Curriculum for

Software Engineering

Bachelor of Engineering Program

2020

Pakistan Engineering Council
&
Higher Education Commission
Islamabad

CURRICULUM

OF

SOFTWARE ENGINEERING

Bachelor of Engineering Program

2020

Pakistan Engineering Council
&
Higher Education Commission
Islamabad

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

1. Engineering Curriculum Review & Development Committee (ECRDC)

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

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

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

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

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

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

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

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

| 8. | Engr Muhammad Raza Chohan | Member |
| | Director General, HEC | |

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

| 10. | Engr Dr Ashfaq Ahmed Sheikh, | Secretary |
| | Additional Registrar, CPD | |

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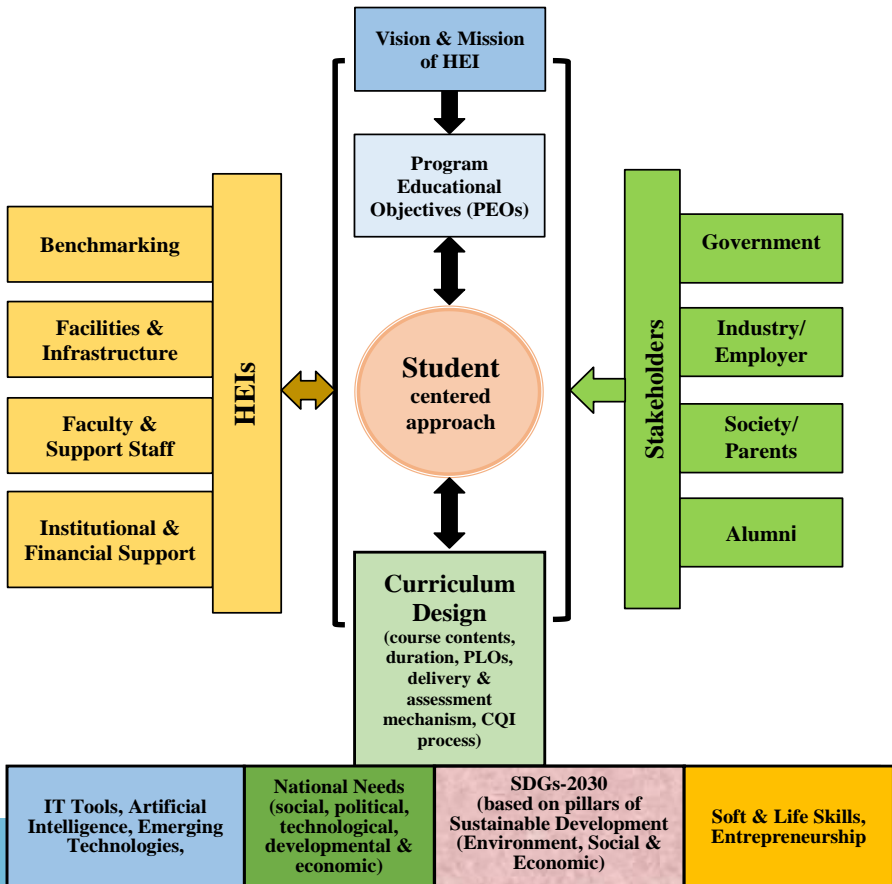
- The ECRDC is responsible to oversee the overall working of curriculum review and development for all engineering programs in terms of strategy, guidance and progress and thereby submission to the relevant forum for adoption/ notification.
- Each Member of ECRDC will also work in the capacity of Convener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

3. OBE-Based Curriculum Development Framework

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

Outcome-Based Education (OBE) - Curriculum Development Framework

Benchmarking		**Vision & Mission of HEI**	**Government**
Facilities & Infrastructure	**HEIs**	**Program Educational Objectives (PEOs)**	**Industry/ Employer**
Faculty & Support Staff		**Student centered approach**	**Stakeholders**	**Society/ Parents**
Institutional & Financial Support		**Curriculum Design** (course contents, duration, PLOs, delivery & assessment mechanism, CQI process)	**Alumni**

IT Tools, Artificial Intelligence, Emerging Technologies,	**National Needs (social, political, technological, developmental & economic)**	**SDGs-2030 (based on pillars of Sustainable Development (Environment, Social & Economic)**	**Soft & Life Skills, Entrepreneurship**

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.
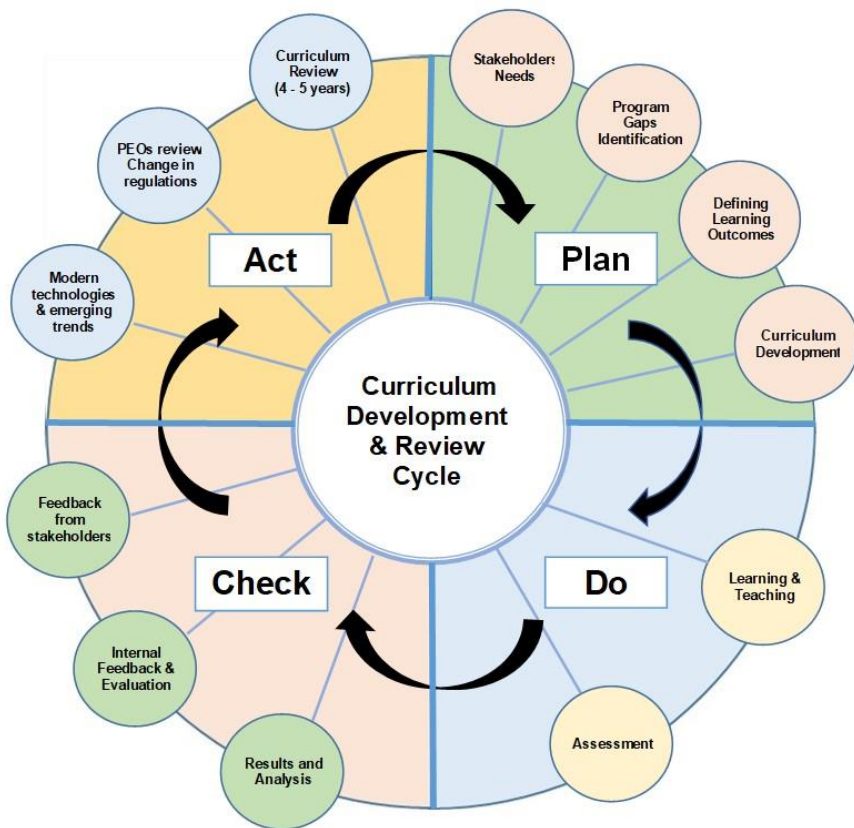
Plan. This stage begins with an analysis of the stakeholders' needs of faculty, current and past students, employers and society in general. The stakeholders' needs are translated into human resource terminology i.e. graduate competencies which in turn translated into educational taxonomy and learning 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 and Allied Engineering

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Electrical and Allied Engineering Disciplines took up the task to review and update the curriculum for Bachelor of Software Engineering degree program. The subject Committee had two meetings on 18-9-2019, 12-12-2019 and 20-01-2020 at PEC HQ, Islamabad besides meetings of Sub-Group for Software Engineering. The Committee consisted of the 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	Engineer Professor Dr Madad Ali Shah Vice Chancellor The Benazir Bhutto Shaheed University of Technology and Skill Development Khairpur Mirs, Sindh	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
Department of Computer Engineering
UET, Lahore | Member |

| 16 | Engr Prof Dr Vali Uddin
Professor
Department of Electronics
Hamdard University, Madinat al-Hikmah
Hakim Mohammad Said Road, 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 | 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 NUST School of Electrical Engineering and Computer Engineering (SEECS), Islamabad	Member
24	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 Software Engineering

1.	Engr. Dr. Hammad Afzal Professor Department of Computer and Software Engineering Military College of Signals Rawalpindi	Lead Sub-Group
2.	Engr. Dr. Ahmer Rashid Professor Department of Computer Engineering GIKI, Topi Swabi	Member

| 3.	Engr. Dr. Akram Sheikh DG-Pakistan Scientific and Technology Information Center, Quaid-e-Azam University Campus Islamabad	Member
4.	Dr Iftikhar Azim Niaz Professor Department of computer Sciences Comsats Islamabad Campus	Member
5.	Engr. Dr. Tabassum Nawaz Professor Department of Software Engineering UET, Taxila	Member
6.	Dr Adnan Habib Professor Department of Computer Engineering UET, Taxila	Member
7.	Engr. Dr. Awais Majeed Professor Department of Software Engineering Bahria University, Islamabad	Member
8.	Engr. Yasir Rizwan Saqib Chief Executive Officer Foot Tech, Lahore	Member
9.	Mr Hidayatullah Kasi Deputy Director Higher Education Commission, Islamabad	Rep HEC
10.	Engr. Dr. Ashfaq Ahmed Shaikh Additional Registrar-CPD Pakistan Engineering Council, Islamabad	Secretary
11.	Engr. Muhammad Kashif Ali Assistant Registrar-CPD Pakistan Engineering Council, Islamabad	AR-CPD

