Curriculum for

Avionics Engineering/ Electrical Engineering (Avionics)

Bachelor of Engineering Program

2020

Pakistan Engineering Council
&
Higher Education Commission
Islamabad

CURRICULUM

OF

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Contents

PREFCE

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

The University Grants Commission (UGC) was the designated authority to develop, review and revise curricula beyond Class-XII 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, Metallurgy, Materials, Mining Engg & Allied Disciplines	Convener
2.	Engr Prof Dr M. Younus Javed Convener Electrical Engg & Allied Disciplines	Member
3.	Engr Malik Saleem Ullah Saeed Convener Chemical Engg & Allied Disciplines	Member
4.	Engr Dr Wasim Khaliq Convener, Civil Engg & Allied Discipline	Member
5.	Engr. Prof. Dr. Iftikhar Hussain Convener, Mechanical and Allied Engineering	Member
6.	Engr Dr Muhammad Ashraf Convener, Agricultural Engg & Allied Disciplines	Member

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

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

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

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

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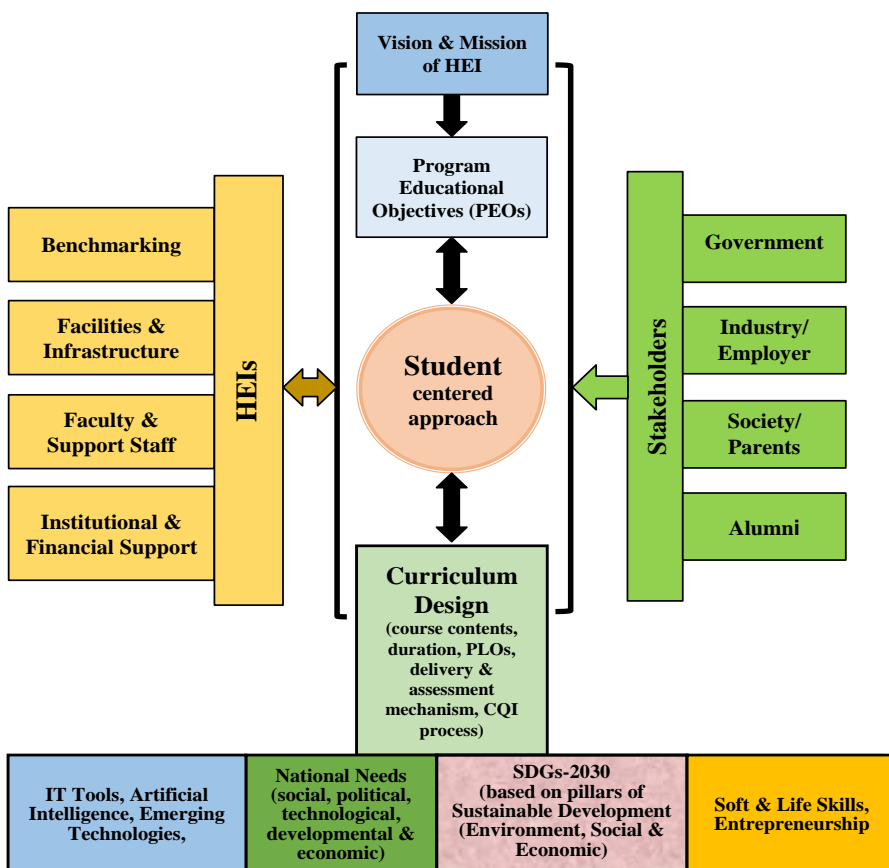
- The ECRDC is responsible to oversee the overall working of curriculum review and development for all engineering programs in terms of strategy, guidance and progress, and thereby submission to the relevant forum for adoption/ notification.
- Each Member of ECRDC will also work in the capacity of Convener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

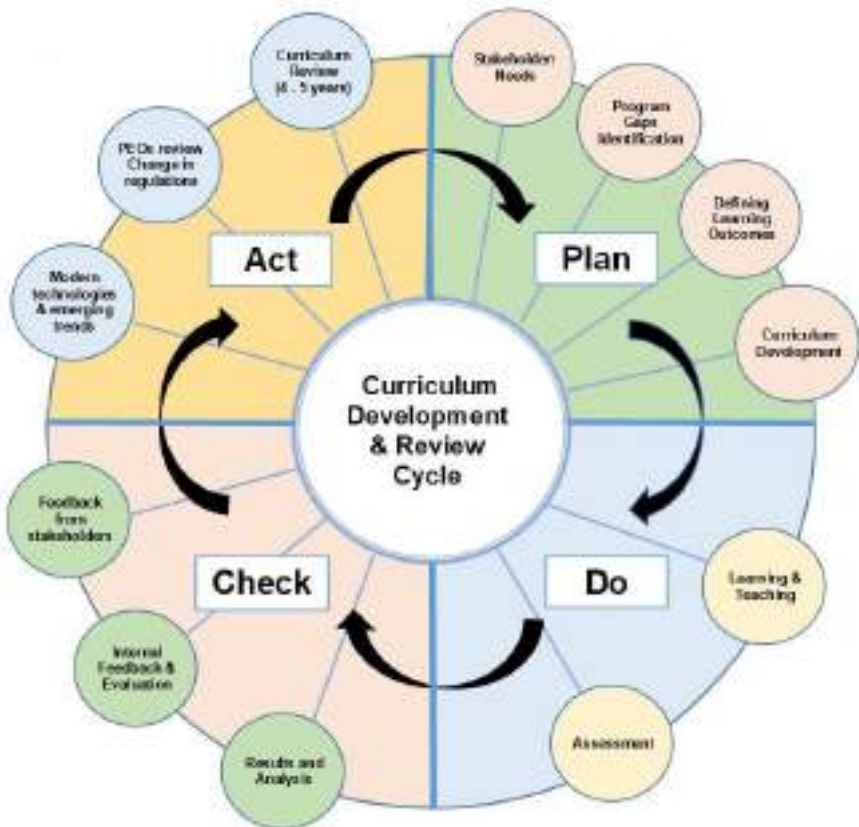## 3. OBE-Based Curriculum Development Framework

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

Outcome-Based Education (OBE) - Curriculum Development Framework

	Vision & Mission of HEI	
	Program Educational Objectives (PEOs)	
Benchmarking		**Government**
Facilities & Infrastructure	**Student centered approach**	**Industry/ Employer**
Faculty & Support Staff		**Society/ Parents**
Institutional & Financial Support		**Alumni**

HEIs — Stakeholders

Curriculum Design (course contents, duration, PLOs, delivery & assessment mechanism, CQI process)

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 & Allied Engineering Disciplines

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Electrical and Allied Engineering Disciplines took up the task to review and update the curriculum for Bachelor of Avionics Engineering degree program. The subject Committee had two meetings on 18-9-2019 and 20-01-2020 at PEC Headquarters Islamabad besides Sub-Group Avionics Engg Meetings on 9-12-2019 and 26-12-2019. The Committee consisted of following members:

1	Engr Prof Dr M. Younus Javed Vice Chancellor HITEC University, Taxila	Convener
2	Engr Dr Saeed Ur Rehman Executive Director Sir Syed CASE Institute of Technology, Islamabad	Member
3	Engr Zafar Mehmood Chief Executive Officer InterSES (International System Engineering and Services Pvt. Ltd), Islamabad	Member
4	Engr Prof Dr Suhail Aftab Qureshi Professor, University of Engineering & Technology, 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 TechFoot, Lahore	Member
7	Engr Prof Dr Jameel Ahmed Dean Faculty of Engineering & Applied Sciences Riphah International University, Islamabad	Member
8	Engr Mairaj Gul General Manager Operations North National Telecommunication Corporation, NTC HQs, Islamabad	Member
9	Engr Prof Mansoor Shaukat Assistant Professor School of Electrical Engineering & Computer Science (SEECS) 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 University of Engineering & Technology, Taxila	Member

12	Engr Prof Dr Madad Ali Shah Vice Chancellor The Benazir Bhutto Shaheed University of Technology and Skill Development Khairpur Mirs, Sindh	Member
13	Engr. Muhammad Roshan Awan Principal Govt. College of Technology, Taxila	Member
14	Engr. Habib Ur Rehman Qaiser Lt. Colonel Army (Rtd), Lahore	Member
15	Dr. Mohammad Ali Maud Professor Department of Computer Engineering UET, Lahore	Member
16	Engr Prof Dr Vali Uddin Professor, Department of Electronics Hamdard University, Karachi	Member
17	Prof. Engr Dr. Nisar Ahmed Professor Ghulam Ishaq Khan Institute of Engg, Sciences & 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. Prof Dr. Syed Mohammad Hasan Zaidi School of Electrical Engineering and Computer Engineering (SEECS), Islamabad	Member
24	Engr. Dr. Tauseef Tauqeer Associate Professor Information Technology University,Lahore	Member
25	Engr. Dr. Zahir Paracha Professor, Department of Electrical Engineering Pakistan Institute of Engineering & Technology, Multan	Member
26	Mr. Hidayatullah Kasi Deputy Director Higher Education Commission, Islamabad	Rep HEC
27	Engr. Dr. Ashfaq Ahmed Shaikh Additional Registrar-CPD Pakistan Engineering Council,Islamabad	Secretary
28	Engr. Muhammad Kashif Ali Assistant Registrar-CPD Pakistan Engineering Council, Islamabad	AR-CPD

5.1 Sub Group Avionics Engineering

1	Engr Dr. Jehanzeb Burki Head of Department College of Aeronautical Engineering, Risalpur	Lead Sub-Group

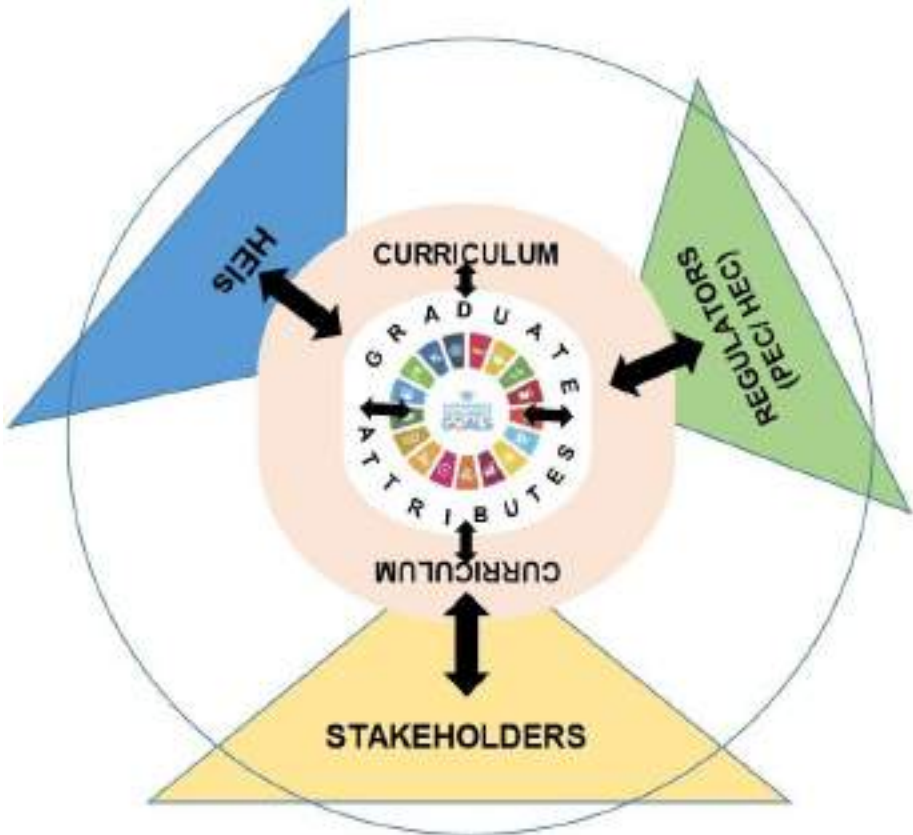| 2. | Dr Ali Hashmi | Expert |
	Director,	
	Space Programme, Islamabad	
3.	Engr Dr Mudassar Farooq	Expert
	Dean of Engineering	
	Air University, Islamabad	
4.	Engr Prof. Dr. Shahid Baqar	Expert
	Professor	
	Department of Avionics Engineering, Karachi	
5.	Engr. Prof. Dr. Farid Gul	Expert
	Professor	
	SEECS, NUST Islamabad	
6.	Engr. Dr. Majid Ali	Expert
	Professor	
	Institute of Space Technology, Islamabad	
7.	Mr. Hidayatullah Kasi	Rep HEC
	Deputy Director	
	Higher Education Commission, Islamabad	
8.	Engr. Dr. Ashfaq Ahmed Shaikh	Secretary
	Additional Registrar-CPD	
	Pakistan Engineering Council, Islamabad	
9.	Engr. Muhammad Kashif Ali	AR-CPD
	Assistant Registrar-CPD	
	Pakistan Engineering Council, Islamabad	

6. Agenda of ECRDC for Electrical and Allied Engineering Disciplines

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

The Convener Engr Prof Dr Younus Javed highlighted the important benchmarks and international best practices to be considered for the development/ revision of the curriculum while taking into account the Outcome Based Education (OBE) system. He also suggested that the Committee comprising professors and experts from academia, industry and R&D institutions has provided a useful input and suggestions covering new developments to be incorporated in the curriculum. He also highlighted the importance of the field of Avionics Engineering for achieving sustainable developments through indigenous solutions while addressing socio-economic issues and challenges envisaged in SDGs-2030 as under and well mapped with courses;

