secretary
    Additional Registrar, CPD
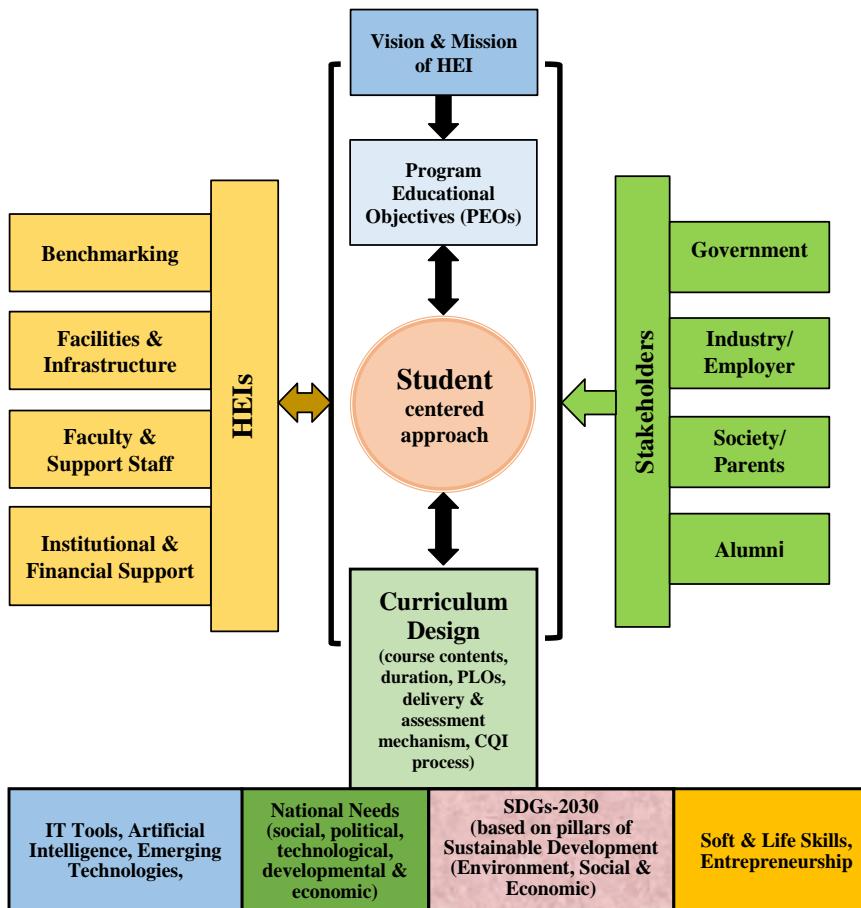
## 2. ECRDC Agenda

- The ECRDC is responsible to oversee the overall working of curriculum review and development for all engineering programs in terms of strategy, guidance and progress and thereby submission to the relevant forum for adoption/ notification.
- Each Member of ECRDC will also work in the capacity of Convener for respective disciplines as mentioned against their names and as per their ToRs.

# 3. OBE-Based Curriculum Development Framework
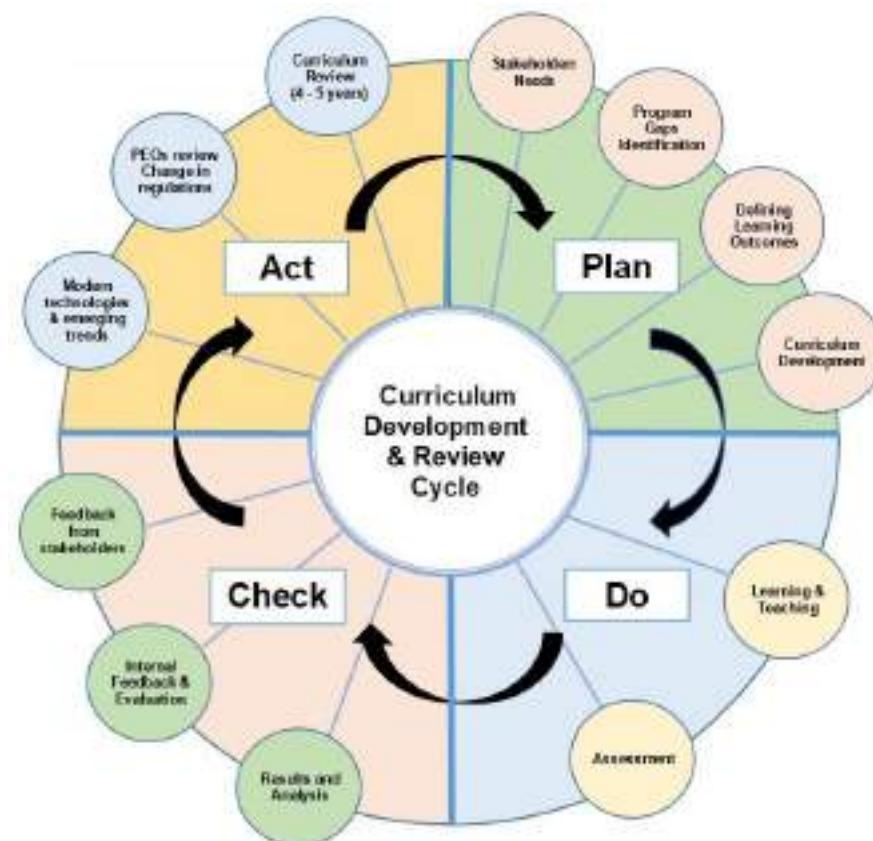
Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student's centered system which concerns what the students will know and be able to do as learning outcomes. The curriculum development under OBE is therefore an integration of graduate attributes and stakeholders' feedback in cognizance with institution's Vision and Mission.

## Outcome-Based Education (OBE) - Curriculum Development Framework

# 4. PDCA Approach to Curriculum Development

The process of curriculum design and development constitutes various interconnected elements with the objective of achieving the intended purpose of the program. The Plan-Do-Check-Act approach (PDCA) as explained below has been followed in the curriculum development and review process.



**Plan.** This stage begins with an analysis of the stakeholders' needs of faculty, current and past students, employers and society in general. The stakeholders' needs are translated into human resource terminology i.e. graduate competencies which in turn translated into educational taxonomy and learning outcomes. Based on the learning outcomes, curriculum is designed backward to meet PLOs.

**Do**. The plan stage is implemented where curriculum is delivered and learning outcomes are assessed to gauge the achievement of PLOs.

**Check**. This stage involves the analysis of assessment results and feedback from students and faculty. Areas for improvement are identified.

**Act.** When the learning outcomes are achieved, the curriculum, learning and teaching strategies and assessment methods are standardized. Best practices are shared and improvement is made for the next cycle of PDCA.

## 5. ECRDC for Electrical & Allied Engineering Disciplines

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Electrical and Allied Engineering Disciplines took up the task to review and update the curriculum for Bachelor of Telecom Engineering degree program. The subject Committee had meetings on    18-9-2019 and 20-2-2020 besides meetings of Sub-Group Telecom Engineering on 15-11-19 and 5-12-2019 at PEC Headquarters Islamabad. The Committee consisted of following members:

| | | |
|---|---|---|
| 1 | Engr Prof Dr M. Younus Javed<br>Vice Chancellor<br>HITEC University, Taxila | Convener |
| 2 | Engr Dr Saeed Ur Rehman<br>Executive Director<br>Sir Syed CASE Institute of Technology, Islamabad | Member |
| 3 | Engr Zafar Mehmood<br>Chief Executive Officer<br>InterSES (International System Engineering and Services Pvt. Ltd) Islamabad | Member |
| 4 | Engr Prof Dr Suhail Aftab Qureshi<br>Professor, Ex Dean<br>University of Engineering & Technology, Lahore | Member |

| | | |
|---|---|---|
| 5 | Engr Prof Dr Usman Akram<br>Associate Professor<br>Department of Computer & Software Engineering<br>NUST College of Electrical & Mechanical Engineering<br>Rawalpindi | Member |
| 6 | Engr Yasir Rizwan Saqib<br>Chief Executive Officer<br>TechFoot, Lahore | Member |
| 7 | Engr Prof Dr Jameel Ahmed<br>Dean<br>Faculty of Engineering & Applied Sciences<br>Riphah International University, Islamabad | Member |
| 8 | Engr Mairaj Gul<br>General Manager Operations North<br>National Telecommunication Corporation, NTC HQs, Islamabad | Member |
| 9 | Engr Prof Mansoor Shaukat<br>Assistant Professor<br>School of Electrical Engineering & Computer Science (SEECS)<br>National University of Sciences and Technology (NUST)<br>Islamabad | Member |
| 10 | Engr Prof Dr Bhawani Shankar Chowdhry<br>Ex Dean, Faculty of Electrical, Electronics & Computer Engg<br>Mehran University of Engg & Technology, Jamshoro | Member |
| 11 | Engr. Prof. Dr. Mohammad Inayat Ullah Babar<br>Vice Chancellor<br>University of Engineering & Technology, Taxila | Member |
| 12 | Engr Prof Dr Madad Ali Shah<br>Vice Chancellor<br>The Benazir Bhutto Shaheed<br>University of Technology and Skill Development<br>Khairpur Mirs, Sindh | Member |

| 13 | Engr. Muhammad Roshan Awan<br>Principal<br>Govt. College of Technology, Taxila | Member |
|----|----|----|
| 14 | Engr. Habib Ur Rehman Qaiser<br>Lt. Colonel Army (Rtd), Lahore | Member |
| 15 | Dr. Mohammad Ali Maud<br>Professor<br>Department of Computer Engineering UET, Lahore | Member |
| 16 | Engr Prof Dr Vali Uddin<br>Professor, Department of Electronics<br>Hamdard University, Karachi | Member |
| 17 | Engr. Prof. Engr Dr. Nisar Ahmed<br>Professor<br>Ghulam Ishaq Khan Institute of Engg, Sciences & Technology<br>Swabi | Member |
| 18 | Engr Prof Dr Waqar Mahmood<br>Director<br>Al-Khawarizmi Institute of Computer Science<br>UET, Lahore | Member |
| 19 | Engr Dr Ismail Shah<br>Ex-Chairman<br>Pakistan Telecommunication Authority, Islamabad | Member |
| 20 | Dr Shazia Nauman<br>Associate Professor<br>Riphah International University, Islamabad | Member |
| 21 | Engr Mohsin Latif<br>Entrepreneur, Vital Imaging, Karachi | Member |
| 22 | Engr Asif Mehmood<br>Director NESCOM, Islamabad | Member |
| 23 | Engr. Porf Dr. Syed Mohammad Hasan Zaidi<br>School of Electrical Engineering and Computer Engineering<br>(SEECS), Islamabad | Member |

| 24 | Engr. Dr. Tauseef Tauqeer<br>Associate Professor<br>Information Technology University, Lahore | Member |
|----|----|----|
| 25 | Engr. Dr. Zahir Paracha<br>Professor, Department of Electrical Engineering<br>Pakistan Institute of Engineering & Technology, Multan | Member |
| 26 | Mr. Hidayatullah Kasi<br>Deputy Director<br>Higher Education Commission, Islamabad | Rep HEC |
| 27 | Engr. Dr. Ashfaq Ahmed Shaikh<br>Additional Registrar-CPD<br>Pakistan Engineering Council, Islamabad | Secretary |
| 28 | Engr. Muhammad Kashif Ali<br>Assistant Registrar-CPD<br>Pakistan Engineering Council, Islamabad | AR-CPD |

## 5.1  Sub Group Telecom Engineering

| 1. | Engr. Dr. Syed Mohammad Hasan Zaidi<br>Professor, NUST School of Electrical Engineering<br>and Computer Engineering (SEECS), Islamabad | Lead Sub-Group |
|----|----|----|
| 2. | Engr. Muhammad Roshan Awan<br>Principal<br>Govt. College of Technology,  Taxila | Member |
| 3. | Engr. Habib Ur Rehman Qaiser<br>Lt. Colonel Army (Rtd)<br>Lahore | Member |
| 4. | Engr Dr Ismail Shah<br>Ex-Chairman<br>Pakistan Telecommunication Authority, Islamabad | Member |
| 5. | Engr. Dr. M. Imran<br>Department of Electrical Engineering<br>Military College of Signals (MCS), Rawalpindi | Member |

| 6. | Engr. Dr. Fasih ud Din Butt<br>Department of Electrical Engineering<br>Comsats Islamabad Campus, Islamabad | Member |
|----|---|---|
| 7. | Engr. Dr. Ali Hassan<br>NUST School of Electrical Engineering and Computer<br>Engineering (SEECS), Islamabad | Expert |
| 8. | Engr. Dr. Danish Ali Mazhar<br>Senior Instructor Telecom<br>TEVTA, Taxila | Expert |
| 9. | Mr. Hidayatullah Kasi<br>Deputy Director<br>HEC, Islamabad | Rep HEC |
| 10. | Engr. Dr. Ashfaq Ahmed Shaikh<br>Additional Registrar-CPD<br>Pakistan Engineering Council, Islamabad | Secretary |
| 11. | Engr. Muhammad Kashif Ali<br>Assistant Registrar-CPD<br>Pakistan Engineering Council, Islamabad | AR-CPD |

# 6. Agenda of ECRDC for Electrical and Allied Engineering Disciplines
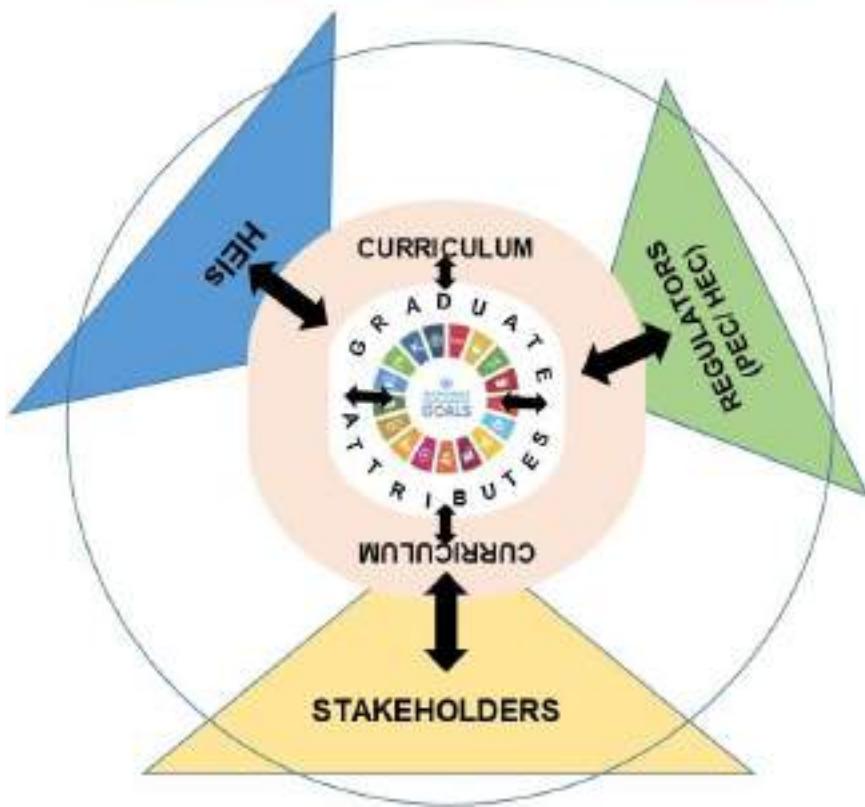
- The Subject ECRDC will work under the overall directions and supervision of main ECRDC comprising all Conveners.
- The key driving lines for the development of engineering curriculum for each discipline will be the overall policy of Pakistan Engineering Council in connection with international commitments (Washington Accord, IPEA etc.) and Government policies/ HEC.
- Review of polices and stakeholders' feedback for the sector(s) relevant to the respective discipline
- Comparative study of the curricula being offered at various engineering universities/institutions following the OBE-based system
- Development and finalization of complete scheme and curriculum for respective discipline including all aspects.

Engr. Prof. Dr. Muhammad Younis Javed, the Convener highlighted the important benchmarks and international best practices to be considered for the revision of the curriculum while taking into account the Outcome Based Education (OBE) system. He also apprised that the Committee comprising professionals and experts from academia, industry and R&D institutions, has provided useful input and suggestions covering new developments to be incorporated in the curriculum. He also highlighted the importance of the field of Telecommunication Engineering for achieving sustainable developments while addressing socio-economic issues and challenges envisaged in Sustainable Development Goals (SDGs) as under and well-mapped with the courses;

- Goal-1: No Poverty
- Goal-2: Zero Hunger
- Goal-3: Good Health and Well-being
- Goal-4: Quality Education
- Goal-5: Gender Equality
- Goal-8: Decent Work and Economic Growth
- Goal-9: Industrial Innovation and Infrastructure
- Goal-12: Responsible Consumption and Production

- Goal-13: Climate Action



**OBE Curriculum towards SDGs-2030 Attainment**

The curriculum therefore has been designed based on above SDGs translating into program objectives and mapped with the scheme of study.

# 7. Program Educational Objectives (PEOs) and Learning Outcomes (PLOs)

As guidance, the sample Program Educational Objectives (PEOs) and Learning Outcomes (PLOs) are given below for a typical Telecom Engineering Program. The HEIs should have their own program objectives (PEOs) and PLOs in line with the institution's Vision and Mission, in cognizance with industrial needs as well as national and international trends.

## 7.1 Program Educational Objectives (PEOs)

The program aims at imparting quality education to Telecom Engineering graduates for contributing to the society through modern technologies and practices in line with SDGs especially Goal-1, Goal-2, Goal-3, Goal-4, Goal-5, Goal-8, Goal-9, Goal-12, and Goal-13.