6. Agenda of ECRDC for Electrical and Allied Engineering

- The Subject ECRDC will work under the overall directions and supervision of main ECRDC, comprising of 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.
- Review of policies and stakeholders' feedback relating sector relevant to the respective discipline
- Comparative study of curricula being offered at various engineering universities/institutions following 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 a useful input and suggestions covering new developments to be incorporated in the curriculum. He also highlighted the importance of the field of Software Engineering for achieving sustainable developments while addressing socio-economic issues and challenges envisaged in Sustainable Development Goals-2030 as under and well-mapped within 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

OBE Curriculum towards SDGs-2030 Attainment
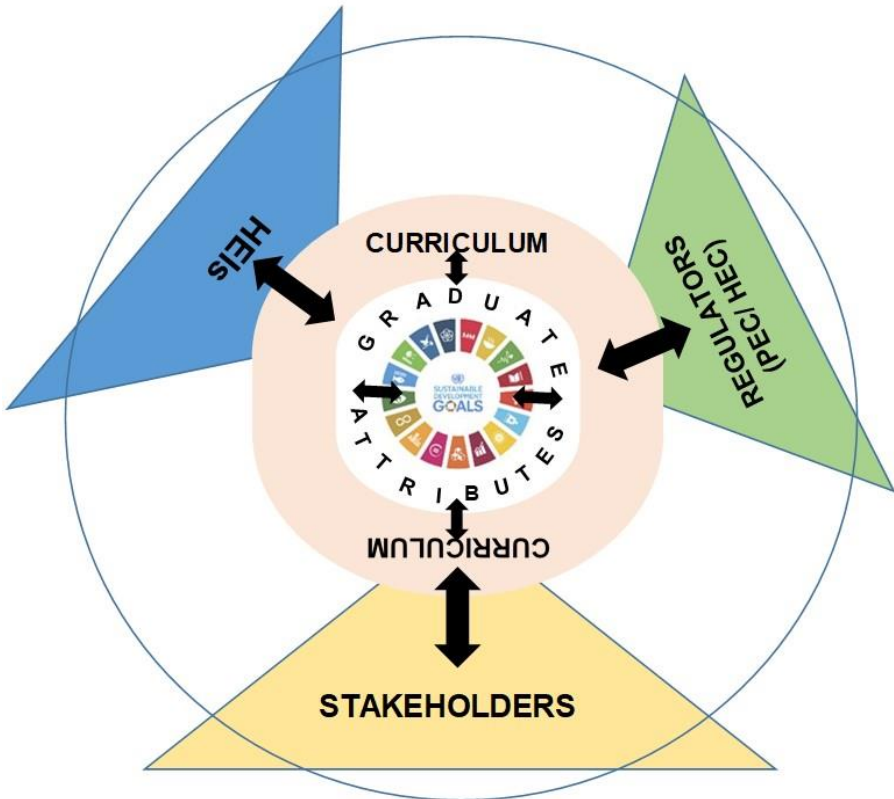
The curriculum therefore has been designed based on above SDGs translating into program objectives and mapped with the scheme of study.

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

As guidance, the sample Program Educational Objectives (PEOs) and Learning Outcomes (PLOs) are given below for a typical Software 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 Software 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 and Goal-9.

The Software Engineers are expected to exhibit after graduation;

1. Demonstrate sound engineering knowledge and skills.
2. Execute and manage teamwork, interpersonal skills and professional growth.
3. Conduct professional practice considering societal, ethical, and environmental aspects.

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
  - o Engineering Domain: minimum 85 Credit Hours
  - o Non-Engineering Domain: minimum 30 Credit Hours

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

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

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

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

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

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

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

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

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

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

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 and Information Science	ICT/AI/ Data Science/ Cyber Security		6 – 9
WK-3/ WK-2	Foundation Engg Courses		Specific to program objectives and outcomes	22 – 24
WK-4/ WK-2/ WK-1	Core Breadth of Engg discipline		Specific to program objectives and outcomes	23 – 24
WK-5/ WK-6	Core Depth of Engg Discipline		Specific to program objectives and outcomes	22 – 24

WK-3/ WK-4/ WK-2/ WK-1	Multidisciplinary Engg Courses		Specific to program objectives and outcomes	6 – 12
			Occupational Health and Safety (mandatory – 01 Cr Hr)	
WK-6/ WK-8/ WK-7	Final Year Design Project (FYDP/ Capstone)	Integration of innovative, creative, technical, management and presentation skills of a graduate towards final year.		6
WK-6/ WK-7	Industrial Training	at least 6 - 8 weeks internship		Qualifying
WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-2	Innovative and Critical Thinking (under relevant courses): - 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;

    o Selection of internship in line with elective subjects/ specific streams

    o Qualifying weightage: 70%

        ▪ At least 75% attendance is mandatory   10%

        ▪ Assessment report from the employer   50%

        ▪ Evaluation at relevant HEIs/ Deptt – presentation   40%

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

- 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 Software 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 Software 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	Language	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	Professional Ethics	Sociology Elective-I	2	0	2
			Sociology Elective-II (Engineering Economics)	2	0	2
	Management Sciences	Professional Practice	Management Science Elective-I (Project Management/ Engg Management)	3	0	3
			Management Science Elective-II (Entrepreneurship and Marketing)	2	0	2
WK-2/ WK-1	Natural Sciences	Math	Calculus and Analytical Geometry	3	0	3
			Linear Algebra	3	0	3
			Probability and Statistics	3	0	3
			Complex Variables and Transforms	3	0	3
			Numerical Analysis	2	1	3
		Physics	Applied Physics	3	1	4
Total (Non-Engineering Domain)				37	2	39

Engineering Domain						
WK-2/ WK-4/ WK-5/ WK-6	Computing and Information Sciences	ICT/AI/Data Science/ Cyber Security	Information and Communication Technologies (ICT)	2	1	3
			Computer Programming	2	1	3
WK-3/ WK-2	Engineering Foundation		Discrete structures	3	0	3
			Object Oriented Programming	3	1	4
			Data Structures & Algorithms	3	1	4
			Operating Systems	3	1	4
			Database System	3	1	4
			Formal Methods in Software Engineering	3	0	3
			Computer Networks	3	1	4
			Computer Architecture and Logic Design	3	1	4
WK-4/ WK-2/ WK-1	Core Breadth of Engg discipline)		Software Engineering Fundamental	3	0	3
			Software Design and Architecture	2	1	3
			Software Construction and Development	2	1	3
			Software Quality Engg	3	0	3
			Software Project Management	3	0	3
			Human Computer Interaction	2	1	3
			Cloud Computing	2	1	3
			Information Security	3	0	3
			Design and Analysis of Algorithms	3	0	3

WK-5/ WK-6	Core Depth of Engg discipline		Engineering Elective-I	3	0	3
			Engineering Elective-II	3	0	3
			Engineering Elective-III	2	1	3
			Engineering Elective-IV	2	1	3
			Engineering Elective-V	2	1	3
			Engineering Elective-VI	2	1	3
WK-3/ WK-4/ WK-2/ WK-1	Multi-Disciplinary Engineering Courses		MDEE-1	3	0	3
			MDEE-2	3	0	3
			Occupational Health and Safety*	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	at least 6 – 8 weeks Internship		0	0	0
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	**Innovative and Critical Thinking (under relevant courses)** - Complex Problem Solving - Complex Engineering Activities - Open Ended Labs - Semester Projects - Case Studies - Problem Based Learning (PBL)					
Total (Engineering domain)				**72**	**22**	**94**
Total (Credit Hours)				**109**	**24**	**133**

* to be taught during 1st year of program.