- Goal-1: No Poverty
- Goal-2: Zero Hunger
- Goal-3: Good Health and Well-being
- Goal-4: Quality Education
- Goal-5: Gender Equality
- Goal-8: Decent Work and Economic Growth
- Goal-9: Industrial Innovation and Infrastructure
- Goal-12: Responsible Consumption and Production
- Goal-13: Climate Action

OBE Curriculum towards SDGs-2030 Attainment

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

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

As guidance, the sample Program Educational Objectives (PEOs) and Learning Outcomes (PLOs) are given below for a typical Avionics 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 Avionics engineering graduates for contributing to the society through modern technologies and practices in line with SDGs especially Goal-1, Goal-2, Goal-3, Goal-4, Goal-5, Goal-8, Goal-9, Goal-12, and Goal-13.

    i.   The graduates of the program will be developed as engineering professionals who will be able to:

    ii.   Demonstrate excellence in profession through in depth knowledge and skills in the field of Avionics Engineering

    iii.   Engage in continuous professional development and exhibit quest for learning, innovation and entrepreneurship

    iv.   Show professional integrity and commitment to social and ethical responsibilities

7.2 Program Learning Outcomes (PLOs)

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

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

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

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

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

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

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

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

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

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

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

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

PLO12 Lifelong Learning: An ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

8. Program Salient Features

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

- **Duration:**   4 years

- **Number of Semesters:**   8

- **Total number of credit hours**:   130 - 136
    - o Engineering Domain: minimum 85 credit hours
    - o Non-Engineering Domain: minimum 30 Credit Hours

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

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

- **Number of weeks per semester**:   15 - 18

- **Number of credit hours per semester**:   15 - 18

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

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

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

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

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

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

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

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

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

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

Knowledge Profile* (WK-1 to WK-8)	Knowledge Area	Sub-Area	Courses	Credit Hours
Non-Engineering Domain				
WK-2	Natural Science	Math	As per program requirements	12 - 15
WK-1		Physics	Applied Physics	6 - 9
		Chemistry	Applied Chemistry	
		Natural Science/ Math Elective	As per program requirements	
WK-7	Humanities	English	Written, communication and presentation skills	4 - 7
		Culture	Islamic Studies and Ethics	2
			Pakistan Studies and Global Perspective	2
		Social Science	Social and soft skills	2 - 6
	Management Sciences	Professional Practice	Professional and Project Management	2 - 6
Total (Non-Engineering Domain)				**min 30**
Engineering Domain				
WK-2/ WK-4/ WK-5/ WK-6	Computer and information Sciences	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 outcome	22 - 24
WK-1/ WK-2/ WK-3/ WK-4	Multidisciplinary Engg Courses		Occupational Health and Safety (mandatory – 01 Cr Hr)	6 - 12
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			
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.

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

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

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

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

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

- **Personal Grooming:** Personal Grooming of young faculty members and students is very important in order to develop and support their professional skills. Therefore, it is required that HEIs should conduct/arrange sessions or counseling hours on regular basis to provide guidance for personal grooming. Personal Grooming is important for positive self-image and increasing the confidence level of the individuals. It would help in enhancing students' self-

esteem and would go a long way in developing an attractive personality by adopting habits like personal hygiene, clothing, appearance, interaction and expressive skills, etc. The students should be motivated and equipped to be entrepreneurs in their relevant field.

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

This curriculum has been designed to guide and facilitate the universities and departments to formulate their own programs according to the industrial needs, emerging trends and recent developments in the field of Avionics 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 Avionics Engineering/ Electrical Engineering (Avionics)

Knowledge Profile (WK-1 to WK-8)	Knowledge Area	Sub Area	Course Title	Theory	Lab	Total
				Credit Hours		
Non-Engineering Domain						
WK-7	Humanities	English	Functional English	2	0	2
			Communication Skills	2	0	2
			Technical Writing and Presentation Skills	2	0	2
		Culture	Islamic Studies and Ethics	2	0	2
			Pakistan Studies and Global Perspectives	2	0	2
	Social Sciences	Electives	Elective -I (Sociology)	2	0	2
			Elective-II (Engg Economics)	2	0	2
	Management Sciences	Professional Practice	Elective I(Project Management, Engg Management)	3	0	3
			Elective II (Entrepreneurship)	2	0	2
WK-2	Natural Science	Math	Calculus & Analytical Geometry	3	0	3
			Linear Algebra	3	0	3
			Differential Equations	3	0	3
			Complex Variables and Transforms	3	0	3
			Probability and statistics	3	0	3
			Numerical Methods	2	1	3
WK-1		Physics	Applied Physics	2	1	3

			Chemistry	Applied Chemistry	2	1	3
Total (Non-Engineering Domain)					**40**	**3**	**43**
Engineering Domain							
WK-2/ WK-4/ WK-5/ WK-6	Computer and Information Science	ICT/AI/ Data Science/ Cyber Security	Information and Communication Technologies (ICT)		2	1	3
			Computer Programming		2	1	3
			Algorithm and Data structures		2	1	3
WK-3/ WK-2	Engineering Foundation	--	Linear Circuit Analysis (DC circuits)		3	1	4
			Electrical Network Analysis (AC circuits)		3	1	4
			Workshop Practice		0	1	1
			Signals and Systems		3	1	4
			Electronic Devices & Circuits		3	1	4
			Digital Logic Design		3	1	4
			Engineering Drawing		0	1	1
			Electromagnetic Field Theory		3	0	3
			Introduction to Aerospace Engg		2	0	2
			Instrumentation & Measurement		2	1	3
WK-4/ WK-2/ WK-1	Avionics Engineering Core (Breadth)		Electronics Circuit Design (Integrated circuits and Op–amps)		2	1	3
			Analog & Digital Communications		3	1	4
			Engg Statics		2	0	2
			Engg Dynamics		3	0	3

			Electromechanical Systems	2	1	3
			Antenna Engineering	2	1	3
			Microwave Engineering	2	1	3
			Control Systems	3	1	4
			Transmission Lines and Waveguide	2	1	3
WK-5/ WK-6	Electrical Engineering Specialization Based Electives (Depth)		Depth Elective-I	2	1	3
			Depth Elective-II	2	1	3
			Depth Elective-III	2	1	3
			Depth Elective-IV	2	1	3
WK-3/ WK-4/ WK-2/ WK-1	Multi-disciplinary Electives (MDE)		MDE-I	3	0	3
			MDE-II	3	0	3
			Occupational Health and Safety*	1	0	1
WK-6/ WK-7/ WK-8	Final Year Design Project (FYDP)	Industrial/ Innovative/ Creative Projects	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 - Semester Project - Case Studies - Open Ended Labs - Problem Based Learning (PBL)					
Total (Engineering Domain)				64	28	92
Total Credit Hours				104	31	135

* to be taught during 1st year of program.

10. Scheme of Studies for Bachelor of Avionics Engineering/ Electrical Engineering (Avionics)

S.#	Course Title	Theory	Lab	Total
	Semester 1			
		Credit Hours		
1	Functional English	2	0	2
2	Calculus and Analytical Geometry	3	0	3
3	Introduction to Aerospace Engg	2	0	2
4	Introduction to ICT	2	1	3
5	Pakistan Studies and Global Perspectives	2	0	2
6	Applied Physics	2	1	3
7	Applied Chemistry	2	1	3
	Total	**15**	**3**	**18**
	Semester 2			
1	Linear Algebra	3	0	3
2	Workshop Technologies	0	1	1
3	Engg Statics	2	0	2
4	Differential Equations	3	0	3
5	Islamic Studies and Ethics	2	0	2
6	Computer Programming	2	1	3
7	Linear Circuit Analysis (DC Circuits)	3	1	4
	Total	**15**	**3**	**18**
	Semester 3			
1	Engg Dynamics	3	0	3
2	Probability and Statistics	3	0	3

3	Engineering Drawing	0	1	1
4	Algorithm and Data structures	2	1	3
5	Electrical Network Analysis (AC circuits)	3	1	4
6	Digital Logic Design	3	1	4
	Total	**14**	**4**	**18**
	Semester 4			
1	Electronic Devices and Circuits	3	1	4
2	Numerical Analysis	2	1	3
3	Complex Variables and Transforms	3	0	3
4	Electromagnetic Field Theory	3	0	3
5	Signals and Systems	3	1	4
	Total	**14**	**3**	**17**
	Semester 5			
1	Transmission Lines and Wave Guide	2	1	3
2	Analog and Digital Communication	3	1	4
3	Communication Skills	2	0	2
4	Electro Mechanical System	2	1	3
5	Electronics Circuits Design (integrated circuits and Op-amps)	2	1	3
6	IDEE-I	3/2	0/1	3
	Total	**14/13**	**4/5**	**18**
	Semester 6			
1	Technical Writing & Presentation Skills	2	0	2
2	Antenna Engg	2	1	3
3	Control System	3	1	4

4	IDEE-II	3	0	3
5	Social Science-II (Engg Economics)	2	0	2
6	Depth Elective I	2	1	3
Total		**14**	**3**	**17**
Semester 7				
1	Instrumentation and Measurement	2	1	3
2	Depth Elective-II	2	1	3
3	Management Sciences Elective I	3	0	3
4	Social Science-I	2	0	2
5	Microwave Engg	2	1	3
6	Final Year Design Project – I	0	3	3
Total		**11**	**6**	**17**
Semester 8				
1	Depth Elective – III	2	1	3
2	Depth Elective –IV	2	1	3
3	Entrepreneurship (Management Sciences Elective-II)	2	0	2
4	Final Year Design Project – II	0	3	3
Total		**6**	**5**	**11**
Grand Total		**135**		

Proposed List of Engineering Depth Electives

- Embedded System
- Radar Systems
- Avionics System Design
- Flight Dynamics and Control
- Guidance, Navigation and Control
- Data Computer and Satellite Communication
- Digital Signal Processing
- FPGA System Design
- Emerging Aviation Technologies
- Radar Signal Processing
- Advance Digital Signal Design
- Cyber Security in Avionics
- Electro Optics/ Infrared
- Artificial Intelligence
- Fundamentals of Avionics Engg
- Manufacturing Process and CNC Machines
- Prototyping
- EMC/EMI

Proposed List of Multi-disciplinary (MDEE) Electives

- Product Design and Development
- Thermodynamics of Propulsion
- Applied Aerodynamics
- Astrodynamics
- AI for Engineers
- Cloud computing and IOT
- Operating Systems
- Computer System Architecture

Proposed Electives for Social Science

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

- Sociology for Engineers
- Professional Ethics
- Economics for Engineers
- Sociology
- Social Anthropology
- Understanding Psychology and Human
- Social Psychology
- Organizational Behavior
- Critical Thinking
- Philosophy
- Human Resource Development
- Culture and Society
- Engineering Law

Proposed Electives for Management Sciences

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

- Entrepreneurship
- Entrepreneurship and Marketing
- Engineering Project Management
- Principle of Management
- Engineering Management
- Quality Management Systems
- Textile Marketing
- Industrial Engineering and Management
- Total Quality Management
- Supply Chain Management
- Production Management

11. Program Specific Lab

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

- Digital & Embedded System Lab
- Guidance, Navigation & Control Lab
- Antenna & Electromagnetic Lab
- Communication Labs
- Radar Lab
- Microwave Lab
- PCB Prototyping Lab
- Advanced Design System Lab
- Thermal Imaging Lab
- Project & Research Lab

12. Courses Details and Teaching-Assessment Approaches

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

12.1   Engineering Domain

Computer and Information Sciences

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, 7th Edition, 2013, McGraw-Hill.
- "Computing Essentials", Timothy O'Leary and Linda O'Leary, 2010, McGraw-Hill.
- Using Information Technology: A Practical Introduction to Computers & Communications", Williams Sawyer, 6th Edition, 2005, McGraw-Hill.
- "Discovering Computers, Complete: You're Interactive Guide to the Digital World.
- Cengage Learning" Shelly GB, Vermaat ME, 2012 Ed.

Computer Programming

Course Outline:

- Introduction to Programming and languages
- Algorithms, Flowcharts and pseudocode
- Overview of programing (C, C+, Python)
- Writing, compiling and debugging
- Coding style
- Statements
- Variables and datatypes
- Operators and expressions
- Selection
- Relational operators
- Conditional Statements
- Conditional operators
- Switch, break, continue
- Logical operators
- Modular programming
- Structures in functions and Arrays
- File pointers
- Error handling
- Revision
- Project Demos

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Paul J. Deitel and Harvey M. Deitel, C: How to Program, Prentice Hall, latest edition.

- The C Programming Language (2nd Ed.) by Kernighan and Ritchie, latest edition.
- Code Complete (latest Ed.) by Steve McConnell.
- The Art of Computer Programming (TAOCP) by Donald E. Knuth, latest edition.