The graduates of the program will develop into professional engineers who will:

- Demonstrate excellence in profession through in depth knowledge and skills in the field of Telecommunication Engineering
- Engage in continuous professional development and exhibit quest for learning, innovation and entrepreneurship
- Show professional integrity and commitment to social and ethical responsibilities

## 7.2 Program Learning Outcomes (PLOs)

Program outcomes are the narrower statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills and attitude that the students acquire while progressing through the program. Specifically, it is to be demonstrated that the students have acquired the following graduate attributes (GAs):

**PLO-01: Engineering Knowledge:** Ability to apply knowledge of mathematics, science and engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

**PLO-02: Problem Analysis:** Ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

**PLO-03: Design/Development of Solutions:** Ability to design solutions for complex engineering problems and design systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

**PLO-04: Investigation:** Ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.

**PLO-05: Modern Tool Usage:** Ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

**PLO-06: The Engineer and Society:** Ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

**PLO-07: Environment and Sustainability:** Ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of, and need for, sustainable development.

**PLO-08: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

**PLO-09: Individual and Team Work:** Ability to work effectively, as an individual or in a team, on multifaceted and/or multidisciplinary settings.

**PLO-10: Communication:** Ability to communicate effectively, orally as well as in writing on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentations, make effective presentations, and give and receive clear instructions.

**PLO-11: Project Management:** Ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team to manage projects in a multidisciplinary environment.

**PLO-12: Lifelong Learning:** Ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

## 8. Program Salient Features

The undergraduate engineering program has been based on the following salient features:

- **Duration:**                                    4 years
- **Number of Semesters:**                 8
- **Total number of credit hours**:        130 - 136
  - o  Engineering Domain:                minimum 85 Credit Hours
  - o  Non-Engineering Domain:         minimum 30 Credit Hours

  (HEIs have flexibility of 15-21 Credit Hours to add courses either in Engineering, Non-Engineering or both Domains to fulfill the program objectives in line with the overall Vision/ Mission of the Institute concerned).

- **Additional Course or Credit Hours Requirements:** Any addition of course or credit hour requirements as per direction or policy of the Government (Provincial or Federal), HEIs have leverage to cater such needs over and above the prescribed requirements in this document.

- **Number of weeks per semester**:        15 - 18
- **Number of credit hours per semester**:    15 - 18
- **Curriculum:** The engineering curriculum is the most important instrument for grooming the students based on 12 Graduate Attributes (GAs) encompassed under the Program Learning Outcomes (PLOs). In order to inculcate different dimensions of thinking – mathematical, computational, design and creative – among students in Cognitive, Psychomotor and Affective domains, the curriculum is based on the following knowledge profiles:

  **WK1 -  Natural Sciences:** A systematic theory-based understanding of natural sciences applicable to the discipline.

**WK2 - Mathematics and Computing:** The concept-based mathematical thinking, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modeling applicable to the discipline.

**WK3 - Engineering Fundamentals:** A systematic, theory-based formulation of engineering fundamentals required in an engineering discipline.

**WK4 - Engineering Specialization:** The knowledge of engineering specialization that provides theoretical frameworks and bodies of knowledge for the accepted practice areas that are at the forefront in a discipline.

**WK5 - Engineering Design:** The Design Thinking Knowledge that supports engineering design in a practice area of an engineering discipline.

**WK6 - Engineering Practice:** The Knowledge of engineering practices (technology) in different practice areas of an engineering discipline.

**WK7 - Engineering in Society:** A systematic, comprehension-based knowledge of the role of engineers in a society and the professional issues related to practicing engineering profession in a discipline: ethics and the professional responsibility of an engineer to public safety including the impact of an engineering activity i.e. economic, social, cultural, and environmental and sustainability

**WK8 - Research Literature:** Engagement with selected knowledge in the research literature of the discipline.

The curriculum matrix covering above knowledge profiles should therefore be composed of non-engineering domain (humanities, math, management and natural sciences), and engineering domain with computer science, foundation, breadth, depth and multidisciplinary courses (including safety) so that different streams could be encouraged within each discipline, enabling students to undertake a range of **Complex Problem Solving** and **Complex Engineering Activities**. The students

may select electives from any of the streams with guidelines from their respective advisors.

| Knowledge Profile* (WK-1 to WK-8)* | Knowledge Area | Sub-Area | Courses | Credit Hours |
|---|---|---|---|---|
| **Non-Engineering Domain** | | | | |
| WK-2 | Natural Science | Math | As per program requirements | 12 - 15 |
| WK-1 | | Physics | Applied Physics | 6 - 9 |
| | | Chemistry | Applied Chemistry | |
| | | Natural Science/ Math Elective | As per program requirements | |
| WK-7 | Humanities | English | Written, communication and presentation skills | 4 - 7 |
| | | Culture | Islamic Studies and Ethics | 2 |
| | | | Pakistan Studies and Global Perspective | 2 |
| | | Social Science | Social and soft skills | 2 - 6 |
| | Management Sciences | Professional Practice | Professional and Project Management | 2 - 6 |
| **Total (Non-Engineering Domain)** | | | | **min 30** |
| **Engineering Domain** | | | | |
| WK-2/ WK-4/ WK-5/ WK-6 | Computer Science | ICT/AI/ Data Science/ Cyber Security | | 6 - 9 |
| WK-3/ WK-2 | Foundation Engg Courses | | Specific to program objectives and outcomes | 22 - 24 |
| WK-4/ WK-2/ WK-1 | Core Breadth of Engg discipline | | Specific to program objectives and outcomes | 23 - 24 |

| WK-5/ WK-6 | Core Depth of Engg Discipline | | Specific to program objectives and outcomes | 22 - 24 |
|---|---|---|---|---|
| WK-1/ WK-2/ WK-3/ WK-4 | Multi-disciplinary Engg Courses | | Specific to program objectives and outcomes | 6 - 12 |
| | | | Occupational Health and Safety (mandatory – 01 Cr Hr) | |
| WK-6/ WK-8/ WK-7 | Final Year Design Project (FYDP/ Capstone | Integration of innovative, creative, technical, management and presentation skills of a graduate towards final year. | | 6 |
| WK-6/ WK-7 | Industrial Training | at least 6 - 8 weeks internship | | Qualifying |
| WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-2 | **Innovative and Critical Thinking (under relevant courses):**<br>- Complex Problem Solving<br>- Complex Engineering Activities<br>- Semester Project<br>- Case Studies<br>- Open Ended Labs<br>- Problem Based Learning (PBL) | | | |
| **Total (Engineering domain)** | | | | **min 85** |
| **Total (Credit Hours)** | | | | **130 - 136** |

\* As a specific or more than one knowledge profile to be covered.

- **Industrial Training:** Internship of at least 6 - 8 weeks is mandatory part of degree requirements towards 3$^{rd}$ to 4$^{th}$ year of program; must be supervised, monitored, evaluated, and reflected in the transcripts under a prescribed mechanism and with defined and mapped rubrics with program objectives;
    o   Selection of internship in line with elective subjects/ specific streams
    o   Qualifying weightage:                                                      70%
        ▪   At least 75% attendance is mandatory                    10%
        ▪   Assessment report from the employer                     50%
        ▪   Evaluation at relevant HEIs/ Deptt – presentation    40%

- **Final Year Design Project (FYDP)/ Capstone:** FYDP aims to challenge innovative, creative, technical, management and presentation skills of a graduate to bring together the learning over the degree program.

  o A final year design project (FYDP) is the confluence of an engineering program. Undertaking a final year design project is a compulsory requirement. It should mainly comprise literature search, individual analysis, modeling and simulation, AI (Artificial Intelligence) and computational data analytics, design and putting together various hardware, software, firmware and Algorithm Engineering / Informatics related to the program to demonstrate a functional concept including rapid prototyping, where applicable.

  o The FYDP shall include complex engineering problems and design systems, components or processes integrating core areas and meeting specific needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

  o A project of this nature should invariably lead to an integration of the knowledge and practical skills as mandated in the program outcomes. In this context, projects of multidisciplinary nature should be encouraged.

  o The FYDP should span over two consecutive semesters, i.e. semester 7 & 8, totaling 6-credit hours and should be fully supervised, assessed and reflected in the transcripts under a prescribed mechanism so as to prepare for joining industry after graduation.

- **Faculty:** The faculty must be trained for the Outcome-Based Education (OBE) system. Their familiarity with the program objectives and outcomes, understanding of the Outcome-Based Assessment (OBA) cycle, enthusiasm for developing an effective program, and the ability to become an active player in this regard are the keys to ensure the attainment of program objectives. The faculty is expected to have the ability to ensure proper implementation of the program, and to develop processes for evaluation, assessment and CQI. A formal training program to groom the faculty should be instituted to become effective instructors in applying pedagogical skills in all aspects of Teaching, Learning and Assessment covering all domains of Knowledge, Skills and Attitude.

- **Personal Grooming:** Personal Grooming of young faculty members and students is very important in order to develop and support their professional skills. Therefore, it is required that HEIs should conduct/arrange sessions or counseling hours on regular basis to provide guidance for personal grooming. Personal Grooming is important for positive self-image and increasing the confidence level of the individuals. It would help in enhancing students' self-esteem and would go a long way in developing an attractive personality by adopting habits like personal hygiene, clothing, appearance, interaction and expressive skills, etc. The students should be motivated and equipped to be entrepreneurs in their relevant field.

- **Presentation and Communication Skills:** Special focus should be given to inculcate communication and presentation skills amongst the graduates through individual and group presentations, technical writing and discussions, throughout the program as a regular feature.

This curriculum has been designed to guide and facilitate the universities and departments to formulate their own programs according to the industrial needs, emerging trends and recent developments in the field of Telecom Engineering. The HEIs have flexibility to incorporate changes in the proposed curriculum within given range of credit hours for engineering and non-engineering domain.

# 9. Framework for Bachelor of Telecommunication Engineering

| Knowledge Profile (WK-1 to WK-8) | Knowledge Area | Sub Area | Course Title | Theory | Lab | Total |
|---|---|---|---|---|---|---|
| | | | | Credit Hours | | |
| **Non-Engineering Domain** | | | | | | |
| WK-7 | Humanities | English | Functional English | 2 | 0 | 2 |
| | | | Communication Skills | 2 | 0 | 2 |
| | | | Technical Report Writing and Presentation | 3 | 0 | 3 |
| | | Culture | Islamic Studies and Ethics | 2 | 0 | 2 |
| | | | Pakistan studies and Global Perspectives | 2 | 0 | 2 |
| | | Social Sciences | Elective-I | 2 | 0 | 2 |
| | | | Elective-II (Economics for Engineers) | 2 | 0 | 2 |
| | Management Sciences | Professional Practice | Elective-I (Engineering Project Management ) | 2 | 0 | 2 |
| | | | Elective-II (Entrepreneurship) | 3 | 0 | 3 |
| WK-2 | Natural Science | Math | Calculus and Analytical Geometry | 3 | 0 | 3 |
| | | | Multivariate Calculus | 3 | 0 | 3 |
| | | | Linear Algebra | 3 | 0 | 3 |
| | | | Differential Equations | 3 | 0 | 3 |
| | | | Numerical Analysis | 2 | 0 | 2 |
| | | | Probability and Statistics | 3 | 0 | 3 |
| WK-1 | | Physics | Applied Physics | 2 | 1 | 3 |
| **Total (Non-Engineering Domain)** | | | | **39** | **1** | **40** |

| | | | Engineering Domain | | | |
|---|---|---|---|---|---|---|
| WK-2/ WK-4/ WK-5/ WK-6 | Computer and Information Science | ICT/AI/ Data Science/ Cyber Security | Information and Communication Technologies (ICT) | 2 | 1 | 3 |
| | | | Object Oriented Programming | 3 | 1 | 4 |
| | | | Computer Aided Design | 0 | 1 | 1 |
| WK-3/ WK-2 | Engineering Foundation | -- | Electric Workshop | 0 | 1 | 1 |
| | | | Circuit Analysis | 3 | 1 | 4 |
| | | | Electrical Network Analysis | 3 | 1 | 4 |
| | | | Digital Logic Design | 3 | 1 | 4 |
| | | | Electromagnetic Theory | 3 | 0 | 3 |
| | | | Electronic Devices and Circuits | 3 | 1 | 4 |
| | | | Communication Systems | 3 | 1 | 4 |
| | | | Signals and Systems | 3 | 0 | 3 |
| WK-4/ WK-2/ WK-1 | Major Based Core (Breadth) | -- | Digital Communications | 3 | 1 | 4 |
| | | | Microprocessors and Microcontrollers | 3 | 1 | 4 |
| | | | Digital Signal Processing | 3 | 1 | 4 |
| | | | Control Systems | 2 | 1 | 3 |
| | | | Antennas and Wave propagation | 3 | 1 | 4 |
| WK-5/ WK-6 | Major Based core (Depth) | -- | Computer Communication Networks | 3 | 1 | 4 |
| | | | Transmission and Switching Systems | 2 | 1 | 3 |
| | | | Microwave Engineering | 3 | 1 | 4 |
| | | | Emerging Wireless Technologies and RF Planning | 2 | 0 | 2 |
| | | | Optical Fiber Communications | 3 | 1 | 4 |
| | | | Wireless and Mobile Communications | 3 | 0 | 3 |
| | | | MBC Depth Elective I | 3 | 0 | 3 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | MBC Depth Elective II | 3 | 0 | 3 |
| WK-3/ WK-4/ WK-2/ WK-1 | Multi-disciplinary Engg Courses | -- | ID Electives I | 2 | 1 | 3 |
| | | | ID Electives II | 2 | 1 | 3 |
| | | | ID Electives III | 2 | 1 | 3 |
| | | | Occupational Health and Safety* | 1 | 0 | 1 |
| WK-6/ WK-7/ WK-8 | Final Year Design Project (FYDP)/ Capstone | Industrial/ Innovative/ creative Projects | FYDP/ Capstone | 0 | 6 | 6 |
| WK-6/ WK-7/ | Industrial Training | At least 6 – 8 weeks internship | | 0 | 0 | 0 |
| WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8 | **Innovative and Critical thinking (under Relevant Courses)**<br>- Complex Problem Solving<br>- Complex Engineering Activities<br>- Semester Project<br>- Case Studies<br>- Open ended labs<br>- Problem Based Learning | | | | | |
| **Total (Engineering Domain)** | | | | 69 | 27 | 96 |
| **Total Credit Hours** | | | | 108 | 28 | 136 |

* to be taught during 1st year of program.

# 10. Scheme of Study for Bachelor of Telecommunication Engineering

| S.# | Course Title | Theory | Lab | Total |
|---|---|---|---|---|
| | **Semester 1** | | | |
| | | Credit Hours | | |
| 1 | Functional English | 2 | 0 | 2 |
| 2 | Information and Communication Technology | 2 | 1 | 3 |
| 3 | Calculus and Analytical Geometry | 3 | 0 | 3 |
| 4 | Applied Physics | 2 | 1 | 3 |
| 5 | Circuit Analysis | 3 | 1 | 4 |
| 6 | Electric Workshop | 0 | 1 | 1 |
| 7 | Pakistan Studies and Global Perspectives | 2 | 0 | 2 |
| | **Total** | **14** | **4** | **18** |
| | **Semester 2** | | | |
| 1 | Communication Skills | 2 | 0 | 2 |
| 2 | Object Oriented Programming | 3 | 1 | 4 |
| 3 | Linear Algebra | 3 | 0 | 3 |
| 4 | Computer Aided Engineering Design | 0 | 1 | 1 |
| 5 | Differential Equations | 3 | 0 | 3 |
| 6 | Electrical Network Analysis | 3 | 1 | 4 |
| | **Total** | **14** | **3** | **17** |
| | **Semester 3** | | | |
| 1 | Islamic Studies and Ethics | 2 | 0 | 2 |
| 2 | Engineering Economics | 2 | 0 | 2 |

| | | | | |
|---|---|---|---|---|
| 3 | Multivariate Calculus | 3 | 0 | 3 |
| 4 | Electronic Devices and Circuits | 3 | 1 | 4 |
| 5 | MDE Elective I | 2 | 1 | 3 |
| 6 | Digital Logic Design | 3 | 1 | 4 |
| **Total** | | **15** | **3** | **18** |
| **Semester 4** | | | | |
| 1 | MDE Elective II | 2 | 1 | 3 |
| 2 | Signals and Systems | 3 | 0 | 3 |
| 3 | Microprocessors and Microcontrollers | 3 | 1 | 4 |
| 4 | Probability and Statistics | 3 | 0 | 3 |
| 5 | Technical Report Writing and Presentation | 2 | 1 | 3 |
| **Total** | | **13** | **3** | **16** |
| **Semester 5** | | | | |
| 1 | Electromagnetic Theory | 3 | 0 | 3 |
| 2 | Control Systems | 2 | 1 | 3 |
| 3 | Communication Systems | 3 | 1 | 4 |
| 4 | Sociology/ Community Service | 2 | 0 | 2 |
| 5 | Computer Communication Networks | 3 | 1 | 4 |
| 6 | Numerical Analysis | 2 | 0 | 2 |
| **Total** | | **15** | **3** | **18** |
| **Semester 6** | | | | |
| 1 | Digital Communications | 3 | 1 | 4 |
| 2 | Antennas and Wave Propagation | 3 | 1 | 4 |
| 3 | Project Management | 3 | 0 | 3 |

| 4 | ID Elective III | 3 | 0 | 3 |
|---|---|---|---|---|
| 5 | Digital Signal Processing | 3 | 1 | 4 |
| **Total** | | **15** | **3** | **18** |
| **Semester 7** | | | | |
| 1 | Microwave Engineering | 3 | 1 | 4 |
| 2 | Optical Fiber Communications | 3 | 1 | 4 |
| 3 | Wireless and Mobile Communications | 3 | 0 | 3 |
| 4 | Emerging Wireless Technologies and RF Planning | 2 | 0 | 2 |
| 5 | Final Year Design Project-I | 0 | 3 | 3 |
| **Total** | | **11** | **5** | **16** |
| **Semester 8** | | | | |
| 1 | Transmission and Switching Systems | 2 | 1 | 3 |
| 2 | MBC Depth Elective I | 3 | 0 | 3 |
| 3 | Entrepreneurship | 2 | 0 | 2 |
| 4 | Final Year Design Project-II | 0 | 3 | 3 |
| 5 | MBC Depth Elective II | 3 | 0 | 3 |
| **Total** | | **10** | **4** | **14** |
| **Grand Total** | | **107** | **28** | **135** |

### Computer and Information System Courses

- Information and Communication Technology
- Object Oriented Programming
- Computer Aided Design
- Object Oriented Programming
- Artificial Intelligence
- Computer Programming
- Introduction to Modelling & Simulation

### Major Based Core (MBC) Depth Electives (Proposed)

- Multimedia Systems
- Satellite Communications
- Telecom Standards and Regulations
- Telecom Traffic Engineering
- Next Generation Networks
- Network Security
- Radar Systems Engineering
- Telecommunication Network Management
- Machine learning for Communication Systems

### Multi-Disciplinary Electives (Proposed)

- GIS/RS applications in Telecom
- Operating Systems
- Data structures and algorithms
- VLSI Systems
- Artificial Intelligence
- Big Data Analytics
- Database Management Systems
- Embedded Systems
- Cyber Security
- Data Analytics
- Reliability in Telecommunication Systems

- Cloud Computing
- Internet of Things
- Operations Management

# 11. Program Specific Labs

The following labs specific to engineering discipline be ensured to cover relevant knowledge domains but not limited to;

- Electric Machines Lab
- Signal Processing Lab
- Data Communication & Internetworking Lab
- Communication Systems Lab
- RF Microwave Lab
- Antenna Lab
- Control & Instrumentation Lab
- Computer Lab
- Project and Research Lab
- PC Labs

## 12. Course Detail and Teaching-Assessment Approaches

### 12.1  Engineering Domain

In the following sections, Course Outlines and teaching-assessment approaches are given for guidance based on a typical semester system. The instructors may adopt or adapt accordingly defining CLOs, course delivery plan, innovative teaching approaches and assessment techniques.

