Curriculum for

Computer Engineering/ Electrical Engineering (Computer)

Bachelor of Engineering Program

2020

Pakistan Engineering Council
&
Higher Education Commission
Islamabad

CURRICULUM

OF

COMPUTER ENGINEERING/ ELECTRICAL ENGINEERING (COMPUTER)

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Contents

PREFACE

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 vides 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, Metallurgy, Materials, Mining Engg & Allied Disciplines	Convener
2.	Engr Prof Dr M. Younus Javed Convener Electrical Engg & Allied Disciplines	Member
3.	Engr Malik Saleem Ullah Saeed Convener Chemical Engg & Allied Disciplines	Member
4.	Engr Dr Wasim Khaliq Convener, Civil Engg & Allied Discipline	Member
5.	Engr. Prof. Dr. Iftikhar Hussain Convener, Mechanical and Allied Engineering	Member
6.	Engr Dr Muhammad Ashraf Convener, Agricultural Engg & Allied Disciplines	Member

7.	Engr Prof Dr Jameel Ahmed Convener Common to All (Non-Engg Component)	Member
8.	Engr Muhammad Raza Chohan Director General, HEC	Member
9.	Engr Dr Nasir Mahmood Khan Additional Registrar (Accreditation), PEC	Member
10.	Engr Dr Ashfaq Ahmed Sheikh Additional Registrar, CPD	Secretary

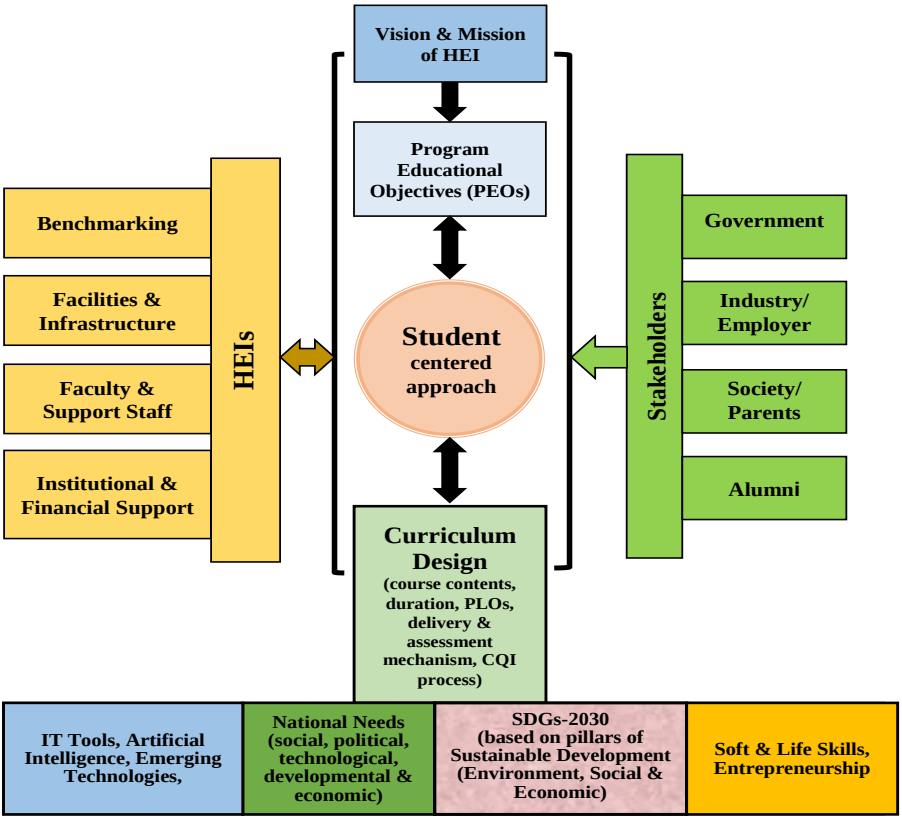
2. ECRDC Agenda

- 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

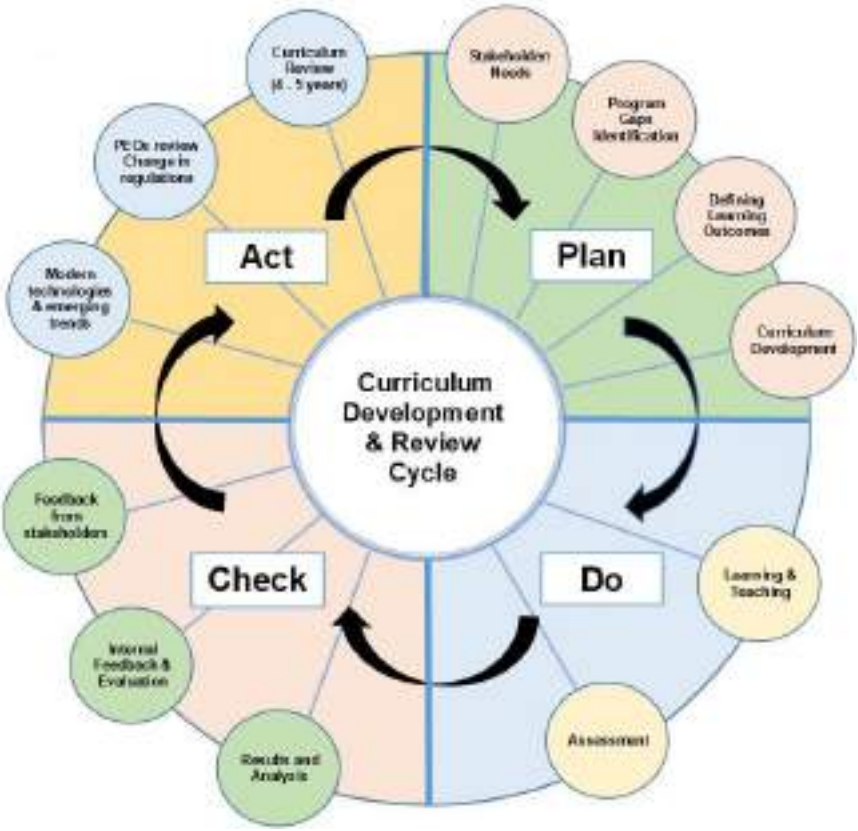
Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student-centered system which concerns what the students would know and be able to do as learning outcomes. The curriculum development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

Outcome-Based Education (OBE) - Curriculum Development Framework



4. PDCA Approach to Curriculum Design and 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 B.E Computer engineering degree program. The subject Committee had two meetings on 18-9-2019 and 20-01-2020 at PEC Headquarters Islamabad besides Sub-Group of Computer Engineering meetings on 8-8-2019 and 27-12-2019 at Karachi. The Committee consisted of following members:

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

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

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

22	Engr Asif Mehmood Director NESCOM Islamabad	Member
23	Engr. Dr. Syed Mohammad Hasan Zaidi Professor NUST School of Electrical Engineering and Computer Engineering (SEECS), Islamabad	Member
24	Engr. Dr. Tauseef Tauqeer Associate Professor Information Technology University, Lahore	Member
25	Engr. Dr. Zahir Paracha Professor Department of Electrical Engineering Pakistan Institute of Engineering & Technology, Multan	Member
26	Mr. Hidayatullah Kasi Deputy Director Higher Education Commission, Islamabad	Rep HEC
27	Engr. Dr. Ashfaq Ahmed Shaikh Additional Registrar-CPD Pakistan Engineering Council, Islamabad	Secretary
28.	Engr. Muhammad Kashif Ali Assistant Registrar-CPD Pakistan Engineering Council, Islamabad	AR-CPD

5.1 Sub Group Computer Engineering

1.	Engr. Prof. Dr. Madad Ali Shah Vice Chancellor The Benazir Bhutto Shaheed University of Technology and Skill Development Khairpur Mirs	Lead Sub-Group
2.	Engr. Prof. Dr. Usman Khalid Professor Department of Computer & Software Engineering NUST, Rawalpindi	Member
3.	Engr Yasir Rizwan Saqib Chief Executive Officer Foot Technology, Lahore	Member
4.	Engr. Prof. Dr. Zubair Ahmed Shaikh Professor and Dean Department of Computer Engineering Muhammad Ali Jinnah University, Campus Karachi	Expert
5.	Engr. Prof. Dr. M Haroon Yousaf Professor Department of Computer Engineering UET, Taxila	Expert
6.	Engr. Prof. Dr. Shabbar Naqvi Professor Dean Faculty of Sciences BUET, Khuzdar	Expert
7.	Engr Prof. Dr. Nasru Minallah Professor Department of Computer System Engineering UET, Peshawar	Expert