Computer Aided Design

Course Outline:

- Introduction to AutoCAD
- Use basic drawing and text commands
- Use basic editing commands (move, copy, erase, etc.)
- Use advanced editing commands (mirror, fillet, etc.)
- Dimensioning capabilities of Auto CAD
- Create and use layers
- Print or plot a drawing
- Create and using blocks
- Be familiar with hatching capabilities of Auto CAD
- Curves
- 3D modeling
- Multiple Lines
- Geometric Shapes
- Isometric drawings
- Polar Arrays

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Introduction to 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 latest edition.
- https://www.mathworks.com/help/simulink/simulation.html
- https://www.mathworks.com/help/simulink/modeling.htm

Artificial Intelligence

Course Outline

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

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Algorithms and Data Structure

Course outlines:

- Data types, Arrays, Records, Set structure, Abstract Data Types, Sequential allocation, Linked allocation. Stacks (Sequential as well as Linked Implementation) Queues. (Sequential as well as Linked Implementation), Linked Lists, Recursive versus Iterative Algorithms, Applications, Towers of Hanoi, Linked Lists, Traversal, Insertion, Deletion, Doubly linked lists, Root Node,
- Terminal Node, Branch Node, Level of a Node, Degree of a node. , Binary Tree, Tree traversal, (In-order/Pre-order/Post-order traversal), Conversion of tree into binary tree/ Bin tree into a Heap. Traversing and searching in a tree, Insertion: Deletion, Heap, Heap-sort, Graphs. Adjacency Matrix, Traversal, DFS, BFS, Path lengths, Shortest Path

- Searching & Sorting Algorithms, Insertion sort, Selections sort, Merge sort, Radix sort, Hashing.

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:

- Horowitz Sahni, "Fundamentals of Data Structures in C++", 1999.
- Lipshutz, "Data Structures", Schaum Outline Series, 1999.
- Weiss, "Data structures and algorithm analysis in C++".
- M. Tanenbaum, "Data structures using C and C++", 2001.

Engineering Foundation Courses

Linear Circuit Analysis

Course Outlines:

- Electric quantities, electric signals, electric circuits
- Kirchhoff's laws, circuit elements. Resistance, series parallel combination, voltage and current dividers, resistive bridges
- Nodal analysis, loop analysis, linearity and superposition, source transformation, one ports, circuit theorems, power calculations. dependent sources, circuit analysis with dependent sources
- The operational amplifier, basic op-amp configurations, ideal op-amp circuit analysis, summing and difference amplifiers, amplifier types
- Capacitance, inductance (including mutual inductance), natural response of RC and RL circuits. Response to DC forcing function
- AC fundamentals; RMS or effective, average and maximum values of current & voltage for sinusoidal signal wave forms.

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

Suggested Books:

- S. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest Edition).
- R E Thomas, A J Rosa and G J Toussaint, "The Analysis and Design of Linear Circuits" John Wiley, 6th Edition, 2009
- C Alexander and M Sadiku, "Fundamentals of Electric Circuits", McGraw-Hill, 4th Edition, 2008
- J D Irwin and R M Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008
- W Hayt, J Kemmerly and S Durbin, "Engineering Circuit Analysis", McGraw-Hill, 7th Edition, 2007.

Electrical Network Analysis

Course Outlines:

- Current and voltage transients,
- RLC circuits with DC and AC excitation,
- Transient response and step response of second order circuits.
- Resonant circuit: series and parallel resonance in AC circuit,
- Q-Factor,
- Analog filters,
- Introduction to phasor representation of alternating voltage and current,
- Single-phase circuit analysis,
- Star-delta transformation for DC and AC circuits,
- Three phase circuits, power in three phase circuits and different methods of its measurements.

- Two-port networks and their interconnections.
- Application of Laplace transform in circuit analysis.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written assignments/ Quizzes, tutorials, 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. Franco, "Electric Circuits Fundamentals", Oxford University Press, (Latest Edition).
- V.V. Burg, "Network Analysis", (Latest Edition)
- R E Thomas, A. J. Rosa and G. J. Toussaint, "The Analysis and Design of Linear Circuits" John Wiley, 6th Edition, 2009
- C. Alexander and M. Sadiku, "Fundamentals of Electric Circuits", McGraw-Hill, 4th Edition, 2008
- J. D. Irwin and R. M. Nelms, "Basic Engineering Circuit Analysis", Wiley, 9th Edition, 2008
- W. Hayt, J. Kemmerly and S. Durbin, "Engineering Circuit Analysis", McGraw-Hill, 7th Edition, 2007.

Workshop Practice

Course Outline:

- Introduction to various technical facilities in the workshop including mechanical and electrical equipment.
- Concepts in electrical safety, safety regulations, earthing concepts, electric shocks and treatment.
- Use of tools used by electricians, wiring regulations, types of cables and electric accessories including switches, plugs, circuit breakers, fuses etc.,
- Symbols for electrical wiring schematics e.g. switches, lamps, sockets etc.,
- Drawing and practice in simple house wring and testing methods,

- Wiring schemes of two-way and three-way circuits and ringing circuits, voltage and current measurements.
- Electric soldering and soldering tools; soldering methods and skills,
- PCB designing, transferring a circuit to PCB, etching, drilling and soldering component on PCB 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:

- Choudhury, "Elements of Workshop Technology", Vol. 1, MPP.
- Chapman, "Workshop Technology", Part-I, II, III, CBS.

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Signals and Systems

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Course Outline:

- Continuous time and discrete time signals
- Periodic signals, even and odd signals, exponential and sinusoidal signals, the unit impulse and unit step functions
- Continues time and discrete time systems
- Linear time invariant (LTI) systems, difference equation, causality, BIBO stability, convolution and correlation
- Discrete time Fourier transforms, time and frequency characterization of signals and systems
- Analysis and design of continuous time systems using Laplace transforms.
- The sampling theorem, aliasing, sampling the discrete time signals

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:

- V. Oppenheim, A. S. Willsky and S. H. Nawab, "Signals and Systems", 2nd Edition, Prentice Hall, 1996
- M. J. Roberts, "Fundamentals of Signals and Systems", McGraw-Hill, 2007
- P. Lathi, "Linear Systems and Signals", 2nd Edition, Oxford, 2004
- S. Haykin and B. Van Veen, "Signals and Systems", 2nd Edition, Wiley, 2002
- L. Phillips, J. M. Parr and E. A. Riskin, "Signals, Systems, and Transforms", 4th Edition, Prentice Hall, 2007.

Electronics Devices and Circuits

Course Outline:

Semiconductor Devices

- Semiconductor Diode Introduction,
- Semiconductors, Energy Levels, n-type and p-type materials,
- Semiconductor Diode,
- Characteristics of Diode,
- Diode Equivalent Circuits Transitions, Recovery, Specification, Notations,
- Testing of Diode, Zener Diode, Light Emitting Diodes,
- Numerical Problems.

Diode Applications

- Introduction,
- Load Line Analysis, Parallel and Series Configurations, Gates, Sinusoidals, Half Wave/Full Wave Rectifiers,
- Clipper and Clamper Circuits,

- Zener Diodes,
- Voltage-Multiplier Circuits and Applications,
- Numerical Problems.

Bipolar Junction Transistors

- Introduction,
- Construction and Operation,
- Amplification analysis,
- Common-Emitter, Common-Base and Common Collector Configurations of BJT,
- Limits of Operation,
- Specification,
- Testing,
- Casing and Terminal Identification of BJTs,
- Numerical Problems.

DC Biasing-BJTs

- Introduction,
- Operating Point, Fixed-Bias, Emitter Bias, Voltage Divider Bias Configurations,
- Collector Feedback, Emitter-Follower, Common-base and Miscellaneous Configurations,
- Design Operations, Current Mirror and Current Source Circuits,
- PNP Transistors,
- Transistor Switching Networks,
- Bias Stabilization,
- Numerical Problems.

BJT AC Analysis

- Introduction,
- AC Domain,
- BJT Modeling, re-Model, CE-Fixed Configuration, Voltage Divider Bias, CE Emitter-Bias, Emitter-Follower, Common-Base, Collector Feedback and Collector Feedback Configurations, Current Gain, RL and RS,
- Two Port Systems, Cascaded Systems, Darlington and Feedback Pair,

- Hybrid Equivalent Model, Hybrid π Model,
- Variations of Transistor Parameter,
- Numerical Problems.

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:

- Electronic Devices and Circuit Theory, H. Boylestad and L. Nashelsky, ISBN-10: 0135026490
- Electronic Devices, Thomas L. Floyd, ISBN-10: 0132359235
- Electronics Principles, Alberto P Malvino ISBN: 978-0073373881

Engineering Drawing

Course Outline:

- Types of lines and usage,
- Dimensioning,
- Orthographic first angle projection,
- Orthographic third angle projection,
- Introduction to computer aided drawing,
- Isometric projection,
- Sectional drawing
- Assembly drawing.
- Reading and preparing electrical engineering drawings such as wiring diagram, power system layout diagram, PCB drawing etc.

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:

- Shawna Lockhart, "Tutorial Guide to AutoCAD", Prentice Hall.
- C. Parkinson, "First Year Engineering Drawing".
- N.D. Bhatt, Engineering Drawing.

Digital Logic Design

Course Outline:

- Number Systems,
- Boolean Algebra,
- Logic Simplification,
- Combinational Logic,
- Sequential Logic,
- Latches, Flip-Flops and their applications.
- Adders, Multiplexers, Counters, Shift Registers
- Simple Arithmetic Logic Unit (ALU).
- Design and implementation of combinational circuits in Verilog,
- Introduction to FPGA.

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:

- M. Morris Mano and Michael D. Ciletti, "Digital Design with an introduction to the Verilog HDL", Prentice Hall, 5th Edition.
- Morris Mano and Charles R. Kime, "Logic and Computer Design Fundamentals", Prentice Hall. Latest Edition
- Tocci and Widmer, "Digital Systems: Principles and Applications". Prentice Hall. Latest Edition

Electromagnetic Field Theory

Course Outline:

- Vector algebra, coordinate systems and transformations,
- Vector calculus,
- Basic concepts of electromagnetic theory
- Properties of static and time-varying electromagnetic fields
- Mathematical description of fundamental laws of electromagnetism
- Electric and magnetic properties of materials
- Physical meaning of Maxwell's equations
- Principles of electromagnetic radiation

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:

- William Hayt and John A. Buck, "Engineering Electromagnetics", McGraw-Hill, ISBN: 0073104639, Latest Edition.
- Sadiku, Matthew N, "Elements of Electromagnetics", Oxford University Press, ISBN: 0195103688, Latest Edition.
- J. D. Kraus, "Electromagnetics", John Wiley & Sons, Latest edition.

- David K. Cheng, "Fundamentals of Engineering Electromagnetics", Addison Wesley.

Introduction to Aerospace Engineering

Course Outline:

A Brief History of Flight

- Balloons and Dirigibles
- Heavier than air flight
- Commercial Air Transport
- Jet Aircraft
- Helicopters
- Conquest of Space
- The Commercial Use of Space
- Exploring the solar system and Beyond
- A permanent human presence

Aerodynamics

- Generating Lift
  - Buoyancy Lift
  - Lift from Fluid Air Motion
  - Coefficient of Pressure
  - Relation between Lift/Drag Vs AOA
- **Sources of Drag**
  - Profile Drag
  - Skin Friction Drag
  - Induced Drag

Aircraft Performance

- Introduction and airfoil Nomenclature
- Performance Parameters
- Aircraft Components
- A Two-dimensional aircraft model
- Steady Flight

- Accelerated Flight

Aircraft Propulsion

- Introduction
- The Propeller
- The illustrated jet engine
  - Intake
  - Compressor
  - Combustor
  - Turbine
  - Nozzle

Aircraft Stability and Control

- Introduction
- Airplane stability
- Static forces and moments on aircraft

Introduction to Aircraft Avionics Systems

- Basic Radar Systems
- Communication systems on an Aircraft
  - VHF
  - IFF
  - DME/TACAN
- Navigation Aids for an Aircraft
  - ADF
  - GPS
  - ILS
  - HUD

Flight Instruments on an Aircraft (Pitot-Static Instruments)

- Altimeter
- ASI
- VVI

The Space environment

- Introduction

- What is Space
- Microgravity

Teaching Methodology (Proposed as applicable):

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

Assessment:

Mid-exam/OHTs, Report writing/Presentation, Assignment, Quizzes, Final exam/ assessment.

Suggested Books:

- John D. Anderson, 'Introduction to Flight', 8th Edition, McGraw-Hill Education, 2016 / Latest Edition..
- John D. Anderson, 'Fundamentals of Aerodynamics', 6th Edition, McGraw-Hill Education, 2016 / Latest Edition.
- Dave Newman, 'Interactive Aerospace Engineering and Design', McGraw-Hill Education, 2002

Instrumentation and Measurements

Course Outline:

- Precision measurements terminologies principles of different measurement techniques;
- Instruments for measurement of electrical and non-electrical quantities including voltmeters, ammeters, function generators, oscilloscopes;
- Systems for signal processing and signal transmission;
- Modern instrumentation techniques;
- Static and dynamic responses of instrumentation and signal conditioning;
- Data acquisition systems;
- Principles of operation, construction and working of different analog and digital meters,
- Advanced Testing & Measuring instruments recording instruments,
- Signal generators,

- Sensors, Input and output transducers; types of bridges for measurement of resistance, inductance, and capacitance; power and energy meters;
- High-voltage measurements,
- PLC systems.
- Types of bridges for measurement of resistance, inductance, and capacitance; power and energy meters;
- High-voltage measurements,
- PLC systems.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Modern Electronic Instrumentation and Measurements Techniques by A. D. Helfrick, W.D. Cooper
- Klaas B. Klaassen and Steve Gee, "Electronic Measurement and Instrumentation," 1996, Cambridge University Press, ISBN: 0521477298.T
- H Kevin, James H, "PC Interfacing and Data Acquisition: Techniques for Measurement, Instrumentation and Control," 2000, Newnes, ISBN: 0750646241.
- Alan S. Morris, Reza Langari, "Measurement and Instrumentation, Theory and Application", Elsevier, 2012, ISBN 978-0-12-381960-4
- Electrical Instrumentation and Measurement techniques, By A. K. Sawhney
- R. C. Dorf and R. H. Bishop, "Modern Control Systems," 12th Edition
- B. C. Kuo, "Automatic Control Systems" 7th Edition

Engineering Breadth Courses

Electronics Circuits Design (Integrated CCTs and Op-amps)

Course outline:

Amplifier Analysis:

Transistor as an amplifier, hybrid model of a transistor, small-signal analysis, large-signal analysis, gain calculation of single-stage amplifier, cascading, multistage gain calculations.