10. Scheme of Studies for Bachelor of Software Engineering

S.#	Course Title	Theory	Lab	Total	S.#	Course Title	Theory	Lab	Total
		Credit Hours					Credit Hours		
First Year									
Semester 1					**Semester 2**				
1	Programming Fundamentals	2	1	3	1	Discrete Structures	3	0	3
2	Functional English	2	0	2	2	Computer Architecture and Logic Design	3	1	4
3	Calculus and Analytical Geometry	3	0	3	3	Linear Algebra	3	0	3
4	Information and Communication Technologies (ICT)	2	1	3	4	Object oriented Programming	3	1	4
5	Applied Physics	3	1	4	5	Communication Skills	2	0	2
6	Pakistan Studies and Global Perspective	2	0	2	6	Islamic Studies and Ethics	2	0	2
7	Occupational Health and Safety	1	0	1					
	Total	**15**	**3**	**18**		**Total**	**16**	**2**	**18**
Second Year									
Semester 3					**Semester 4**				
1	Data structure and algorithm	3	1	4	1	Complex Variables and Transforms	3	0	3
2	Database Systems	3	1	4	2	Numerical Analysis	2	1	3
3	Software Engg Fundamentals	3	0	3	3	Computer Networks	3	1	4
4	Probability and Statistics	3	0	3	4	Software Design and Architecture	2	1	3
5	Operating Systems	3	1	4	5	Design and Analysis of Algorithms	3	0	3
					6	Sociology Elective-I	2	0	2
	Total	**15**	**3**	**18**		**Total**	**15**	**3**	**18**

Third Year								
Semester-5				Semester-6				
1	Engineering Elective-I	3	0	3	1	Engineering Elective-II	3	0	3
2	Cloud Computing	2	1	3	2	Management Science Elective-II (Entrepreneurship & marketing)	2	0	2
3	MDEE-I (Embedded Systems)	2	1	3	3	Former Methods in Software Engg	3	0	3
4	Soft Construction and Development	2	1	3	4	Software Project Management	3	0	3
5	Technical Writing and Presentation Skills	3	0	3	5	Human Computer Interaction	2	1	3
6	Management Science Elective-1 (Engg Management/ Project Management)	3	0	3	6	Software Quality Engg	3	0	3
Total		**15**	**3**	**18**	**Total**		**16**	**1**	**17**
Fourth Year								
Semester 7				Semester 8				
1	Engineering Elective-III	3	0	3	1	Engineering Elective-V	3	0	3
2	Engineering Elective-IV	3	0	3	2	Engineering Elective-VI	3	0	3
3	Information Security	3	0	3	3	MDEE-II (Internet of Things)	3	0	3
4	Social Science-II (Engg Economics)	2	0	2	4	FYDP (Part-II)	0	3	3
5	FYDP (Part-I)	0	3	3			0	0	0
Total		**11**	**3**	**14**	**Total**		**9**	**3**	**12**
Total Credit Hours						**133**		

These are proposed engineering and non-engineering elective courses and the HEIs may further add or choose courses as per their program objectives and needs.

List of Engineering Electives Courses for BE Software Engineering

- Agent Based Software Engineering
- Big Data Analytics
- Cloud Computing
- Deep Learning
- Mobile Application Development
- High Performance Computing
- Machine Learning
- Artificial Intelligence
- Natural Language Processing
- Semantic Web
- Social Network Analysis
- Computer Vision
- Software Metrics
- Systems Programming
- Visual Programming
- Real Time Systems
- Data Visualization
- Mobile Application Development
- Computer Graphics
- Data Encryption and Security
- E-Commerce
- Topics in Software Engineering

List of Multi-Disciplinary Elective Courses

- Embedded Systems
- Internet of Things

11. Program Specific Labs

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

- Programming Fundamentals
- Introduction to ICT
- Computer Architecture and Logic Design
- Object Oriented Programming
- Data Structures and Algorithms
- Database Systems
- Computer Networks
- Operating Systems
- Distributed and Cloud Computing
- Software Construction and Development

12. Course Detail 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 and Communication Technologies (ICT)

Course Outline:

Introducing Computer Systems: Basic Definitions

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

Basic Operations and Components of a Generic Computer System

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

Processing Data

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

The Internet

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

Introduction to Embedded Systems

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

Networking Basics

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

Database Management

- Hierarchy of Data
- Maintaining Data
- Database Management Systems

Exposure to ICT Tools and Blogs (Student Assignment)

Protecting your Privacy, your Computer and your Data

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

ICT in Education

Future Trends in ICT

Final Presentations

Tools / Software Requirement

Microsoft Office, Windows, Virtual Box, Netbeans

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Computer Programming

Course Outline:

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

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Computer Aided Design

Course Outline:

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

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Mastering AutoCAD latest edition and AutoCAD LT latest edition by George Omura with Brian Benton, (latest edition).

- AutoCAD® latest edition And AutoCAD Lt® latest edition No Experience required by Donnie Gladfelter.

Introduction to Modelling 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

Introduction to Data Science

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 preprocessing 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,
- 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, 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.

<div align="center">

Artificial Intelligence

</div>

Course Outline:

- Introduction to AI Systems
- Solving problems and AI Application
    a. Solving problems by searching
    b. Converting the problem statement into actions transitions and goal statements.
- Informed search methods
    a. BFS, DFS, Uniform cost Search, Iterative deepening
- Uninformed Search
    a. Heuristics and greedy search A*.
- Local Search
    a. Hill climbing, Simulated Annealing, GA
- Game Playing
    a. Adversarial Search and Games
    b. Min Max Algorithm
- Neural Networks
    a. Introduction to Machine learning, Perceptron, NN
- Utility Based Agents
    a. Constraint Satisfaction Problems
    b. CSP Backtracking
    c. Reinforcement Learning,
    d. Markov Decision Processes
- Knowledge Based Agents
    a. Inference in Predicate and FOL
    b. 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

Programming Fundamentals

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

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:

- Starting out with Python, latest Edition, Tony Gaddis.
- Starting out with Programming Logic & Designs, latest Edition, Tony Gaddis,
- The C Programming Language, latest Edition by Brian W. Kernighan, Dennis M.Ritchie
- Object Oriented Programming in C++ by Robert Lafore, latest edition.
- 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
- C How to Program, latest Edition by Paul Deitel & Harvey Deitel
- Problem Solving and Program Design in C++, latest Edition by Jeri R. Hanly & Elliot B Koffman

Engineering Foundation Courses

Discrete Structures

Course Outline:

- Introduction to Discrete Structures: Discrete v. Continuous in Mathematics.
- Propositional Calculus, Biconditionals, Equivalence, Applications to Natural Language and System Specification.
- Predicates and Quantifiers, Algorithms: Searching, Linear and Binary Search.
- Sorting: Bubble Sort, Insertion Sort.
- Algorithmic Efficiency: Big O Notation; Theorems and Examples
- Big O for Combinations of Functions, Complexity of Algorithms: Linear and Binary Search, Miscellaneous Asymptotic Analysis Topics.
- Counting: Product and Sum Rules, Counting Examples.
- Pigeonhole Principle: Generalized Pigeonhole Principle.
- Permutations and Combinations: Binomial Theorem and Identities, Pascal's Identity, Pascal's Triangle.
- Number Theory: Divisibility, Division Algorithm, Modular Arithmetic, Modular Arithmetic and Congruences, Prime Numbers, Fundamental Theorem of Arithmetic, GCD, LCM.
- Review of Number Theory, Algorithm for div and mod (Quotient and Remainder),
- Euclid's Algorithm for GCD, Review of Asymptotic Analysis.
- Integer representations, Computing representations, Integer addition algorithm, Integer multiplication algorithm, Exponentiation, Exponentiation Algorithms.
- Graph Theory Introduction, Types of Graphs.
- Paths and Circuits: Euler Circuits and Paths, Graph Isomorphism.
- Planar Graphs, K3, 3, Euler's Formula.
- Shortest Path Problems and Dijkstra's Algorithm, Complexity, Hamiltonian Circuits, Traveling Salesman Problem
- Trees: Definitions and basic properties, Applications of Trees: Searching, Binary Search Trees, Tree Traversal: Inorder, Preorder, Postorder, Applications to file systems, expressions.
- Spanning Trees: Construction of spanning trees, Breadth First Search, Depth First Search, Minimum Spanning Trees

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:

- K. Rosen, "Discrete Mathematics and Its Applications", latest Edition.
- S. Epp, "Discrete Mathematics with Applications", latest edition.

Object Oriented Programming

Course Outline:

- User defined data types, Structures, Unions and Enumerations.
- Recursion, Preprocessing in C++.
- Bit Manipulation, Strings, Pointers.
- Reference and Dynamic memory allocation.
- Function Pointers, ADTs and C++ Classes-I.
- C++ Classes-II Constructor, Destructor, Copy Constructor.
- Inheritance, Virtual Functions and Polymorphism.
- Operator Overloading, Function and class templates.
- Exception Handling.
- I/O Streams and File Handling.
- Graphics.
- GUI Programming.
- Introduction to Standard Template Library (STL).
- Project and case studies.

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:

- C++ How to Program, 10/e, Paul J. Deitel and Harvey Deitel, latest edition, ISBN-10: 9780134448237.
- C++ Primer, Stanley B. Lippman, Josée Lajoie, and Barbara E. Moo, latest edition, ISBN-10: 9780321714114.