## Computer and Information System Courses

### Information and Communication Technologies (ICT)

**Course Outline:**

**Introducing Computer Systems: Basic Definitions**

- Computer and Communication Technology
- The applications of ICT - particularly for Engineers

**Basic Operations and Components of a Generic Computer System**

- Basic operations: Input, Processing, Output, Storage Basic components: Hardware, Software, Data, Users
- Types of storage devices

**Processing Data**

- Transforming data into information
- How computers represent and process data
- Processing Devices
- CPU architectures

**The Internet**

- The Internet and the World Wide Web- browsers, HTML
- URLs/ How DNS works
- Email and other programs

**Introduction to Embedded Systems**

- What is an Embedded System
- Applications
- Components
- Programming Languages
- Popular Development Platforms

**Networking Basics**

- Uses of networks
- Common types of networks (LAN, WAN, MAN etc.)
- Introduction to OSI Model
- Future of Networks

**Database Management**

- Hierarchy of Data
- Maintaining Data
- Database Management Systems

**Exposure to ICT Tools and Blogs (Student Assignment)**

**Protecting your privacy, your computer and your data**

- Basic Security Concepts
- Threats to users
- Threats to hardware
- Threats to Data

**ICT in Education**

**Future Trends in ICT**

**Final Presentations**

**Tools / Software Requirement**

Microsoft Office, Windows, Virtual Box, Netbeans

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- "Introduction to Computers", Peter Norton, latest Edition, McGraw-Hill.
- "Computing Essentials", Timothy O'Leary and Linda O'Leary, latest edition, McGraw-Hill.
- Using Information Technology: A Practical Introduction to Computers & Communications", Williams Sawyer, latest Edition, McGraw-Hill.
- "Discovering Computers, Complete: Your Interactive Guide to the Digital World. Cengage Learning" Shelly GB, Vermaat ME, latest Ed.

## Computer Programming

**Course Outline:**

- Introduction to Programming and languages
- Algorithms, Flowcharts and pseudocode
- Overview of programing (C, C+, Python)
- Writing, compiling and debugging
- Coding style
- Statements
- Variables and datatypes
- Operators and expressions
- Selection
- Relational operators
- Conditional Statements
- Conditional operators
- Switch, break, continue
- Logical operators

- Modular programming
- Structures in functions and Arrays
- File pointers
- Error handling
- Revision
- Project Demos

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Paul J. Deitel and Harvey M. Deitel, C: How to Program, Prentice Hall, latest edition.
- The C Programming Language (2nd Ed.) by Kernighan and Ritchie, latest edition.
- Code Complete (latest Ed.) by Steve McConnell,
- The Art of Computer Programming (TAOCP) by Donald E. Knuth, latest edition.

## Computer Aided Design

**Course Outline:**

- Introduction to AutoCAD
- Use basic drawing and text commands
- Use basic editing commands (move, copy, erase, etc.)
- Use advanced editing commands (mirror, fillet, etc.)
- Dimensioning capabilities of Auto CAD
- Create and use layers
- Print or plot a drawing
- Create and using blocks

- Be familiar with hatching capabilities of Auto CAD
- Curves
- 3D modeling
- Multiple Lines
- Geometric Shapes
- Isometric drawings
- Polar Arrays

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Mastering AutoCAD latest edition and AutoCAD LT by George Omura with Brian Benton, (latest edition).
- AutoCAD® latest edition And AutoCAD Ltd latest edition No Experience required by Donnie Gladfelter.

### Introduction to Modeling and Simulation

**Course Outline:**

**Simulation**

- Prepare Model Inputs and Outputs
- Configure Simulation Conditions
- Run Simulations
- View and Analyze Simulation Results
- Test and Debug Simulations
- Optimize Performance
- Simulation Guidelines & Best Practices

**Modeling**

- Design Model Architecture
- Manage Design Data
- Design Model Behavior
- Configure Signals, States, and Parameters
- Configure Inputs and Visualizations
- Analyze and Remodel Design
- Test Model Components
- Modeling Guidelines & Best Practices

**Tools/ Software Requirement**

- Matlab

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Introduction to Matlab for Engineering Students by David Houcque, Northwestern University latest edition.
- https://www.mathworks.com/help/simulink/simulation.html
- https://www.mathworks.com/help/simulink/modeling.htm

**Artificial Intelligence**

**Course Outline**

This course gives a broad overview of the fundamental theories and techniques of Artificial Intelligence.

- Overview of AI Problems;

- Intelligent Behavior: Turing Test, Rationale versus Non-rationale Reasoning;
- Problem Characteristics: Fully versus Partially Observable,
- Single versus Multi agent; Intelligent Agents: reactive, deliberative, goal-driven, utility-driven, and learning agents; Uninformed Search: Depth First, Breadth First, Depth First with Iterative Deepening;
- Informed Search: Hill climbing, A*- Search and their Time and Space Complexity, Local Search, Genetic Algorithm; Game Playing: Minimax, Evaluation functions, Alpha-beta pruning; Propositional and Predicate Logic; Resolution and Theorem Proving; Forward and Backward Chaining;
- Machine Learning: Introduction,
- Supervised learning: Instance based learning, Decision tree, Artificial neural networks, Unsupervised Learning: K-means Clustering, Reinforcement Learning.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Stuart J. Russell and Peter Norvig, "Artificial Intelligence: A Modern Approach", latest Edition, Prentice Hall, ISBN-13: 978-0136042594.
- Elaine Rich and Kevin Knight, "Artificial Intelligence", latest Edition, McGraw-Hill, ISBN-13: 978-0070522633.
- R. J. Schalkoff, "Artificial Intelligence in Engineering Approach", latest edition, McGraw Hill, ISBN-13: 978-0070550841.
- Peter Jackson, "Introduction to Expert Systems", latest Edition, Addison Wesley, ISBN-13: 978-0201876864.
- Ivan Bratko, "Prolog Programming for Artificial Intelligence", latest Edition, Addison Wesley, ISBN-13: 978-0321417466.

## Object Oriented Programming

**Course Outline**

- Procedural versus object oriented programming languages,
- Object oriented design strategy and problem solving, pointers, file handling,
- Objects and classes, member functions, public and private members,
- Dynamic memory management,
- Constructors and destructors, templates,
- Object encapsulation, derived classes, class hierarchies,
- Inheritance and polymorphism,
- Operator overloading, stream class,
- Practical design through object oriented programming.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Robert Lafore, "Object oriented programming using C++", latest Edition, Sams, ISBN-13: 978-0672323089.
- Joshua Bloch, "Effective Java", latest Edition, Addison Wesley, ISBN-13: 978-0321356680.
- Dusty Phillips, "Python 3 Object Oriented Programming", latest Edition, Packet Publishing, ISBN-13: 978-1849511261.

# Engineering Foundation Courses

## Electric Workshop

**Course Outline**

- Topics covered include: Introduction to technical facilities in a workshop including mechanical and electrical equipment, concepts in electrical safety, safety regulations, earthing concepts, electric shocks and treatment, use of tools used by electricians
- Wiring regulations, types of cables and electrical accessories including switches, plugs, circuit breakers and fuses etc.,
- UPS/ invertors and battery charging, industrial, domestic and auto wiring, symbols for electrical wiring schematics, wiring schemes of two-way, three-way and ringing circuits,
- Electric soldering / de-soldering,
- PCB design, transferring a circuit to PCB, etching, drilling and soldering components on PCB.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- W.A.J. Chapman, "Workshop Technology", latest Edition, Elsevier Butter-worth Heinemann, ISBN-13: 978-0713132724.
- Choudhry H. S. K., "Elements of Workshop Technology", latest edition, Media Promoters, ISBN-13: 978-8185099149.
- R.P. Sing, "Electrical Workshop: A Textbook", latest Edition, International Publishing House, ISBN-13: 978-8189866716.

## Circuit Analysis

**Course Outline:**

- Topics include: Electric quantities, electric circuits,
- Kirchhoff's laws,
- Circuit elements, resistance, series parallel combination, voltage and current dividers, resistive bridges and ladders,
- Practical sources and loading,
- Instrumentation and measurement,
- Nodal analysis, loop analysis, linearity and superposition, source transformation,
- Circuit theorems, power calculations, dependent sources,
- Circuit analysis with dependent sources, the operational amplifier,
- Basic op-amp configurations, ideal op-amp circuit analysis, summing and difference amplifiers, amplifier types, capacitance, inductance, natural response of RC and RL circuits,
- Response to DC forcing function, transient response of first order circuits, step,
- Pulse and pulse train responses, first order op-amp circuits,
- Transient response and step response of second order circuits.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- C. Alexander and M. Sadiku, "Fundamentals of Electric Circuits", latest Edition, McGraw- Hill, ISBN-13: 978-0073380575.
- J. D. Irwin and R. M. Nelms, "Basic Engineering Circuit Analysis", latest Edition, John Wiley, ISBN-13: 978-0470128695.
- J.W. Nilsson and Susan A. Riedel, "Electric Circuits", latest Edition, Addison-Wesley Publishing, ISBN-13: 978-0136114994.

- Ronald E. Thomas, Albert J. Rosa, and Gregory J. Toussaint, "The Analysis and Design of Linear Circuits", latest Edition, John Wiley, ISBN-13: 978-1118065587.

## Electrical Network Analysis

**Course Outline**

- Current and voltage transients,
- RLC circuits with AC excitation,
- Resonant circuit: series and parallel resonance in AC circuit, Q-Factor, mutual inductance and transformers,
- Introduction to phasor representation of alternating voltage and current,
- Single-phase circuit analysis, star-delta transformation for DC and AC circuits,
- Poly-phase generators, phase sequence,
- Vector diagrams for balance and unbalanced three phase networks,
- Power in three phase circuits and different methods of its measurements,
- Two-port networks and their interconnections,
- Application of Laplace transform in circuit analysis.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- C. Alexander and M. Sadiku, "Fundamentals of Electric Circuits", latest Edition, McGraw- Hill, ISBN-13: 978-0073380575.
- J. D. Irwin and R. M. Nelms, "Basic Engineering Circuit Analysis", latest Edition, Wiley, ISBN-13: 978- 0470128695.
- J.W. Nilsson and Susan A. Riedel, "Electric Circuits", latest Edition, Addison-Wesley Publishing, ISBN-13: 978-0136114994

## Digital Logic Design

**Course Outline**

- Number Systems, Boolean Algebra,
- Logic Gates (AND, OR, NOT etc.),
- Karnaugh Maps, QM Method, Combinational circuits,
- Half & Full Adder and Subtractor,
- Comparator, Encoders, Decoders, Multiplexer, De-multiplexer,
- Sequential Circuits, Flip Flop, (RS, JK, D, T, Master Slave),
- State Transition Diagram, Counters, Registers, Memories, PLAs,
- Programmable Logic Devices (PLDs).

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- M. Morris Mano, "Digital Design", latest Edition, Prentice Hall, ISBN-13: 978-0131989245.
- Roger L. Tokheim, "Digital Electronics: Principles and Applications", latest Edition, McGraw-Hill, ISBN-13: 978-0078309823.
- Thomas L. Floyd, "Digital Fundamental", latest Edition, Prentice Hall, ISBN-13: 978-0135057964.
- Ronald J. Tocci, Neal Widmer and Greg Moss, "Digital Systems: Principles and Applications", latest Edition, Prentice Hall, ISBN-13: 978-0135103821.
- M. Morris Mano, "Digital Logic and Computer Design Fundamentals", latest Edition, Prentice Hall, ISBN-13: 978-0131989269.

## Electromagnetic Theory

**Course Outline**

- Review of Vector Analysis, Orthogonal Coordinate Systems,
- Vector Calculus, Gradient, Divergence and Curl,
- Theorems: Helmholtz Theorem, Divergence theorem and applications, Stokes theorem and applications, Greens' Theorem and applications,
- Coulomb's Law, Gauss Law, Electric Flux Density, Poisson's Value Problems, Magnetic Fields, Current Density, Biot-Savart Law,
- Vector Magnetic Potential, Magnetic Field Intensity, Boundary Conditions,
- Maxwell's Equations In Integral and Point Form, Poynting Vector, Plane Wave,
- Propagation in Isotropic Media, and Simulation using standard tools.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- J. D. Kraus, "Electromagnetics", latest Edition, John Wiley & Sons, ISBN-13: 978-0070356214.
- David K. Cheng, "Fundamentals of Engineering Electromagnetics", latest Edition, Pearson, ISBN-13: 978-1292026589.
- William Hayt and John A. Buck, "Engineering Electromagnetics", latest Edition, McGraw-Hill, ISBN-13: 978-0073380667.
- Sadiku, Matthew N, "Elements of Electromagnetics", latest Edition, Oxford University Press, ISBN-13: 978-0195387759.
- Umran S. Inan, Aziz Inan and Ryan Said, "Engineering Electromagnetics and Waves", latest Edition, Prentice Hall, ISBN-13: 978-0132662741.

## Electronic Devices & Circuits

**Course Outline**

- Forward & Reverse Characteristics of Diode, Special Purpose Diodes, Equivalent Circuit of a Diode, Diode as a Switch, Diode Applications,
- Half Wave & Full wave rectifiers, Clipper & Clamper circuits,
- Bipolar Junction Transistor, Transistor Operation, Types of Transistor, Transistor Biasing Configurations,
- Common Emitter, Common Base, Common Collector,
- DC & AC analysis of BJT, Field Effect Transistors, FET Biasing Techniques,
- Common Drain, Common Source, Common Gate,
- Fixed Bias and Self Bias Configuration, Voltage Divider Biasing,
- Universal JFET Bias Curve, DC & AC analysis of FETs.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- S. Sedra and K. C. Smith," Microelectronic Circuits", latest Edition, Oxford University Press, ISBN-13: 978-0195323030.
- Robert Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", latest Edition, Prentice Hall, ISBN-13: 978-0132622264.
- Robert Paynter, "Introductory Electronic Devices and Circuits: Electron Flow Version", latest Edition, Prentice Hall, ISBN-13: 978-0131716414.
- Richard Jaeger and Travis Blalock, "Microelectronic Circuit Design", latest Edition, McGraw-Hill, ISBN-13: 978-0073380452.

## Communication Systems

**Course Outline**

- Introduction to Communication Model, Essential BW of signal, Shannon's equation,
- Distortion and equalization (With a brief introduction of Fourier analysis, convolution and correlation concepts if required), linear modulation (AM and its types),
- Exponential Modulation, Demodulation and detection techniques,
- Transmission BW for AM & FM signals,
- Pre-emphasis and de-emphasis circuits,
- Pulse Modulation and Demodulation,
- Fundament concepts of probability and random processes,
- Noise and its treatment, SNR of AM and FM.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- B.P. Lathi, "Modern Digital and Analog Communication Systems", Fourth Edition, 2009, Oxford University Press, ISBN-13: 978-0195331455.
- L. W. Couch, "Digital & Analog Communication Systems", Eighth Edition. 2014, Prentice Hall, ISBN-13: 978-7121200304.
- S. Haykin, "Communication Systems", Fifth Edition, 2009, Wiley, ISBN-13: 978-0471697909.
- A.B Carlson and Paul Crilly, "Communication Systems," Fifth Edition, 2009, McGraw-Hill, ISBN-13: 978-0073380407.