Current Sources:

(Simple current mirror, Widler and Wilson current source): output stage design;

Differential Amplifiers:

DC and AC analysis of differential amplifier; design of simple differential amplifier; level translator;

Use of op-amp:

As a circuit element, offset and offset compensation, op-amp with negative feedback, frequency response of an op-amp, DC and AC analysis of op-amp ICs;

Classification of Amplifiers on the Basis of Biasing:

Class A amplifier, class B amplifier, class AB amplifier, class C amplifier, push-pull amplifier, and complementary symmetry amplifier.

Feedback:

Feedback concept, feedback amplifiers, voltage feedback amplifier, current feedback amplifier. Effect of feedback on frequency response.

Practical Amplifier Considerations:

Input and output impedance, amplifier loading, impedance matching.

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. Sedra and K. C. Smith, "Microelectronic Circuits", Oxford University Press, Latest edition.
- Behzad Razavi "Fundamentals of Microelectronics," Wiley, Latest edition.
- Robert L. Boylestad and Louis Nashelsky "Electronic Devices and Circuit Theory", Prentice Hall, Latest edition.
- Thomas L. Floyd "Electronic Devices (Conventional Current Version)", Prentice Hall, Latest edition
- T. F. Bogart, "Electronic devices and circuits". Latest Edition.

Microwave Engineering

Course outline:

- RF behavior of Passive Components and RF models, Chip components,
- Distributed Circuit elements, Strip Lines, Microstrip Lines,
- Coupled Striplines/Coupled microstriplines,
- Smith Chart, Impedance and Admittance Transformation, Parallel and series Connection,
- Impedance Matching Networks,
- Analysis of Single and Multiport Networks using Network Parameters,
- Microwave Filter Design, Microwave Amplifier design, Mixers and Detectors, Oscillators,
- Power dividers, Directional Couplers, Circulators,
- Microwave Systems.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- David M. Pozar, "Microwave Engineering", Wiley, 2009
- Microwave Devices & Circuits by Samuel Y. Liao 3rd Ed (1990)
- Understanding Microwave by Allan W Scott Revised Edition (2005)
- Microwave Transistors and Amplifiers by Guillermo Gonzalez. 2nd Ed (1996)
- Microwaves made simple by W.S. Cheung 1st Ed (1985)

Antenna Engineering

Course Outline:

- Antenna and radiation, basic antenna types (two wire antenna + dipole), isotropic, omni-directional antennas, practical antenna types
- Antenna pattern, beam area, beam solid angle, radiation intensity, gain and directivity,
- Short dipole, fields of a short dipole, the thin linear antenna, radiation patterns of a dipole antenna, Helical antenna, modes of operation (Helix), design procedure.
- Micro-strip antennas + feeding methods, transmission line models, cavity model, slot antenna + feeding method, different forms of slot antenna.
- Horn Antenna, phase center, rectangular horn design, reflector antenna, corner reflector + parabolic dish, Yagi-Uda configuration, Yagi-Uda design
- Point sources, antenna arrays, different cases of isotropic sources, principle of pattern multiplication, pattern synthesis
- Linear array of N isotropic sources, Evaluation of total field, Broadside and End-fire arrays, Beam scanning and Null pointing, Phase shifters, Beam switching feed network
- Antennas for different applications, mobile phones and antennas, satellite antennas, active antennas, multiband / broadband antennas
- Reflection coefficient, vector network analyzer, anechoic chamber, antenna gain measurement
- Maxwell's equations, transmission lines, wave equation, plane waves, phase velocity, lossy media, propagation mechanisms, geometrical optics, diffraction, single knife edge, fresnel zones, propagation models, path loss, noise modeling, free space loss, plane earth loss, link budget

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:

- Antenna Theory Analysis and Design by C.A. Balanis, John Wiley & Sons, Latest Edition.
- Antennas for all applications by J. D. Krauss, Latest edition.
- Antennas and propagation for wireless communication systems by Simon R. Saunders, Latest edition.
- Fields and Waves Electromagnetics by David K Cheng, 2nd Ed (1989).
- Antenna Theory and Design by Stutzman, John Wiley & Sons, 3rd Ed (2012).

Transmission Lines and Waveguides

Course Outline:

- Transformer and motional EMFs and Maxwell's equations in final forms
- Time harmonic fields
- Electromagnetic wave propagation, wave propagation in lossy dielectrics, plane waves in lossless dielectrics, free space and good conductors.
- Power and the Poynting vector, reflection of a plane wave at normal incidence and oblique incidence, interaction of EM waves with Ionosphere, transmission lines
- Introduction & parameters transmission line equations, input impedance, SWR and Power, Smith chart, transients on transmission lines
- Micro-strip transmission lines
- Rectangular waveguides, Transverse Magnetic (TM) modes, Transverse Electric (TE) modes, power transmission and attenuation
- Waveguide current and mode excitation, waveguide resonators

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 Electromagnetics by Matthew N. O. Sadiku 6th Ed (2015)
- Engineering Electromagnetics by William H Hayt, Latest Edition.
- Field and Wave Electromagnetic by David K Cheng, Latest Edition.

Electromechanical Systems

Course Outline:

- Theory and application of rotating electrical machines and transformers
- Principles of electromagnetic energy conversion
- Introduction and operation of DC motors and their characteristics, commutation and speed control and transformers for single and polyphase circuits.
- Principle of operation of AC generators and their characteristics
- Concepts of efficiency and losses
- Construction operation and characteristics of polyphase induction motors
- Synchronous AC motors & Universal motors
- Fault location in machines and selection of machines.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Electric Machinery Fundamentals by Stephen J. Chapman, Latest Edition
- Electric Machines: Theory, Operation, Applications, Adjustment and Control by Charles Hubert, Latest Edition
- Circuit Devices and Systems by Ralph J Smith 5th Ed (2007)
- Direct & Alternating Current Machinery by Rosenblatt and Friedman 2nd (1990)

Engineering Statics

Course Outline:

- General principles of statics and the equilibrium of bodies under the action of forces
- Properties of forces, moments, couples, resultants and analysis of two-dimensional problems.
- Application of equilibrium principles to simple trusses and to frames and machines.
- Beam external and internal effects
- Topics of beams and types of friction.

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:

- Engineering Mechanics by J L Meriam & L.G. Kraige, Latest edition
- Engineering Mechanics by Irving H Shames, Latest edition
- Engineering Mechanics (Statics) by R C Hibbeler, Latest edition

Engineering Dynamics

Course Outlines:

- Rectilinear, angular, plane curvilinear and space curvilinear motion.
- Linear impulse and momentum
- Work and energy
- Impact and constrained motion of connected particles
- Equations of relative velocity, relative acceleration are encountered
- Vector geometry and vector algebra.

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:

- Engineering Mechanics (Dynamics), J L Meriam& L G Kraige, Latest Edition
- Engineering Mechanics (Dynamics) by R C Hibbeler, Latest Edition
- Engineering Mechanics by Higdon and Stiles, Latest Edition

Analog and Digital Communication

Course Outline:

- Introduction to Communication Systems
- Elements and limitations of communication systems
- Modulation and coding. Signals
- Spectra and filtering
- Linear CW modulation and angle CW Modulation
- Sampling and pulse modulation,
- Receivers for CW modulations
- Probability and random processes
- Analog communication in noise

- Baseband digital transmission

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:

- Modern Digital and Analog Communication Systems by B P Lathi, Oxford University press, Latest Edition
- An Introduction to Analog and Digital Communications by Simon Haykin and Michael Maher, Latest Edition
- Digital Communications by John Proakis and Masoud Salehi, Latest Edition
- Digital Communications: Fundamentals and Applications by Bernard Sklar and Pabitra K Ray, Latest Edition

<div align="center">Control Systems</div>

Course Outline:

Systems and their Models, Dynamic Response

Modeling examples, differential equations, impulse response, transfer functions, poles and zeros, feedback.

Root Locus Design

Evans' root locus method, dynamic compensation.

Frequency Response Design

Bode plots, Nyquist stability criterion.

State Space Design

Introduction to modern control, linear pole placement, estimator design, LQR.

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:

- Norman S. Nise, "Control Systems Engineering", Latest Edition
- Franklin, Powell and Emami-Naeini, "Feedback Control of Dynamic Systems", Latest Edition
- Steffani, Savant, Shahian and Hostetter, "Design of Feedback Control Systems" Saunders College Publications, Latest Edition
- Katsushiko, Ogata, "Modern Control Engineering," McGraw-Hill, Latest Edition
- R. C. Dorf and R. H. Bishop, "Modern Control Systems," Latest Edition
- B. C. Kuo, "Automatic Control Systems", Latest Edition

Depth Engineering Courses

Avionics System Design

Course Outline:

Design Criteria for Safety Critical (DAL-A) Avionics Systems

- Fundamentals of Fly by Wire (FBW) Flight Control System (FCS).
- Implementation of FBW FCS.
- Concept of Redundancies for Enhanced Reliability.
- Practical Aspects of using Redundant Channels.

Future Avionics Surveillance Systems

- Automatic Dependent Surveillance – Broadcast.
- Sense and Avoid Methodologies.
- Aircraft Trajectory Optimization and 4D Navigation.
- Introduction to SESAR and Next-Gen ATM.

Avionics Architectures

- Introduction to ARINC-429 Data Bus.
- Fundamentals of Mil-Std-1553 Data Bus.
- Introduction to AFDX Data Bus.
- Integrated Modular Avionics architecture
- Introduction to advanced military architectures

Processes for Design and Development of Certifiable Avionics

- Guidelines for Development of Civil Aircraft and Systems (ARP-4754)
- Software design as per RTCA-DO-178
- Airborne hardware design as per RTCA-DO-254
- Processes for certifiable Avionics system design
- Packaging, Electrical Power and EMC standards
- Fault tolerant Avionics

Additional Topics

- Converting user requirements to design specifications
- Mission profile data
- Aircraft electrical power distribution
- Product design aspects
- Life Cycle support

Safety Assessment

- Functional Hazard Analysis
- Failure Mode and Effect Analysis

Case Studies:

i. Implementation of Aircraft Communication Systems.
ii. Analysis of Contemporary Avionics Issues.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Principles of Avionics" by Albert Helfrick ISBN: 1885544170, Avionics Communication Inc, (2002).
- Digital Avionics Systems" by Cary R Spitzer, ISBN: 1930665121, The Blackburn Press, 2nd Ed (2000).
- Introduction to Avionics Systems" by R P G Collinson, ISBN: 1402072783, Kluwer Academic Publishers, 2nd Ed Dec 2002.
- Civil Avionics Systems" by Ian Moir and Allan Seabridge ISBN: 0470029293, John Wiley & Sons Ltd, (2006).
- Military Avionics Systems" by Ian Moir and Allan Seabridge ISBN: 0470016329, John Wiley & Sons Ltd, (2006).

Radar Systems

Course Outline:

Introduction & Radar Range Equation (RRE)

- Introduction to Radars.
- Derivation & application of RRE.
- Minimum Detectable Signals & Receiver Noise.
- Probability Density Function & SNR.
- Integration of Radar Pulses.
- Radar Cross Section & RCS Fluctuations.
- PRF & Range Ambiguities.
- Physical interpretation of RRE parameters.
- System Losses.

CW, FMCW and MTI Pulse Doppler Radars

- Doppler Effect.
- CW Radar.
- FMCW Radar.
- Introduction to Pulse Doppler radar.

- Delay Line Cancellers.
- Multiple / Staggered PRF.
- Range Gating.
- Radar Signal Processing.
- MTI Limitations.
- Non Coherent MTI.
- MTI from Moving Platform

Tracking Radars

- Introduction to Tracking.
- Conical Scan.
- Sequential Lobing.
- Monopulse Tracking.
- Tracking in Range.
- Track While Scan.

Radar RF Front End

- Radar Transmitter Components.
- Radar Transmitter Design.
- Radar Receiver Design.
- Displays.
- Radar Processors.
- Radar Networking.
- Radar Antenna parameters.
- Radar Antenna Types.
- Radiation Patterns.
- Stabilization.
- Radomes.

Detection of Radar Signals

- Detection of Radar Signals in Noise.
- Matched Filter Receiver.
- Correlation Detection.
- Detection Criteria.
- Detector Characteristics.

- Automatic Detection.
- Constant-False-Alarm-Rate (CFAR) Receiver.
- Information Available from Radar.
- Theoretical Accuracy of Radar Measurement.
- Ambiguity Diagram.
- Pulse Compression.
- Classification of Targets.
- Propagation Effects.
- Radar Clutter.

Other Radar Topics

- Phased Array Radars.
- Synthetic Aperture Radars.
- Airborne and Multi-Function Radars.
- Automotive Radars.
- Electronic Warfare.
- Radar Performance Modeling.