Data Structures and Algorithms

Course Outline

- Fundamentals of data structures: An overview of computer programming, Data types, abstract data types, C/C++ background,
- Review of pointers, Pointer arithmetic, Pointer indirections
- Computational complexity of algorithms and their time-space analysis: Running time calculations, Asymptotic notations for algorithmic complexity analysis.
- Lists Data Structure: Simple arrays, Linked lists, Linear search vs binary search
- Lists Data Structure: Double linked lists, Circular linked lists.
- Stacks & Queues: Sequential/array implementation of stacks and queues, Linked list implementation of stacks and queues.
- Arithmetic expressions: Polish notation, Recursion: Recursive implementation of stacks and queues.
- Sorting: Bubble sort, Insertion sort, Selection sort.
- Sorting: Merge sort, Quick sort, Counting Sort & Radix sort, Heap sort (tentative).
- Trees: Data structure definition and generic implementation, Tree traversals and its application, Binary tree, binary search tree, Expression trees, AVL trees.
- Huffman coding, B-Tree.
- Graphs: Adjacency matrix implementation, Linked list implementation
- Graphs Search: Depth-first traversal of graphs, Breadth-first traversal of graphs, Shortest distance algorithms

- Hashing and searching: Hashing techniques, Implementation of Hashing techniques
- Priority Queues: Binary Heap and its 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, Assignment, Project report, Quizzes, Final term.

Suggested Books:

- Data Structures and Algorithm Analysis in C by Mark Weiss. Addison Wesley; ISBN: 0-201-49840-5, latest edition.
- Data Structures and Algorithm Analysis in C++ by Mark Weiss. Addison Wesley; ISBN 0321-44146-X, latest edition
- Introduction to Algorithms, Thomas H. Cormen et al, latest edition.

Operating Systems

Course Outline

- Basic Elements: Evolution of the Microprocessor, Instruction Execution.
- Interrupts: Interrupts and the Instruction Cycle, Interrupt Processing, Multiple Interrupts.
- Memory: The Memory Hierarchy, Cache Memory, Direct Memory Access.
- Operating System: Objectives and Functions, The Evolution of Operating Systems, Developments Leading to Modern Operating Systems.
- Virtual Machines: Virtual Machine Architecture.
- Multiprocessor and Multicore Organization: OS Design Considerations for Multiprocessor and Multicore.
- Processes: Process Definition, Process States, Process Description, Process Control, OS Execution.
- Processes and Threads: Types of Threads, Multicore and Multithreading.
- Principles of Concurrency.

- Mutual Exclusion, Hardware Support, Semaphores.
- Multi-Process Synchronization: Producer/Consumer Problem.
- Message Passing: Readers/Writers Problem.
- Deadlocks: Principles of Deadlock, Deadlock Prevention, Detection and Avoidance, An Integrated Deadlock Strategy.
- Memory Management: Memory Partitioning, Paging, Segmentation, Virtual Memory, Hardware and Control Structures for Virtual Memory.
- Fetch Policy, Placement Policy, Replacement Policy, Resident Set Management, Cleaning Policy, Load Control.

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:

- Silberschatz, P. B. Galvin and G. Gagne, "Operating System Concepts, Internals & Design Principles", latest Ed., Wiley.
- William Stallings "Operating Systems: Internals & Design Principles", latest Ed., Prentice Hall.
- S. Tanenbaum and A. S. Woodhull "Modern Operating Systems", latest Ed., Prentice Hall.

Database System

Course Outline

- Introducing the Database and the DBMS.
- Design life cycle of Databases, Data modelling and Data model Case Study
- Database Design.
- Entity Relation (ER) Model.
- Extended Entity Relationship Model.
- Relational Data Model Concepts.

- Mapping of ER & EER-Model to Relational Model.
- Basics of SQL: DDL Statements, DML Statements, Constraints and, Basic Retrieval Queries.
- Relation Algebra.
- Functional Dependencies.
- Normalization Basics and Need for Normalization.
- Physical Database design.
- Query Processing and Optimization.
- Transaction Processing.
- Concurrency Control Techniques.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Database System Concepts latest Edition by Abraham
- Fundamentals of database by Elmasri, latest edition
- Date, C, J.: "An Introduction to Database Systems", latest Edition, Pearson, Boston.

Formal Methods in Software Engineering

Course Outline

- Formal methods (FM) introduction: What are FM? When, How and Why use FM? How project management can be done with FM: Gathering requirement, from Information Requirement to formal Specifications and validating formal specifications.
- Introducing Z: What is Z? Informal requirements, data flow diagrams, state transition diagram, and state transition tables. Introducing schemas: Basic

types and abbreviations, axiomatic descriptions, state schemas, operation schemas, implicit preconditions and schema calculus.

- Elements of Z: Sets and types, declarations, variables, expressions, operators, predicates, equations and laws. Structure: Tuple, Records, Relations, Tables, Databases, Pairs and Binary Relations, Functions, Sequences and Operators.
- Logic: Basic predicates, using predicates in Z, relations as predicates, logical connectives, logic and natural Language, quantifiers, Z and Boolean types, predicates and undefined expressions. Synthesis: Set comprehensives, lambda expressions, formal specifications, conveniences and shortcuts, modeling systems and change.
- Schemas and schema calculus: Conjunctions and disjunctions, other schema operators. Schema types and bindings: Generics & free types.
- Formal reasoning: Calculation and proof, laws, checking specifications, preconditions, formal reasoning and intuition, machine-checked proof.
- Studies in Z: Document Control System, Text Processing, Eight Queens.
- Computer graphics and computational geometry. Rule-based programming: Essential elements, facts and rules, deducing new facts, checking the rules and specifying rule based programs.
- Graphical user interface: Events, display and dialogs, selecting a display, changing setting value, Z and state transition systems, changing the machine state.
- Safety-critical protection system: Partition, refinement and enforcing the Safety Requirements.
- Modeling large systems: A single subsystem, many subsystems, useful idioms, subsystems, conditions and modes.
- Object-Oriented Programming model and Z, inherits and schema inclusion, OO Z dialects. Concurrency and Real-time.
- Refinement, program derivation and formal verification and converting Z specification into code.

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:

- The Way of Z: Practical Programming with Formal Methods by Jonathan Jacky, Cambridge University Press.
- Understanding Z: a Specification Language and its Formal Semantics. J. M. Spivey, Cambridge University Press, New York, NY, USA.
- Modern Formal Methods and Applications, Hossam A. Gabbar, Springer-Verlag 200

Computer Networks

Course Outline

- Internet: Definitions and protocols.
- Network core: packet/circuit switching, Internet structure.
- Principles of network applications: Web and HTTP.
- Electronic Mail: SMTP, POP3, IMAP.
- DNS: P2P applications.
- Transport-layer services: Multiplexing and demultiplexing.
- Connectionless transport: UDP.
- Principles of reliable data transfer.
- Connection-oriented transport: TCP Flow control and connection management.
- Principles of congestion control.
- TCP congestion control.
- Network Layer: Virtual circuit and datagram networks, routers.
- IP: Internet Protocol: Datagram format, IPv4 addressing, ICMP, IPv6.
- Routing algorithms: Link state, Distance Vector, Hierarchical routing, Routing in the Internet, RIP, OSPF.
- Link Layer: Error Correction and Detection Techniques, Carrier Sense Multiple Access.

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:

- Johnson, Allan. LAN Switching and Wireless, CCNA Exploration Labs and Study Guide (Lab Companion). Cisco Press, latest edition.
- Rullan, John. Accessing the WAN, CCNA Exploration Labs and Study Guide (Lab Companion). Cisco Press, latest edition.
- Kreigh, Jack. "CCIE Routing and Switching Lab Exam Prep." Latest edition.

Computer Architecture and Logic Design

Course Outline

- Digital and Analog Quantities, Number Systems
- Logic Operations, and Codes
- Logic Gates
- Boolean Algebra and Logic Simplification
- Combinational Logic Analysis
- Functions of Combinational Logic
- Flip-Flops and Related Devices
- Counters
- Shift Registers: Register Transfer and Micro operations.
- Low Level Programming: Machine Language; Assembly Language
- Micro programmed Control
- Central Processing Unit
- Input-Output Organization
- Memory Organization

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:

- Digital Fundamentals, latest edition by Thomas L. Floyd. ISBN 978-81-317-3448-3.
- Digital Logic & Computer Design by M. Morris Mano. ISBN 978-81-7758-409-7, latest edition.
- Computer System Architecture, latest Edition by M. Morris Mano.
- Computer Organization and Design, latest Edition by David Patterson and John Hennessy.

Engineering Breadth Courses

Software Engineering Fundamentals

Course Outline

- Nature of Software, 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
- Fundamentals of Software design, Architectural design
- Object-oriented representation, Structural decomposition
- Design and implementation
- UML diagrams and 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, 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:

- Software Engineering, Sommerville I., latest Edition, Pearson Inc.,
- Software Engineering, A Practitioner's Approach, Pressman R. S.& Maxim B. R., latest Edition, McGraw-Hill.