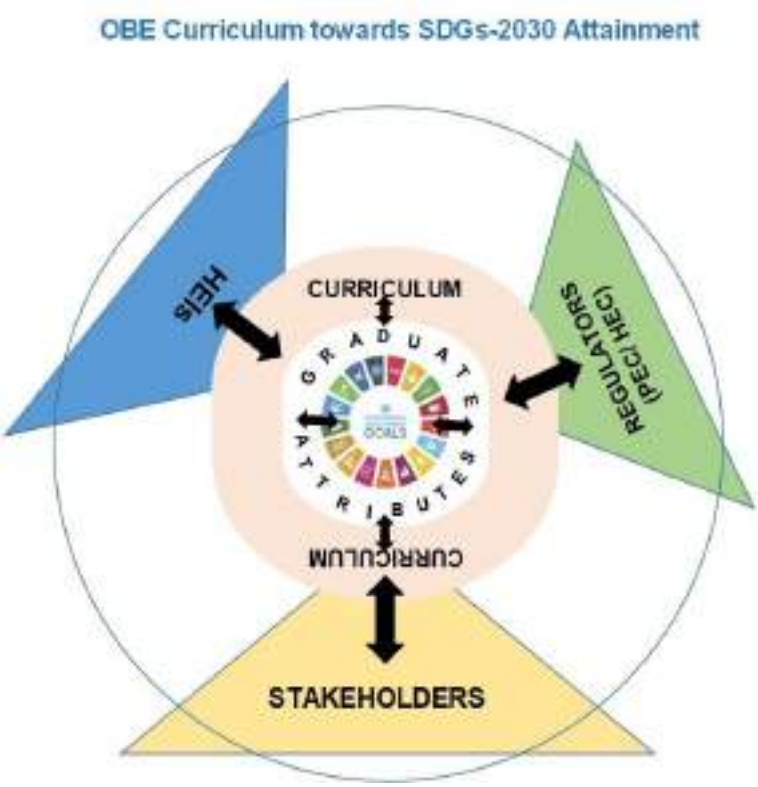
8.	Engr Prof. Dr. Muniba Memon Assistant Professor Department of Computer Science & Software Engineering Indus University, Karachi	Expert
9.	Engr Prof. Dr.Asad Arfeen Assistant Professor Department of Computer and Information System Engineering NED – UET, Karachi	Expert
10.	Engr. Prof. Dr. Asim Imdad Assistant Professor Department of Computer System Engineering Muhammad Ali Jinnah University (MAJU) Campus Karachi	Expert
11.	Engr Khadim Hussain Bhatti Registrar Pakistan Engineering Council, Islamabad	Expert
12.	Mr. Hidayatullah Kasi Deputy Director Higher Education Commission, Islamabad	Rep HEC
13.	Engr. Dr. Ashfaq Ahmed Shaikh Additional Registrar-CPD Pakistan Engineering Council, Islamabad	Secretary
14.	Engr. Muhammad Kashif Ali Assistant Registrar-CPD 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.

The Convener Engr Prof Dr Younus Javed highlighted the important benchmarks and international best practices to be considered for the development/ revision of the curriculum while taking into account the Outcome Based Education (OBE) system. He also suggested that the Committee comprising professors 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 Computer Engineering for achieving sustainable developments while addressing socio-economic issues and challenges envisaged in Sustainable Development Goals (SDGs) as under and well-mapped within the curriculum;

- 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-11: Sustainable Cities and Communities
- Goal-12: Responsible Consumption and Production



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

7. Program Education Objectives (PEOs) and Learning Outcomes (PLOs)

As guidance, the sample Program Educational Objectives (PEOs) and Learning Outcomes (PLOs) are given below for a typical Computer Engineering Program. The HEIs should have their own program objectives, PLOs and CLOs 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 Computer 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-11 and Goal-12.

The graduates of the program will able to:

i. Demonstrate excellence in profession through in depth knowledge and skills in the field of Computer Engineering
ii. Engage in continuous professional development and exhibit quest for learning, innovation and entrepreneurship
iii. 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):

PLO1 Engineering Knowledge: An ability to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

PLO2 Problem Analysis: An ability to identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.

PLO3 Design/Development of Solutions: An ability to design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.

PLO4 Investigation: An ability to investigate complex engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.

PLO5 Modern Tool Usage: An ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.

PLO6 The Engineer and Society: An ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice and solution to complex engineering problems.

PLO7 Environment and Sustainability: An ability to understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of, and need for, sustainable development.

PLO8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.

PLO9 Individual and Team Work: An ability to work effectively, as an individual or in a team, on multifaceted and /or multidisciplinary settings.

PLO10 Communication: An ability to communicate effectively, orally as well as in writing, on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PLO11 Project Management: An ability to demonstrate management skills and apply engineering principles to one's own work, as a member and/or leader in a team, to manage projects in a multidisciplinary environment.

PLO12 Lifelong Learning: An 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
  - Engineering Domain: minimum 85 Credit Hours
  - 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, 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-2/ WK-3	Foundation Engg Courses		Specific to program objectives and outcomes	22 - 24
WK-1/ WK-2/ WK-4	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	Multidisciplinary Engg Courses		Specific to program objectives and outcomes	6 - 12
			Occupational Health and Safety (mandatory – 01 Cr Hr)	
WK-6/ WK-7/ WK-8	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 mandatory internship		Qualifying
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	**Innovative and Critical Thinking (under relevant courses):** - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open Ended Labs - 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 3rd to 4th 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;
  - Selection of internship in line with elective subjects/ specific streams
  - 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.

- 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.
- 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.
- 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.
- 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 Computer 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 Computer 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 Writing and Presentation Skills	3	0	3
		Culture	Islamic Studies and Ethics	2	0	2
			Pakistan Studies and Global Perspective	2	0	2
		Social Sciences	Social Science Elective-I (Professional Ethics/ Sociology for Engineers)	2	0	2
			Social Science Elective-II (Engg. Economics)	2	0	2
	Management Sciences	Professional Practice	Management Science Elective – I (Entrepreneurship)	2	0	2
			Management Science Elective - II (Engg. Management/ Project Management)	3	0	3
WK-2	Natural Sciences	Math	Calculus and Analytic Geometry	3	0	3
WK-1			Differential Equations	3	0	3
			Complex Variables and Transforms	3	0	3
			Linear Algebra	2	0	2
			Probability and Statistics	3	0	3
			Numerical Methods	2	1	3
		Physics	Applied Physics	2	1	3
Total (Non-Engineering Domain)				**38**	**2**	**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
			Computer Programming	3	1	4
			Discrete Structures	3	0	3
WK-3/ WK-2	Engineering Foundation	--	Computer Engineering Workshop	0	1	1
			Digital Logic Design	3	1	4
			Circuit Analysis	3	1	4
			Electronic Devices and Circuits	3	1	4
			Object Oriented Programming	3	1	4
			Data Structures and Algorithms	3	1	4
			Signals and Systems	3	1	4
			Computer Organization and Architecture	3	1	4
WK-4/ WK-1/ WK-2	Major Based Core (Breadth Courses)	--	Computer Communication and Networks	3	1	4
			Microprocessors and Interfacing	3	1	4
			Operating Systems	3	1	4
			Data Base Management Systems	3	1	4
			Software Engineering	3	0	3
			Digital Signal Processing	3	1	4
			Digital System Design	3	1	4
WK-5/ WK-6	Major Based Core (Depth courses)	--	Cloud and Distributed Computing	3	1	4
			Comp. Engg. Depth Elect.-I	3	1	4
			Comp. Engg. Depth Elect.-II	3	1	4

			Comp. Engg. Depth Elect.-III	3	1	4
WK-3/ WK-4/ WK-2/ WK-1	Multi-Disciplinary Engineering Courses	--	MDE Elective -1	3/2	0/1	3
			MDE Elective – 2	3/2	0/1	3
			Occupational Health and Safety (Mandatory)	1	0	1
WK-6/ WK-7/ WK-8	Final Year Design Project (FYDP)/ Capstone	Industrial/ Innovative/ Creative Project	FYDP (Part-I)	0	3	3
			FYDP (Part-II)	0	3	3
WK-6/ WK-7	Industrial Training (Summer)	At least 6 -8 weeks internship (summer)		0	0	0
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	**Innovative & Critical Thinking (under relevant courses)** - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open Ended Labs - Problem Based Learning (PBL)					
Total (Engineering Domain)				**69 (67)**	**26(28)**	**95**
Total (Credit Hours)				**107 (105)**	**28(26)**	**135**