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 Radar Systems 3rd Edition by Merill I Skolnik; McGraw Hill.
- Radar System Analysis and Design 3rd Edition by Baseem R Mahafza, CRC Press.
- Introduction to Airborne Radar 2nd Edition by George W Stimson, SciTech Publishing.
- Radar System Performance Modeling 2nd Edition by G. Richard Curry, Artech House.

Guidance and Navigation

Course Outline:

Guidance

- Introduction to Tactical Missile Guidance.
- Proportional Navigation & Miss Distance.
- Kalman Filter Basics.

Navigation

- Navigational Frames of References.
- Introduction to Radio Navigation Systems.

Radio Navigation Aids

- Concept of Hyperbolic Intercepts and Triangulation.
- VOR.
- DME.

Inertial Navigation System

- Principles of Gyroscopes.
- Types of Gyroscopes.
- Computation of Position using Dead Reckoning.

GNSS

- Principle of Operation of GPS.
- GPS Data Format.
- Solution of GPS Equations to Compute Position.
- GPS Errors.

Auto Landing Systems

- Instrument Landing System.
- Microwave Landing System.
- GBAS Landing System.

Air Traffic Management

- Basics of Air Traffic Management.
- Area Navigation (RNAV).

- Required Navigation Performance (RNP).
- Performance Based Navigation (PBN).

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:

- Avionics Navigation Systems; Second Ed by Myron Kayton, Walter Fried, Wiley and Sons.
- Tactical and Strategic Missile Guidance, 6th Ed by Paul Zarchan, AIAA.
- Introduction to Avionics Systems" by R P G Collinson, ISBN: 1402072783, Kluwer Academic Publishers, 2nd Ed Dec 2002.
- Aircraft Communication and Navigation Systems, Mike Tooley and David Wyatt, Elsevier Press.

Flight Dynamics and Control

Course Outline:

Introduction

- Introduction to Flight Control Systems.
- Review of Handling Qualities and the Effects of Different Feedback Loops.

Longitudinal Flight Control

- Introduction.
- Longitudinal Stability Augmentation.
- Effects of Different Feedbacks.
- Pitch Hold Autopilot.
- Velocity Hold Autopilot.
- Altitude Hold Autopilot.
- Flight Path Angle Hold Autopilot.

Lateral Flight Control

- Introduction.
- Lateral Stability Augmentation.
- Effects of Different Feedbacks.
- Bank Angle Hold Autopilot.
- Heading Angle Hold Autopilot.
- Navigational Autopilots.

Glide Slope Hold

- Automatic Flare Control.
- Localizer Hold Mode.
- VOR Hold Mode.

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:

- Flight Dynamics Principles, Second Edition, by M. V. Cook.
- Introduction to Aircraft Flight Mechanics, by Thomas R. Yechout.
- Flight Stability & Automatic Control, Second Edition, Robert Nelson.
- Modern Control Engineering, Fifth Edition, by Katsuhiko Ogata.

Electromagnetic Compatibility - EMC Theory, Design and Measurement

Course Outline:

Fundamentals of EMC

- Introduction to Electromagnetic Interference (EMI).
- Conducted and Radiated Emission.
- Conducted and Radiated Susceptibility.
- Product Slippage.

EMC Standards and Regulations

- American and European EMC Standards.
- Generic Standards & Product Standards.
- FCC Regulations & other Specifications.
- Achieving Compliance for Products and Problems Encountered.
- Routes to Compliance.
- EMC Theory.
- Electromagnetic Field propagation.
- Skin effects.
- Electric and Magnetic Dipole.
- Near field and far field Radiation.
- Capacitive and Inductive Coupling.
- Rayleigh range of antennas
- Common-mode and differential-mode emission
- ESD coupling

EMC Measurement Test Facilities

- ESD (Electrostatic Discharge) Test.
- Conducted Emission Test.
- Conductive Immunity Test.
- Radiated Emission Test.
- Radiated Immunity Test.
- Harmonic and Voltage Fluctuations.

Test Facilities

- EMC in Large Systems.

- Open Field Test Sites.
- Normalized Site Attenuation.
- Screened Rooms and Anechoic Chambers.
- TEM Cells.
- Antenna for EMC Measurement.

Diagnostic Testing and EMC Design

- E and H Field Shielding.
- Screening Effectiveness.
- Cross Talk.
- Common Impedance.
- PCB Layout.
- Switching Noise.
- Coupling of External Field to Cable.
- Component Placement and Mounting.

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:

- Testing for EMC Compliance: Approaches and Techniques, Mark I. Montrose, Edward M. Nakauchi, Wiley Press.
- EMC for Product Designers, Tim Williams, 4th Edition, Elsevier Press.
- Introduction to Electromagnetic Compatibility 2nd Edition, Wiley Press.

Digital Signal Processing

Course Outline:

Introduction

- Introduction to Signals and Systems.
- Classification of Signals.
- Analog to Digital and Digital to Analog Conversion.

Discrete Time Signals and Systems

- Classification of Systems.
- Linear Time Invariant Systems and Their Properties.
- Linear Constant Coefficient Difference Equation.
- Correlation of Discrete Time Energy Signals.

The Z-transform

- Definition.
- Properties of z-transform.
- Inverse z-transform.
- Analysis of LTI Systems in z-domain.

Frequency Domain Analysis of Signals and LTI Systems

- Frequency Analysis of Discrete Time Signals.
- Frequency Domain characteristics of LTI systems.
- Frequency Response of LTI Systems.
- Notch, Comb Filters.

Sampling and Reconstruction

- Ideal Sampling and Reconstruction of Continuous Time Signals.
- Analog to Digital and Digital to Analog Converters.
- Sampling and Reconstruction of Continuous Time Signals.

Discrete Fourier Transform

- Frequency Domain Sampling: The Discrete Fourier Transform.
- Properties of DFT.
- Effect of Zero Padding and Window Length.

Implementation and Design of Discrete Time Systems

- Structures of FIR Systems.
- Structures of IIR Systems.
- Design of FIR Filters.

Measurement of FFT

- FFT Measurement Techniques.
- Implementation of FFT on Embedded Hardware.
- Radar Pulse Integration.
- Pulse Compression Techniques.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Digital Signal Processing: Principles, Algorithms and Applications, 4th Edition, by J. G. Proakis, D.G. Manolakis, 2006.
- Discrete-time Signal Processing, 3rd Edition, by A.V. Oppenheim, R.W. Schafer, 2009.
- Digital Signal Processing; A Computer Based Approach, 3rd Edition, by S.K. Mitra.

FPGA Based Design for Embedded Systems

Course Outline:

FPGA-Based Systems

- How VLSI Characteristics Affect FPGAs and FPGA-Based Logic Design.

VLSI Technology

- How Classical Logic Design Techniques Relate to FPGA-Based Logic Design.

FPGA Fabrics

- Understanding FPGA Fabrics
- The Basic Programmable Structures of FPGAs.

Combinational Logic

- Specifying and Optimizing Logic to Address Size, Speed, and Power Consumption.

Sequential Machines

- Verilog, VHDL, and Software Tools for Optimizing Logic and Designs.

Architecture

- The Structure of Large Digital Systems, including Register-Transfer Design Methodology.

Large-Scale Systems

- Building Large-Scale Platform and Multi-FPGA Systems.

A start-to-finish DSP Case Study Addressing a Wide Range of Design Problems

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- FPGA-Based System Design by Wayne Wolf
- Digital System Design with FPGA by Cem Unsalan and Bora Tar.

Fundamentals of Avionics Engineering

Course Outline:

Introduction

- Introduction about Avionics Engineering.
- Historical background.

Airborne Segment

- Navigation Systems
  - Global Positioning System.
  - Inertial Navigation System.
  - Instrument Landing System.
  - Weather Radar.
- Flight Control
  - Fly by wire.
  - Auto Pilot.
- Communication Systems
  - Air to Ground Voice communication.
  - Air to Ground Data Communication.
  - Onboard Communication systems.
- Special Systems
  - Identification of Friend and Foe.
  - Electronic Warfare Systems.
  - Traffic Collision Avoidance System.
  - Enhanced Ground Proximity Warning System.
  - Fire Control Radar.
  - Automatic dependent surveillance—broadcast (ADS-B).
  - Electronics Engine Control (EEC)/Digital Engine (electronic) Control (DEC) / Full
  - Authority Digital Engine (electronic) Control (FADEC).

- Human machine Interface
  - o Glass Cockpit.
  - o Head up Displays.
  - o Helmet Mounted Displays.
- Avionics Integration
  - o Avionics Mux bus
  - o MIL-STD-1553B Digital Time Division Command/Response Multiplex Data Bus
  - o ARINC 429 Digital Information Transfer System

Ground Segment

- Air Traffic Control System.
  - o Communication system.
    - ▪ Ground to air Voice Communication.
    - ▪ Ground to air Data Communication.
  - o Surveillance System
    - ▪ Surveillance (Primary) Radar
    - ▪ Surveillance (Secondary) Radar
    - ▪ Automatic dependent surveillance—broadcast (ADS-B)
  - o Navigation System
    - ▪ Instrument Landing System
    - ▪ Distance Measuring Equipment
    - ▪ VHF Omni Ranging
    - ▪ Non directional Beacon
    - ▪ Automatic Direction Finder
    - ▪ Tactical Air Navigation

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 Avionics "by Dale R cundy ISBN 0-13-227489-2 Prentice Hall Inc 1997.
- Principles of Avionics" by Albert Helfrick ISBN: 1885544170, Avionics Communication Inc, (2002).
- Civil Avionics Systems" by Ian Moir and Allan Seabridge ISBN: 0470029293, John Wiley & Sons Ltd, (2006).
- "Military Avionics Systems" by Ian Moir and Allan Seabridge ISBN: 0470016329, John Wiley & Sons Ltd, (2006).

Advanced Digital System Design

Course Outline:

History and Overview

- Explain the purpose and role of digital logic design.
- Understand digital design using hardware description languages.

Combinational Logic Design Fundamentals

- Analyze and design combinational circuits.
- Use of Boolean algebra to verify/prove complex Boolean expression.
- Design a circuit that is free of static and dynamic hazards.

Synchronous Sequential Circuit Design Fundamentals

- Differentiate between different types of flip-flops and latches.
- Perform Mealy and Moore state machine design.
- Understand the concept of equivalent states and apply it to state reduction.
- Calculate timing conditions for proper operation of sequential circuits.

Verilog Hardware Description Language

- Use Verilog for modeling basic combinational and sequential blocks in digital systems.
- Verify circuit/system design via simulation using VHDL and Quartus II.
- Synthesize circuits from VHDL models on Altera's FPGA Prove and state the symmetries of the Fourier transforms for real signals.

Introduction to Programmable Logic Devices

- Be familiar with Read-Only Memory (ROM), Programmable Logic Arrays (PLA), Programmable Array Logic (PAL), and Field Programmable Gate Arrays (FPGA).
- Design digital circuits using PLDs.

Several Design Examples

- Use Verilog HDL to describe a digital system at the behavioral level for testing the system.
- Know how designs should be coded structurally if specific hardware structures are to be generated.
- Understand the concept of dividing a design into a controller and data path sections, and apply it to several design examples.

Algorithm State Machine (ASM) Charts

- Convert state diagrams to ASM Charts.
- Use ASM charts to design sequential state machines.

Hardware Testing and Design for Testability

- Digital system testing for combinational and sequential circuits.
- Design for testability and employ different testing methods that make digital systems easier to test.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Michael D. Ciletti, Advanced Digital Design with the Verilog HDL, 2nd Edition, Pearson, 2011/Latest, ISBN: 978-0136019282

- Steve Kilts, Advanced FPGA Design: Architecture, Implementation, and Optimization, Wiley, 2007/Latest, ISBN: 978-0470054376
- Samir Palnitkar, Verilog HDL: A Guide to Digital Design and Synthesis, 2nd Edition, Pearson Education, 2003/Latest, ISBN-13: 978-8178084893

Cyber Security in Avionics Engineering

Course Outline:

Fundamental Principles of Cyber Security

- Introduce Confidentiality, Integrity and Availability (CIA) triad with examples.
- State the significance of cyber security in aviation and narrate some relevant security breach incidents.
- Define basic security terms including vulnerability, threat, attack and, risk.
- Differentiate between security policy and security mechanism with examples.
- Classify different types of security attacks including interception, modification, masquerading, interruption, fabrication and repudiation.
- Define and differentiate cryptography and cryptanalysis.

Classical Cryptography

- Explain the difference between Transposition and Substitution Ciphers.
- Elaborate different classical cipher systems such as Cæsar cipher, Shift cipher, Vigènere cipher, and Rail-Fence Cipher.
- Extend classical cipher history with overview and history of Enigma machine.

Avionics Network and Security Fundamentals

- Review fundamental components of on-board aircraft electronic systems including sensors, communication infrastructure, navigation, flight management, and cockpit displays.
- Explain the architecture of avionics data busses including MIL-STD-1553, ARINC-429 and Commercial Standard Digital Bus.
- Present an overview of emerging networking requirements of Internet of Aviation Things including in-flight entertainment systems, smart airports, predictive aircraft maintenance, and third-party software / firmware upgrade requirements.

- Describe the evolving security threats associated with emerging aviation networks and recommended security controls.

Symmetric Key Cryptography

- Elaborate the differences between Private and Public Key cryptography and Block and Stream ciphers.
- Outline the purpose and methods of inducing Confusion and Diffusion.
- Describe the structure of Fiestal cipher
- Explain Data Encryption Standard (DES), 3DES and Advanced Encryption Standard,
- Elaborate cipher chaining modes including ECB, CBC, CFB, OFB and Counter modes.
- Introduce steganography and elaborate with the help of basic steganography algorithms.