Software Design and Architecture

Course Outline

- Software Design Concepts, Design principles
- System design and software architecture
- Architectural design issues
- Software Architecture, Architectural Structures & Styles-,
- Architectural Patterns, Interactive systems with MVC architecture
- Middleware and service-oriented architecture
- Component based design and development
- Model driven development
- Object-Oriented Design with UML, Exploring inheritance and object composition
- Data design, Persistent layer design
- Functional Design
- User interface design
- Web applications design
- Mobile application design

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:

- Software Engineering, A Practitioner's Approach, Pressman R. S.& Maxim B. R., latest Edition, McGraw-Hill.
- Object-Oriented Analysis, Design and Implementation, Brahma Dathan, Sarnath Ramnath, latest Edition, Springer, University Press.
- Essential Software Architecture, Gorton I., latest Edition, Springer – Verlag

Software Construction and Development

Course Outline

- Moving from design to implementation code
- Regular expressions and grammars, Parser generators
- Software Construction fundamentals
- Designing specifications
- Mutability and immutability
- Recursion and Abstract data types
- Abstraction functions and rep invariants
- Interfaces, Graphical user interfaces
- Recursive data types
- Concurrency, thread safety, Sockets and networking
- Queues and message passing, Locks and synchronization
- Code refactoring
- Exception handling
- Static checking and testing
- Code review

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:

- Client-Centered Software Development, Allen B. Tucker, CRC Press, latest edition.
- Software Essentials: Design and Construction, Adiar Dingle, CRC Press, latest edition.
- Clean Code: A Handbook of Agile Software Craftsmanship, Robert C. Martin, Prentice Hall, latest edition.

Software Quality Engineering

Course Outline

- Introduction to Software Quality and Quality Engineering
- Software quality factors and attributes, software quality models
- SQA Process Implementation Activities
- SQA plan and project plan
- Software inspections, Software reviews, Inspection checks and metrics
- Software testing concepts, issues and techniques, Software testing lifecycle
- Software quality metrics, product metrics, process metrics
- Test Planning Process, Testing documentation
- Software testing techniques, Testing philosophies
- Testing strategies, Model based testing,
- Software testing techniques, Testing using models,
- Domain and combinatorial testing,
- Unit and integration testing, Acceptance testing,
- Test automation
- Open issues on software testing

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:

- Software Quality: Concepts and Practice, Daniel Galin, John Wiley & Sons, latest edition
- Introduction to Software Testing, Paul Ammann and Jeff Offutt, latest Edition, Cambridge University Press.
- Introduction to Software Quality, Gerard O'Regan, Springer International, latest edition.

Software Project Management

Course Outline

- Introduction to Software Project Management
- Project Management concepts
- Project Management Tools
- PMI's Knowledge areas, PMI Framework
- PMI Process Groups.
- Understanding Organizations. Project Planning, Project Evaluation
- Selection of an Appropriate Approach in Project
- Software Effort Estimation, Activity Planning
- Risk Management, Evaluating the Risks to the Schedule, Risk Control
- Configuration Management and Maintenance
- Environment for Configuration Control
- Resource Allocation
- Monitoring & Control
- Review and Evaluation
- Challenges of Outsourcing in Project Management

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:

- Information Technology Project Management, Schwalbe, K., latest Edition, Cengage Learning.
- A guide to the project management body of knowledge (PMBOK guide), Project Management Institute Inc, latest Edition.
- Software Project Management, Bob Hughes and Mike Cotterell, McGraw-Hill Education; latest Edition.

Human Computer Interaction

Course Outline

- Contexts for HCI. Introduction to HCI
- Guidelines, Principles and Theories of interactive systems
- Design Process,
- Evaluation and the User Experience
- Interaction design process
- Interaction Styles
- Cognitive aspects and social interaction
- Design Issues in user experience
- Documentation and User Support (Help)
- Interfaces and its design
- Data gathering, Data analysis, interpretation and presentation
- Usability inspection methods, Usability testing methods,
- New Interaction Technologies, Usability in practice,
- Visual Design and Typography, Icon Design,
- Ubiquitous, Augmented and Virtual Reality.

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:

- Designing the User Interface, Ben Shneiderman, Catherine Plaisant et al, latest Edition, Pearson Education
- Interaction Design: Beyond HCI, Helen Sharp, Yvonne Rogers, Jennifer Preece, latest Edition, John Wiley & Sons.
- Designing Interactive Systems: A Comprehensive Guide to HCI, UX and Interaction Design, Benyon, D. latest Edition, Pearson.

Cloud Computing

Course Outline

- Introduction to cloud computing
- Cloud benefits and challenges
- Cloud service providers and cloud ecosystem
- Concurrency in the cloud
- Parallel and distributed systems
- Cloud access and cloud interconnection networks
- Cloud data storage
- Cloud applications
- Cloud hardware
- Cloud software
- Cloud resource management and scheduling
- Cloud security
- Privacy and compliance issues
- Portability and interoperability issues
- Big Data, Data streaming and Mobile cloud

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:

- Cloud Computing: Theory and Practice, Dan C. Marinescu, latest Edition, Morgan Kaufmann.
- Cloud Computing, Sandeep Bhowmik, Cambridge University Press, latest edition.

<div align="center">**Information Security**</div>

Course Outline

- Introduction to Information Security
- Need for security
- Legal, ethical and Professional issues in information security
- Planning for security
- Risk Management
- Security technology: Access control, Firewalls and VPNs
- Intrusion detection and prevention systems
- Cryptography
- Unintentional programming oversights, Malicious code, countermeasures
- Browser attacks, Web attacks, E-mail attacks
- Security in operating systems
- Network security attacks and security counter measures
- Security in databases
- Cloud security tools and techniques
- Physical security

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:

- Principles of Information Security, Michael E. Whitman and Herbert J. Mattord, latest Edition, Cengage Learning.
- Security in Computing, Pfleeger, C.P., Pfleeger, S.L. & Margulies, J., latest Edition, Prentice Hall.

Design and Analysis of Algorithms

Course Outline

- Foundations of Algorithms, Problem solving
- Proving correctness of algorithm using Loop Invariants
- Asymptotic Notations: Worst, Best and Average Case Behavior of Algorithms;
- Big O notation; Complexity Classes i.e. Constant, Linear, Quadratic;
- Empirical Measurements of Performance
- Time and Space Tradeoffs in Algorithms
- Recurrence Algorithms; Analysis of Iterative and Recurrence Relations;
- Master Theorem; Divide and Conquer; Recursive Backtracking;
- Worst Case Quadratic Sorting Algorithms,
- Worst or Average Case Sorting Algorithms (Quick, Heap & Merge Sort)
- Representation of Graphs, Depth First and Breadth First Traversal
- Brute Force Algorithms; Greedy Algorithms; Approximation Algorithms
- Dynamic Programming; Branch-and-Bound Techniques;
- Heuristics; Reductions: Transform and Conquer;
- Basic Computability: The Complexity Classes P and NP; Introduction to NP Complete Problem.

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:

- Introduction to Algorithms, Cormen, T. H., Leiserson, C.E., Rivest, R.L.& Stein, C(CLRS)., 3rd Edition, MIT Press, 2009
- An Introduction to the Analysis of Algorithms, Sedgewick, R.& Flajolet, P., 2nd Edition, Pearson Education, 2013
- Introduction to the Design and Analysis of Algorithms, Anany Levitin, 3rd Edition, Pearson Education, 2012

Engineering Depth Courses (Engg Electives)

Agent Based Software Engineering

Course Outline

- Overview of agent-based software engineering.
- Methodologies for agent-based modeling, analysis and design:
- Agent-based Unified Modeling Language (AUML)
- Agent-based analysis and design
- Other agent-based analysis and design methods.
- Agent communication and knowledge sharing: knowledge level communication among software agents
- Knowledge Interchange Format (KIF)
- Agent-based System Architecture and Organization.
- FIPA: Foundation for Intelligent Physical Agents
- FIPA specification, the application, abstract architecture, agent communication, agent management and agent message transport standards and guidelines.

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:

- Multi-agent Systems: A Modern Approach to Distributed Artificial Intelligence, Gerhard Weiss, latest edition, MIT Press.
- Agent-Oriented Methodologies, Paolo Giorgini, Idea Group Publishing, latest edition.
- Agent-Oriented Software Engineering III, Fausto Giunchiglia, James J. Odell, Gerhard Weiss, Springer Verlog - LNCS 2585, latest edition.

Big Data Analytics

Course Outline

- Introduction to Big Data Analytics
- Big Data Platforms
- Data Store & Processing using Hadoop
- Introduction to Spark, The Spark Programming Model
- Spark SQL and data frames, Spark Job Execution, Intro to Spark
- Streaming, Building systems using Spark Streaming,
- RDD Fundamentals, Programming With RDDs and Key-Value Pairs,
- Big Data Storage and Analytics
- Extract-Transform-Load operations (ETL)
- Exploratory Data Analysis (EDA)
- Linked Big Data
- Graph Computing and Graph Analytics
- Graphical Models and Bayesian Networks
- Big Data Visualization

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:

- Mining of Massive Datasets, Jure Leskovec, Anand Rajaraman, Jeff Ullman, latest edition.
- Hadoop: The Definitive Guide, Tom White, latest edition.
- Data-Intensive Text Processing with Map Reduce, Jimmy Lin and Chris, latest edition.