***** to be taught during 1st year of program

10. Scheme of Study for Bachelor of Computer Engineering

Course Title	Theory	Lab	Total	Course Title	Theory	Lab	Total
	Credit Hours				Credit Hours		
Year 1							
Semester 1				**Semester 2**			
Calculus and Analytical Geometry	3	0	3	Linear Algebra	2	0	2
Islamic Studies and Ethics	2	0	2	Circuit Analysis	3	1	4
Information and Communication Technologies (ICT)	2	1	3	Computer Programming	3	1	4
Applied Physics	2	1	3	Electronic Devices and Circuits	3	1	4
Functional English	2	0	2	Communication Skills	2	0	2
Engg. Workshop	0	1	1	Pakistan Studies and Global Perspective	2	0	2
Occupational Health and Safety	1	0	1				
Total	**12**	**3**	**15**	**Total**	**15**	**3**	**18**
Year 2							
Semester 3				**Semester 4**			
Digital Logic Design	3	1	4	Differential Equations	3	0	3
Technical Writing	3	0	3	Data Structures and Algorithms	3	1	4
Object Oriented Programming	3	1	4	Signals & Systems	3	1	4
Discrete Structures	3	0	3	Computer Architecture and Organization	3	1	4
Complex Variables and Transforms	3	0	3	MS-Elective – II (Engg Project Management)	3	0	3
Total	**15**	**2**	**17**	**Total**	**15**	**3**	**18**
Year 3							
Semester 5				**Semester 6**			
Microprocessors and Interfacing	3	1	4	Database Management System	3	1	4
Digital Signal Processing	3	1	4	CEDE -I	3	1	4
Computer Communication Networks	3	1	4	CEDE -II	3	1	4

Operating Systems	3	1	4	Software Engg.	3	0	3
Engg. Economics (Social Science-II)	2	0	2	Probability and Statistics	3	0	3
Total	**14**	**4**	**18**	**Total**	**15**	**3**	**18**
Year 4							
Semester 7				**Semester 8**			
Entrepreneurship	2	0	2	Social Science Elective-I	2	0	2
Digital System Design	3	1	4	CEDE -IV	3	1	4
Cloud and Distributed Computing CEDE-III	3	1	4	MDEE - II	3	0	3
Numerical Analysis	2	1	3	Senior Design Project-2	0	3	3
Senior Design Project -1	0	3	3	MDEE -I	3	0	3
Total	**10**	**6**	**16**	**Total**	**11**	**4**	**15**
Total Credit Hours					**135**		

List of Electives for Computer Engineering Program

Computer Engineering Depth Electives (CEDE)

- Cloud and Distributed Computing
- Internet of Things
- Embedded System Design
- Artificial intelligence and Machine Learning
- Image Processing and Analysis
- System and Network Security
- Systems Programming
- High Performance Computing
- Control Engineering
- Algorithm Design and Analysis
- Hardware Design for DSP and ML

Multi-Disciplinary Engineering Electives (MDEE)

- Human Computer Interaction (UI/UX)
- Block Chain Technologies and Applications
- Neural Networks and Fuzzy Logic
- Robotics and Automation
- Mobile Application/Game Development
- Virtual Reality
- Software Quality Assurance
- Instrumentation and Controls
- VLSI System Design
- Data Warehousing and Big Data
- Applied Thermodynamics
- GIS and Remote Sensing
- Health, Safety and Environment (HSE)
- Biomedical Engg
- Business Process Re-engineering

11. Program Specific Labs

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

- Image Processing Lab
- Data Communication & Network Lab
- Computing Lab
- Digital System Lab
- Software Development Lab
- Microprocessor Lab
- Project and Research Lab
- Electronics System Lab
- Communication Lab
- Data Management Lab
- Computer Workshop

12. Course Details and Teaching-Assessment Approaches

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.

12.1 Engineering Domain

Information & Communication Technologies

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

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 Edition.

Computer Programming

Course Outline:

- Introduction to problem solving, a brief review of Von-Neumann architecture, Introduction to programming, role of compiler and linker, Introduction to algorithms
- Basic data types and variables, input/output constructs, arithmetic, comparison and logical operators
- Conditional statements and execution flow for conditional statements
- Repetitive statements and execution flow for repetitive statements
- Lists and their memory organization, multi-dimensional lists

- Introduction to modular programming, function definition and calling, stack rolling and unrolling
- String and string operations
- Pointers/references, static and dynamic memory allocation
- File I/O operations.
- Design, development and testing of complex engineering problems.

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:

- Problem Solving with C++, latest Edition, Walter Savitch, Addison Wesley,
- C++ How to Program, latest Edition, Deitel & Deitel, Prentice Hall.
- Java: An Introduction to Problem Solving and Programming, latest Edition, Walter Savitch, Addison-Wesley.
- Introduction to Computation and Programming Using Python: With Application to Understanding Data, latest Edition by Guttag, John.
- Practice of Computing Using Python, latest Edition by William Punch & Richard Enbody.

Discrete Structures

Course Outline:

- Logic: propositional logic, logical equivalence, predicates & quantifiers, and logical reasoning.
- Sets: basics, set operations
- Functions: one-to-one, onto, inverse, composition, graphs
- Integers: greatest common divisor, Euclidean algorithm.
- Sequences and Summations

- Mathematical reasoning: Proof strategies, Mathematical Induction, Recursive definitions, Structural Induction
- Counting: basic rules, Pigeon hall principle, Permutations and combinations, Binomial coefficients and Pascal triangle.
- Probability: Discrete probability. Expected values and variance.
- Relations: properties, Combining relations, Closures, Equivalence, partial ordering
- Graphs: directed, undirected graphs.
- Trees, O-Notation and the Efficiency of Algorithms

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:

- Discrete Mathematics and Its Applications by Kenneth Rosen. Latest Edition, McGraw Hill Publishing Co.
- Discrete Mathematics by Richard Johnsonbaugh latest edition, Prentice Hall Publishers.

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 AutoCAD
- Create and use layers
- Print or plot a drawing

- Create and using blocks
- Be familiar with hatching capabilities of AutoCAD
- 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 2017 and AutoCAD LT 2017 by George Omura with Brian Benton, (latest edition), 2016.
- AutoCAD® 2015 And AutoCAD Lt® 2015 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.
- https://www.mathworks.com/help/simulink/simulation.html
- https://www.mathworks.com/help/simulink/modeling.html

Engineering Foundation Courses

Computer Engineering Workshop

Course Outline:

Architecture of a Computer and the Technological Evolution

- Various types of Computer architectures
- Computer components and their interconnections
- Microprocessors.
- Memories.
- Storage (Fixed/Removable and Cloud)
- Buses.
- Ethernet and Wireless communications.
- Input/Output.
- Power supply.

Computer Components

- Actions to manage electrical and digital components of computer
- Tools to assemble a computer.
- Voltage levels in a computer.
- Digital and computer systems voltage standards.
- Testing voltage levels.
- Assemble and disassemble a computer.
- Tools to analyze and detect incidents.

Analysis and Measurement Tools

- Power supply.
- Multimeter.
- Oscilloscope.
- Signal/Function generator.

Digital Systems

- Microprocessor-based systems.
- Digital 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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- Upgrading and Repairing PCs, latest edition by Scott Mueller, QUE Press.
- The IT Support Handbook by Mike Halsey, latest edition, A Press.

Circuit Analysis

Course Outline:

- Introduction to Circuits and Systems. Power calculation, Active and passive elements. Dependent and independent sources.
- Series and parallel configuration of resistors. Finding equivalent resistance of a circuit containing series, parallel and series-parallel networks.
- Kirchoff's Voltage law. Application of KVL to DC Circuits. Related examples and problems.
- Kirchoff's Current law. Application of KCL to DC Circuits. Related examples and problems.
- Concept of dependent sources in the application of KCL / KVL to AC circuits. Numerical example of circuits with voltage and current sources based on KCL.
- The Y - ∇ system. The ∇ - Y system. Finding Equivalent resistance of different resistor combinations.
- DC bridge circuit analysis. Determination of unknown impedance with bridge circuit.
- Mesh Current method. Super Mesh handling techniques. Related Problems. Mid Term Examination.
- Node Voltage method. Super node handling techniques. Related problems.
- Thevenin's and Norton's Theorem. Numerical Examples on Thevenin's Theorem (Circuits with current, Voltage and dependent source).