Public Key Cryptography and Key Management

- Illustrate the fundamental tradeoffs of Public Key vs Symmetric Key cryptography.
- Review fundamental concepts of Number theory and Modular arithmetic.
- Explain the design and working of RSA algorithms and Digital Signatures.
- Introduce the requirements of key-management.
- Elaborate Diffie-Hellmen key exchange protocol.

Message Authentication and Hash Functions

- Overview the basic requirements of message authentication.
- Evaluate the working of SHA-1 algorithm and analyze its authentication features.

Network Security Threats & Controls

- Review OSI layer stack and explain layer-specific design vulnerabilities, attacks and controls.
- Introduce host and network firewalls. Elaborate the key features and differences between packet filtering and stateful packet filtering firewall.
- Analyze key differences between Intrusion Detection and Intrusion Prevention systems.

- Evaluate the design and implementation principles of Virtual Private Networks.

Aviation Security Regulations

- Overview the regulatory requirements of International Air Transport Association (IATA), Federal Aviation Administration (FAA) and International Civil Aviation Organization (ICAO).
- Evaluate security regulations covered in ICAO Annex 17 and EU Common Security and Defense Policy.
- Elaborate Cyber security management systems as per the IATA Aviation Cyber Security Toolkit.
- Understand and Apply security controls over Next-Generation ATC, Onboard Aircraft IP Networks and Aircraft external interface devices.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- William Stalling, "Cryptography and Network Security – Principles and Practices", 8th Edition, Pearson, 2019.
- Jeffrey Price, Jeffrey Forrest, "Practical Aviation Security: Predicting and Preventing Future Threats", 3rd Edition, 2016.
- Radia Perlman, Charlie Kaufman, Mike Speciner, "Network Security: Private Communication in a Public World", 2nd Edition, Prentice Hall, 2002.
- Matt Bishop, "Computer Security: Art and Science", 2nd Edition, Addison-Wesley Professional, 2018.
- Cary R. Spitzer, "The Avionics Handbook", 1999.
- Cary Spitzer, Uma Ferrell, Thomas Ferrell, "Digital Avionics Handbook", 3rd Edition, CRC Press, 2017.

- Clarence Rodrigues, "Commercial Aviation Safety", 5th Edition, McGraw-Hill Education, 2011.

Electro Optics / Infrared

Course Outline:

Overview

- Introduce Imaging, Electro-Optical and Infrared (EO/IR) Systems.
- Introduce Wavelength dependencies and typical EO/IR scenarios.
- Explain analytical parameters; sensitivity and resolution.
- Introduce Linear Systems approach.

Relevant Mathematical Functions and Techniques

- Introduce complex functions.
- Explain convolution and correlation.
- Revise Fourier Transform and its properties.
- Explain transform pairs

Linear Shift-Invariant Systems

- Explain the basics of LSI systems, impulse response and Optical Transfer Function (OTF).
- Compare system Point Spread Function (PSF) and Modulation Transfer Function (MTF) versus component PSF and MTF
- Define spatial sampling, resolution and sampled imaging systems.

Diffraction

- Define properties of electromagnetic waves and coherence.
- Explain Fresnel and Fraunhofer diffraction from an aperture and thin lens.
- State thin lens optical system diffraction PSF and MTF.
- Compute diffraction MTF with pencil and paper.
- Describe applications of diffraction theory.

Sources of Radiation

- Introduce radiometry and photometry.
- Explain how to identify EO/IR targets against various backgrounds.

- Explain sensitivity considerations.
- Describe target and background spatial characteristics.
- Discuss typical Mid-Wave and Long-Wave contrasts and solar effects.

Atmospherics

- Explain atmospheric components and structure.
- Explain various atmospheric properties like atmospheric transmission, absorption, scattering, path radiance, turbulence and MTF.
- Discuss different models and practical considerations.

Optics

- State reflection and Snell's law of refraction.
- Explain rules for thin lens ray-tracing and Gauss's Equation.
- Briefly describe spherical mirrors, thick lens and multiple-lens systems.
- Define various terms related to optics such as vergence, field-of-view, resolution, f-number and numerical aperture etc.
- Explain aberrations, optical materials and diffraction blur.

Detectors

- Explain different types of detectors; photon, thermal and infrared detectors.
- Define various properties of detectors; responsivity, sensitivity and angular subtense.
- Calculate detector transfer functions.
- Explain scanning configurations and implementations.

Electronics

- Explain different detector and readout integrated circuits.
- Compare conversion of spatial and temporal frequencies.
- Calculate electronics transfer function.
- Explain the effects of Noise and Uniformity Correction (NUC).

Image Processing

- Discuss basics of sampling theory.
- Explain applications of image filtering.
- Demonstrate super-resolution Image reconstruction and image fusion.

Displays, Human Perception and Automatic Target Recognizers

- Explain different types of displays; Cathode-Ray Tubes (CRT), Light-Emitting Diodes (LED), Liquid-Crystal Displays (LCD), Plasma Displays.
- Discuss sampling, display processing and human perception.
- Calculate MTF and Contrast Threshold Function (CTF) of a human eye.
- Explain automatic target recognition.

EO/IR System Performance and Target Acquisition

- Define Sensitivity and resolution.
- Explain Noise Equivalent Temperature Difference (NETD).
- Explain Minimum Resolvable Temperature Difference (MRTD).
- Describe Target acquisition with limited frequency and with target task performance metric
- Calculate system MTF and CTF
- Explain different target sets
- Define and measure quality of images and performance of imaging systems through National Imagery Interpretability Rating Scale (NIIRS)
- Quantify and predict quality of sensor data for Intelligence, Surveillance and Reconnaissance (ISR) missions.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Ronald G. Driggers, Introduction to Infrared and Electro-Optical Systems, 2012 / Latest Edition.
- William Wolfgang Arrasmith, Systems Engineering and Analysis of Electro-Optical and Infrared Systems, 2017.
- Glenn D. Boreman, Basic Electro-Optics for Electrical Engineers, 1998/ Latest Edition.

- William L. Wolfe, Introduction to Infrared System Design, 1996/ Latest Edition.

Emerging Aviation Technologies

Course Outline:

The course involves the understanding of following topics:

Power Systems and Synthetic Aperture Radars

- Introduce and familiarize with aircraft electrical power systems
- Explain antenna design tools
- Apply the concepts of Synthetic Aperture Radar

Networks Evolution

- Discuss 5G networking
- Illustrate about evolution of network generations

Fiber Optics and NCW

- Explain Network Centric Warfare
- Illustrate fiber-optics and their application

Channel Capacity and SDRs

- Explain operations of software defined radios
- Analyze applications of Information Theory and Coding

Machine Learning, SATCOM and EM waves

- Illustrate machine learning
- Explain operating principle of satellite communication
- Explain applications of EM numerical techniques

New Technologies regarding flight controls and weaponry

- Explain the mechanism of Weapon guidance
- Analyze the concepts of flight control systems
- Illustrate the IR seeking capability of missiles

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, Labs.

Assessment:

Assignments, Quizzes, OHT/Mid Term, Presentations, Final Exam.

Suggested Books:

- Latest Research papers and emerging trends in the fields of science and technology.

Manufacturing Process and CNC Machines

Course Outline:

Introduction

- Brief about the overview of the technology
- Describe metal casting industry
- Describe sand casting industry

Metal Classification

- Introduce of metal classification
- Explain ferrous metals
- Explain non-ferrous metals
- Explain precious metals
- Explain high temperature metals
- Describe safety precautions for handling metals
- Explain measurement of metals and different shapes

Understanding Drawings

- Introduce different elements of drawing
- Explain and measure dimensions
- Brief about information present on drawing
- Differentiate between types of drawings and prints

- Explain geometric dimensioning and tolerancing
- Explaining planning and metalwork project

Layout Work

- Prepare a metal for layout
- Explain different layout tools
- How to measure angles
- How to make a layout
- Explain different safety precautions of layout

Hand Tools

- Understand the basics of hand tools
- Explain the functioning of pliers, wrenches, screwdrivers, striking tools, chisels and files

Sheet Metal

- Introduce sheet metal
- Explain patterns
- What are the procedures of cutting sheet metal
- What are the procedures of bending sheet metal
- How to make common sheet metal joints
- How to fasten metal sheet
- Explain metal safety procedures
- Explain the soldering conditions
- Explain different brazing techniques

Teaching Methodology: (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Modern Metal Working by John R Walker, 10th Edition (2018)
- Process Selection: From Design to Manufacture by K G Swift & J D Booker, 2nd Edition (1994)
- Software Manual, Turning for Windows, INTELYS
- Software Manual, Milling for Windows, INTELYS

Prototyping

Course Outline:

Introduction

- Introduce the product design and development
- Explain engineering notebooks / documentation
- Brief about Shop safety

Proof of Concept Design

- Describe Engineering design
- Explain proof of concept model
- Explain reverse engineering
- Explain rapid prototyping

Understanding Drawings

- Explain fundamentals of 3D modeling
- Describe formatting drawing sheets
- Introduce different elements of drawing
- Explain and measure dimensions
- Brief about information present on drawing

Modeling

- Explain component development from customer specifications
- Explain basic manufacturing processes
- Introduce modeling of existing components
- Describe the development of a product concept

Assembling

- Explain component sourcing
- Describe final assembly
- Brief about assembly modeling
- Explain assembly testing
- Explain assembly drawing with bill of materials
- Describe manufacturing Process plan
- Explain final product testing and troubleshooting

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Reverse Engineering: an Industrial Perspective, Raja, Vinesh, Fernandes, Kiran J. (Eds.), Spinger 2008
- Rapid Prototyping: Principles and Applications, Rafiq I. Noorani, Wiley 2005
- Rapid Manufacturing: An Industrial Revolution for the Digital Age, N. Hopkinson, R. Hague, P. Wiley 2005.
- SolidWorks Student Design Kit (License available through textbook)

Radar Signal Processing

Course Outline:

Basics of Radar System and its Performance

- Explain the components of a radar system and their relationship to overall system performance
- Study the radar operating environment
- Illustrate the techniques used to improve the radar performance

- Explain the increasingly sophisticated techniques used to extract ever more information from radar signals using advanced digital signal and data processing

Radar Signal Model

- Discuss and analyze Radar signal models while studying the performance metrics in the radar range equation
- Explain the extensive data on modeling the reflectivity and Doppler characteristics of atmospheric, land, and sea clutter and many of the common mean reflectivity and statistical models needed for clutter analysis
- Illustrate the mechanisms of scattering and reflection and the concept of radar cross section for targets, while keeping in view the common statistical models for radar cross section needed to evaluate detection performance
- Explain the concept of radar cross section for targets
- Compare different Swerling models for fluctuating targets

Pulsed Radar Data Acquisition

- Discuss and analyze digital data acquisition system for radar systems
- Categorize and illustrate considerations in the selection of sampling rates and quantization strategies and their corresponding effect on signal fidelity, resolution, aliasing, and noise properties, as well as processor memory and computational requirements

Radar Waveform Design

- Analyze waveform design and its effect on different radar parameters
- Explain use of pulse compression for high-range resolution
- Analyze matched filter on most common wideband waveforms,
- Categorize waveform types such as linear frequency modulation or "chirp" and phase-coded waveforms ranging from Barker codes to a variety of polyphase codes
- Describe methods of range side lobe control
- Explain the ambiguity function as a means of designing and understanding waveform properties

Doppler Processing

- Illustrate the Doppler shift phenomena

- Compare the two major forms of Doppler processing for clutter reduction: moving target indication (MTI), and pulse-Doppler processing
- Discuss MTI including blind speeds, staggered pulse repetition frequencies, and airborne MTI
- Explain pulse-Doppler processing
- Explain the important topics of blind zones and ambiguity resolution
- Evaluate the concept of pulse-pair processing method widely used in weather radar
- Illustrate and analyze Displaced Phased Center Array (DPCA) and Adaptive DPCA (ADPCA)

Radar Signal Detection

- Explain and analyze the most fundamental radar task of search and detection
- Explain search processes
- Explain the idea of statistical detection
- Illustrate the importance of probabilities in evaluating radar performance
- Illustrate the advanced signal processing concepts related to detection theory such as LRT, Explain detection of fluctuating targets, CFAR and its performance

Synthetic Aperture Radar

- Describe overview of synthetic aperture radar (SAR) imaging while discussing its implementation in context with signal processing
- Describe SAR data collection and derivation of widely applicable resolution and sampling equations.
- Compare different SAR image formation algorithms such as Doppler beam sharpening, one of the simplest imaging algorithms; and back projection, the current "gold standard" for advanced imaging
- Discuss the unique phenomenology of SAR imaging, including layover, shadows, and speckle

Beam Forming and STAP

- Describe the basic concept of beamforming while building on the radar data cube obtained using radar data acquisition in signal processing terminologies

- Illustrate the advanced concept of Space Time Adaptive Processing in terms of its importance, advantages and limitations in modern radar systems while keeping in purview of signal processing domain
- Explain DPCA as STAP

Estimation and Tracking

- Discuss and illustrate basic parameter estimation and some of the data association and resolution problems that complicate radar tracking
- Discuss post-detection position measurements and tracking as well as high-resolution techniques which address position measurements in range, angle, and Doppler
- Illustrate basic concepts of precision and accuracy lead to the understanding of the Cramèr-Rao lower bound on precision
- Compare and evaluate several estimators of range, Doppler shift, and angle are then reviewed, and their performance
- Compare a number of tracking algorithms are introduced, from the basic $\alpha-\beta$ tracker to the Kalman filter

Teaching Methodology (Proposed as applicable):

Lecturing (audio / video aids), Written Assignments, Studies related to engineering disciplines, Semester Project, Industrial / Field visits, Report Writing

Assessment:

Assignments, Quizzes, OHT/Mid Term, Presentations, Final Exam.