Deep Learning

Course Outline

Introduction to neural networks

- Perceptron
- Activation functions
- Back-propagation;
- Multi-Layer Perceptron

Convolutional Neural Networks

- Convolution as feature extractor
- CNN Layers
- Conv, ReLU, Pooling and FC.
- Hyperparameters: Stride, Depth and Padding.

Regularization Techniques

- L1, L2,
- Dropout,
- Data Augmentation and Early Stopping

Transfer Learning and Fine Tuning.

- Implementing fine tuning and transfer learning on digit recognition

CNN Architectures

- LeNet
- AlexNet
- VGG
- Inception Family, ResNet and DenseNet

Autoencoders and variants

Sequential Data

- Recurrent Neural Networks
- Vanishing Gradient Problem
- Long Short Term Memory Networks and Variants
- Back Propagation in LSTMs – Implementing LSTMs

Generative Adversarial Networks (GANs)

- Discriminative and Generative Models

Deep Learning for Object Detection

- R-CNN, Spatial Pyramid Pooling
- Fast, Faster and Mask R-CNN
- Deep Learning for Object Detection: Single Shot Detectors – RFCN, SSD and YOLO

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:

- Deep Learning (Adaptive Computation and Machine Learning series), Ian Goodfellow, Yoshua Bengio, Aaron Courville, The MIT Press, latest edition.
- Deep Learning: A Practitioner's Approach, Josh Patterson and Adam Gibson, O'Reilly Media, latest edition.
- Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, Nikhil Buduma and Nicholas Locascio, O'Reilly Media, latest edition.
- Deep Learning with Python, Francois Chollet, O'Reilly Media, latest edition.

Mobile Application Development

Course Outline

Mobiles Application Development Platform

- HTML5 for Mobiles;

Android OS Architecture

- Framework and Application Development;

IOS: Architecture

- Framework and Application Development;

Windows Mobile Architecture

- Framework and Application Development;

Calling Built-in Applications using Intents;

Displaying Notifications; Components of a Screen;

- Adapting to Display Orientation;
- Managing Changes to Screen Orientation;
- Utilizing the Action Bar;

Creating the User Interface;

- Listening for UI Notifications; Views; User Preferences;

Persisting Data; Sharing Data;

Sending SMS Messages; Getting Feedback; Sending Email;

Consuming Web Services Using HTTP;

- Web Services: Accessing and Creating;
- Displaying Maps;
- Location-aware Applications;

Publishing Android Applications; Deployment on App Stores;

Mobile Platform Constraints; Emerging Technologies

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:

- Professional Android application development, Reto Meier, Wrox Programmer to Programmer, latest edition.
- iOS Programming: The Big Nerd Ranch Guide, Conway, J., Hillegass, A., & Keur, C., latest Edition.
- Android Programming: The Big Nerd Ranch Guides, Phillips, B. & Hardy, B., latest Edition.

High Performance Computing

Course Outline

Programming languages and programming-language extensions for HPC

- Compiler options and optimizations for modern single-core and multi-core processors
- Execution profiling, timing techniques, and benchmarking for modern single-core and multi-core processors
- HPC Architectures
- Spark; Hadoop

Parallelization strategies, task parallelism, data parallelism, and work sharing techniques

- Parallel programming with OpenMP and (Posix) threads
- Message passing with MPI
- HPC numerical libraries and auto-tuning libraries
- Advanced parallel algorithms
- Other parallel programming tools and languages (UPC, CAF, ...)

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:

- Deep Learning (Adaptive Computation and Machine Learning series), Ian Goodfellow, Yoshua Bengio, Aaron Courville, The MIT Press, latest edition.
- Deep Learning: A Practitioner's Approach, Josh Patterson and Adam Gibson, O'Reilly Media, latest edition.
- Fundamentals of Deep Learning: Designing Next-Generation Machine Intelligence Algorithms, Nikhil Buduma and Nicholas Locascio, O'Reilly Media, latest edition.
- Deep Learning with Python, Francois Chollet, O'Reilly Media, latest edition.

Machine Learning

Course Outline

- Introduction to machine learning and statistical pattern recognition
- Supervised learning
  - Full Bayes, Naïve Bayes
  - Decision Trees for Classification
  - Regression for both categorical & numerical data
  - Ensemble methods, Random forests, Boosting (Adaboost and Xgboost), Stacking;
- Four Components of Machine Learning Algorithm (Hypothesis, Loss Functions, Derivatives and Optimization Algorithms),
- Gradient Descent, Stochastic Gradient Descent, Linear Regression, Nonlinear Regression,
- Support Vector Machines, Kernel Methods, Logistic Regression,
- Neural networks; Softmax, Perceptron,
- Unsupervised learning:
  - K-means
  - Density Based Clustering Methods (DBSCAN, etc.)
- Gaussian mixture models
- Reinforcement learning; Tuning model complexity;
- Evaluation Metrics; Reporting predictive performance

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:

- Elements of Statistical Learning, latest edition.
- Pattern Recognition & Machine Learning, latest Edition, Chris Bishop
- Machine Learning: A Probabilistic Perspective, 1st Edition, Kevin R Murphy
- Applied Machine Learning, online Edition, David Forsyth
- http://luthuli.cs.uiuc.edu/~daf/courses/LearningCourse17/learning-book-6-April-nn
  revision.pdf

Natural Language Processing

Course Outline

- Deterministic and stochastic grammars
  - Parsing algorithms
  - CFGs
- Representing meaning/ Semantics, Semantic roles
- Temporal representations
- Corpus-based methods
- N-grams and HMMs
- Smoothing and Backoff
- POS tagging and morphology
- Information retrieval; Information extraction
- Vector space model
- Precision and recall
- Language translation
- Text classification, categorization, Bag of words model.

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:

- Python Machine Learning, Sebastian Raschka. Publisher: Packt Publishing, latest edition.
- Natural Language Processing with Python: Analyzing Text with the Natural Language
  Toolkit Latest Edition, Steven Bird, Ewan Klein and Edward Loper Publisher: O'Reilly
  Media, latest edition.
- Speech and Language Processing, Latest Edition, Daniel Jurafsky and James H. Martin Publisher: Prentice Hall, latest edition.

Semantic Web

Course Outline

- Introduction to the semantic web
- Introduction to ontologies
- Ontology languages for the semantic web
- Resource Description Framework (RDF)
- Lightweight ontologies: RDF Schema
- Web Ontology Language (OWL)
- Query language for RDF: SPARQL
- Ontology Engineering
- Semantic web and Web 2.0
- Applications of Semantic Web

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:

- Build Flexible Applications with Graph Data, Toby Segaran, Colin Evans, Jamie Taylor, O'Reilly Media, latest edition
- Foundations of Semantic Web Technologies, Pascal Hitzler, Markus Krotzsch, Sebastian Rudolph, latest edition.
- Introduction to the Semantic Web and Semantic Web Services, Liyang Yu, Chapman and Hall/CRC, latest edition.

Social Network Analysis

Course Outline

Basics of Social Network Analysis

- The Social Network and How to Represent It
- Types of Networks & relations
- Network variables
- A Brief History of Social Network Analysis

Mathematical Foundations

- Graphs
- Paths and components
- Adjacency matrices

Data Collection Network questions

- Question formats
- Data collection and reliability
- Data from electronic sources

Data Management

- Data import & export
- Cleaning network data; Data transformation, Normalization
- Matching attributes and networks; Converting attributes to matrices

Multivariate Techniques Used in Network Analysis

- Multidimensional scaling
- Correspondence analysis
- Hierarchical clustering

Visualization & Layout

- Node filtering
- Visualizing network change
- Exporting visualizations

Testing Hypotheses

- Permutation tests
- Dyadic hypotheses
- Mixed dyadic–monadic hypotheses
- Node level hypotheses
- Whole-network hypotheses

Centrality

- Undirected, non-valued networks
- Directed, non-valued networks
- Valued networks
- Negative tie networks

Analyzing Two-mode Data

- Converting to one-mode data
- Converting valued two-mode matrices to one-mode

Large Networks

- Reducing the size of the problem
- Choosing appropriate methods

- Sampling
- Small-world and scale-free networks

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:

- Analyzing Social Networks Second Edition by Stephen P Borgatti, Martin G Everett, Jeffrey C Johnson, latest edition.
- Social Network Analysis: Methods and Examples 1st Edition by Song Yang, Franziska B Keller, Lu Zheng, latest edition.
- Social Network Analysis Fourth Edition by John Scott, latest edition.