## Signals and Systems

**Course Outline**

- Complex number and their applications,
- Introduction to continuous-time and discrete-time signals and systems,
- Linear time invariant (LTI) systems,
- Difference equation, causality, BIBO stability, convolution and correlation,
- Fourier series and transforms, time and frequency characterization of signals and systems,
- The sampling theorem, aliasing, z-transform and introduction to discrete Fourier transform.
- Case studies: communication systems, linear feedback systems and analog filter.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Alan V. Oppenheim, Alan S.Willsky and S. Hamid, "Signals and Systems", latest Edition, Prentice Hall, ISBN-13: 978-0138147570.
- Simon Haykin and Barry Van Veen, "Signals and Systems", latest Edition, Wiley, ISBN-13: 978-0471138204.
- B. P. Lathi, "Linear Systems and Signals", latest Edition, Oxford University Press, ISBN-13: 978-0195158335.
- Anand Kumar, "Signals and Systems", latest edition Prentice Hall, ISBN-13: 978-8120345614.

# Major Based Core (Breadth)

## Digital Communications

**Course Outline**

- Digital modulation techniques, Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK), and Phase Shift Keying (PSK),
- Differential encoding and M-ary signaling, performance of M-ary Signaling, pulse shapes, matched filters, eye diagram,
- Performance (BER and bps/Hz) comparisons of modulation schemes in band limited and non-band limited channels,
- Forward error correction codes,
- Basic concepts of information theory,
- Cellular systems, diversity and multiple access techniques.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- J. G. Proakis and M. Salehi, "Digital Communications", latest Edition, McGraw Hill, ISBN: 978-0072957167.
- B. Sklar, "Digital Communications", latest Edition, Prentice Hall, ISBN: 978-0130847881.
- L. W. Couch, "Digital and Analog Communication Systems", latest Edition, Prentice Hall, ISBN: 978-0132915380.
- S. Haykin, "Digital Communication Systems", latest Edition, Wiley, ISBN: 978-0471647355.

## Microprocessors and Microcontrollers

**Course Outline**

- Introduction to microprocessors, instruction set architecture (ISA),
- Assembly language programming, hardware model, read/write cycles, exception/interrupt processing,
- Memory systems, I/O devices, DMA, interfacing to memory and I/O devices, analog-to-digital and digital-to-analog converters,
- Introduction to microcontrollers, Application, Basic Core Architecture, and Pin Configuration,
- Microcontroller instruction set and programming, Handling of Timers, Counter and Interrupts, Serial Communication, RS-232 protocol, Interfacing of devices including ADC 0804 & ADC 0808, DAC, Keypad interfacing, Stepper motor and LCD, Introduction to PIC microcontrollers.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Barry B. Brey, "The Intel Microprocessors: 8086/8088, 80186/80188, 80286, 80386, 80486, Pentium, Pentium Pro Processor, Pentium II, Pentium III, Pentium 4", latest Edition, Prentice Hall, ISBN-13: 978-0135026458.
- Douglas V. Hall, "Microprocessor and Interfacing: Programming and Hardware", latest Edition, Tata McGraw-Hill, ISBN-13: 978-0070257429.
- Han-Way Huang, "PIC Microcontroller: An Introduction to Software & Hardware Interfacing", latest Edition, Thomson Delmar Learning, ISBN-13: 978-1401839673.

- Muhammad Ali Mazidi, Janice Mazidi and Rolin McKinlay, "8051 Microcontroller and Embedded Systems", latest Edition, Prentice Hall, ISBN-13: 978-0131194021.
- J. W. Valvano, "Embedded Systems: Introduction to Arm® Cortex(TM)-M3 Microcontrollers (Volume 1)", latest Edition, Create Space Independent Publishing Platform, ISBN-13: 978-1477508992.
- J. W. Valvano," Embedded Systems: Real-Time Interfacing to Arm® Cortex(TM)-M Microcontrollers", Create Space Independent Publishing Platform, latest edition ISBN-13: 978-1463590154.

## Digital Signal Processing

**Course Outline**

- Discrete-time signal and its representation, Discrete-time signals and systems, Time-domain analysis of discrete-time signals,
- Frequency-domain analysis, Discrete-time Fourier series, Discrete-time Fourier transform, System response and frequency response,
- Z-transform and its properties, Solution of difference equations using Z-Transform,
- DFT and FFT algorithms,
- Implementation of Discrete-Time systems, Digital filter design, FIR and IIR filters.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- John G. Proakis and Dimitris K Manolakis, "Digital Signal Processing-Principles, Algorithms and Applications", Fourth Edition, 2006, Prentice Hall, ISBN-13: 978-0131873742.

- V. Oppenheim and R. W. Schafer, "Discrete-Time Signal Processing," Third Edition, 2009, Prentice Hall. ISBN-13: 978-0131988422.
- Richard Lyons, "Understanding Digital Signal Processing", Third Edition, 2010, Prentice Hall. ISBN-13: 978-0137027415.

## Control Systems

**Course Outline**

- Classification of open and closed loop control, advantages and disadvantages,
- Effects of feedback, examples including servomechanism, system model and characterization,
- Block diagrams and canonical form, examples of control systems from telecom applications such as satellite tracking, LNAV/VNAV in aviation,
- Flight control systems, heading tracking, signal flow graphs, DE and Laplace transforms, transfer function, poles and zeros,
- Time domain analysis, steady-state error using static error coefficient method, dynamic error constant method, feedback characteristics of control systems, sensitivity of control systems, basic action of controllers (Proportional, Integral, PI and PID controllers),
- Stability assessment (Routh, Bode, Nyquist, Nichols chart),
- Compensation and compensator design for telecommunications applications and state space.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- S. Ghosh, "Control Systems: Theory and Applications", latest Edition, Pearson, ISBN-13: 978-8131708286.

- R. C. Dorf and R. H. Bishop, "Modern Control systems", latest Edition, Prentice Hall, ISBN-13: 978-0136024583.

## Antennas and Wave Propagation

### Course Outline

- Radiation fundamentals and antenna parameters – radiated power, radiation resistance, radiation efficiency, input impedance, radiation pattern, directivity and gain, linear antennas,
- Matching and feeding networks, antenna arrays, aperture antennas, micro-strip antennas, broadband antennas,
- Antennas in wireless technology,
- Properties of receiving antennas – reciprocity, effective antenna area and radar cross section, radio wave propagation,
- Effects of ground and atmosphere on propagation.

### Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

### Assessment:

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

### Suggested Books:

- Constantine A. Balanis, "Antenna Theory: Analysis and Design", latest Edition, Wiley, ISBN-13: 978-0471667827.
- John D. Kraus and Ronald J. Marhefka, "Antennas", latest Edition, McGraw-Hill, ISBN-13: 978-0071232012.

# Major Based Core (Depth)

## Computer Communication Networks

**Course Outline**

- What Is the Internet? The network edge, the network core, delay, loss, and throughput in packet-switched networks,
- Protocol layers and their service models, networks under attack,
- History of computer networking and the Internet,
- Principles of network applications, the web and HTTP, FTP, transport-layer services, UDP,
- Principles of reliable data transfer, TCP, network layer, Internet Protocol (IP), link layer services, error-detection and correction techniques,
- Wireless and mobile networks, wireless links and network characteristics, Wi-Fi: 802.11 wireless LANs, cellular Internet access,
- Multimedia networking applications, streaming stored audio and video, making the best of the best-effort service,
- Protocols for real-time interactive applications,
- Providing multiple classes of service and providing Quality of Service guarantees.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- J. F. Kurose and K. W. Ross, "Computer Networking: A Top-Down Approach", latest Edition, Pearson, ISBN-13: 978-0132856201.
- Douglas E. Comer, "Computer Networks and Internets", latest Edition, Addison-Wesley, ISBN-13: 978-0133587937.
- S. Tananbaum and D. J. Wetherall, "Computer Networks", latest Edition, Prentice Hall, ISBN-13: 978-0132126953.

**Wireless and Mobile Communications**

**Course Outline**

- Cellular Systems, Interference Geometry, Reuse Factor,
- Trunking Theory, Cell Sectoring, Hand-offs, Multipath-fading, Fading Characteristics, Fading distributions,
- Coherence Bandwidth, Level Crossing Rate, Coherence Time, Coherence Bandwidth, Doppler Spectrum, Broadband Channel Models,
- Multiple Access Techniques, TDMA/FDMA, CDMA,
- Introduction to Digital Modulations, Geometry of Signals, Matched Filtering, Correlation Receivers,
- Linear Modulation Techniques,
- Power Spectrum Analysis,
- Multi-carrier Modulation Techniques, OFDM, Sub-Channel allocations in OFDM,
- Introduction to 4G/LTE, Uplink SD-FDMA.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- T. S. Rappaport, Wireless Communications, latest Edition, Prentice Hall
- "Principles of Mobile Communications, latest Edition. By: Gordon L. Stuber. Publisher: Kluwer publishers.

**Transmission and Switching Systems**

**Course Outline**

- Digital Telephone Network basics, PSTN, PLMN, dB in Communications, Power Levels, digital over analog transmission,

- Principle of speech digitization, Voice Compression and Transmission, Asynchronous/Synchronous Transmission, Line Coding, Error Coding, Time Division Multiplexing, Space Division Multiplexing,
- Statistical Time Division Multiplexing, PDH and SDH multiplexing hierarchies, exchange hierarchy, PBX, Blocking Probabilities, 4-wire switching, Switch Matrix Control,
- Time and Space Division Switching, Two-dimensional Switching, Toll Switch, Digital Cross Connect & Digital Switching, types of switching,
- Basic functions of typical digital switching exchanges software structure of SPC digital switches,
- Line Codes for Fiber Optic Transmission, routing techniques, software life cycle, Channel SS7 signaling components, intelligent Networks Associated Signaling (CAS) and Common Channel Signaling (CCS) ITU's Common Channel Signaling System #7 (CCS7 Or SS7),
- Broadband implementation in commercial exchange and introduction to soft switches.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- J. E. Flood, "Telecommunication Switching, Traffic and Networks" latest Edition, Prentice Hall, ISBN-13: 978-8131705025.
- John Bellamy, "Digital Telephony", latest Edition, Wiley Interscience, ISBN-13: 978-0471345718.
- Roger L. Freeman, "Telecommunications Transmission Handbook", latest Edition, Wiley, ISBN-13: 978-0471672487.
- David R. Smith, "Digital Transmission Systems", latest Edition, Springer, ISBN-13: 978-1461347262.

## Microwave Engineering

**Course Outline**

- Review of Maxwell's equations, field in media and boundary conditions, the plane wave, reflection from media (dielectric, conductor) boundary, loss in conductors, surface resistance,
- Energy, power, transmission line theory, the lossless line, terminated line,
- Smith's chart, quarter wave transformer, lossy transmission line, general solution of waveguides, TEM TE and TM modes, TE and TM solution in rectangular waveguide, TEM modes on coaxial line and Strip-line structure, Quasi-TEM on Micro-strip line,
- Characteristic impedance and loss calculations,
- Microwave network analysis, impedance and equivalent voltage and current, impedance matrix, the scattering matrix, signal flow graphs, microwave matching networks, lumped single stub and double stub matching, microwave resonators,
- Properties of series and parallel resonator, transmission line resonator, waveguide resonator, dielectric resonator, resonator coupling, microwave power dividers and couplers,
- Properties of three port and four ports networks,
- Wilkinson's power divider, hybrid coupler quadrature, coupled line coupler and
- Introduction to microwave active devices.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Book:**

- D. M. Pozar, "Microwave Engineering", latest Edition, Wiley, ISBN-13: 978-0470631553.

## Emerging Wireless Technologies and RF Planning

**Course Outline**

- Channel structure, signal flow, operation and maintenance features vis-à-vis cellular and WLAN/WMAN/WPAN technologies,
- Wireless network planning process,
- RF environment introduction and propagation model, antenna and feeder system, link budget,
- Capacity theory, site survey, network optimization process,
- Signalling trace, access optimization, handoff optimization, power control optimization, drop call optimization, drive test,
- Introduction to advanced tools for network planning, simulation and optimization

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Ghosh, J. Zhang, J. G. Andrews and R. Muhamed, "Fundamentals of LTE", latest Edition, Prentice Hall, ISBN-13: 978-0137033119.
- Y. Xiao and Y. Pan, "Emerging Wireless LANs, Wireless PANs, and Wireless MANS: IEEE 802.11, IEEE 802.15, 802.16 Wireless Standard Family", latest Edition, Wiley, ISBN-13: 978-0471720690.
- D. M. Dobkin, "RF Engineering for Wireless Networks", latest Edition, Newnes, ISBN-13: 978-0750678735.
- H. Hammuda, "Cellular Mobile Radio Systems: Designing Systems for Capacity Optimization", latest Edition, Wiley, ISBN-13: 978-0471956419.
- J. Wheat, R. Hiser, J. Tucker, A. Neely and A. McCullough, "Designing a Wireless Network: Understanding How Wireless Communication Works", latest Edition, Syngress, ISBN-13: 978-1928994459.

## Machine Learning for Communications

**Course Outline**

- Data understanding, data preparation,
- Principles of modeling, multiple linear regression, logistic regression,
- Decision trees and random forests, clustering, classification, decision-making Traps,
- Fundamentals of numerical optimization, special use cases for machine learning application for communications, that may include machine learning for physical layer design, adaptive modulation and coding (AMC): classical AMC, using support vector machines, using k-nearest neighbours, k-means and reinforcement learning,
- Various aspects of communication systems, wireless system design, where machine learning can be applicable in various OSI layers of a communication system and how real time schedulers can benefit from advanced machine learning techniques,
- Design of weiner filters and regression techniques in ML, filtering techniques such as FIR, IIR and the deep neural network architectures such as CNN, RNN,
- Use of principal component analysis in massive mimo system design, auto encoders in wireless communication transceiver design, etc.,
- Connections between hidden markov model (commonly used for NLP) and viterbi algorithm commonly used in convolutional decoders in wireless systems
- Machine learning for optical network design, user grouping/clustering in device-to-device and heterogeneous networks for offloading and interference management,
- Traffic prediction and clustering of small cells,
- Channel State Information Prediction for 5G Wireless Communications using deep learning,
- Deep Reinforcement Learning for Dynamic Multi-channel Access in wireless networks
- Projects based on Kaggle assignments based on application of ML and DL on wireless communications based network data

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- O. Simeone, "A Brief Introduction to Machine Learning for Engineers", Foundations and Trends in Signal Processing, 12(3-4), 200-431, latest edition
- C. M. Bishop, Pattern Recognition and Machine Learning, Springer, latest edition.
- R. S. Sutton and A. G. Barto, Reinforcement Learning: An Introduction, MIT Press, latest edition.
- J. Watt, R. Borthani, and A. K. Katsaggelos, Machine Learning Refined: Foundation, Algorithms, and Applications, Cambridge University Press, latest edition.
- David J.C. Mackay, "Information Theory, Inference and Learning Algorithms", ISBN-10: 052164298, latest edition.
- Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, latest edition.
- C. Jiang and H. Zhang and Y. Ren and Z. Han and K. C. Chen and L. Hanzo, "Machine Learning Paradigms for Next-Generation Wireless Networks" latest edition.
- T. J. OShea and J. Hoydis, "An introduction to machine learning communications systems" latest edition.
- M. A. Alsheikh, S. Lin, D. Niyato and H. P. Tan, "Machine Learning in Wireless Sensor Networks: Algorithms, Strategies, and Applications" latest edition.
- T. J. OShea, T. Erpek, and T. C. Clancy, "Deep learning based MIMO communications" latest edition.

- Z. Chang, L. Lei, Z. Zhou, S. Mao and T. Ristaniemi, "Learn to Cache: Machine Learning for Network Edge Caching in the Big Data Era," in IEEE Wireless Communications, vol. 25, no. 3, pp. 28-35, latest edition.
- Imran, A. Zoha and A. Abu-Dayya, "Challenges in 5G: how to empower SON with big data for enabling 5G," in IEEE Network, vol. 28, no. 6, pp. 27-33, latest edition.
- Zappone, Alessio et al. "Wireless Networks Design in the Era of Deep Learning: Model-Based, AI-Based, or Both?" IEEE Transactions on Communications 67: 7331-7376 latest edition.
- IEEE Comsoc Machine Learning for Communications Emerging Technologies Initiative, latest edition.

## Optical Fiber Communications

**Course Outline**

- Introduction to optical fiber communications, basic principles, Snells law,
- Numerical aperture, Fresnel loss, fiber types, single mode and multimode, optical fiber losses, (attenuation, dispersion, polarization),
- Special optical fibers, light sources (LED, LASER), light detection (p-i-n and APD), components and connectors, link budget calculations (power based and rise time based),
- Receiver design considerations (IM/DD and Coherent systems), modulation schemes, receiver performance (BER and Eye Diagram) optical measurement (e.g., OTDR) optical DWDM systems,
- Examples from commercial implementations, e.g., TAT-9, TAT-14, optical amplifiers, EPON, GPON and introduction to FSO.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- J. Senior, "Optical Fiber Communications: Principles and Practice", latest Edition, Prentice Hall, ISBN-13: 978-0130326812.
- G. Keiser, "Optical Fiber Communications", latest Edition, McGraw Hill, ISBN-13: 978-0073380711.
- J. Ahmed, M. Y. Siyal, F. Adeel and A. Hussain, "Optical Signal Processing by Silicon Photonics", latest Edition, Springer, ISBN-13: 978-9814560108.
- G. P. Agrawal, "Fiber-Optic Communication Systems", latest Edition, Wiley, ISBN-13: 978-0470505113.

# Engineering Depth Courses

## Multimedia Systems

**Course Outline**

- Multimedia systems, multimedia networks and applications, networking terminology,
- Digitizing principles, text, image audio, video information representation,
- Text and image compression techniques (JPEG, MPEG)
- Audio and video compression standards for multimedia communication,
- Construction of 3-D images and videos,
- Transport of high definition video signals and VoD.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Fred Halsall, "Multimedia Communications: Applications, Networks, Protocols and Standards", latest Edition, Addison-Wesley, ISBN: 978-0201398182.
- Y. Wang, J. Ostermann and Y-Q Zhang, "Video Processing and Communications", latest Edition, Prentice Hall, ISBN: 978-0130175472.