Suggested Books:

- Mark A Richards, "Fundamentals of Radar Signal Processing", 2nd Edition (2014)
- Mark A Richards; James A Scheer; William A Holm, "Principles of Modern Radar Vol. I: Basic Principles", Raleigh, NC SciTech Publishers, (2010)
- William A. Melvin, James A. Scheer, "Principles of Modern Radar Vol. 2: Advanced Techniques", (2013)
- William A. Melvin, James A. Scheer, "Principles of Modern Radar Vol. 3: Radar Applications", (2014)

VLSI Design

Course Outline:

Introduction and Historical Perspective

- Define digital integrated circuits (ICs) and compare the developments in the past and present; and predict the growth of IC technology in future.
- Summarize quality metrics of digital design.
- Discuss cost of IC, functionality and robustness, performance, power and energy consumption.

The Manufacturing Process

- Explain manufacturing of ICs.
- Discuss use of silicon wafers for manufacturing.
- Illustrate photolithography and other recurring process steps.
- Discover the trends in process technology.

The Static CMOS Inverter

- Evaluate the robustness of the CMOS Inverter.
- Interpret switching threshold and noise margins.
- Analyze performance of CMOS inverter.
- Calculate the extrinsic and intrinsic capacitances.
- Calculate propagation delay using first-order analysis.
- Interpret delay optimization in inverter.
- Estimate dynamic and static power consumption and analyze the combine effect.
- Determine energy and energy-delay relationship.

Designing Combinational Logic Gates

- Explain static CMOS design.
- Interpret delay optimization in complex logic and associate the method of logic effort.
- Analyze and optimize complex logic gates.
- Compare the complementary CMOS, ratioed logic and pass-transistor logic designs.
- Discuss the basic principles of dynamic logic design.

- Describe cascading of dynamic gates and issues in dynamic design.

CMOS Layout

- Discuss layout of standard cells and data path cells layout.
- Draw the stick diagrams for planning the layout and routing of ICs.

Designing Sequential Logic Circuits

- Explain synchronous timing and timing constraints.
- Understand clock skew and clock jitter and discuss clock constraints in edge-triggered systems.
- Interpret clock distribution techniques.
- Differentiate between latch and register.
- Understand design of master-slave register and evaluate clock parameters.

Design of Arithmetic Building Block

- Evaluate the design of adders.
- Understand the designs of multiplier and shifter

Design of Memory

- Classify types of memories and discuss their architectures.
- Understand the basic designs of SRAM, DRAM, ROM and EEPROM cells.
- Explain memory peripheral circuitry including address decoders, sense amplifiers and voltage references.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- J. M. Rabaey, A. Chandrakasan, B. Nikoliv, Digital Integrated Circuits - A Design Perspective, 2nd Edition, Pearson, 2003.

- N. Weste, D. Harris, CMOS VLSI Design - A Circuits and Systems Perspective, 4th Edition, Pearson, 2010.

Multidisciplinary Engineering Courses

List of Multi-disciplinary Electives (MDE)

- Product Design and Development
- Thermodynamics of Propulsion
- Applied Aerodynamics
- Astrodynamics
- AI for Engineers
- Cloud computing and IOT
- Operating Systems
- Computer System Architecture

Astrodynamics

Course Outline:

- Two-Body Orbital Mechanics
- Elliptical, Circular, Parabolic and hyperbolic orbit
- Orbit Determination from Observations
- Basic Orbital Maneuvers
- In-Plane and Out-of-Plane orbit changes and its practical implications
- Position and Velocity as a Function of Time
- Classical formulations of the Kepler problem
- Orbit Determination from two Positions and Time
- P-Iteration method and Gauss problem
- Ballistic Missile Trajectories
- Effect of launching errors on range and remedial actions
- Lunar Trajectories
- Patched-Conic approximation and the non-coplanar lunar trajectories
- Interplanetary Trajectories
- Perturbations

- Numerical integration methods and Analytic formulation of perturbative accelerations.

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:

- R.R. Bate, D.D. Mueller, J.E. White, Fundamentals of Astrodynamics, Dover Publications, 1971 / Latest Edition.
- C. Brown, Spacecraft Mission Design, 2nd Edition, AIAA, 1998 / Latest Edition.
- P. Fortescue, Spacecraft Systems Engineering, 3rd Edition, Wiley, 1999 / Latest Edition.
- G. Swinerd, How Spacecraft Fly: Spaceflight without Formulae, Copernicus, 2008 / Latest Edition.
- M.J.L. Turner, Rocket and Spacecraft Propulsion, 3rd Edition, Springer, 2005.

Applied Aerodynamics

Course Outline:

- Aerodynamics and fundamental physical quantities
- Aerodynamic forces and the equation of state & units
- Hydrostatic equation and the relation between geopotential and geometric altitudes
- Pressure, temperature and density altitude
- Continuity, momentum and energy equations
- Isentropic flow and speed of sound.
- Low speed wind tunnels and flow separation
- Turbulent and laminar boundary layer
- Airfoils, Wings and other Aerodynamic Shapes

- Lift, drag and moment coefficients.
- Infinite and finite flow
- Compressibility correction for lift coefficient
- Critical Mach number and critical pressure coefficient
- Supersonic wind tunnel and equations of compressibility and supersonic flow
- Viscosity and boundary layer
- Reynolds number and introduction to dynamic similarity.

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:

- John D. Anderson, Introduction to Flight, 8th Edition, McGraw-Hill, 2016
- Ilan Kroo, Applied Aerodynamics: A Digital Textbook, 5th Edition, Desktop Aeronautics, 2007.

IoT and Cloud Computing

Course Outline:

- Evolution of the Internet into Internet of People, Things and Everything
- High level IoT architecture
- Fundamental principles of machine to machine (guided / autonomous) communications.
- IoT systems' building blocks
- Elaborate configurations of Wireless sensor and Adhoc networks.
- IoT operational constraints
- IoT communication protocols
- Layered architecture, constructs and handshaking algorithms
- Hardware features of a IoT embedded platform
- Software constructs of IoT programming language

- IoT-specific vulnerabilities and malwares
- IoT-specific security solutions
- Enabling technologies in cloud computing
- Layers in the cloud building blocks
- Threats in cloud security
- Data centers and their architecture
- Cloud Resource Management
- Cloud Storage

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:

- David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Robert Barton, Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", Pearson Education, 2017.
- Samuel Greengard, The Internet of Things (The MIT Press Essential Knowledge series)
- CunoPfister, "Getting Started with the Internet of Things: Connecting Sensors And Microcontrollers To The Cloud (Make: Projects)", O' Reilly, 2011.
- Peter Waher, "Learning Internet of Things", Packt Publishing Ltd, 2015
- Time Pulver, "Hands-On Internet of Things with MQTT: Build connected IoT devices with Arduino and MQ Telemetry Transport (MQTT)", Oct, 2019.
- Michael J. Kavis, Architecting the Cloud, 2014/1st Edition.
- Thomas Erl, Cloud Computing: Concepts, Technology, and Architecture, 2013/1st Edition.

Product Design and Development

Course Outline:

- Characteristics of successful product development
- Marketing, design and manufacturing of a product
- Duration, cost and challenges of product development
- Marketing, design, and manufacturing
- Development processes and organizations
- Concept development process and adaption of generic product development process
- Selection of organizational structure and the guiding principles
- Strengths, weaknesses and their examples for organization matrix
- Product planning
- Identifying customer needs
- Developing product specifications
- Concept generations
- Concept selection as an integral part of the product development process
- Two-stage concept selection methodology
- Concept testing
- Product architecture and its properties
- Four-step method to structure the decision process
- Industrial design (ID)
- Statistics on typical investments in ID
- Costs and benefits of investing in ID
- Method for assessing the quality of the ID effort for a completed product

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:

- Product Design & Development by Ulrich & Eppinger, 7th Edition (2019)

Thermodynamics of Propulsion

Course Outline:

- Thermodynamics and energy and list the application areas
- Zeroth law of thermodynamics and temperature scales
- Manometer, barometer and atmospheric pressure
- Energy, energy transfer, and general energy analysis
- Energy transfer by heat and work
- First law of thermodynamics and relate energy balance, energy change of a system
- Properties of pure substance
- Property tables, enthalpy, saturated liquid, saturated vapor states, saturated liquid–vapor mixture, superheated vapor, compressed liquid, ideal-gas equation of state
- Energy analysis of closed systems
- Mass and energy analysis of control volumes
- Conservation of mass principle and mass balance for steady-flow processes
- Steady-flow systems, nozzles, diffusers, turbines, compressors, throttling valves, mixing chambers and heat exchangers
- Second law of thermodynamics
- Carnot cycle, carnot principles, carnot heat engine, refrigerator and heat pump
- Entropy change of pure substances, isentropic processes and property diagrams
- Reversible steady-flow work
- Reversible/ irreversible work
- Exergy transfer by heat, work, and mass
- Decrease of exergy principle and exergy destruction

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:

- Yunus A. Cenjel Michael A. Boles, "Thermodynamics – An Engineering Approach", McGraw-Hill, 9th Edition / Latest Edition, 2018.
- M J Moran, H N Shapiro, "Fundamentals of Engineering Thermodynamics", Wiley, 9th Edition / Latest Edition, 2018.
- J B Jones, G A Hawkins, "Engineering Thermodynamics", Wiley, 5th Edition / Latest Edition, 1986.

Operating Systems

Course Outline:

- Introduction to Operating Systems, history, purpose and different types
- Introduction to basic concepts related to operating systems such as concurrency, scheduling, dispatch, memory and device management, file systems, security and protection
- Overview of some open source operating systems
- Structure of operating systems, user-interface, systems calls and types, system programs, operating system debugging and system boot
- Process concept, scheduling, Inter-process communication, Communication in Client-Server Systems
- Threads, multithreading models, libraries and issues, operating-system examples
- CPU scheduling concepts, algorithms, multiple-processor scheduling, algorithms evaluation and examples from operating systems
- Process synchronization, critical-section problem, synchronization hardware, semaphores, classical problems of synchronization, monitors, deadlocks and starvation, and examples
- Memory management, swapping, contiguous memory allocation, paging, segmentation and examples from operating systems
- Virtual memory, demand paging, and page replacement algorithms
- Thrashing, files and directories, file systems, file protection and allocation, disk space management
- Protection and Security, access matrix, control and implementation, user authentication

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:

- Abraham Silberschatz, Greg Gagne, Peter B. Galvin, Operating System Concepts, 10th Edition, John Wiley and Sons, 2018/Latest, ISBN: 978-1-118-06333-0
- Andrew S Tanenbaum and Herbert Bos, Modern Operating Systems, 4th Edition, 2014/Latest, ISBN: 978-0-133-59162-0

Computer Systems Architecture

Course Outline:

- Computer design basics, data-paths, arithmetic/logic unit, shifters, data-path representation, simple computer architecture, single-cycle hardwired control, multiple-cycle hardwired control.
- Computer architecture concepts, operand addressing, instruction set architectures, data-transfer instructions, data-manipulation instructions, floating-point computations, program control instructions.
- Types of computers, pipelined data-path, reduced instruction set computer, complex instruction set computer.
- Computer input and outputs, sample peripherals, I/O interfaces, serial communication, modes of transfer.
- Computer memory accessing, priority interrupt, direct memory access.
- Memories, memory hierarchy, locality of reference, cache memory and virtual memory.

Teaching Methodology (Proposed as applicable):

Lectures (with animations), Written assignments/Quizzes, One Hour Tests, Semester project, Industrial/Field visits, Group discussion, Report Writing.

Assessment:

Design Projects, Report writing/Presentation, Assignment, Project report, Quizzes, Final term exam/ assessment.

Suggested Books:

- M. Morris R. Mano, Charles R. Kime and Tom Martin, Logic & Computer Design Fundamentals, 5th Edition, Pearson, ISBN-13: 978-0133760637, 2016.
- John L. Hennessy, David A. Patterson, and Computer Architecture: A Quantitative Approach, 6th Edition, MK, And ISBN-13: 978-0128119051, 2017.
- John F. Wakerly, Digital Design Principles and Practices, 5th Edition, Pearson, 2018.

Artificial Intelligence (AI) for Engineers

Course Outline:

- Introduction to AI, history of AI, Intelligent agents
- Uninformed search, Heuristic search, Informed search, A* algorithm, Adversarial search
- Games, Constraint Satisfaction Problems
- Machine Learning: Basic concepts, linear models, perceptron, K nearest neighbors, advanced models, neural networks, SVMs, decision trees
- Unsupervised learning, Markov decision processes and reinforcement learning, Logical Agents, propositional logic and first order logic
- AI applications (Autonomous Aircraft, Computer Vision, Navigation, Robotics, Natural Language Processing)
- Legal, regulatory, ethical, and policy questions raised by advancements in artificial intelligence and its increasing use

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

Suggested Books:

- Russell, Stuart J., and Peter Norvig. Artificial Intelligence: A Modern Approach. Malaysia; Pearson Education Limited, 2016.
- Qiangfu ZHAO and Tatsuo Higuchi, Artificial Intelligence: From Fundamentals to intelligent searches, Kyoritsu, 2017
- Marsland, Stephen. Machine learning: An Algorithmic Perspective. CRC press, 2015.
- Anzai, Y., 2012. Pattern recognition and machine learning. Elsevier.