- Superposition Theorem. Numerical Examples on Superposition theorem (Circuits with current, Voltage and dependent source). Maximum Power transfer theorem.
- Transient and Steady State Response, Switching operations in circuits, Response of inductor and capacitor. Use of Differential Equations in circuit analysis. RL Transient and Steady State response. General case with a simple numerical example. Numerical Examples on RL circuits with initial conditions. Numerical examples on RL circuits with current source included.
- Transient and steady state response of an RC circuit. General case with a simple numerical example. RC circuits with initial conditions. Numerical examples of RC circuits with initial conditions. Numerical example of RC circuits with current source. Numerical examples of RC circuits with mixed sources.
- Introduction to second order circuits. Conditions for over damping, critical damping and under damping. Simple example of RLC series circuit with condition of over-damping and critical damping.
- Second order circuit analysis with voltage sources. Second order circuits with current and voltage sources.
- AC fundamentals; nodal analysis, loop analysis, linearity and superposition, source transformation, circuit theorems.

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:

- Electric circuits by James W Nilsson & Susan A Riedel, latest Edition, Addison Wesley.
- S. Franco, "Electric Circuits Fundamentals", Oxford University Press, Latest Edition

- W. Hayt, J. Kemmerly and S. Durbin, "Engineering Circuit Analysis", McGraw-Hill, latest Edition.

Object Oriented Programming

Course Outline:

- Concepts of object oriented paradigm
- Classes and Objects
- Relationship between classes
- Encapsulation
- Inheritance
- Polymorphism
- Abstract classes and interfaces
- Overloading and overriding
- Object-oriented design
- Event-driven programming, Event propagation
- Exception handling
- Streams and Serialization
- Threading, Multi-threading
- Packages
- Recursion, use of stacks, queues and lists from API
- Building GUI applications.

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:

- An Introduction to Object Oriented Programming with Java by C. Thomas WU, McGraw Hill Publishers latest Edition

- Python 3 Object-oriented Programming - latest Edition by Dusty Phillips.
- Object Oriented Programming in Java – A Graphical Approach by Katherine E. Sanders & Andries Van Dam, latest edition.

Data Structures and Algorithms

Course Outline:

- Abstract data types
- Complexity analysis, Big Oh notation
- Stacks (linked lists and array implementations)
- Recursion and analyzing recursive algorithms, divide and conquer algorithms
- Sorting algorithms (selection, insertion, merge, quick, bubble, heap, shell, radix, bucket)
- Queue, dequeuer, priority queues (linked and array implementations of queues)
- Linked list & its various types, sorted linked list, searching an unsorted array
- Binary search for sorted arrays, hashing and indexing
- Open addressing and chaining
- Trees and tree traversals, binary search trees
- Heaps, M-way tress, balanced trees, graphs
- Breadth-first and depth-first traversal, topological order
- Shortest path, adjacency matrix and adjacency list implementations
- Memory management and garbage collection.

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:

- Data Structures and Algorithm Analysis in C++, latest Edition, Mark Weiss,

Prentice Hall.

- Data Structures and Algorithm Analysis in Java, latest Edition, Mark Weiss, Prentice Hall.

Digital Logic Design

Course Outline:

- Basic understanding of Digital Systems and Binary Numbers, use of binary numbers and their manipulation.
- Explanation of various number systems and conversion from and to different number systems.
- Introduction and basic definitions of Boolean Algebra and Logic Gates with different types of logic gates.
- Axiomatic Definition of Boolean Algebra, Basic Theorems and Properties of Boolean Algebra.
- Logic operations being performed by the various logic gates.
- Introduction to Gate-Level Minimization and explanation of multiple methods of Gate-Level Minimization.
- Overview of Hardware Description Language and its implementation.
- Introduction to Combinational Logic and combinational circuits along with their analysis and design procedures.
- Working of adders, multipliers, comparators, encoders, decoders and multiplexers demultiplexers.
- Understanding of Synchronous Sequential Logic designs, storage elements like flip flops and latches.
- Analysis of clocked sequential circuits and Synthesizable HDL Models of Sequential Circuits.
- Introduction to Registers and Counters along with their different types like shift registers, ripple counters and Synchronous counters.
- Details description of Memory and Programmable Logic.
- Analysis of memory decoding, error detection and correction and programmable logic arrays.
- Introduction of Designing at the Register Transfer Level and algorithmic state machines (ASMs).

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Case Studies relevant to engg disciplines, Semester Project, Lab work

Assessment:

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

Suggested Books:

- M. Morris Mano & Michael D. Ciletti, "Digital Design", Pearson, latest edition.
- M. Morris Mano, "Digital logic and computer design." Pearson, latest edition.

Signals & Systems

Course Outline:

- Introduction to the instinctive and conventional skills needed for evaluating signals and systems.
- Developing an understanding of the principles of LTI continuous-time and discrete-time systems and its association with signals.
- Understanding of the mathematical representations and methods for analyzing signals and systems.
- The course combines lectures and Matlab simulation exercises to get the concepts of both continuous-time and discrete-time forms of signals and systems.
- Introduction to the types of Signals and Systems, Impulse response / Differential equation models of Continuous-time (CT) systems, CT and Discrete-time (DT) Convolution, CT Fourier Series, CT Fourier Transform (CTFT), DT signals and systems, Laplace-Transform.
- Introduction to the Laplace-Transform, The Region of Convergence for the Laplace-Transform, The Inverse Laplace-Transform and Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot.
- Introduction to the Z-Transform , The Region of Convergence for the z-Transform, The Inverse Z-Transform and Geometric Evaluation of the Fourier Transform from the Pole-Zero Plot.

- Introduction to linear feedback systems and some applications and consequences of feedback systems.
- Analysis of Root-locus of linear feedback systems and the Nyquist stability criterion.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Case Studies relevant to engg disciplines, Semester Project, Lab work

Assessment:

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

Suggested Books:

- Alan V. Oppenheim, Alan S. Willsky, "Signals and Systems" latest Edition, Prentice Hall.
- Lathi, Bhagwandas Pannalal, and Roger A. Green, "Linear systems and signals", Vol. 2. New York: Oxford University Press, latest edition.

Computer Organization and Architecture

Course Outline:

- Introduction to Computer System Architecture and Digital Computers.
- Register transfer language. Arithmetic, logic and shift micro operations.
- Common bus system design and memory transfers, Tristate buffers.
- Binary data. Arithmetic operations on signed binary numbers. Overflow detection circuit design.
- Design of Arithmetic Logic Unit and Control Unit. Hardwired Control Unit, Micro programmed Control Unit.
- Microprocessor organization, microprocessor sequencing. Memory cycle, memory read cycle, memory-write cycle.
- Microprocessor instruction set and addressing modes. Types of microprocessor instructions, machine language, introduction to assembly language.
- Stack operations, Subroutines, Interrupts, Priority Interrupt.

- Memory system design, memory hierarchy, primary memory (RAM, ROM), secondary memory. Function table of RAM & ROM, memory address map. Interfacing microprocessor with memory.
- Cache memory, Different designs of cache memory system.
- Input/output Interface, memory mapped input/output, isolated input/output. Parallel peripheral interface, serial communication interface, dedicated interface components. Direct memory access.
- Virtual memory system, Address mapping using pages.
- Introduction to parallel processing, Multiprocessor systems, Pipeline processing

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, Case Studies relevant to engg disciplines, Semester Project, Lab work

Assessment:

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

Suggested Books:

- Patternson & John Hennessy, Computer Organization and Design the Hardware/Software Interface, David, latest Edition.
- William Stallings, "Computer Organization and Architecture: Designing for Performance", latest Edition, Prentice Hall.
- John Hennessy, David Patterson, "Computer Architecture - A Quantitative Approach", latest Edition, Morgan Kaufmann Publishers Inc.