## Satellite Communications

**Course Outline**

- Principles of satellite communication, uplink and downlink frequencies,
- Types of satellites, orbital mechanics,
- Introduction , Kepler's laws, orbital elements, perturbations and antennas, polarization, the space segment, power supply, altitude control, station keeping, thermal control, TT&C subsystem, transponders, antenna subsystem,
- The earth segment, receive-only home TV systems, transmit/receive earth stations, the space links, equivalent isotropic radiated power, transmission losses, link power budget equation, system noise, carrier-to-noise ratio,
- Interference between satellite circuits, combined (C/I) due to interference on uplink and downlink, antenna gain function, pass band interference, multiple access techniques,
- Direct broadcast satellite (DBS) services, MSAT, VSATs, and GPS.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- G. Maral, M. Bousquet and Z. Sun, "Satellite Communications Systems: Systems, Techniques and Technology", latest Edition, Wiley, ISBN: 978-0470714584.
- T. Pratt, C. W. Bostian and J. E. Allnutt, "Satellite Communications", latest Edition, Wiley, ISBN: 978-0471370079.

## Telecom Standards & Regulations

**Course Outline**

- Introduction to ICT Basic Concepts and Selected Regulatory Terminologies,
- Pakistan Telecom Background/Historical Perspective,
- Introduction to and Functioning of Telecom Regulatory Stakeholders in Pakistan,
- Telecom Deregulation and Liberalization, Regulating for Effective Competition,
- Process of legislation in Pakistan and Introduction to Telecom Policies, Act, Rules and Regulations,
- Introduction to / Familiarization with International/ Regional Telecom Organizations / Bodies,
- Introduction to Telecom Standards and Protocols.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- The Association of Progressive Communications (APC) ICT Policy Handbook, latest edition.

- Telecommunication Regulations Handbook latest edition, published by World Bank/info Dev; Chapters 1 & 2, soft copy available at www.worldbank.org

## Telecom Traffic Engineering

**Course Outline**

- Poisson process, Markov processes, birth-death processes, purpose of tele traffic theory, tele traffic models, classical model for telephone traffic, classical model for data traffic,
- Telecommunication networks, network level - switching and routing, link level - multiplexing and concentration, shared media - multiple access, circuit switched network modeled as a loss network, packet switched network modeled as a queuing network,
- Traffic measurements, traffic variations, traditional modeling of telephone traffic, traditional modeling of data traffic, simple tele traffic model, Poisson model, Erlang model, binomial models, Engset model M/M/1, M/M/n, generation of traffic process realizations,
- Generation of random variable realizations, collection of data, statistical analysis,
- Network planning, traffic forecasts, dimensioning, MPLS traffic management, IP-networks,
- Traffic and congestion control in the Internet and QoS architectures in the Internet.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- T. Viswanathan, "Telecommunication Switching Systems and Networks", latest Edition, Prentice Hall, ISBN: 978-81-203-5083-0.
- J. C. Bellamy, "Digital Telephony", latest Edition, Wiley, ISBN: 978-0471345718.
- Chee Hock Ng, Soong Boon-Hee, "Queueing Modelling Fundamentals: With Applications in Communication Networks", latest Edition, Wiley-Interscience, ISBN: 9780470519578.
- G. Giabene, "Queuing Theory and Telecommunications: Networks and Applications", latest Edition, Springer, ISBN: 978-1461440833.
- Donald Gross, John F. Shortle, James M. Thompson, Carl M. Harris, "Fundamentals of Queueing Theory", latest Edition, Wiley-Interscience, ISBN: 9780471791270.
- Leonard Kleinrock, "Queueing Systems (Volume I): Theory," John Wiley & Sons, latest edition. ISBN: 0471491101

## Next Generation Networks

**Course Outline**

- NGN standardization by ITU, fixed and mobile broadband as basis for NGN, NGN architectures, NGN services, QoS and IMS for NGN deployments, VoIP and IPTV services over NGN, Internet of Everything, VPN in NGN, IPv6-based NGN, migration scenarios from legacy networks to NGN,
- Business approaches and regulation for NGN, future networks as defined by ITU, including network virtualization, software defined networking, smart ubiquitous networks, big data issues,
- OTT service providers versus Telco service models, impact of M2M in the future, convergence of regulation towards future networks, cloud computing, including ITU's framework,
- Cloud ecosystem, architectures and cloud service models, cloud security, OTT cloud services, Telco cloud implementations,
- Mobile cloud computing services and applications, as well as business and regulation aspects for cloud computing.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Valdar, A., "Understanding Telecommunications Networks", latest edition, IET Telecommunications Series. ISBN 9781849197458.
- Wilkinson, N., "Next generation networks services: Technologies and strategies", latest edition, John Wiley & Sons. 196 p. ISBN 0-47148667.
- Ohrtman, F D. "Softswitch Architecture for VoIP", latest edition: McGraw-Hill, 359 p. ISBN 0-071409777.
- Mueller, S M., "APIs and Protocols for Convergent Network Services", latest edition McGraw-Hill, 445 p. ISBN 0-07138880X.
- Hu Hanrahan, "Network Convergence: services, Applications, Transport, and Operations Support", latest edition, John Wiley & Sons. ISBN-13: 978-0470024416.

## Network Security

**Course Outline**

- Web security, security standards, intruders and viruses, firewalls,
- Shannon's theory of perfect secrecy, shift and product cipher, Vernon's one-time pad;
- Secret key and public/private key cryptography, cryptographic hashes and message digests, authentication systems (Kerberos),
- Digital signatures and certificates, Kerberos and X.509v3 digital certificates, PGP and S/MIME for electronic mail security,
- Current network security publications and web sites.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- William Stallings, "Network Security Essentials: Applications and Standards", latest Edition, Prentice Hall, ISBN: 978-0133370430.
- C. Kaufman, R. Perlman and M. Speciner, "Network Security: Private Communication in a Public World", latest Edition, Prentice Hall, ISBN: 978-0130460196.
- Keith M. Martin, "Everyday Cryptography: Fundamental Principles and Applications", latest Edition, Oxford university press, ISBN-13: 978-0199695591.

**Radar Systems Engineering**

**Course Outline**

- Operation, range equation, frequencies, parameters and prediction of range performance,
- Minimum detectable signal, receiver, signal to noise ratio,
- Integration of radar pulses, radar cross section, transmitter power,
- Antenna parameters, system losses, propagation effects, radar clutters, CW and frequency modulated radar, MTI and pulse Doppler radar, tracking radar, radar transmitters, antennas, receivers, displays and duplexers, detection criteria, detector characteristics,
- Performance of radar operator, automatic detection, atmospheric echoes and detection of target in clutter.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- B. Edde, "Radar: Principles Technology and Applications", latest Edition, Prentice Hall, ISBN: 978-0137523467.
- M. Skolnik, "Introduction to Radar Systems", latest Edition, McGraw Hill, ISBN: 978-0072881387.
- Merrill Skolnik, "Radar Handbook". Latest Edition, McGraw-Hill, ISBN: 978-0071485470.
- Mark A. Richards, James A. Scheer and William A. Holm, "Principles of Modern Radar", latest edition, Scitech Publishing Inc., 978-1891121524.
- George W. Stimson, "Introduction to Airborne Radar (Aerospace & Radar Systems)", latest edition, Scitech Publishing Inc., 978-1891121012.
- Bassem R. Mahafza, "Radar Systems Analysis and Design Using MATLAB", latest Edition, CRC Press, 978-1439884959.
- Fulvio Gini, Antonio De Maio and Lee K. Patton, "Waveform Design and Diversity for Advanced Radar Systems", latest IET Publishers, 978-1849192651.

## Telecommunication Network Management

**Course Outline**

- TNM architecture, functional architecture,
- Physical architecture and information, logical layered architecture,
- TNM relationship with other management approaches, requirements, analysis, and class diagrams, alarm management information object classes,
- Inheritance and relationship between alarm list and information,

- IRP operations, generic rules, TNM design, eTOM, NGOSS, ITIL, managing next generation networks, ITU-T M.3100 information model, G.803, CMIP, F-interface architecture, SNMP,
- Packet types and fundamentals of RF planning.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- S. Aidarous and T. Plevyak, "Telecommunications Network Management: Technologies and Implementations", latest Edition, Wiley-IEEE Press, ISBN: 978-0780334540.
- H-G. Hegering, S. Abeck, B. Neumair, "Integrated Management of Networked Systems: Concepts, Architectures and their Operational Application", latest Edition, Morgan Kaufmann, ISBN: 978-0123911100.

# Multidisciplinary Engineering Courses

## Numerical Methods in Engineering

**Course Outline**

- Floating point number system, error analysis, solutions of equations, interpolation, splines,
- Numerical differentiation and integration, numerical methods in linear algebra,
- System of linear equations, method of least squares, eigenvalues, eigenvectors,
- Solution of ordinary and partial differential equations.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Book:**

- Erwin Kreyszig, "WIE Advanced Engineering Mathematics", latest Edition, John Wiley & Sons, ISBN-13: 978-0470647653.

## Operating Systems

**Course Outline**

- Overview of computer system and operating system,
- Process description and control, process scheduling, threads, symmetric multiprocessing, mutual exclusion and critical section, lost update problem, busy waiting versus blocking,
- Peterson's algorithm, interrupt disabling and spin lock, semaphore, partitioning, paging and segmentation, virtual memory,
- Address translation and page fault handling, page table and translation look aside buffer, memory management algorithms,
- Fetch policy, replacement policy, resident set management, I/O devices, organization of I/O function, I/O buffering, disk scheduling, RAID,
- Organization of files and directories, secondary storage management, file systems, and modern operating systems.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Andrew Tanenbaum and Albert Woodhull," Operating Systems Design and Implementation", latest Edition, Prentice Hall, ISBN-13: 978-0131429383.
- Andrew Tanenbaum, "Modern Operating Systems", latest Edition, Prentice Hall, ISBN-13: 978-0136006633.
- William Stalling, "Operating Systems: Internals and Design Principles", latest Edition, Prentice Hall, ISBN-13: 978-0133805918.
- Abraham Silberschatz, Peter B. Galvin and Greg Gagne, "Operating System Concepts", latest Edition, Wiley, ISBN-13: 978-0470128725.

## VLSI Systems

**Course Outline**

- MOS device models including Deep Sub-Micron effects, circuit design styles for logic, arithmetic and sequential blocks,
- Estimation and minimization of energy consumption,
- Interconnect models and parasitics, device sizing and logical effort, timing issues (clock skew and jitter) and active clock distribution techniques,
- Memory architectures, circuits (sense amplifiers) and devices and testing of integrated circuits.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Book:**

- Rabaey, Jan, Anantha Chandrakasan and Bora Nikolic, "Digital Integrated Circuits: A Design Perspective", latest Edition, Prentice Hall, ISBN-13: 978-0130909961.

## Data Structures and Algorithms

**Course Outline**

- Fundamental data structures, data types, abstract data types, user defined data types,
- Algorithms and their complexity, time-space trade off, arrays, records and pointers, matrices, linked lists, circular lists, two way lists,
- Sequential (array) and linked implementation of stacks and queues, polish notation, recursion, towers of Hanoi,
- Recursive implementation of stacks and queues, priority queues, tree, binary tree, binary search tree, traversals, threaded trees, heap, general trees, graphs, depth-first/breadth first traversal, adjacency matrix,
- Shortest distance algorithms, sorting, insertion sort, selection sort, merge sort, radix sort), hashing, searching: (linear search, binary search, depth first / breadth first search.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Robert Lafore, "Data Structures and Algorithms in Java", latest Edition, Prentice Hall, ISBN-13: 978-0672324536.
- Robert Lafore, "Object-Oriented Programming in C++", latest Edition, Prentice Hall, ISBN-13: 978-0672323089.

## Embedded Systems

**Course Outline**

- Introduction to Embedded Systems, Hardware Architecture of Embedded Systems,
- Programming Model of Embedded Systems,
- I/O Port structure and Memory Organization,
- Serial and Parallel Interface,
- Timers and Interrupt Handling,
- Software Design for Embedded Systems, Single Board Computer,
- Software Development Tools,
- Hardware Interfacing and Introduction to AVR Microcontrollers.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Scott MacKenzie, "The 8051 Microcontroller", latest Edition, Prentice Hall, ISBN-13: 978-0130195623.
- Craig Steiner, "The 8051/8052 Microcontroller Architecture, Assembly Language and Hardware Interfacing", latest edition Universal Publishers, ISBN-13: 978-1581124590.
- Kalrasanjeev Kumar Kalra and Alka Kalra, "Architecture and Programming of 8051 Microcontrollers", latest edition MikroElektronika, ISBN-13: 978-9380386317.

## Reliability in Telecommunication Systems

**Course Outline**

- Introduction, basic reliability concepts, kinds of failure,
- The reliability function, catastrophic-failure models, combinational reliability, system reliability,
- Effects of repair, mathematical design,
- Statement of design problem in mathematical terms,
- Yield and drift reliability,
- Methods for computing probability of system success and optimization techniques

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written assignments/Quizzes, Case Studies relevant to Engg. disciplines, Semester project, Guest speaker, Industrial/Field visits, Group discussion, Report Writing.

**Assessment:**

Mid-term, Report writing/Presentation, Assignment, Project report, Quizzes, Final exam.

**Suggested Books:**

- Peter W. Becker and Finn B. Jensen, "Design of Systems and Circuits for Maximum reliability and production yield", latest edition, Wiley Publishers, ISBN-13: 978-0070042308.

## Occupational Health and Safety

**Course Description:**

This course introduces the student to the study of workplace occupational health and safety. The student will learn safe work practices in offices, industry and construction as well as how to identify and prevent or correct problems associated with occupational safety and health in these locations as well as in the home.

**Learning Outcomes:**

Upon successful completion of this course, the student will be able to:

- Identify hazards in the home, laboratory and workplace that pose a danger or threat to their safety or health, or that of others.
- Control unsafe or unhealthy hazards and propose methods to eliminate the hazard.
- Present a coherent analysis of a potential safety or health hazard both verbally and in writing, citing the Ontario Occupational Health and Safety Regulations as well as supported legislation.
- Demonstrate a comprehension of the changes created by WHMIS and OSHA legislation in everyday life.

**Course Outline:**

**Health and Safety Foundations**

- Nature and scope of health and safety
- Reasons/benefits and barriers for good practices of health and safety
- Legal frame work and OHS Management System

**Fostering a Safety Culture**

- Four principles of safety- RAMP (Recognize, Assess, Minimize, Prepare)
- Re-thinking safety-learning from incidents
- Safety ethics and rules
- Roles and responsibilities towards safety
- Building positive attitude towards safety
- Safety cultures in academic institutions

**Recognizing and Communicating Hazards**

- Hazards and Risk
- Types of hazards: Physical (mechanical and non-mechanical), Chemical (Toxic and biological agents), electrical, fire, construction, heat and temperature, noise and vibration, falling and lifting etc.
- Learning the language of safety: Signs, symbols and labels

**Finding Hazard Information**

- Material safety data sheets
- Safety data sheets and the GHS (Globally Harmonized Systems)

**Accidents & Their Effect on Industry**

- Costs of accidents
- Time lost
- Work injuries, parts of body injured on the jobs
- Chemical burn Injuries
- Construction injuries
- Fire injuries

**Assessing and Minimizing the Risks from Hazards**

- Risk Concept and Terminology
- Risk assessment procedure
- Risk Metric's
- Risk Estimation and Acceptability Criteria
- Principles of risk prevention
- Selection and implementation of appropriate Risk controls
- Hierarchy of controls

**Preparing for Emergency Response Procedures**

- Fire
- Chemical Spill
- First Aid
- Safety Drills / Trainings:
  - Firefighting
  - Evacuation in case of emergency

**Stress and Safety at Work Environment**

- Workplace stress and sources
- Human reaction to workplace stress
- Measurement of workplace stress
- Shift work, stress and safety
- Improving safety by reducing stress
- Stress in safety managers
- Stress and workers compensation

**Incident Investigation**

- Importance of investigation
- Recording and reporting
- Techniques of investigation
- Monitoring
- Review
- Auditing Health and Safety

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), written assignments/quizzes, tutorials, case studies relevant to engineering disciplines, semester project, guest speaker, industrial/field visits, group discussion, report writing

**Assessment:**

Mid-semester exam, report writing/presentation, assignment, project report, quizzes, end-semester exam

**Suggested Books:**

The A-Z of health and safety by Jeremy Stranks, 2006.

The Manager's Guide to Health & Safety at Work by Jeremy Stranks, 8th edition, 2006.

Occupational safety and health law handbook by Ogletree, Deakins, Nash, Smoak and Stewarts, second edition, 2008.

**12.2 Non-Engineering Domain**

# English Courses

## Functional English

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- Follow English vocabulary and skills to use it in professional life.
- Identify common errors usually made by the Learners of English as second language
- Practice English correctly in speaking and writing

**Course Outlines:**

- Public Speaking
- The Art of Creating a Power Point Presentation.
- Interacting with the Opposite Gender
- Classroom Etiquettes and Teachers' Expectations
- Articles
- Prepositions
- Homophones
- Punctuation
- Tenses in English Grammar
- Formal Letter Writing
- Summary writing
- Organizing and planning your writing
- Sensory Perception in writing.
- Critical thinking
- Final Term Project

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- P. C. Wren & H. Martin "High School English Grammar & Composition".
- Colin W. Davis & Andrew J. Watts New Expressway For English 1 (New Edition)
- Herta A. Murphy & Herbert William Hildebrandt. Effective Business Communications
- Diana Hacker. A Writer's Reference
- Sadat Ali Shah. Exploring The World Of English
- J. Thomson and A. V. Martinet. Practical English Grammar, "University Physics", 13th Edition

## Communication Skills

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- Communicate effectively using intermediate- to-advanced level English while developing the understanding of essentials of communication skills.
- Participate in group discussions by attentive listening, questioning to clarify ideas, eliciting responses, or disagreeing in a constructive way.