Computer Vision

Course Outline

- Introduction, Image formation, Spatial and frequency domain processing,
- Feature detection and extraction, Image registration, Segmentation, Camera calibration,
- Structure from motion, Motion estimation, Stereo vision,
- Object detection and recognition, Object tracking, 3D scene reconstruction,
- Context and scene understanding, Image stitching,
- Image-based and video-based rendering,
- High-performance computing paradigms for vision and image processing.

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:

- Computer Vision - A Modern Approach, by D. Forsyth and J. Ponce, Prentice Hall, latest edition.
- Szeliski R., Computer Vision - Algorithms and Applications, Springer, latest edition.
- J. R. Parker, Algorithms for Image Processing and Computer Vision, Willey Publishing Inc. latest edition.
- Gonzalez R. C., Woods R. E., Digital Image Processing, Pearson Education, latest edition.

Software Metrics

Course Outline

- Overview of software metrics;
- Basics of measurements; Goal-based framework for software measurement; Software measure classification;
- Empirical investigation, principles and techniques;
- Formal experiments: Planning, principles, types and selection;
- Measuring internal product attributes: size and structure; Measuring cost and effort;
- Measuring external product attributes: quality and reliability; Software test metrics; Object-oriented metrics

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:

- Software Metrics: A Rigorous and Practical Approach, (3rd ed.), N.E. Fenton and J. Bieman, CRC Press, latest edition.
- Software Metrics: A Guide to Planning, Analysis, and Application, C. Ravindranath Pandian, Auerbach Publications, CRC Press Company, latest edition.
- Metrics and Models in Software Quality Engineering, Stephen H. Kan, latest edition, Addison-Wesley Professional.

System Programming

Course Outline

- Introduction to the Microsoft Windows/LINUX ® Operating System,
- File Processing, Memory Management, Memory Mapped Files and DLLs,
- Process management, Threads and scheduling, Thread synchronization,
- Inter-process Communication,
- Input/Output, Device Drivers (USB or Parallel Port),
- File System Drivers, Filter Drivers

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:

- Windows System Programming latest edition, Johnson M. Hart, Addison Wesley
- The Windows NT Device driver book 2nd edition, Art Baker, Prentice Hall.

Visual Programming

Course Outline

- Visual Programming Basics;
- Introduction to Events; Fundamentals of Event-driven Programming, message handling, user interfaces, graphics device interface, painting and drawing, windows management, input devices, resources, string and menu resource, dialogs and windows controls, common controls, dynamic link libraries, threads and synchronization, network programming,
- Building Class Libraries at the Command Line, Class Libraries, Using References, Assemblies, Private Assembly Deployment, Shared Assembly Deployment, Configuration Overview, Configuration Files,
- Programmatic Access to Configuration, Using SDK Tools for Signing and Deployment, Metadata, Reflection, Late Binding, Directories, Files, Serialization, Attributes, Memory Management and Garbage Collection,
- Threading and Synchronization, Asynchronous Delegates, Application Domains, Marshal by Value, Marshal by Reference,
- Authentication and Authorization, Configuring Security, Code Access Security, Code Groups, Evidence, Permissions, Role-Based Security, Principals and Identities, Using Data Readers, Using Data Sets,
- Interacting with XML Data, Tracing Event Logs, Using the Boolean Switch and Trace Switch Classes, Print Debugging Information with the Debug Class,
- Instrumenting Release Builds with the Trace Class,
- Using Listeners, and Implementing Custom Listeners.

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:

- Visual C#: How to Program, Deitel and Deitel, latest Edition, Prentice Hall / Pearson Education.
- Programming in C# .NET, J.C. Bradley, A.C. Millspaugh, McGraw-Hill, latest edition.
- Microsoft Visual C# 2013 Step by Step (Step by Step Developer), Sharp, J., latest Edition, Microsoft Press.

Real Time Systems

Course Outline

- Introduction to Real Time Systems, Categories,
- Characteristics and challenges,
- Requirement Specification and Design, Design fundamentals, Elements of modular design, Concurrency,
- Realtime & other application areas, Real Time Operating Systems, Memory management,
- Fundamental of microprocessor based systems,
- Input output interfacing technique, Real time programming,
- Real Time Analysis, Schedulability analysis, Scheduling policies, Designing with rate monotonic analysis

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Software Engineering for Real-Time Systems, Cooling J., Addison-Wesley, latest edition.
- Real-time Systems and Programming Languages, latest Edition, Burns A., Wellings A. J., Addison Wesley, UK.

- Principles of Concurrent and Distributed Programming. Ben-Ari M., Addison-Wesley, latest edition.

Data Visualization

Course Outline:

- Data visualization, the art and science of turning data into readable graphics, explore how to design and create data visualizations based on data available and tasks to be achieved, data modeling, data processing (such as aggregation and filtering),
- Mapping data attributes to graphical attributes, and strategic visual encoding based on known properties of visual perception,
- Evaluate the effectiveness of visualization designs, and think critically about each design decision,
- Choice of color and choice of visual encoding. Students will create their own data visualizations, and learn to use Open Source data visualization tools.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Interactive Data Visualization for the Web by Scott Murray latest edition
- Semiology of Graphics by Jacques Bertin, latest edition.
- The Grammar of Graphics by Leland Wilkinson, latest edition.

Computer Graphics

Course Outline

- Fundamental Concepts: forward and backward rendering (i.e., ray-casting and rasterization), applications of computer graphics: including game engines, cad, visualization, virtual reality, polygonal representation, basic radiometry, similar triangles, and projection model,
- Use of standard graphics APIs (see HCI GUI construction); basic rendering:
- Rendering in nature, i.e., the emission and scattering of light and its relation to numerical integration, affine and coordinate system transformations, ray tracing,
- Visibility and occlusion, including solutions to this problem such as depth buffering, painter's algorithm, and ray tracing, the forward and backward rendering equation, simple triangle rasterization, rendering with a shader-based API, texture mapping, including minification and magnification (e.g., trilinear MIP-mapping),
- Application of spatial data structures to rendering, sampling and anti-aliasing, scene graphs and the graphics pipeline;
- Geometric modeling: basic geometric operations such as intersection calculation,
- Proximity tests, polynomial curves and surfaces,
- Approximation techniques such as polynomial curves, bezier curves, spline curves and surfaces, animation as a sequence of still images.

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:

- Computer Graphics with OpenGL (latest Edition) by Donald D. Hearn, Prentice Hall, ISBN-10: 0136053580.

- Foundations of 3D Computer Graphics by S. J. Gortler, The MIT press, latest edition.
- Fundamentals of Computer Graphics, latest Edition, A K Peters.
- Computer Graphics: Principles and Practice, latest Edition, Addison Wesley.
- Real-Time Rendering, latest Edition, A K Peters.

Data Encryption and Security

Course Outline

- Principles of data encryption techniques and their application in information security,
- Concepts about several cryptography techniques and important security systems, classical encryption, block chippers and Data Encryption Standard (DES),
- Advanced Encryption Standard (AES), block cipher, stream cipher, public-key cryptography, hash functions,
- Message authentication code and digital signature, to develop engineering approach within the students for solving real-life challenges in information security.

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:

- Cryptography and Network Security: Principles and Practice, William Stallings, latest edition.
- Cryptography and Network Security (latest Edition), B. Forouzan and D. Mukhopadhyay, Mc-Graw Hill.
- Wireshark for Security Professionals, J. Bullock and J. T. Parker, Wiley, latest edition.

E-Commerce

Course Outline

- An overview of E-Commerce & its business models and concepts,
- Planning an E-Commerce Framework,
- Managing Products and Categories, Product Variations and User Uploads, Enhancing the User Experience, The Shopping Basket,
- The Checkout and Order Process, Shipping and Tax, Discounts, Vouchers, and Referrals, Checkout, Taking Payment for Orders,
- User Account Management, Administration: Dashboard, Managing Products and Categories, Managing Orders, Customers, Refunds, Voucher Codes, Shipping, Deploying, Security, and Maintenance,
- Web Payment Systems, Social, Legal, and Ethical Issues of E-Commerce, Auctions, Portals, and Communities, SEO.

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:

- E-Commerce, Kenneth Laudon and Carol Guercio Traver, latest Edition, Pearson.
- PHP 5 E-commerce Development, Michael Peacock, Packt Publishing, latest edition.
- Introduction to E-Commerce, Jeffrey F. Rayport, McGraw-Hill, latest Edition.
- Electronic Commerce, Gary Schneider, Course Technology; latest Edition.