Electronic Devices and Circuits

Course Outline:

- Diodes: The Ideal Diode, Semiconductor materials, Energy levels, extrinsic materials.
- Semiconductor Diode, Resistance Levels, Diode Equivalent Circuits.
- Diode Applications: Loadline Analysis, Diode Approximations, Serial Diode Configurations with DC Inputs, Parallel and Series-parallel Configurations

- AND/OR Gates, Half Wave rectification, Full Wave Rectification, Clippers
- Clampers, Zener Diodes., Voltage Multiplier Circuits
- Bipolar Junction Transistors (BJTs):
  Transistor Construction, Transistor Operation, Common base Configuration Transistor Amplifying Action
- Common Emitter Configuration, Common Collector Configuration, Limits of Operation.
- DC biasing –BJTs:
  Operating Point, Fixed-Bias Circuit, Emitter-Stabilized Bias Circuit, Voltage-Divider Bias.
- FIELD-EFFECT TRANSISTORS:
  Construction and Characteristics of JFETs, Transfer Characteristics.
- Depletion-Type MOSFET, Enhancement-Type MOSFET, CMOS
- FET BIASING:
  Fixed-Bias Configuration, Self-Bias Configuration, Voltage-Divider Biasing
- Depletion-Type MOSFETs, Enhancement-Type MOSFETs
- BJT TRANSISTOR MODELING:
  Amplification in the AC Domain, BJT Transistor Modeling
- The Important Parameters: The re Transistor Model
- BJT SMALL-SIGNAL ANALYSIS:
  Common-Emitter Fixed-Bias Configuration, Voltage-Divider Bias
- Hybrid parameters, ac gain and frequency analysis of single/multi stage amplifiers. Classes of amplifiers, power amplifiers, differential amplifiers, operational amplifiers and applications.

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:

- Robert Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory", Prentice Hall, Latest Edition.
- Thomas L. Floyd, "Electronic Devices", Latest Edition
- V.K. Mehta, "Principles of Electronics ", Latest Edition
- Malvino, "Electronic Principles", Latest Edition

Engineering Breadth Courses

Computer Communication and Networks

Course Outline:

- Introduction to Computer Networks
- OSI reference model, the TCP/IP reference model
- Packet switching and architectures
- Circuit switching and architectures
- Data link layer and issues
- Error correction and congestion control in networks
- Network layer and issues (Protocols and Services)
- IPv4 and IPv6, IP addressing and subnetting
- Network Routing
- Introduction to Multi-Protocol Label Switching (MPLS)
- Wireless networks
- Transport Layer and Issues (TCP and UDP)
- Software defined Networking (SDN)/ Virtual network functions (VNF)
- Multimedia networking and streaming services
- Introduction to multi- Protocol label switching

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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- Computer Networking A Top Down Approach latest Edition by Jim Kurose and Keith Ross, Pearson publishers.

Micro Processor and Interfacing

Course Outline:

- Introduction to Microprocessor and Microcontrollers
- Brief History of Intel's microprocessors history
- Understanding of different Number systems and conversions
- Working and analysis of Instruction cycle
- Intel 80x86 processors architecture
- Fundamentals of Assembly Language
- 8086/8088 hardware
- Memory Interfacing and Basic I/O Interface
- The PIC 18F Microcontroller
- The PIC microcontroller programming
- Timer and Counters Programming
- Interrupts Programming
- Serial Port Programming in C/Assembly
- Interfacing with 18F Microcontroller

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, Assignments, Project Report, Quizzes, Final Term, Lab assessment

Suggested Books:

- Barry B. Brey, "The Intel Microprocessors 8086/8088, 80186, 80286, 80386, 80486, Pentium and Pentium Pro Processor, Pentium-II, Pentium-III, Pentium-4, Architecture, Programming and Interfacing", latest Edition, Prentice-Hall.
- Ytha Y. Yu and Charles Marut, "Assembly Language Programming and Organization of the IBM PC", McGraw-Hill, latest edition.
- M. Ali Mazidi, Rollind D. Mckinlay and Danny Causey, "PIC Microontroller and Embedded Systems using Assembly and C for PIC18", latest edition, MicroDigital.

Operating Systems

Course Outline:

- Operating System objectives, evaluation, organization and their types.
- Process Control & description.
- Computing Threads.
- Processor scheduling.
- Concurrency – Principles, Mutual Exclusion (Hardware Support, Operating System Support), synchronization, Deadlock.
- Memory Management - linking, dynamic memory allocation, dynamic address translation, virtual memory, and demand paging. File systems - storage devices, disk management and scheduling.
- Directories, protection, reliable storages and crash recovery.
- Virtual Machines.
- Distributed Process communication.

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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- Operating Systems: Internals and Design Principles by William Stallings (Pearson Publishers), latest edition
- Modern Operating Systems by Andrew S. Tanenbaum and Herbert Bros (Pearson Publishers), latest edition
- Operating Systems by Gary Nutt (Pearson Publishers), latest edition.
- Operating System Concepts by Abraham Silberschatz, Peter B. Galvin, Greg Gagne (John Wiley & Sons Publishers), latest edition.

Software Engineering

Course Outline:

- Overview of Software Engineering
- Professional software development
- Software engineering practice
- Software process structure
- Software process models
- Agile software Development, Agile process models
- Agile development techniques
- Requirements engineering process
- Functional and non-functional requirements
- Context models, Interaction models, Structural models, behavioral models
- Model driven engineering
- Architectural design
- Design and implementation
- UML diagrams
- Design patterns
- Software testing and quality assurance, Software evolution
- Project management and project planning
- Configuration management, Software Process improvement.

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:

- Software Engineering: A Practitioner's Approach by Pressman, Roger S. and Bruce Maxim, latest Edition, McGraw Hill.
- Software Engineering by Sommerville, latest Edition, Pearson Education.

Digital System Design (DSD)

Course Outline:

- Introduction to the High-level digital design methodology using VERILOG, Design, Implementation, and Verification.
- Introduction of System Design Flow and Fixed-point Arithmetic with Analysis of FPGA-based design and logic.
- Application requiring HW implementation, Floating-Point to Fixed-Point Conversion.
- Analysis of Architectures for Basic Building Blocks, Adder, Compression Trees, and Multipliers.
- Transformation for high speed using pipelining, retiming, and parallel processing.
- Dedicated Fully Parallel Architecture, Time shared Architecture, Hardwired State Machine based.
- Analysis of Micro Program State Machine based Design and their implementations.
- Introduction of the Pipelining, Retiming, Look-ahead Transformation and Polyphase Decomposition.
- Analysis of Unfolding and Folding of Architectures techniques and mathematical transformation for folding.
- Introduction to the Designs based on Finite State Machines and Micro-programmed State Machines.

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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- Shoab A. Khan ,"Digital Design of Signal Processing Systems", John Wiley & Sons, latest edition
- Samir Palnitkar, "VERILOG HDL-A guide to digital design and synthesis", Prentice Hall, latest edition.
- Michael D. Ciletti, "Advanced Digital Design with VERILOG HDL", Prentice Hall, latest edition.

Digital Signal Processing (DSP)

Course Outline:

- An insight to the theory and application of DSP and solid foundation in the basics of DSP related to both signal analysis and system analysis,
- Analysis of design with some exposure to advanced topics in signal processing.
- Concepts of three core areas of DSP: Analysis, Design and Implementation.
- Introduction to Linear Time-invariant systems and properties of Linear Time-invariant systems.
- Analysis of Linear constant-coefficient difference equations.
- Frequency domain representation of discrete-Time signals and systems.
- Matlab simulation exercises to understand the theories and concepts of discrete-time forms of signals and systems.
- Overview of various types of DSP processors, Fourier transforms, z-Transform, Sampling, Filters, DFT and FFT.
- Frequency domain representation of sampling and reconstruction of a band limited signal from its samples.

- Basics of discrete-Time processing of continuous-Time signals and continuous-Time processing of discrete-Time signals.
- Introduction to the design of Discrete-time IIR filters from continuous-time filters and design of FIR filters by windowing.
- Introduction to the real and imaginary part of sufficiency of the Fourier transform for causal sequences.

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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- A.V. Oppenheim, "Discrete Time Signal Processing", Pearson, latest edition.
- James H. McClellan, Ronald W. Schafer, Mark A. Yoder, "Digital Signal Processing First", Pearson, latest edition.

Database Management Systems

Course Outline:

- Database Fundamentals: Definitions
- Database system and its components
- Benefits of Databases
- Data Independence
- Three-level architecture
- Database management Systems and their functions. Data model and Database Design - Entity-Relationship Model
- Relational Model
- Relational Algebra

- Relational design principles based on Functional Dependencies and normal forms. Relational Database Implementation – SQL, Implementing using DDL and DML
- Database Development Process
- Indexing and Hashing
- Database Administration – ACID properties of transactions
- Recovery and Concurrency Control
- Basics of Query Processing Advanced topics: Database Security, Reliability and Integrity; Distributed Databases
- Decision Support Systems, Data Warehousing and Data Mining.