**Course Outlines:**

By the end of the semester students will have skills including:

**Writing Skills**

- Vocabulary Building
- Writing Skills: Essays and Letters
- Common Writing Errors
- Purposeful Writing

**Reading Skills**

- Skimming and Scanning

- Critical Reading
- Reading for Understanding
- Techniques and strategies to develop sound vocabulary.

**Listening Skills**

- Introduction to Communication Process
- Seven Cs of Communication
- Types of Listening
- Listening for Comprehension

**Speaking Skills**

- Verbal and Non-Verbal Communication
- Basics of Presentation Skills
- Presentation Strategies and public speaking skills.
- Use of Audio-Visual Aids
- Basics of Group Communication
- Listening Skills
- Communicate effectively in job interviews.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Anchor in English-II (Lessons 1-5), A SPELT Publication
- Christopher Fry, "Summary Writing (Book-I)", Oxford University Press
- College Essays by John Langland
- Barron's TOFFL iBT Edition
- Communication Skills for Engineers by Sunita Marshal and C. Muralikrishna

## Technical Writing and Presentation Skills

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- The students will be able to write technically correct statements, assignments, final year project report, project proposal, short report and research paper
- The students would be able to their write CV, cover letter and business/ professional Correspondence meeting all criteria
- The students would be able to present their work/ research at a technical forum.

**Course Outlines:**

- Introduction to Technical writing
- Proposal write-up and improvement strategies Introduction to research and research types choosing research problems and research advisors How to carry out research
- Formulation – Problem statement, Literature
- Review
- Design - Methodology
- Analysis - Data analysis and interpretation Good writing style techniques
- Uses of correct words
- Presenting and publishing research
- Write business/professional correspondence, cover letter and CV
- Writing meeting minutes

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Writing for Computer science by Justin Zobel Research Methodologies – A step by step guide for beginners, Ranjit Kumar.

# Mathematics Courses

## Linear Algebra

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- To comprehend basic concepts of Linear Algebra and optimization
- To apply techniques of Linear Algebra and optimization for solution of engineering problems

**Course Outline:**

**System of Linear Equations and Applications**

- Overview of linear system of equations, Cases of unique solution, No solution and infinite solutions,
- Echelon form, Gauss elimination method, Inversion of matrix in the context of solution of system of equations, LU factorization, Row space and column space
- Relevant engineering case studies such as Network analysis, Traffic Flows, Balancing chemical reaction, Leontief Input-output model, Finding max stress in compound cylinder, Applications of linear systems in force balancing of structures, Markov process

**Vector Spaces and Transformations**

- Vector Spaces: Real vector spaces, Subspaces, Basis and dimension, Rank, Nullity
- Gram-Schmidt process for finding orthonormal basis
- Linear Transformation, Kernel of Transformation, Range of Transformation, Matrix of Transformation,
- Applications: Cryptography, Coding and decoding, Breaking of codes, Robotic Applications of linear transformations

**Eigenvalues and Eigen Vectors**

- Eigenvalues, Eigenvectors, Similar matrices, Diagonalization,
- Quadratic forms, Positive definite Matrices, Singular Value Decomposition, Inner product Spaces
- Applications of linear Algebra: Constructing curves and surfaces, Computer graphics, Genetics

**Linear Programming**

- Solution Introduction to linear programming, Optimization, Graphical method, Simplex method, Optimization problems in engineering and economics
- Dual simplex methods, Duality theory, Primal and dual problems, transportation models, north-west corner, least-cost and Vogel's approximations methods,
- Assignment model, the transshipment model and other relevant engineering case studies

**Application of Linear Algebra in Dynamical Systems**

- Numerical System of linear ODEs, Eigenvalue problems, Homogeneous and nonhomogeneous system of ODE.
- Dynamical systems, Population dynamics, Prey-Predator models, Stability analysis

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Introductory Linear Algebra: By Bernard Kolman and David R. Hill, Latest Edition.
- Elementary Linear Algebra: By Howard Anton and Chris Rorrers, Latest Edition.

## Calculus and Analytical Geometry

**Area Scope:**

- To develop a clear understanding of fundamental concepts of single variable calculus
- To apply concepts of differentiation and integration to solve complex engineering problems

**Course Outline:**

**Analytical Geometry:**

- Review of vectors, scalars and vector products.
- Three dimensional coordinate system and equation of straight line and plane

**Functions Limit and Continuity:**

- Review of functions and graphs,
- Limits & Continuity,
- Techniques of Finding Limits,
- Discontinuity,
- Limits of Sine and Cosine and Exponential Functions

**Differentiation:**

- Introduction to Derivatives
- Examples of Derivatives
- Derivative as Rate of Change
- Derivative's Rules
- Implicit Differentiation
- Higher order derivatives
- Leibnitz Theorem

**Applications of Derivatives:**

- Applications of Derivatives
- Monotonic functions
- Optimization problems
- Relative and Absolute extrema
- First and second derivative tests

- Point of inflection
- Concavity
- Curvature
- Indeterminate Forms and L' Hospital rule
- Differentials

## Integration:

- Integrals and Properties of Integrals
- Techniques of Integration
- Integration by Parts
- Definite Integrals
- Integration of Trigonometric
- Exponential and Inverse Functions
- Integration by Partial Fractions
- Reduction Rules

## Applications of Integration:

- Applications of Integration
- Area under the curve
- Area between curves
- Solids of Revolution
- Volume of Solids of revolution by disk
- Washer, Cylindrical shell & Cross Section Methods
- Center of Pressure and Depth of Center of Pressure
- Center of mass
- Arc length

## Improper Integrals:

- Improper Integral
- Integrals and Singularities
- Convergence of improper integrals

## Infinite Sequence and Series:

- Sequence and Infinite Series
- Convergence and Divergence of sequences and series
- Positive Term Series

- Integral Test
- Basic Comparison Test
- Limit Comparison Test
- Ratio and Root tests
- Alternating series
- Absolute and Conditional Convergence

**Power and Taylor Series:**

- Power series
- Maclaurin and Taylor Series and its Applications

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Thomas' Calculus by George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass, Pearson, USA.
- Swokowski, Onlinick & Pence: Calculus
- Robert T. Smith & Roland B. Minton: Calculus
- Calculus: Early Transcendentals by James Stewart. Brooks/Cole USA.

## Differential Equations

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- To define basic mathematical concepts related to differential equations
- To describe different types of analytical methods for solution of differential equations

- To formulate different engineering problems in the form of differential equations

**Course Outline:**

**Basic Concepts and Modeling**

- Linear Differential equations, Non-Linear, Differential equations, Solutions of differential equations, General solutions, Particular solutions, Initial and boundary value problems, Degree and order of ODEs
- Formulation of first-order ODEs: Case studies related to finding age of fossils, Mixing problems and free fall motion, finding temperature of a building, RL, RC circuits, Airplane take-off problem, Population dynamics and logistic equations etc.

**Analytical Methods of Solution for First-order ODEs**

- Variable separable method, Reduction to variable separable form, Homogeneous equations, Differential equations reducible to homogeneous form, Solution of the related ODE models by these methods
- Exact equations, Integrating factors, Linear equations and related examples, Bernoulli's equations, Orthogonal trajectories and solution of the related ODE models by these methods

**Mathematical Models Based on Second-order ODEs**

- Formulation of a single RLC circuit, Spring mass systems, Earthquake model of a single story building
- Bungee Jumper model, Bridge collapse problem etc.

**Analytical Methods of Solution for Second-order ODEs**

- Homogeneous linear ODEs, Method of reduction order , Wronskain determinant to check independence of the solution, and related examples
- Cauchy-Euler equations and related examples, Non-homogeneous linear ODEs, Method of undetermined coefficients
- Method of variation of parameters and related example
- Analytical solution of the related ODE models by these methods

**Series Solution for Second-order ODEs**

- Series solution of ODEs and convergence tests
- Series solution of Legendre equation, Frobenious method of solution for Bessel equation and related applications

**Laplace Transform**

- Laplace Transform, Derivation of Basic formulae, Inverse Laplace Transform, First shift theorem
- Laplace transform of integrals and derivative, Solution of second order ODEs by Laplace Transform, Unit step function and its Laplace transform, Second shift theorem, Convolution
- Application of Laplace transform to a system of ODEs and related applications

**Partial Differential Equations**

- Partial Differential Equations and their types, Applications of partial differential equations in Engineering
- Method of Separation of Variables Method (MSVM) and solution of wave equation by the MSVM
- Method of Separation of Variables Method (MSVM) and solution of heat equation by the MSVM

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Advanced Engineering Mathematics by Erwin Kreyzig, John Wiley & Sons Inc. Latest Edition.
- Differential Equation with Boundary Value problems by D. G. Zill, M. R Cullen Latest Edition, Brooks/Cole Publishers.

- A First Course on Differential Equations with Modelling Applications by D. G. Zill, Latest Edition, Brooks/Cole Publishers.
- An Introduction to Mathematical Modelling by Bender, E.A., Latest Edition, Wiley, New York.

## Numerical Analysis

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- To comprehend different numerical techniques such as: error propagation, interpolation, differentiation, integration, eigenvalues and solution of algebraic and differential equations
- To apply the numerical techniques to different linear and nonlinear engineering problems

**Course Outline**

**Error Analysis and Interpolation**

- Error analysis, Types of error, Sources of error, Norms of vectors and matrices, Computer arithmetic, Condition number of a matrix, Significant digits and loss of significant digits, Floating point arithmetic, Binary and decimal representation, Single and double precision
- Interpolation: Newton forward and backward difference formula for interpolation, Central difference interpolation formulae, Lagrange's interpolation, Error in interpolation, Linear least square approximation, Interpolation versus least square approximation, relevant engineering case studies

**Numerical Differentiation and Integration**

- Derivation of numerical differentiation of first order and second order derivatives using two points, three points, and five points formulas along with its application in engineering, Relevant case studies
- Numerical integration: Trapezoidal rule, Simpson's rules, Composite Trapezoidal Simpson Rules and Romberg integration, Applications of numerical in engineering, Relevant case studies

**Methods of Solution a System of Linear Equations**

- Solution of system of linear algebraic equations, Gauss elimination method
- LU factorization, Tridiagonal solver
- Applications of these methods in engineering disciplines, relevant case studies

**Iterative Methods for Linear and Nonlinear Equations**

- Numerical Solution of nonlinear equations: Bisection method, Newton's method, Secant method, Convergence analysis of these methods
- Newton's method for system of nonlinear equations
- Solution of system of linear equations by Jacobi, Gauss Seidel and SOR methods, Applications of these methods in engineering disciplines, relevant case studies

**Numerical Methods for IVPs and BVPs**

- Euler's method and its variations, Taylor's higher order methods, Error analysis, Consistency, stability and convergence
- Runge-Kutta methods of order 2, 3, and 4, Stiff ODEs, Consistency, stability and convergence
- Linear multistep methods, Numerical solution of system of ODEs
- Numerical solution of BVPs by Finite Difference Method
- Applications in engineering: Some relevant case studies

**Numerical Methods for Computing Eigenvalues**

- Eigenvalues and Eigenvectors of matrix: power method,
- Inverse power method, Shifted inverse power method.
- Applications of eigenvalues in engineering disciplines.

**Numerical Optimization**

- Unconstrained Optimization,
- Golden search ratio, Lagrange Multipliers,
- Method of steepest descent
- Applications of optimization in engineering disciplines

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Numerical Analysis: By Richard L. Burden, J. Douglas Faires, Latest Edition
- Numerical methods for scientist and engineers by R.W. Hamming (Latest Edition)
- Numerical methods for Engineers by Steven C. Chapra and R. P. Canale (Latest Edition)

## Probability & Statistics

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- To understand the basic concept of Statistics and Probability and their need in engineering.
- To describe properties and classifications of probability density functions, regression analysis and interval estimation
- To apply different probability and statistics techniques in engineering problems

**Course Outline**

**Basic Statistics**

- Statistics, Branches of Statistics, Importance of statistics, population, sample, observation, variables, measurement of variable, Data, primary data, secondary data

**Data Presentation**

- Frequency distribution (grouped, ungrouped), stem and leaf display, histogram, frequency polygon, cumulative frequency polygon, Simple & Multiple Bar diagrams

**Measure of Central Tendency**

- Arithmetic Mean (A.M), Geometric Mean (G.M), Harmonic Mean (H.M), Quantiles (Median, Quartiles, Deciles, Percentiles), Mode, Applications of Averages

**Measure of Dispersion**

- Background, Range, Quartile deviation, Mean deviation, Variance, Standard deviation, Coefficient of variation, Moments, Moments ratios, Skewness, Kurtosis
- Applications in different Engineering Disciplines

**Simple Regression, Correlation and Curve Fitting**

- Introduction to regression theory, Simple linear regression line, Line fitting by least square methods, Coefficient of determination,
- Simple correlation, coefficient of correlation, fitting of a first and second degree curve, fitting of exponential and logarithmic Curves, related problems.
- Principle of least squares.

**Probability and Random Variables**

- Probability review, Laws of probability, Conditional probability, Bayesian theorem, independent, dependent events.
- Random variables, Discrete and Continuous random variables, Probability mass and density functions, Distribution functions, Mathematical expectation,
- Variance of random variable, Bivariate distribution, Joint probability distribution, Moment generating function

**Probability Distributions**

- Discrete distributions:
- Bernoulli distribution, Binomial, Geometric, Negative binomial, Hyper-geometric, Poisson distribution, Properties and application of these distributions.
- Continuous Distributions: Uniform Distribution, Exponential distribution, Normal distribution, Applications

**Sampling and Sampling Distributions**

- Introduction, Population, Parameter & Statistic, Objects of sampling, Sampling distribution of Mean, Standard errors, Sampling & Non-Sampling Errors,
- Random Sampling, Sampling with & without replacement, Sequential Sampling, Central limit theorem.
- Applications in relevant engineering discipline

**Statistical Inference and Testing of Hypothesis**

- Introduction to inferential statistics, Estimation, hypothesis testing of population mean, proportion,
- Variance, Applications in Engineering

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Introduction to Statistical theory part 1, by Sher Muhammad Chuadary (Latest Edition)
- Advanced Engineering Mathematics, by Erwin Kreyszig (Latest Edition)
- Probability and Statistics for Engineers and Scientists, by Antony Hayter.
- Elementary Statistics, by Bluman.

## Complex Variables & Transforms

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- Explain the concept of complex number system, complex function, limit, continuity, differentiability and integral of complex valued functions
- Utilize the theory of complex integration and power series (Taylor series. Laurent series) to solve problems from the area of residue calculus
- Apply various transforms to solve complex integration.

**Course Outline**

**Introduction:**

- Review of complex numbers, Complex valued functions, Elementary functions (exponential and logarithmic functions, Trigonometric and hyperbolic functions and theirs inverses),
- Limits and continuity,
- Applications in Engineering

**Complex Differentiation and Integration**

- Derivatives of complex valued functions, Differentiability,
- Analyticity, Cauchy Riemann Equations, Harmonic Functions,
- Complex integrals, Cauchy-Goursat Theorem, Independence of Path, Cauchy's Integral Formulas and Their Consequences, Applications

**Power Series:**

- Taylor Series, Laurent Series, Singularities, Zeros and poles, Residue integration method, Residue theorem,
- Conformal mapping

**Laplace Transformation:**

- Linearity, Scaling, First shifting theorem, Heaviside's Shifting theorem,
- Inverse Laplace transformation, Properties of inverse Laplace,
- Convolution theorem, Applications in relevant engineering discipline

**Special functions and Fourier Transforms:**

- (Gamma, Beta functions, Periodic functions, Error function),
- Fourier Series, Fourier Sine and Cosine series,
- Fourier transform, Fourier cosine and sine transform, properties.
- Applications in relevant engineering discipline

**Z-Transformation:**

- Z-transform, Properties of Z-transform, linearity and scaling, Standard Z-transform, Inverse Z-transform,
- Inverse Z- transform by using residue, convolution theorem of Z-transform,
- Formation of difference equation and its solution using Z-transform.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Advanced Engineering Mathematics, by Erwin Kreyszing, Latest Edition
- Complex Variables and Applications by Churchill, Latest Edition
- R. J. Beerends, Fourier and Laplace Transform, Cambridge University Press, Latest Edition.
- Jeffry A, Advanced Engineering Mathematics, Elsevier, Latest Edition

## Multivariate Calculus

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- To develop a clear understanding of fundamental concepts of multivariable variable calculus

- To describe of the concept of gradient, multiple integrals in rectangular, polar, cylindrical and spherical coordinates, directional derivatives, and optimization problems
- To apply the concepts line integrals, surface integrals, volume integrals, Green's, Stokes', Gauss theorems to different engineering problems

## Course Outline:

### Geometry of Space:

Analytical Space Geometry, Cylindrical and Spherical coordinates, Lines in space, Intersection of Line and a Plane

### Vector-Valued Functions and Motion in Space:

Functions of several variables, their limits and continuity, Quadratic Surfaces, Parametric representation of curves, Velocity and Acceleration, Arc length, Tangent, Normal, Bi-normal, Curvature & Torsion

### Partial Differentiation:

Partial derivatives, Total Differentials, Chain Rule with More Variables, Directional derivatives

### Applications of Partial Derivatives:

Optimization Problems, Extrema of functions of several variables, Conditional extrema, Lagrange Multipliers and Example

### Multiple Integrals

Double Integration,  Order of Integration, Double Integrals in Polar Coordinates, Applications: Mass and Average Value, Moment of Inertia, Triple Integrals, Rectangular and Cylindrical Coordinates, Applications and Examples, Triple Integrals in Spherical Coordinates

### Vectors in 3 Space:

Introduction to vectors, Scalar and vector product, Volume of parallelepiped and tetrahedron, Gradient of a Scalar Field, Divergence of a Vector Field, Curl of a Vector Field

**Integration in Vector Fields:**

Line Integral, Integration around Closed Curves. Work Done, Potential and Related Examples, Conservative and non-Conservative Fields, Green's Theorem, Divergence Theorem, Stoke's Theorem, Applications of Double and Triple integrals

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Thomas' Calculus by George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass. Pearson, USA.
- George B. Thomas, Jr. and Ross L. Finney, Calculus and Analytic Geometry
- Swokowski, Onlinick & Pence: Calculus
- Robert T. Smith & Roland B. Minton: Calculus
- Calculus: Early Transcendental by James Stewart, Brooks/Cole USA

**Applied Physics**

**Course Outline:**

**Vectors:**

Review of vectors, Ordinary Differentiation of Vector, Gradient of Scalar field, Divergence and Curl of Vector Field. Line, surface and volume integrals with their applications.