Advanced Topics in Software Engineering

Course Outline

- Latest trends in Software Engineering,
- Software Development and Software management techniques,
- Software validation and verification techniques,
- Development in various computing technologies,
- Open source software development,
- Software & IT operations & maintenance

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:

- Software Engineering: A Practitioner's Approach by Roger Pressman, McGraw-Hill Education; latest edition.
- Software Engineering by Ian Sommerville, Pearson, latest edition

Multi-Disciplinary Courses

Embedded Systems

Course Outline

- Introduction to computing
- AVR Microcontroller and AVR Architecture
- AVR I/O Port Programming
- AVR Programming in C and Hardware Connection
- AVR Timer, Interrupt and Serial Port Programming in Assembly and C
- SPI Protocol and MAX7221 Display Interfacing

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:

- Naimi, Sepehr, Sarmad Naimi, and Muhammad Ali Mazidi. "The AVR Microcontroller and Embedded Systems Using Assembly and C: Using Arduino Uno and Atmel Studio", 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.

Internet of Things

Course Outline

- History and overview
- Writing to Actuators and Reading from Sensors
- IOT Protocols
- Device as HTTP Client and IOT
- Sending HTTP Requests-simple and efficient ways
- Device as a HTTP Server and Handling Sensor Requests
- Handling Actuator Requests and Going Parallel
- Server side handling
- Designing and applications
- Designing different real-time solution for real-life 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, Assignment, 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.

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.

12.2 Non-Engineering Domain

English Courses

Functional English

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outlines:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- P. C. Wren & H. Martin "High School English Grammar & Composition".
- Colin W. Davis & Andrew J. Watts New Expressway For English 1 (latest 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", latest 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:

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, latest edition.
- Christopher Fry, "Summary Writing (Book-I)", Oxford University Press, latest edition.
- College Essays by John Langland, latest edition.
- Barron's TOFFL iBT latest Edition.
- Communication Skills for Engineers by Sunita Marshal and C.Muralikrishna, latest edition.

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, latest edition.

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 Book:

- 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 Modelling

- 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

Extent to which development intend stosensitize society land under-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. Gumboil 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,. 2010. Humanitarian Engineering. Morgan and 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".

Engineering Economics

Area Scope:

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

Course Outline

Engineering Economics

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

Interest Rate and Economic Equivalence

- Interest: The Cost of Money
- Economic Equivalence
- Development of Formulas for Equivalence Calculation
- Unconventional Equivalence Calculations

Understanding Money and Its Management

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

Present-Worth Analysis

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

Annual Equivalent-Worth Analysis

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

Rate-of-Return Analysis

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

Cost Concepts Relevant to Decision Making

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

Depreciation and Corporate Taxes

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

Developing Project Cash Flows

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

Project Risk and Uncertainty

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

Special Topics in Engineering Economics

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Contemporary Engineering Economics by Chan S. Park, latest edition, Pearson, ISBN: 9780134105598
- Engineering Economic Analysis by Donald G. Newnan, Jerome P. Lavelle, Ted G. Eschenbach, latest edition, Oxford University Press, ISBN: 978-0199339273
- Engineering Economy by Leland T. Blank and Anthony Tarquin, latest edition.

Sociology

Area Scope:

The knowledge units in this area collectively encompass the following:

- To introduce the necessary subject knowledge and understanding required for the successful study of Sociology and related Social Science disciplines at undergraduate.
- To develop skills of application, analysis and evaluation in the context of the study of Social Science.
- To develop a knowledge and understanding of sociology both at a global and national level.
- To introduce the planning and organization skills necessary to develop as independent, autonomous learners.
- To develop the confidence and competence of the students as learners and to assist them in taking some responsibility for their own learning through directed study and reading.

Course Outline:

- Introduction: Sociological Perspective,
- The Development of Sociology,
- The Role of Values in Sociology, Prejudice In Early Sociology,
- Theoretical Perspective in Sociology. Culture: Components of Symbolic Culture, Subcultures and Counter Cultures, Cultural Universals, Animals and Culture,
- Technology and Global Village, Sociology and New Technology.
- Socialization: Social Development of Self, Mind, and Emotions,
- Socialization into Gender Social Structure and Interaction,
- Social Institutions. Research in Sociology: Research Model, Research Methods. Experiments, Ethics,
- Bureaucracy and Formal Organizations, Rationalization of Society, Formal Organizations and Bureaucracy,
- Voluntary Associations Social Classes, Economy, Politics, Power and Authority, Family, Medicine, Health and Illness, Population and Urbanization, Social Movements

- Social Psychology with special reference to attitudes, attributions and behavior, Emotions, Cognition and Thinking, Reasoning, Problem- Solving and Creativity, Personality, Intelligence, and Abnormal Behavior, etc.
- Introduction to the Field of Organizational Behaviour
- Conflict and Negotiation in the Workplace
- Leadership in Organizational Settings and Organizational Culture
- Ethics: In General an introduction and the development of ethical theory.
- Ethics in Islam, a comprehensive view with different ethics approaches and Ethics Theories
- Research Methods for Society and Sociology

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Social Psychology

Area Scope:

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

Course Outline:

- Principles of sociology and psychology with emphasis on the individual and his/her reciprocal interaction with groups,

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Edward Alsworth Ross, "Social Psychology", Macmillan, latest edition.
- Emory Stephen Bogardus, "Essentials of Social Psychology", Univ. of Southern, California Press, latest edition.
- Hewstone, M., & Stroebe, W. (Eds.), "Introduction to Social Psychology", Oxford: Blackwell Publishers, latest edition.
- Lesko, W.A. "Readings in social psychology General, classic, and contemporary selections, latest edition., 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.

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
  - o Selected Verses of Surah Al-Baqara Related to Faith (Verse No-284-286)
  - o Selected Verses of Surah Al-Mumanoon Related to Characteristics of Faithful (Verse No-1-11)

Islamic Culture and Civilization

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

Social System of Islam

- Basic Concepts of Social System in Islam
- Elements of Family and their Rights - Parents, Women, Husband & Wife, Children
- Inheritance – Rights and Laws

- Social Rights – Neighbors, Relatives and Society
- Equality and Brotherhood
  - o Selected Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- Concept of Welfare State – Period of Khilafat-e-Rashida

Professional Ethics and Morality

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

Islam and Science

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

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Al-Qur'ān القرآن (selected text).
- Sayyid Tāhir Rasūl Qādri **دروس قرآن 52** (Karachi: Islamic Research Academy, 7th ed., 2017).
- Sayyid Hasan-uddin Ahmad**, تعلیمات قرآنی** 2-vols., (Karachi: Jasarat Publications, 1998).
- Muhammad Shafī', **معارف القرآن** (Karachi: Dar-ul-Isha'at, 2000).
- Sayyid Abu'l A'lā Mawdūdī, **تفہیم القرآن** 6vols., (Lahore: Islamic Publications, 1998). [Preambles of all (114) chapters.]
- Amin Ahsan Islahi, **تدبرالقرآن** (Lahore: Farān Publications, 2005).
- Khawaja Abdul Waheed, **موضوعات قرآن وانسانی زندگی** (Islamabad: Islamic Research Institute, 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 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:

- 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.   The management of engineering. New York: Wiley.
- Cleland, David.   Field guide to project management. New York: Wiley.
- Eisner, H.   Essentials of project management and systems engineering management. New York: Wiley.
- Frame, J. D.   Managing projects in organizations. San Francisco: Jossey-Bass
- Goldratt, Eliyahu.   Critical chain. North River Press.
- Haynes, M.E. Project management: From idea to implementation. Los Altos, CA: Crisp Publications.
- Lewis, James, Project planning, scheduling & control. New York: McGraw-Hill
- Lewis, James, P.   Mastering project management. New York: McGraw-Hill
- Lientz, Bennet & Rea, Kathryn.   Project management for the 21st century. San Diego: Academic Press.

- Miller, Roger & Lessard, Donald. The strategic management of large engineering projects. Cambridge, MA: MIT Press.
- Nicholas, J.M. Managing business & engineering projects. Englewood Cliffs, NJ: Prentice Hall.
- Shtub, Avraham, Bard, Jonathan, & Globerson, Shlomo. Project management: Engineering, technology, and implementation. Englewood Cliffs, Prentice-Hall.
- Project Management by Adrienne Watt
- J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons. New York. (Reference).

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 2010
- William D. Bygrave and Andrew Zacharak, Entrepreneurship 2nd Edition, Wiley, 2012.
- Entrepreneurship by Hisrich, McGraw- Hill, 2009
- Principles of Marketing, Cotrell McGraw- Hill 2012
- Paul Burns and Jim Dew Hurst: Small Business and Entrepreneurship
- P.N. Singh: Entrepreneurship for Economic Growth
- Peter F. Drucker: Innovation and Entrepreneurship Peter F. Drucker
- John B. Miner: Entrepreneurial Success
- "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
- "Entrepreneurial Marketing," Lessons from Wharton's Pioneering MBA Course, Morgan, H. L., A. Kallianpur, and L. M. Lodish, John Wiley & Sons, 2001

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.

<div align="center">

Engineering Management

</div>

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.