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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- An Introduction to Database Systems by C. J. DATE (Latest Edition)
- Database Systems Concepts by Henry F. Korth and Abraham Silberschatz (Latest Edition)
- Database Systems by Thomas Conolly and Carolyn Begg (Latest Edition).

Engineering Depth Courses

Cloud and Distributed Computing

Course Outline:

- Introduction to Cloud Computing
- Adopting the Cloud
- Exploiting Software as a Service (SaaS)
- Exploring the technical foundation for PaaS
- Building services with solution stacks
- Managing cloud storage
- Employing support services
- Deploying Infrastructure as a Service (IaaS)
- Building a Business Case
- Migrating to the Cloud

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

Suggested Books:

- Cloud Computing: AUTHOR: Sandeep Bhowmik, Hooghly Engineering and Technology College, Hooghly, April 2017
- Distributed and Cloud Computing: From Parallel Processing to the Internet of Things 1st Edition by Kai Hwang, Jack Dongarra Geoffrey C. Fox
- Cloud Computing Theory and Practice by Dan C. Marinesco. MK Publishers 2017

Internet of Things

Course Outline:

- What is the IoT and why is it important
- Introduction to the Elements of an IoT ecosystem.
- Understanding of Technology and business drivers.
- Description of IoT applications, trends and implications.
- Analysis of Sensing components and devices, Sensor modules, nodes and systems.
- Wireless technologies for the IoT as well as Edge connectivity and protocols.
- Introduction to the Wireless sensor networks (WSNs) and Internet connectivity and MGC architecture, CortexM and BLE.
- Analysis of Typical costs and computing an energy budget, Energy management and sleep states.
- Introduction to the Microcontrollers: Peripherals, buses and DMA
- Brief explanation of Operating systems and introduction to the concepts of multiprogramming.
- Overview of IoT and Big Data overlap – stream processing and Data Aggregation.
- Network as a distributed query processor?
- Concepts of Time Synchronization, Localization ,IoT Security
- Energizing IoT devices: battery/harvesting/wirelessly
- Discussion about Future Research and Development Opportunities, Analytics and applications.
- Basic understanding of Signal processing, real-time and local analytics, Databases, cloud analytics and applications.

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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

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

Embedded Systems

Course Outline:

- Introduction to Embedded Systems, Embedded Products (i.e., Cell Phones, Robots, GPS, Cameras, Transaction Terminals, and Industrial Controllers)
- Analysis of The Design and Development Process for a new embedded product.
- Introduction to the Software Development and Debug Tool Flows.
- Hardware for Embedded Systems Design, Processors, Chipsets, and Memory, ARM and X86 ISA, I/O devices and bus interfaces, Example Design (i.e. basic parallel I/O port).
- Introduction to the Common Bus Standards (i.e., ISA, PCI, AMBA, PCI Express) and Common I/O interface Standards (i.e., Parallel, RS-232, SPI, I2C, and USB).
- Analysis of Analog I/O using A/D and D/A convertors, Driving high current and high voltage I/O devices (i.e., high-power LEDs, speakers, motors, and solenoids).
- Using PWM to efficiently control external I/O devices (i.e., dimmable lights, speakers, and motor speed control)
- Basic concepts of Programmed I/O, Interrupt driven I/O, Using DMA for I/O transfers, Example System Designs (i.e., small 32-bit ARM and X86-based systems)
- Introduction of Software for Embedded Systems Design, Role of an Embedded Operating System, Hard and Soft Real-time systems, Multitasking, Threads, and Synchronization.

- Operating Systems used in Embedded Devices (Windows Embedded, Linux, Android)
- Overview of an example RTOS, Building an OS for a new device, Application Development using OS APIs for I/O devices and GUIs, I/O device examples (i.e., A/D, RS-232, cameras, GPS, displays, wired and wireless networks, and touch input).
- BSPs and developing OS Device Drivers for new I/O devices, Developing Software for Safety Critical 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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- Naimi, Sepehr, Sarmad Naimi, and Muhammad Ali Mazidi. "The AVR Microcontroller and Embedded Systems Using Assembly and C: Using Arduino Uno and Atmel Studio", MicroDigital latest Edition.
- M. Wolf, “Computer as Components: Principles of Embedded Computing System Design”, latest Edition, Morgan Kaufman Publishers.
- J. Yiu, “The Definitive Guide to the ARM Cortex-M3”, latest Edition, Elsevier.
- Ganssle, Jack. “The firmware handbook”. Elsevier, latest edition.
- Alan Burns and Andy Wellings, “Real-time Systems and Programming Languages”, Addison-Wesley latest edition.

Hardware Design for DSP and ML

Course Outline:

- Introduction to Embedded System Design with Hybrid Processors, Fixed-point & Floating-point Arithmetic and Processors.
- Analysis of Architecture for DSPs, FPGAs and GPP.
- Introduction to ZYNQ SOC for H/W, SW Co-Design, ZYNQ design Flow and peripheral interfacing, AXI interfacing and Custom IP Creation.
- Understanding of Memory Hierarchy, DMA Controller and AXI interfacing with Custom Logic, Partial Dynamic Reconfiguration for Practical Applications.
- Analysis of MPSoC Design and Conversion of DSP/ML Algorithms with Case Studies.
- Folding/Unfolding of Algorithms for Hardware Mapping, Application Specific Processor Design with Case Studies.
- Implementing the Case Studies pertaining to CNN, Clustering, Adaptive Filtering and Big Data Analysis Algorithms.

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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- Louise H. Crockett, Ross A. Elliot, Martin A., "The Zynq Book Tutorials for Zybo and ZedBoard", Strathclyde Academic Media, latest edition.
- Shoab A. Khan, "Digital Design of Signal Processing Systems", John Wiley & Sons, latest edition.

High Performance Computing

Course Outline:

- Introduction to modern processors
- Optimization techniques for serial core
- Vector Processors – Vector and Matrix Algorithms
- Vector Processor Analysis
- Design and development of parallel algorithms
- Processor resource utilization
- Architectures: N-wide superscalar architectures
- Multi-core Architecture.
- Multi-threaded Architecture.
- Models (SIMD, MIMD, SIMT, SPMD, Dataflow Models, Demand-driven Computation etc.) GPGPUs Framework like CUDA and OpenCL.
- Thread Organization
- Fundamental Design Issues in Parallel Computing
- Parallel Programming – Shared Memory and Message Passing Programming
- The Message Passing Interface (MPI). Characterization of Distributed Systems
- Inter-process Communication
- Locality optimization on HPC architectures
- Topology and affinity in multi-core environment.

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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- High Performance Computing: Modern Systems and Practices, by Thomas Sterling, Matthew Anderson, latest edition.
- Introduction to High Performance Computing for Scientist and Engineers, by

Georg Hager and Gerhard Wellein, latest edition.

Systems Programming

Course Outline:

- Introduction to Systems Programming; Storage Device Hierarchy; Cache; Resource Management in Operating Systems.
- Systems Communication.
- Information Storage.
- Integer Representations.
- Integer Arithmetic.
- Floating Point.
- Program Encodings.
- Arithmetic and Logical Operations.
- Control Structures.
- Procedures.
- Array Allocation and Access.
- Heterogeneous Data Structures.
- Combining Control and Data in Machine-Level Programs.
- The Y86-64 Instruction Set Architecture.
- Logic Design and the Hardware Control Language HCL.
- Sequential Y86-64 Implementations.
- General Principles of Pipelining.
- Pipelined Y86-64 Implementations.
- Understanding Modern Processors.
- Loop Unrolling.
- Eliminating Loop Inefficiencies.
- Reducing Procedure Calls.
- Enhancing Parallelism.
- Storage Technologies.
- Locality.
- Memory Hierarchy.
- Cache Memories.
- Compiler Drivers.
- Static Linking.

- Object Files.
- Executable Object Files.
- Exceptions.
- Processes.
- Process Control.
- System Call Error Handling.
- Nonlocal Jumps.
- Physical and Virtual Addressing.
- VM as a Tool for Caching.
- VM as a Tool for Memory Management.
- The Intel Core i7/Linux Memory System.
- Memory Mapping.
- Dynamic Memory Allocation.
- Garbage Collection.
- Unix I/O.
- Files Opening and Closing.
- Reading and Writing Files.
- I/O Redirection.
- Standard I/O.
- The Client- Server Programming Model.
- The Global IP Internet.
- The Sockets Interface.
- Web Servers.
- Concurrent Programming with Processes.
- Concurrent Programming with I/O Multiplexing.
- Concurrent Programming with Threads.
- Shared Variables in Threaded Programs.
- Synchronizing Threads with Semaphores.
- Using Threads for Parallelism.
- Other Concurrency Issues.