**Electricity & Magnetism:**

Electric field due to Discrete and Continuous Charge Distributions, Electrostatic Potential of discrete and Continuous charges, Gauss's Law and its Applications,

Lorentz Force and Hall Effect, Ampere's Law, Magnetic Field due to current element (Circular Current Loop and Solenoid), Faraday's law, and Maxwell's equations.

**Waves & Oscillations:**

Types of Waves and Superposition Principle, Wave Speed on a stretched string, Wave equation, Energy & Power of a Wave, Principle of Superposition and Standing Waves. Simple Harmonic oscillations. Forced & damped oscillations.

**Optics and Lasers:**

Huygens Principle, Two-slit interference, Single-Slit Diffraction, Resolving power of Optical Instruments, Lasers and laser light, Working principle of lasers.

**Atomic and Nuclear Physics:**

Planck's explanations of Black Body Radiation, Photoelectric Effect, Compton Effect, De-Broglie Hypothesis, Atomic Nucleus and Properties of Nucleus, Radioactive Decay and Radioactive Dating.

**Conduction of Electricity in Solids:**

The electrical properties of solids, Energy level in crystalline solids, Insulators, metals, semiconductors, doped semiconductors. The p-n Junction, The Transistor.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), written assignments/quizzes, tutorials, case studies relevant to engineering disciplines, semester project, guest speaker, industrial/field visits, group discussion, report writing

**Assessment:**

Mid-semester exam, report writing/presentation, assignments, project report, quizzes, end-semester exam

**Suggested Books:**

- Halliday, Resnick and Walker, "Fundamentals of Physics" 10th Edition Extended
- Hugh D. Young and R.A. Freedman, University Physics. 12th Edition
- Raymond A Serway and John W. Jawett, Jr. Physics for Scientists and Engineers with modern Physics, 09th Edition.

- G. B. Thomas, R. L. Finney, "Calculus and Analytic Geometry", 13th Edition.

# Social Sciences Courses

## Sociology for Engineers

**Area Scope:**

This course is meant to provide engineering students, with an opportunity to view the discipline of sociology from the engineering perspective and will highlight its application to engineering profession. This will also enable the engineers to fit their technical ideas into a socially acceptable product /project in a more successful manner. The knowledge units in this area collectively encompass the following:

- To introduce to the methods and philosophy of the social science to help their understanding of the socio-cultural dimension of human existence as a fundamental reality in engineering projects etc.
- To provide opportunity for students to begin the process of considering social problems/ issues while designing engineering products.
- To allow engineers to play a pro-active role in critical discussions of social issues specifically.
- To demonstrate comprehension of roles and functions of various social institutions, state organizations, Professional bodies and relationships for analyzing their social impact Assessment.

**Course Outline:**

**Fundamental Concepts and Importance of Sociology for Engineers**

What is sociology? Nature, Scope, and Importance of Sociology, Sociological Perspectives and Theories, Social Interactions, Social Groups/ Social Institutions & heir interface with Engineering Project/services, Sociology & Impact of Technology & Engineering Products/Projects on Society.

**Cultural Impacts of Engineering Projects on Society**

Definition of Culture, Types of Culture & Elements of Culture, Culture & Power, Authority, Dominance Socialization and Personality, Role of Engineering Projects on Culture, social norms and values of Society, Cultural Infusion of Engineers in Society

**Theoretical Perspective of Sociology: Diffusion and Innovation; Adoption and Adaptation; Social development; Community Development**

Community Development & Social consequences of Industrialization, Development Processes of Societal Development, Cooperation and Conflict in Community Development in Engineering Context.

**Understanding of Societal & Ethical Norms and Values for Engineers**

Engineering Ethics, Engineering product/services for less privileged, Role of Engg & Technology in addressing Social inequality, Core Social Values/Norms affecting Engg Performance

**Organizational Social Responsibility (OSR) of Engineers**

- Extenttowhichdevelopmentintendstosensitizesocietalandunder-privileged needs
- Gender inclusiveness and balance
- Special and Disadvantaged Community of the Area
- Planning for community inclusiveness
- Societal Obligation of Engineers

**Engineers, Society and Sustainability**

Social System and Concept of Sustainable Development Technology and Development, Population Dynamics in Pakistan, Causes and Consequences of Unplanned Urbanization, Community Development, Programs in Pakistan, Community Organization & Engineering Projects, Population, Technological & Industrial expansion and Development with focus on social/human/ethical dimensions.

**Industrial & Organizational Psychology**

Interpersonal Relations, Interpersonal Behavior, Formation of Personal Attitudes, Language and Communication, Motivations and Emotions, Impact of Technology on human feelings and level of Sensitivity

**Climate Change and Ecological Friendliness from Engineering Perspective**

Ecological Processes, Ecosystem and Energy, Impact of Engineering Projects on Eco System & Human Ecology, Industrial & Environmental impact on Population & General Masses, Technological Intervention, Ecosystem and Physical

Environment, Social Impact of Technology & Engineering Products & Services (Solid Waste Disposal, Pollution control etc.).

**Social Approaches and Methodologies for Development Administration & Stakeholders Analysis:**

All Phases of the Project (pre, post and execution) Structured, Focused Group, Stakeholder Consultative Dialogues etc. Dynamics of Social Change, Sociology of Change and Industrial Development, Social Change due to Technology Driven Economic Growth.

**SIA (Social Impact Assessment):**

Base line and need-assessment, evaluation and impact assessment surveys of the development projects. Role of Engg & Technology for Creating Social Cohesiveness & Societal Integration. Technology Based change in Collective Behavior, Social Audit of Engineering Projects.

**Engineering Intervention for Social Stratification:**

Factors of Social Stratification, Engineering Interventions for addressing Social Stratification, Social Mobilization through Technological Innovation.

**Case Studies of Different Development Projects in Social Context**

**Teaching Learning Approaches:**

Lectures (audio,/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Project / Field Visits, Group discussion, Community Service, Report Writing, Social Impact Review and Social Audit of Engg Project

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Godhade, J. B., and S.T. Hunderkari. 2018. Social Responsibility of Engineers. International Journal of Academic Research and Development. Latest edition.

- Nichols, S.P. and Weldon, W.F. latest edition. Professional Responsibility: The Role of Engineering in Society Center for Electro-mechanics, The University of Texas at Austin, USA.
- Aslaksen, E.W. latest edition. The Relationship between Engineers and Society: is it currently fulfilling its potential? Journal and Proceedings of the Royal Society of New SouthWales, latest edition. Gumbooya Pty Lte, Allambie Heights, Australia.
- Bell, S. Engineers, Society and Sustainability. Synthesis Lectures on Engineers, Technology, and Society. Edited by Caroline Baillie, University of Western Australia. Morgan and Claypool Publishers, latest edition
- Jamison, A., Christensen, S.H., and Lars, B. latest edition. A Hybrid Imagination: Science and Technology in Cultural Perspective.
- Vermaas, P., Kroes, P., Poet, l., and Houkes, W. latest edition. A Philosophy of Technology: From Technical Artefacts to Socio technical systems.
- Mitcham, C., and Munoz, D. Humanitarian Engineering. Morgan and Claypool Publishers, latest edition
- Riley, D. Engineering and Social Justice. Morgan and Claypool Publishers.
- Bugliarello, G. latest edition. The Social Functions of Engineering: A Current Assessment, A Chapter in "Engineering as A Social Enterprise".

## Sociology

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- To introduce the necessary subject knowledge and understanding required for the successful study of Sociology and related Social Science disciplines at undergraduate.
- To develop skills of application, analysis and evaluation in the context of the study of Social Science.
- To develop a knowledge and understanding of sociology both at a global and national level.

- To introduce the planning and organization skills necessary to develop as independent, autonomous learners.
- To develop the confidence and competence of the students as learners and to assist them in taking some responsibility for their own learning through directed study and reading.

**Course Outline:**

- Introduction: Sociological Perspective,
- The Development of Sociology,
- The Role of Values in Sociology, Prejudice In Early Sociology,
- Theoretical Perspective in Sociology. Culture: Components of Symbolic Culture, Subcultures and Counter Cultures, Cultural Universals, Animals and Culture,
- Technology and Global Village, Sociology and New Technology.
- Socialization: Social Development of Self, Mind, and Emotions,
- Socialization into Gender Social Structure and Interaction,
- Social Institutions. Research in Sociology: Research Model, Research Methods. Experiments, Ethics,
- Bureaucracy and Formal Organizations, Rationalization of Society, Formal Organizations and Bureaucracy,
- Voluntary Associations Social Classes, Economy, Politics, Power and Authority, Family, Medicine, Health and Illness, Population and Urbanization, Social Movements
- Social Psychology with special reference to attitudes, attributions and behavior, Emotions, Cognition and Thinking, Reasoning, Problem-Solving and Creativity, Personality, Intelligence, and Abnormal Behavior, etc.
- Introduction to the Field of Organizational Behaviour
- Conflict and Negotiation in the Workplace
- Leadership in Organizational Settings and Organizational Culture
- Ethics: In General an introduction and the development of ethical theory.
- Ethics in Islam, a comprehensive view with different ethics approaches and Ethics Theories
- Research Methods for Society and Sociology

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Henslin, Sociology: A Down-to-Earth Approach, latest edition.
- D. Kendall, Sociology in our Times. Wadsworth Pub Co, latest edition.

## Engineering Economics

**Area Scope:**

- Apply the appropriate engineering economics analysis method(s) for problem solving i.e. present worth, annual cost, rate of return, payback, break-even, benefit-cost ratio
- Evaluate the cost effectiveness of individual projects using the methods learnt, draw inferences for investment decisions, and compare the life cycle cost of multiple projects.
- Compute the depreciation of an asset using standard depreciation techniques to assess its impact on present or future value

**Course Outline:**

**Engineering Economics**

- Role of engineers in business
- Economic decisions v/s design decisions
- Large scale engineering projects and types of strategic economic decisions
- Fundamental principles of engineering economics

**Interest Rate and Economic Equivalence**

- Interest: The Cost of Money
- Economic Equivalence

- Development of Formulas for Equivalence Calculation
- Unconventional Equivalence Calculations

## Understanding Money and Its Management

- Nominal and Effective Interest Rates
- Equivalence Calculations with Effective Interest Rates and with Continuous Payments
- Changing Interest Rates
- Debt Management
- Investing in Financial Assets

## Present-Worth Analysis

- Project Cash Flows
- Initial Project Screening Methods: payback Screening and Discounted Cash Flow Analysis
- Variations of Present-Worth Analysis
- Comparing Mutually Exclusive Alternatives

## Annual Equivalent-Worth Analysis

- Annual Equivalent-Worth Criterion
- Capital Costs versus Operating Costs
- Applying Annual-Worth Analysis
- Life-Cycle Cost Analysis
- Design Economics

## Rate-of-Return Analysis

- Rate of Return and Methods of Finding It
- Internal Rate-of-Return Criterion
- Mutually Exclusive Alternatives

## Cost Concepts Relevant to Decision Making

- General Cost Terms; Classifying Costs for Financial Statements
- Cost Classifications for Predicting Cost Behavior
- Future Costs for Business Decisions
- Estimating Profit from Production

**Depreciation and Corporate Taxes**

- Asset Depreciation: Economic versus Accounting
- Book and Tax Depreciation Methods (MACRS)
- Depletion
- Income Tax Rate to be used in Economic Analysis
- The Need for cash Flow in Engineering Economic Analysis

**Developing Project Cash Flows**

- Cost-Benefit Estimation for Engineering Projects
- Developing Cash Flow Statements

**Project Risk and Uncertainty**

- Origins of Project Risk
- Methods of Describing Project Risk: Sensitivity, Break-Even and Scenario Analysis

**Special Topics in Engineering Economics**

- Replacement Decisions
- Capital Budgeting Decisions
- Economic Analysis in the Service Sector

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Contemporary Engineering Economics by Chan S. Park, latest edition, Pearson ISBN: 9780134105598
- Engineering Economic Analysis by Donal G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, latest edition, Oxford University Press, ISBN: 978-0199339273

- Engineering Economy by Leland T. Blank and Anthony Tarquin.

## Social Psychology

**Area Scope:**

To impart knowledge of social psychology of attraction; attitudes and prejudice; altruism and aggression; personal and social identities; conformity; group influence and their applications in the real world.

**Course Outline:**

- Principles of sociology and psychology with emphasis on the individual and his/her reciprocal interaction with groups,
- basic psychological factors, attribution and perception of others, attitudes and attitudinal change, social attitudes, altruism, helping others, aggression, hurting others, prejudice, disliking others, discrimination and stereotypes,
- Language and communication, society and cultures, culture and personality, small groups and their relation to the individual, leadership and group dynamics. Attraction, attitudes and prejudice; altruism and aggression; personal and social identities, conformity, group influence, moral and ethical issues, harassment,
- Corruption and its control, thinking processes and decision making.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Edward Alsworth Ross, "Social Psychology", Macmillan, latest edition.
- Emory Stephen Bogardus, "Essentials of Social Psychology", Univ. of Southern, California Press, latest edition.

- Hewstone, M., & Stroebe, W. (Eds.), "Introduction to Social Psychology", 3rd ed., Oxford: Blackwell Publishers, latest edition.
- Lesko, W.A. "Readings in social psychology General, classic, and contemporary selections, latest edtion.

## Community Services

**Area Scope:**

Community service-learning provides a variety of benefits to the students and the community service has a unique way of developing an individual's leadership skills, sense of community, civic ethic, self-esteem, and other personal characteristics. Every service activity benefits a specific individual or group. Whether it is building homes for the poor, serving victims of chronic or terminal illness, tutoring children, addressing environmental needs or any other service, there is a person or group who ultimately benefits from your time. Finally, the organization where you conduct your service benefits enormously. Volunteers can make important contributions to Community benefit agencies (nonprofit) and government programs in their attempt to deal with the complex and growing needs of society.

**Course Outline:**

- Develop and implement service programs
- Develop workplace communication strategies
- Analyze impacts of sociological factors on clients in community work and services
- Manage and promote diversity
- Manage legal and ethical compliance
- Facilitate workplace debriefing and support processes
- Reflect on and improve own professional practice
- Manage work health and safety
- Assess co-existing needs
- Coordinate complex case requirements
- Develop, facilitate and review all aspects of case management
- Provide case management supervision
- Undertake project work
- Lead and manage team effectiveness

- Manage personal work priorities and professional development
- Manage meetings

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Schools and Community: The Communitarian Agenda in Education By James Arthur; Richard Bailey, Falmer Press, latest edition.
- Studying Service-Learning: Innovations in Education Research Methodology by Shelley H. Billig, Alan S. Waterman , Lawrence Erlbaum Associates, latest edition.


### Organizational Behavior

**Course Outline:**

**Introduction to Organizational Behavior**

- Organizational Disciplines and topics
- Psychological Perspective
- Social-Psychological Perspectives

**Structure and Control in Organization**

- Introduction of Bureaucracy
- Managerial Work
- Contingency theory
- Organizational Design

**Individual and Work Learning**

- Learning Theories

- Learning and Work

**Stress**

- Types of Stress and Work
- Occupational Stress Management

**Individual Differences**

- Personality and its factors
- Personality dimensions and social learning Intelligence

**Motivation and Job Satisfaction**

- Needs at Work
- Theories of Motivation and job satisfaction
- Correlates of Job satisfaction
- Correlates of Job satisfaction

**Group and Work**

- Social Interaction
- Dramaturgy and impression Management
- Social Skill

**Group and Inter Group Behavior**

- Group Structure & Norms
- Group Processes
- How throne Studies

**Leadership**

- Leadership as an attribute
- Leadership Style

**Patterns of Work**

- Work-the classical approach
- Marx, Weber, & The critique of labor
- Foucault & Disciplinary Power
- Conflict and Consent in Work
- The labor Process debate

- Work place control and resistance
- Industrial conflict and industrial relations

## Organizational Culture

- Organizational culture and strategic management
- Exploring organizational culture
- Evaluating concept of culture

## Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engineering disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

## Assessment:

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

## Suggested Books:

- Finchan, R., & Rhodes, P. latest edition, Principles of Organizational Behaviour, Oxford.
- Noe, R., Hollenbeck, J. Gerhart, B., & Wright, P. latest edition, Human Resource Management, 5th ed., McGraw Hill.
- Newstrom John W. (2007), Organizational Behaviour, (12th Ed), McGraw Hill.
- Luthan Fred, (2005), Organizational Behaviour, McGraw Hill Inc.
- Robins, Stephen, (2005), Organizational Behaviour, McGraw Hill Inc.