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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- Computer Systems: A Programmer's Perspective (latest Edition) by Randal E. Bryant, David R. O'Hallaron, Published by Pearson.
- Computer Organization and Architecture (latest Edition) by William Stallings Published by Pearson.

Image Processing and Analysis

Course Outline:

- Concept of digital image, Types of images
- Visual Perception, Light & Electromagnetic Perception, Image sensing &acquisition, Spatial and luminance resolution parameters
- Image Sampling and quantization
- Pixel relationships, Imaging defects, Mathematical operations for image processing
- Geometric and gray-level Transformations
- Histogram Processing
- Spatial Filtering, Convolution & Correlation, Smoothing & Sharpening Filters
- Fourier Transform, DFT, Frequency domain enhancement
- Image Restoration
- Morphological operations
- Color image processing
- Edge detection, Image segmentation
- Feature representation
- Real-time Applications in image processing.

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:

- Digital Image Processing by Rafael C. Gonzalez, Richard E. Woods, Addison Wesley, latest Edition.

Data Science: Tools and Techniques

Course Outline:

- Introduction to Data Science
- Data Science Life cycle & Process (Asking Right Questions, Obtaining Data, Understanding Data
- Building Predictive Models, Generating Visualizations) For Building Data Products
- Introduction to Data (Types of Data and Datasets), Data Quality (Measurement and Data Collection Issues)
- Data pre-processing Stages (Aggregation, Sampling, Dimensionality Reduction, Feature subset selection, Feature creation etc.)
- Algebraic & Probabilistic View of Data
- Introduction to Python Data Science Stack (Python, Numpy, Pandas, Matplotlib)
- Relational Algebra & SQL, Scraping & Data Wrangling (assessing, structuring, cleaning & munging of data)
- Basic Descriptive & Exploratory Data Analysis
- Introduction to Text Analysis (Stemming, Lemmatization, Bag of Words, TF-IDF)
- Introduction to Prediction and Inference (Supervised & Unsupervised) Algorithms
- Introduction to Scikit Learn, Bias-Variance Tradeoff, Model Evaluation & Performance Metrics (Accuracy, Contingency Matrix, Precision-Recall, F-1 Score, Lift, etc.)
- Introduction to Map-Reduce paradigm

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:

- Python for Data Analysis, latest Edition, William McKinney
- An Introduction to Statistical Learning with Applications in R, latest Edition, G. James, D. Witten, T. Hastie and R. Tibshirani
- Computational and Inferential Thinking: The Foundations of Data Science, latest Edition, A. Adhikari and J. DeNero
- Data Mining and Analysis: Fundamental Concepts and Algorithms, latest Edition, M. Zaki & W. Meira,
- Data Science from Scratch, latest Edition, Joel Grus
- Doing Data Science, latest Edition, Cathy O'Neil and Rachel Schutt
- Introduction to Data Science. A Python Approach to Concepts, Techniques and Applications, latest Edition, Laura Igual.

Artificial Intelligence and Machine Learning

Course Outline:

Introduction to AI Systems

Solving problems and AI Application

- Solving problems by searching
- Converting the problem statement into actions transitions and goal statements.

Informed search methods

- BFS, DFS , Uniform cost Search, Iterative deepening

Uninformed Search

- Heuristics and greedy search A*.

Local Search

- Hill climbing , Simulated Annealing , GA

Game Playing

- Adversarial Search and Games
- Min Max Algorithm

Neural Networks

- Introduction to Machine learning, Perceptron , NN

Utility Based Agents

- Constraint Satisfaction Problems
- CSP Backtracking
- Reinforcement Learning,
- Markov Decision Processes

Knowledge Based Agents

- Inference in Predicate and FOL
- Building a Knowledge base

Forward and backward chaining

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 term.

Suggested Books:

- S. Russell and P. Norvig. Artificial Intelligence: A Modern Approach. Prentice Hall, latest edition

- R. Brachman, H. Levesque. Knowledge Representation and Reasoning, Morgan Kaufmann, latest edition.
- G. Luger. Artificial Intelligence: Structures and Strategies for Complex Problem Solving.
- Addison Wesley; latest edition, E. Alpaydin. Introduction to Machine

Multi-Disciplinary Engineering Courses

Blockchain Technologies and Applications

Course Outline:

- Introduction to Blockchain technology.
- Blockchain data structure.
- Public Key Infrastructure and blockchains.
- Distributed Ledgers.
- Consensus Mechanism
- Transactions and transactions life cycle
- Sending, Receiving and checking transactions
- Blockchain types (public, private, semiprivate and propriety)
- Methods of decentralization
- Hyper ledgers
- Blockchain as a service
- Scalability in Blockchain
- Privacy in Blockchain
- Cryptoassests (cryptocurrencies) management and mining methods.

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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- Blockchain Science: Distributed Ledger Technology by Roger Wattenhofer, Publisher: Independently published latest edition.
- Distributed Ledger Technology: The Science of the Blockchain latest Edition by Roger Wattenhofer. Publisher: CreateSpace Independent Publishing Platform; latest edition.
- Mastering Blockchain: Distributed Ledger Technology, Decentralization, and Smart Contracts Explained, 2nd edition– March 30, 2018 by Imran Bashir.

Robotics and Automation

Course Outline:

- Introduction of the Types of robots and Types of joints used in robots.
- Logical analysis of Spatial description, Manipulator Kinematics, Jacobians, And Inverse kinematics.
- Understanding of Dynamics of Robots, Path Planning and Trajectory Analysis.
- Analysis of Production Systems, Automation Principles and Strategies, Numerical Control (NC), CNC Machines and its Programming.
- Basics of Manufacturing operations, Product/Production relationship Production rate and production capacity.
- Introduction to Programmable Logic Controllers (PLCs), Ladder Logic and Programming Formats, Relay Logic, Timers and Counters.
- Storage System and Automated storage and retrieval system.
- Overview of Material Transport System and Manual Assembly Lines Analysis.
- Group Technology and cellular Manufacturing system
- Flexible Manufacturing System

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, Assignments, Project Report, Quizzes, Final Term.

Suggested Books:

- JJ Craig, "Introduction to Robotics: Mechanics and Control", 4th edition, Pearson, latest edition.
- R. M. Murray, Z. Li, S. S. Sastry, "A Mathematical Introduction to Robotic Manipulation", Taylor & Francis, latest edtion.
- Mikel P. Groover, "Automation, Production Systems, and Computer Integrated Manufacturing", Pearson, latest edition
- E A Parr, "Programmable Controllers", Newnes, latest edition.

VLSI System Design

Course Outline:

- Introduction to VLSI, VLSI Challenges, Major Approaches in VLSI, ASIC, FPGA, PLD, PLA, PAL etc., Levels of Abstraction System on Chip Design, Low Power Designs
- IC Fabrication Process, IC Manufacturing Sequence, Overview of Silicon Process, Photolithography Process, Die Assembly & Testing
- CMOS Layout Design, Layout Design Methodology, Design Rules, Stick Diagram, Layout Example
- MOS Transistor Theory, Semiconductor IC Chip, PN-Junction Modes of Transistor DC characteristics of CMOS Inverter, Propagation Delay, Noise Margin, Timing/Sizing, Power Consumption of Transistor Propagation Delay Models
- Static & Dynamic Logic Circuits, Introduction to Combinational & Sequential Circuits, De Morgan's Law & Boolean Algebra Rules, Static & Dynamic Logic Circuits, Memory Logic Circuits
- Structural & Behavioral Modelling of RTL Combinational & Sequential Logic Circuits with VHDL/Verilog language
- System Level Design, Characteristics & Requirements of system level design, System-level Models

- Future Roadmap & IC Technologies, Technology Generation Moore & ITRS Roadmap, Emerging Devices, Wafer, Types of ICs, Nanoelectronics, Nanotube, Nanowire, Nanotechnology

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, Assignments, Project Report, Quizzes, Final Term.

Suggested Books:

- Jan M. Rabaey, Anantha Chandrakasan, Borivoje Nikolic, "Digital Integrated Circuits" latest Edition, Prentice Hall.
- Neil Weste & David Harris, "CMOS VLSI Design: A Circuits & Systems Perspective" latest Edition., Pearson

Electrical and Electronic Instrumentation

Course Outline:

- Basic principal of measurement
- Precision measurements terminologies principles of different measurement techniques
- Types of measurement devices, construction and working of different analog and digital meters
- Measurement of physical quantities
- Measurement methods
- Error theory, structure of measurement, transducers, signal conditioning, sensors and condensers, types of signal conditioning, Measurement displays, LCD, CRT, etc.)
- Recording frequency meters phase meters digital voltmeter, oscilloscope.

- Sensitivity, accuracy, and uncertainty; instruments for measurement of electrical properties, pressure, temperature, position, velocity, flow rates (mass and volume) and concentration, modern instrumentation techniques
- Static and dynamic responses of instrumentation principles of operation, signal generators, power and energy meters
- High-voltage measurements.

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:

- Klaas B. Klaassen and Steve Gee, "Electronic Measurement and Instrumentation," latest edition, Cambridge University Press.
- H Kevin, James H, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control," latest edition, Newnes.

Mobile Application/Game Development

Course Outline:

- Introduction to Mobile Computing
- Mobiles Application Development Platform
- Development Environment, Factors in Developing Mobile Applications
- HTML5 for Mobiles
- Android OS: Architecture
- Framework and Application Development; iOS: Architecture Framework
- User-interface, Text-to-Speech Techniques, Intents and Services
- Storing and Retrieving Data, Communications Via Network and the Web
- Telephony, Notifications and Alarms, Graphics, Multimedia, Location, Hardware Sensors, Developers and App store license agreements, Security and

Hacking, Platforms Issues. Challenges with Mobility and Wireless Communication; Location-aware Applications

- Performance/Power Trade-offs; Mobile Platform Constraints; Emerging Technologies
- Game Development: Introduction to Game Development,
- Introduction to Gaming Market and Revenue,
- Introduction to Game Development Life Cycle, Unity3D as Best tool for Game Development
- Introduction to 3D Graphics and 2D Graphics, C# Basics
- Introduction Game Programming (Scripting)
- Introduction to 3D and 2D animations
- Introduction to Game Cinematics
- Introduction to Augmented Reality (AR) and Virtual Reality (VR)
- Making Product ready for Release (alpha and beta testing)
- Post Processing and Marketing of the Final Product

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:

- IOS Programming: The Big Nerd Ranch Guide, latest Edition, Joe Conway, Aaron Hillegass and Christian Keur, Big Nerd Ranch Guides.
- Android Programming: The Big Nerd Ranch Guides, latest Edition, Bill Phillips and Brian Hardy, Big Nerd Ranch Guides.
- Professional Android 4 Application Development, latest Edition, Reto Meier, Wrox professional press.
- Introduction to Game Design, Prototyping, and Development, by Jeremy Gibson
- Unity Scripting reference, https://docs.unity3d.com/ScriptReference/

Human Computer Interaction

Course Objectives:

- Define the theory of basic concepts of human computer interaction that concern human cognition, interfaces and interaction
- Explain basic task analysis and the rules, models of human centered design in interactive software applications.
- Design good user interfaces which are applicable to different user types by applying user centered design techniques.
- Analyze the general features of the software or website's content & design based on User Experience (UX) strategies.
- Evaluate graphical user interface of software using questionnaire to determine the usability problems.

Course Outline:

- Study of theoretical concepts of human-computer interaction (HCI), Psychology of usable things,
- Processes for User-Centered Design, Metrics and Measures for Evaluation,
- Usability heuristics and principles of Usability testing, Physical capabilities, Cognitive and social models for interaction design,
- Principles of good interaction design and Accessibility,
- Design Principles of GUI, Visual design elements,
- Data gathering,
- Task analysis,
- Prototyping, Help and user documentation,
- Internationalization,
- Usability inspection methods, Usability testing methods, Usability in practice
- New Interaction Technologies,
- Visual Design and Typography, Icon Design,
- Ubiquitous,
- Augmented and Virtual Reality.

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:

- Designing the User Interface: Strategies for Effective Human-Computer Interaction, Ben Shneiderman and Catherine Plaisant, 6th Ed, Pearson Inc, 2016.
- Don't Make Me Think, Revisited, 3rd Edition by Steve Krug, 2014.
- About Face: The Essentials of Interaction Design, Alan Cooper, Robert Reimann, David Cronin, Christopher Noessel, 4th Ed, Wiley, 2014.
- Human Computer Interaction, ALAN DIX, JANET FINLAY, GREGORY D. ABOWD, RUSSELL BEALE; 3rd Edition, Pearson. Prentice Hall

Data Warehousing and Mining

Course Outline:

Data Warehouse: Basic concepts, operational DBMS v/s data Warehouse. Data Warehouse characteristics, Architecture and component. Data Modeling, Schema Design, star and snow-Flake Schema. OLAP and OLTP. ROLAP, MOLAP and HOLAP.

Data Mining: Introduction, KDD process. Data extraction and preprocessing.

Classification and Prediction: Basic concepts and Classification algorithms; Decision trees, Naïve-Bayes Classifier, K-nearest neighbor.

Clustering Analysis: Clustering overview, clustering algorithms; K-Means, Hierarchical Clustering.

Association Rules: Basic concepts and methods.

Data Mining Trends and Research Frontiers: cloud data warehousing, web, Spatial and temporal data mining.

Data Mining Tools & Applications: RapidMiner / Weka

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:

- Data Mining: Concepts and Techniques, J. Han, J. Pei, M. Kamber, Publishers, Elsevier, 3 Edition, 2011.
- Introduction to Data Mining, Pang-Ning Tan, Vipin Kumar, Michael Steinbanch, Pearson Education.
- Data Mining, V. Pudi, P. R. Krishna, Oxford University.

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 the body injured on the job
- 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.

12.2Non-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. Muralikrishn

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.

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 Methodology (Proposed as applicable):

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. Vol. 03; Special Issue. March, 2018.
- Nichols, S.P. and Weldon, W.F. 2017. Professional Responsibility: The Role of Engineering in Society Center for Electro-mechanics, The University of Texas at Austin, USA.
- Aslaksen, E.W. 2016. The Relationship between Engineers and Society: is it currently fulfilling its potential? Journal and Proceedings of the Royal Society of New SouthWales, Vol.148. Nos.455-456. 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
- Jamison, A., Christensen, S.H., and Lars, B. 2011. A Hybrid Imagination: Science and Technology in Cultural Perspective.
- Vermaas, P., Kroes, P., Poet, l., and Houkes, W. 2011. A Philosophy of Technology: From Technical Artefacts to Socio technical systems.
- Mitcham, C., and Munoz, D. 2010. Humanitarian Engineering. Morganand Claypool Publishers. Riley, D. 2008. Engineering and Social Justice. Morgan and Claypool Publishers.
- Bugliarello, G. 1991. 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, 11th edition.
- D. Kendall, Sociology in our Times. Wadsworth Pub Co.

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, 2006
- Emory Stephen Bogardus, “Essentials of Social Psychology”, Univ. of Southern, California Press, 2006
- Hewstone, M., & Stroebe, W. (Eds.), “Introduction to Social Psychology”, 3rd ed., Oxford: Blackwell Publishers, 2006
- Lesko, W.A. “Readings in social psychology General, classic, and contemporary selections, 6th ed., 2006.

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, 2000.
- Studying Service-Learning: Innovations in Education Research Methodology by Shelley H. Billig, Alan S. Waterman , Lawrence Erlbaum Associates, 2003

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

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. (2003), Principles of Organizational Behaviour, 3rd Oxford.
- Noe, R., Hollenbeck, J. Gerhart, B., & Wright, P. (2006), 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.

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
- 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, 6th edition, Pearson 2015, ISBN: 9780134105598
- Engineering Economic Analysis by Donal G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, 12th edition, Oxford University Press, ISBN: 978-0199339273
- Engineering Economy by Leland T. Blank and Anthony Tarquin

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.

Outlines:

- 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
  - 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
  - Selected Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)
- Profession and Professionalism in Islam
- Characteristics of a Professional
  - Truthfulness, Honesty, Sincerity, Patience, Gratitude, Meditation and Research
- Role for Human Safety and Environment
- Time Management
- Prophet Muhammad (PBUH) – Role Model
  - Selected Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
  - 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
  - Selected Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
  - 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, 7th ed., 2017).
- Sayyid Hasan-uddin Ahmad**, تعلیمات قرآنی** 2-vols., (Karachi: Jasarat Publications, 1998).
- Muhammad Shafi', **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, 3rd 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 Outlines

- 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 Contents:

- 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 Outlines

- 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.

Available at:
http://www.pec.org.pk