## Professional Ethics

### Area Scope:

The objective of this course is to grasp ideals and principles as they have been spelled out in a variety of traditional ethical systems and to apply these conceptual structures and guidelines to major problems and dilemmas of engineering practices in a corporate culture.

**Course Outline:**

- Engineering Ethics, Ethical concepts, and Types
- Moral Autonomy, Kohlberg's & Gilligan's Theory
- Profession and Professionalism
- Moral Reasoning, Ethical Theories
- Critique codes of ethics
- Moral frameworks, Personal commitments and professional life
- Engineering as social experimentation
- Involving the public in the design process, Case studies for engineering as social experimentation
- Assessment of safety and risk, Design considerations, uncertainty
- Risk-benefit analysis, Safe-exit and fail safe systems
- Case Studies for the Design Process Case studies in impact of safety/risk on design
- Employee/employer rights and responsibilities
- Confidentiality and conflict of interest
- Whistle-blowing, case studies on professional behavior/policies on the job
- Environment, sustainable development, Multinational corporations, globalization of engineering

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Ethics in Engineering 4th edition, by Mike W. Martin, Roland Schinzinger, McGraw-Hill, New York, 2005.
- Fundamentals of Engineering Economics, 3rd ed., by Chan S. Park
- Engineering Ethics: Concepts and Cases, 4th edition, by Charles E. Harris, Michael S. Pritchard, Michael J. Rabins, Wadsworth, 2008.
- The Seven Habits of Highly effective people by Stephan r. Covey

- Principle Centered Leadership Stephan r. Covey
- Change your lens change your life by (Faiez H. Seyal)
- How to Manage by Ray Wild
- Happiness by Richard Layard

# Cultural Courses

## Islamic Studies and Ethics

**Course Description:**

The Islam is a religion of peace and harmony for all humans based on knowledge and guidance in the Holy Quran. The basic teachings of Islam are comprehensive, practicable and universal. Therefore, this course briefly presents the vision of life and applied aspects of ethical system.

**Area Scope:**

- To enhance understanding of Islamic Culture and Civilization
- To understand values and social system in Islam
- To improve students' ethical and professional skill and critical thinking

**Course Outline:**

**Islam – Religion of Peace and Harmony**

- Basic Concepts – Islam, Quran and Hadith
- Faith and Religious Life
  - Selected Verses of Surah Al-Baqara Related to Faith (Verse No-284-286)
  - Selected Verses of Surah Al-Mumanoon Related to Characteristics of Faithful (Verse No-1-11)

**Islamic Culture and Civilization**

- Basic Concepts and of Characteristics of Islamic Culture and Civilization
- Education System of Islam
- Political System of Islam – Dynamics, Sovereignty and Institutions
- Economic System of Islam – Principles, Riba, Trade and Commerce
- Acceptance of Other Religions – Interfaith Harmony
- Foreign Policy

**Social System of Islam**

- Basic Concepts of Social System in Islam
- Elements of Family and their Rights - Parents, Women, Husband & Wife, Children
- Inheritance – Rights and Laws
- Social Rights – Neighbors, Relatives and Society
- Equality and Brotherhood
  o Selected Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- Concept of Welfare State – Period of Khilafat-e-Rashida

**Professional Ethics and Morality**

- Basic Concepts - Islam and Ethics
  o Selected Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)
- Profession and Professionalism in Islam
- Characteristics of a Professional
  o Truthfulness, Honesty, Sincerity, Patience, Gratitude, Meditation and Research
- Role for Human Safety and Environment
- Time Management
- Prophet Muhammad (PBUH) – Role Model
  o Selected Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
  o Selected Versus of Surah Al-Ihzab Related to Adab Al-Nabi (Verse No. 6, 21, 40, 56, 57, 58)

**Islam and Science**

- Islam and Science
- Role of Muslims in Science and Education
- Critical Thinking and Innovation
  o Selected Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
  o Selected Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No1,14)

**Note:** All topics should be taught/covered in the light of relevant Verses from Holy Quran and Ahadiths.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Al-Qur'ān القرآن (selected text).
- Sayyid Tāhir Rasūl Qādri **52 دروس قرآن** (Karachi: Islamic Research Academy, 7<sup>th</sup> ed., 2017).
- Sayyid Hasan-uddin Ahmad**, تعلیمات قرآنی** 2-vols., (Karachi: Jasarat Publications, 1998).
- Muhammad Shafī',معارف القرآن (Karachi: Dar-ul-Isha'at, 2000).
- Sayyid Abu'l A'lā Mawdūdī, **تفہیم القرآن** 6vols., (Lahore: Islamic Publications, 1998). [Preambles of all (114) chapters.]
- Amin Ahsan Islahi, تدبرالقرآن (Lahore: Farān Publications, 2005).
- Khawaja Abdul Waheed, **موضوعات قرآن وانسانی زندگی** (Islamabad: Islamic Research Institute, 3<sup>rd</sup> ed., 1997).
- Khurram Murad, رب کا پیغام (Lahore: Manshūrat, Mansoora, 2000)
- Hameed ullah Muhammad, "Emergence of Islam", Islamic Research Institute (IRI), Islamabad
- Hameed ullah Muhammad, "Muslim Conduct of State" Sh Muhammad Ashraf, Kashmir Bazar, India (Latest Edition)
- Hameed ullah Muhammad, "Introduction to Islam" Compiled by The CSS Point, www.thecsspoint.com
- Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan, (Latest Edition).
- H.S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989).
- Islamic Education by A. S. Bukhari & M. D Zafar, Latest Edition.

- Muslim's character by M. Al-Ghazali, Latest Edition.

## Pakistan Studies and Global Perspective

**Area Scope:**

The knowledge units in this area collectively encompass the following:

- Have a better understanding of the rationale for the creation of Pakistan.
- Enable students to contribute in social, political and economic growth of Pakistan.
- Become a part of strong nation with a sense of ownership and responsibility towards Pakistan
- Play an active role toward sustainable development of Pakistan in global perspective.

**Course Outline:**          **Time Duration**

**Historical and Ideological Perspective**        **5 hrs**

a. Pakistan Movement
   - Aligarh Movement
   - Two Nations Theory
b. Founders of Pakistan
   - Allama Muhammad Iqbal
   - Quaid-e-Azam Muhammad Ali Jinnah
   - Other Leaders (Women and other Pakistan Movement Leaders)
c. Quaid's Vision for Pakistan
d. Kashmir – An unfinished Agenda of Partition

**Constitution of Pakistan**        **4 hrs**

a. An overview of constitutional development in Pakistan
b. Salient features of the Constitution of 1973
c. Constitutional Amendments
d. Fundamental Rights and Responsibilities of Citizens

**Contemporary Pakistan**         **4 hrs**

    a.   Pakistan's society, culture and demography – celebrating diversity
    b.   Current Challenges: social, economic, environmental, political and external
    c.   Nation's resilience in War on Terror

**Economy of Pakistan**         **4 hrs**

    a.   An overview of Economy
    b.   Services, Manufacturing and Agricultural Profile of Pakistan
    c.   Regional Economic Cooperation
    d.   One Belt One Road (OBOR) – CPEC

**Land of Opportunities**         **4 hrs**

    a.   Physical features: diversity and beauty
    b.   Natural resources - mineral, water, energy, agriculture & livestock, and marine resources
    c.   Tourism and Culture

**Pakistan's Foreign Policy**         **5 hrs**

    a.   Foreign Policy – Principles and Objectives
    b.   Relations with Neighbors
    c.   Major Economies
    d.   Muslim World
    e.   Geo-political and strategic significance of Pakistan in Regional and Global Politics

**Pakistan in pursuit of Global Agenda**     **4 hrs**

    a.   SDGs-2030 - Pakistan Goals
    b.   Commitments on Climate Change
    c.   Peace and Security

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Khalid B. Sayeed, Pakistan: The Formative Phase 1857 – 1948, Pakistan Publishing House, 1960
- Gulam Allana, Quaid-e-Azam: the story of Pakistan, Ferozsons, 1967.
- Shahid M. Amin, Pakistan's Foreign Policy: A Reappraisal, Oxford University Press, 2010.
- S. Akbar Zaidi, Issues in Pakistan's economy, Oxford University Press, 2003.
- Hamid Khan, Constitutional & political history of Pakistan, Oxford University Press, 2003
- Rafi Raza, *Pakistan in Perspective 1947-1997*, Oxford University Press, 2003
- Sharif-ul-Mujahid, *The Ideology of Pakistan*, Progressive Publishers, 1974.
- Ziring Lawrence, *Pakistan in the Twentieth Century,* Oxford University Press, 1997 -
- Burke S. M. & Ziring Lawrence, *Pakistan's Foreign Policy,* Oxford University Press, 1973. Mohammad Qadeer , Pakistan
- Climate Change Policies-Ministry of Climate Change, Islamabad-http://mocc.gov.pk/
- Sustainable Development Goals (SDGs)-  www.pc.gov.web/sdg/sdgpak
- Economic Survey of Pakistan- http://finance.gov.pk/survey_1617.html
- Foreign Policies-  Ministry of Foreign Affairs, Pakistan http://mofa.gov.pk/
- Population Census of Pakistan- Economic Survey of Pakistan http://finance.gov.pk/survey_1617.html
- Issues in Pakistan's Economy by S. Akbar Zaidi, ISBN: 0195790529.
- Pakistan's Foreign Policy: A Reappraisal by Shahid M. Amin. ISBN: 0195798015
- Newspapers editorial and selected journalistic writings on current affairs.
- Pakistan (Lands, Peoples, & Cultures) by Carolyn Black, Bobbie Kalman. ISBN: 0778797147

# Management Sciences Courses

### Engineering Project Management

**Area Scope:**

The primary objective of this course is to get the fair understanding of core issues pertaining to Engineering Project Management. This course is aimed at providing both basic and some advanced exposure to emerging trends in the field of Project Management, so as to enable the engineering professionals of tomorrow to successfully complete sophisticated projects within the constraints of capital, time, and other resources with due regards to stakeholders set of expectations. Engineering students will learn key Project Management skills and strategies and will be able to face emerging challenges.

**Core Objectives of this course are:**

- To develop competencies in project costing, budgeting, and financial appraisal;
- To gain exposure to project Planning Control and Management, using standard tools and schedule variance analysis;
- To appreciate the elements of risk and quality in hi-tech projects;
- To learn Project Management by "practice", through the medium of "End of Semester Group Project"; and
- To appreciate and understand the use of computers in Project Management, especially a tool like MS Project & Primavera etc.

**Course Outline:**

**Project Management Concepts**

History of Project Management, Introduction to Project Management, Project, Program & Portfolio Management, Project characteristics, Objectives& Requirements, Project Phases/Stages, Project Life Cycle, Project Environment, Project Scope & Project Charter, Project Manager, Project Stakeholder Analysis.

**Project Proposal Development**

Project Proposal, Characteristics of good proposal, Types of Proposals, Request for Proposal, Request for Quotation etc.). Proposal Templates etc.

**Project Feasibility**

Brief review of various aspects of Project Feasibility like Technical, Social, Managerial, Economic, Financial & Marketing, Administrative etc.

**Project Selection Criteria (Economic Analysis of Engineering Projects)**

Using Break Even Analysis, Cost Benefit Ratio, Internal Rate of Return, Net Present Value etc.

**Project Contract & Procurement Management**

Engineering contracts, Type of contracts, understanding of procurement Process & Cycle, PPRA Rules

**Project Planning and Scheduling**

Project Planning (Resource & HR Planning), Work Breakdown Structure, Project Network & Scheduling, Manning Schedule and Activity Charts, Critical Path Method (CPM)/Project Evaluation & Review Techniques

**Project Costing & Estimation**

Cost Estimation in Projects, Cost components in projects and methods for cost estimation in projects, Cost Control in Projects, Estimation of Outstanding Work, Earned Value Management, Schedule & cost variance analysis

**Project HRM & Communication Management**

Effective organization and communication for Successful Projects, Project Organizational Structures (Project matrix and project based organizations), Project HR Plan preparation, HR Need Assessment and HR Matrix, Building and Managing effective project team, Selection & control mechanism of HRM in Projects, Effective Communication Plan.

**Project Risk Management**

Definitions Project Risk, Project Risk Management Tools, Types of Project Risk, Project Risk Assessment, Risk Identification and Mitigation, Monitoring & Controlling Risk, Generic Risk Management Strategies & Technique.

**Computer Application in Project Management**

Basic/Elementary Introduction and hands on basic exposure of use of MS Project & Primavera P6 Software in Project Management

**Project Quality Management**

Defining Quality, Quality Assurance, Quality Management, 7 Quality Improvement Tools as applied to Project Management, Project Quality Management Plan, Quality Management Processes and Strategies

**Project Closure & Termination**

Project Evaluation, defining project success, Project Completion Criteria, Project Audit, Project Termination &When to close a project, the termination process, Project Close Up & lesson learnt, & Project Archive

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Project Management: A system Approach to Planning, Scheduling and Controlling latest Edition, Harold Kerzner
- Bennett, F. Lawrence. Latest edition. The management of engineering. New York: Wiley.
- Cleland, David. Latest edition   Field guide to project management.  New York: Wiley.
- Eisner, H.  Essentials of project management and systems engineering management.  New York: Wiley, latest edition.
- Frame, J. D.  Managing projects in organizations. San Francisco: Jossey-Bass
- Goldratt, Eliyahu. Latest edition Critical chain.  North River Press.
- Haynes, M.E.  Project management:  From idea to implementation.  Los Altos, CA:  Crisp Publications latest edition.
- Lewis, James, Project planning, scheduling & control.  New York: McGraw-Hill, latest edition.

- Lewis, James, P. Latest edition. Mastering project management. New York: McGraw-Hill
- Lientz, Bennet & Rea, Kathryn. Latest edition. Project management for the 21st century. San Diego: Academic Press.
- Miller, Roger & Lessard, Donald. Latest edition. The strategic management of large engineering projects. Cambridge, MA: MIT Press.
- Nicholas, J.M. Managing business & engineering projects. Englewood Cliffs, NJ: Prentice Hall, latest edition
- Shtub, Avraham, Bard, Jonathan, & Globerson, Shlomo. 1994. Project management: Engineering, technology, and implementation. Englewood Cliffs, Prentice-Hall latest edition.
- Project Management by Adrienne Watt, latest edition.
- J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons. New York. Latest edition.

## Entrepreneurship

**Area Scope:**

- Develop a business plan with an appropriate business model
- Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career
- Demonstrate the ability to find an attractive market that can be reached economically

**Course Outline:**

- Basic Concept-Entrepreneurship
- Innovation and Entrepreneurship
- Basic Plan Development Cycle
- Intellectual Rights
- Financial and Legal Modalities
- Marketing
- Industrial Competiveness
- Gap Analysis, Critical Thinking and Idea Generation
- Business Plan Development
- Successful Case Studies (local)

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Michael J Etzel, Bruce J Walker, William J Stanton, Marketing, McGraw-Hill, latest edition.
- William D. Bygrave and Andrew Zacharak, Entrepreneurship 2nd Edition, Wiley, latest edition.
- Entrepreneurship by Hisrich, McGraw- Hill, latest edition.
- Principles of Marketing, Cotrell McGraw- Hill, latest edition.
- Paul Burns and Jim Dew Hurst: Small Business and Entrepreneurship, latest edition.
- P.N. Singh: Entrepreneurship for Economic Growth, latest edition.
- Peter F. Drucker: Innovation and Entrepreneurship Peter F. Drucker, latest edition.
- John B. Miner: Entrepreneurial Success, latest edition.
- "Marketing that Works: How Entrepreneurial Marketing Can Add Sustainable Value to Any Sized Company", by Leonard Lodish, Howard Morgan, Shellye Archambeau and Jeffrey Babin, Pearson FT Press, latest edition.
- "Entrepreneurial Marketing," Lessons from Wharton's Pioneering MBA Course, Morgan, H. L., A. Kallianpur, and L. M. Lodish, John Wiley & Sons, latest edition.

## Principles of Management

**Area Scope**

- The focus will be on the learning fundamental principles of management and of managing people and organization.
- Develop analytical and conceptual framework of how people are managed in small, medium and large public and private national and international organizations.

**Course Outline:**

- Introduction, overview and scope of discipline
- The evolution and emergence of management thought
- Management functions
- Planning concepts, objectives, strategies and policies
- Decision making
- Organizing; departmentalization, line/staff authority, commitments and group decision making
- Staffing: principles of selection, performance, career planning
- Leading: Motivation, leadership, communication
- Controlling: the system, process and techniques of controlling
- Management and Society: future perspective

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- Stephen P. Robins, Mary Coulter: Management, latest edition.
- H. Koontz Odonnel and H. Weihrich: Management, latest edition.
- Mc Farland: Management: Foundation and Practice, latest edition.
- Robert M. Fulmer: The New Management, latest edition.

## Engineering Management

**Course Outline:**

- Industrial networks
- Fundamentals of Product and Process development
- Business Community and New Generations of Managers
- Practical Skills Knowledge and Experience in Commercialization of New Technological Inventions
- Use of Multidisciplinary Science Based Knowledge,
- Problem Solving, Teamwork and Outreach Activity,
- Major steps in proof of concept to intellectual property protection,
- Prototype development
- Fabrication and assembly routes
- Materials procurement,
- Identification and creation of new markets
- Development of business plan
- Appropriate technology and marketing
- Distribution and financing
- Routes and strategies for specific technology under development.

**Teaching Methodology (Proposed as applicable):**

Lectures (audio/video aids), Written Assignments/ Quizzes, Tutorials, Case Studies relevant to engg disciplines, Semester Project, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

**Assessment:**

Mid Term, Report writing/ Presentation, Assignments, Project Report, Quizzes, Final Term

**Suggested Books:**

- R. A. Bulgelman, Strategic Management of Technology and innovation, latest Edition McGraw Hill.