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 (New Edition)
- Herta A. Murphy & Herbert William Hildebrandt. Effective Business Communications
- Diana Hacker. A Writer's Reference
- Sadat Ali Shah. Exploring The World Of English
- J. Thomson and A. V. Martinet. Practical English Grammar, "University Physics", 13th Edition

Communication Skills

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outlines:

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

Writing Skills

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

Reading Skills

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

Listening Skills

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

Speaking Skills

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Technical Writing and Presentation Skills

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outlines:

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

Teaching Methodology (Proposed as applicable):

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

Assessment

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

Suggested Books:

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

Mathematics Courses

Linear Algebra

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline:

System of Linear Equations and Applications

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

Vector Spaces and Transformations

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

Eigenvalues and Eigen Vectors

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

Linear Programming

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

Application of Linear Algebra in Dynamical Systems

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Calculus and Analytical Geometry

Area Scope:

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

Course Outline:

Analytical Geometry:

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

Functions Limit and Continuity:

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

Differentiation:

- Introduction to Derivatives
- Examples of Derivatives
- Derivative as Rate of Change

- Derivative's Rules
- Implicit Differentiation
- Higher order derivatives
- Leibnitz Theorem

Applications of Derivatives:

- Applications of Derivatives
- Monotonic functions
- Optimization problems
- Relative and Absolute extrema
- First and second derivative tests
- Point of inflection
- Concavity
- Curvature
- Indeterminate Forms and L' Hospital rule
- Differentials

Integration:

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

Applications of Integration:

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

- Center of mass
- Arc length

Improper Integrals:

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

Infinite Sequence and Series:

- Sequence and Infinite Series
- Convergence and Divergence of sequences and series
- Positive Term Series
- Integral Test
- Basic Comparison Test
- Limit Comparison Test
- Ratio and Root tests
- Alternating series
- Absolute and Conditional Convergence

Power and Taylor Series:

- Power series
- Maclaurin and Taylor Series and its Applications

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Thomas' Calculus by George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass, Pearson, USA.
- Swokowski, Onlinick & Pence: Calculus

- Robert T. Smith & Roland B. Minton: Calculus
- Calculus: Early Transcendentals by James Stewart. Brooks/Cole USA.

Differential Equations

Area Scope:

The knowledge units in this area collectively encompass the following:

- To define basic mathematical concepts related to differential equations
- To describe different types of analytical methods for solution of differential equations
- To formulate different engineering problems in the form of differential equations

Course Outline:

Basic Concepts and Modeling

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

Analytical Methods of Solution for First-order ODEs

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

Mathematical Models Based on Second-order ODEs

- Formulation of a single RLC circuit, spring mass systems, Earthquake model of a single story building

- Bungee Jumper model, Bridge collapse problem etc.

Analytical Methods of Solution for Second-order ODEs

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

Series Solution for Second-order ODEs

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

Laplace Transform

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

Partial Differential Equations

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Advanced Engineering Mathematics by Erwin Kreyzig, John Wiley & Sons Inc. Latest Edition.
- Differential Equation with Boundary Value problems by D. G. Zill, M. R Cullen Latest Edition, Brooks/Cole Publishers.
- A First Course on Differential Equations with Modelling Applications by D. G. Zill, Latest Edition, Brooks/Cole Publishers.
- An Introduction to Mathematical Modelling by Bender, E.A., Latest Edition, Wiley, New York.

Numerical Analysis

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline

Error Analysis and Interpolation

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

Interpolation versus least square approximation, relevant engineering case studies

Numerical Differentiation and Integration

- Derivation of numerical differentiation of first order and second order derivatives using two points, three points, and five point's 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.

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Complex Variables & Transforms

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Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline

Introduction:

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

Complex Differentiation and Integration:

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

Power Series:

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

Laplace Transformation:

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

Special functions and Fourier Transforms:

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

Z-Transformation:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Multivariate Calculus

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline:

Geometry of Space:

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

Vector-Valued Functions and Motion in Space:

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

Partial Differentiation:

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

Applications of Partial Derivatives:

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

Multiple Integrals:

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

Vectors in 3 Space:

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

Integration in Vector Fields:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Applied Physics

Course Outline:

Vectors:

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

Electricity & Magnetism:

Electric field due to Discrete and Continuous Charge Distributions, Electrostatic Potential of discrete and Continuous charges, Gauss's Law and its Applications, Lorentz Force and Hall Effect, Ampere's Law, Magnetic Field due to current element (Circular Current Loop and Solenoid), Faraday's law, and Maxwell's equations.

Waves & Oscillations:

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

Optics and Lasers:

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

Atomic and Nuclear Physics:

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

Conduction of Electricity in Solids:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Halliday, Resnick and Walker, "Fundamentals of Physics" 10th Edition Extended
- Hugh D. Young and R.A. Freedman, University Physics. 12th Edition
- Raymond A Serway and John W. Jawett, Jr. Physics for Scientists and Engineers with modern Physics, 09th Edition.
- G. B. Thomas, R. L. Finney, "Calculus and Analytic Geometry", 13th Edition.

Applied Chemistry

Area Scope:

The knowledge units in this area collectively encompass the following:

- Understand Properties, reaction and electrochemistry of metals
- Enable the students to acquire knowledge of computer chips fabrications, Liquid coolant and their working.
- Will be able to demonstrate the chemical thermodynamics & heat Transfer, various heat reactions and Fluid Chemistry
- Have command on Nature properties and Chemical composition of materials and their spectroscopic characterization methods.

Course Outline:

- Basic of Elemental Chemistry, Electrochemistry, Conductive metals, Conductance and Resistance of various metals, Electrode Fabrication, Electrolytic Cells, Galvanic Cells, Cell potentials, Modification of Batteries, Transistors, resistors, capacitors and inductors modification, Corrosions, Surface Chemistry.
- Fabrication of computer chips, Solder: New requirements for lead-free fabrication to a leadfree solder. Liquid Cooling. Various coolants and their level of cooling

- Introduction and laws of Thermodynamics & heat transfer, Heat of Reactions, Entropy, Heat of Combustion & Formation, Endothermic and Exothermic Reactions & Factors involved, Fluid Chemistry, Fluids types and its Properties, Fluids and Electrolytes.
- Mechanics of Materials: Nature properties and Chemical composition of materials, ceramics, metals, Characterization of materials by using Spectroscopic Techniques, Tribology

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:

- "Fundamentals of Thermal Fluid Sciences" Yunus A. Cengel and Co-authors McGraw-Hill Education; latest edition.
- "Essentials of Polymer Science and Engineering" Paul C Painter and Co-authors, DEStech Publications, latest edition.
- Power Electronics Handbook, 4th Ed. by Muhammad H Rashid, Elsevier Inc. latest edition.
- Advances in Heat Transfer, Edited by Ephraim M. Sparrow, John P. Abraham, John
- M. Gorman, W. J. Minkowycz, Volume 51 Elsevier Ltd, latest edition
- Handbook of Green Information and Communication Systems, Mohammad S. Obaidat, Alagan Anpalagan and Isaac Woungang, Elsevier Inc, latest edition.
- Interstellar Molecules, Their Laboratory and Interstellar Habitat, Editors: Yamada, Koichi M. T., Winnewisser, Gisbert (Eds.), Springer-Verlag Berlin Heidelberg, latest edition.
- Recent Advances in Spectroscopy, Theoretical, Astrophysical and Experimental, latest edition.
- Perspectives, Editors: Chaudhuri, R.K., Mekkaden, M.V., Raveendran, A.V., Narayanan, A.S. (Eds.), Springer-Verlag Berlin Heidelberg, latest edition.

- Nanoscale, Authors: Oscar Alejandro Oviedo, Luis Reinaudi, Silvana Graciela
- García, Ezequiel Pedro Marcos Leiva, Editor: Fritz Scholz, Publisher: Springer, latest edition
- Electrochemical Energy Systems - Foundations, Energy Storage and Conversion, Artur Braun, Publisher: De Gruyter, latest edition"
- An Introduction to Electrochemistry, By S. Glasstone, Publisher Maurice Press, latest edition.
- "Advanced Heat and Mass Transfer" Amir Faghri, Yuwen Zhang, John Howell, Global Digital Press, latest edition.
- Introduction to Thermal Sciences" Frank W. Schmidt and Co-authors, Wiley; latest edition, 1993

Social Sciences Courses

Sociology for Engineers

Area Scope:

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

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

Course Outline:

Fundamental Concepts and Importance of Sociology for Engineers

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

Cultural Impacts of Engineering Projects on Society

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

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

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

Understanding of Societal & Ethical Norms and Values for Engineers

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

Organizational Social Responsibility (OSR) of Engineers

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

Engineers, Society and Sustainability

Social System and Concept of Sustainable Development Technology and Development, Population Dynamics in Pakistan, Causes and Consequences of Unplanned Urbanization, Community Development, Programs in Pakistan, Community

Organization & Engineering Projects, Population, Technological & Industrial expansion and Development with focus on social/human/ethical dimensions.

Industrial & Organizational Psychology

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

Climate Change and Ecological Friendliness from Engineering Perspective

Ecological Processes, Ecosystem and Energy, Impact of Engineering Projects on Eco System & Human Ecology, Industrial & Environmental impact on Population & General Masses, Technological Intervention, Ecosystem and Physical Environment, Social Impact of Technology & Engineering Products & Services (Solid Waste Disposal, Pollution control etc.).

Social Approaches and Methodologies for Development Administration & Stakeholders Analysis:

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

SIA (Social Impact Assessment):

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

Engineering Intervention for Social Stratification:

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

Case Studies of Different Development Projects in Social Context

Teaching Learning Approaches:

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

Group discussion, Community Service, Report Writing, Social Impact Review and Social Audit of Engg Project

Assessment:

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

Suggested Books:

- Godhade, J. B., and S.T. Hunderkari. 2018. Social Responsibility of Engineers. International Journal of Academic Research and Development. Latest edition.
- Nichols, S. P. and Weldon, W. F. latest edition. Professional Responsibility: The Role of Engineering in Society Center for Electro-mechanics, The University of Texas at Austin, USA.
- Aslaksen, E. W. latest edition. The Relationship between Engineers and Society: is it currently fulfilling its potential? Journal and Proceedings of the Royal Society of New SouthWales, latest edition. Gumbooya Pty Lte, Allambie Heights, Australia.
- Bell, S. Engineers, Society and Sustainability. Synthesis Lectures on Engineers, Technology, and Society. Edited by Caroline Baillie, University of Western Australia. Morgan and Claypool Publishers, latest edition
- Jamison, A., Christensen, S. H., and Lars, B. latest edition. A Hybrid Imagination: Science and Technology in Cultural Perspective.
- Vermaas, P., Kroes, P., Poet, l., and Houkes, W. latest edition. A Philosophy of Technology: From Technical Artefacts to Socio technical systems.
- Mitcham, C., and Munoz, D. Humanitarian Engineering. Morgan and Claypool Publishers, latest edition
- Riley, D. Engineering and Social Justice. Morgan and Claypool Publishers.
- Bugliarello, G. latest edition. The Social Functions of Engineering: A Current Assessment, A Chapter in"Engineering as A Social Enterprise.

Sociology

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline:

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

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Engineering Economics

Area Scope:

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

Course Outline:

Engineering Economics

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

Interest Rate and Economic Equivalence

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

Understanding Money and Its Management

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

Present-Worth Analysis

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

Annual Equivalent-Worth Analysis

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

Rate-of-Return Analysis

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

Cost Concepts Relevant to Decision Making

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

Depreciation and Corporate Taxes

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

Developing Project Cash Flows

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

Project Risk and Uncertainty

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

Special Topics in Engineering Economics

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Social Psychology

Area Scope:

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

Course Outline:

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

- Corruption and its control, thinking processes and decision making.

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Edward Alsworth Ross, "Social Psychology", Macmillan, latest edition.
- Emory Stephen Bogardus, "Essentials of Social Psychology", Univ. of Southern, California Press, latest edition.
- Hewstone, M., & Stroebe, W. (Eds.), "Introduction to Social Psychology", 3rd ed., Oxford: Blackwell Publishers, latest edition.
- Lesko, W.A. "Readings in social psychology General, classic, and contemporary selections, latest edtion.

Community Services

Area Scope:

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

Course Outline:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Organizational Behavior

Course Outline:

Introduction to Organizational Behavior

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

Structure and Control in Organization

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

Individual and Work Learning

- Learning Theories
- Learning and Work

Stress

- Types of Stress and Work
- Occupational Stress Management

Individual Differences

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

Motivation and Job Satisfaction

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

Group and Work

- Social Interaction
- Dramaturgy and impression Management
- Social Skill

Group and Inter group Behavior

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

Leadership

- Leadership as an attribute
- Leadership Style

Patterns of Work

- Work-the classical approach
- Marx, Weber, & The critique of labor
- Foucault & Disciplinary Power
- Conflict and Consent in Work
- The labor Process debate
- Work place control and resistance
- Industrial conflict and industrial relations

Organizational Culture

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Finchan, R., & Rhodes, P. latest edition, Principles of Organizational Behaviour, Oxford.

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

Professional Ethics

Area Scope:

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

Course Outline:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Ethics in Engineering 4th edition, by Mike W. Martin, Roland Schinzinger, McGraw-Hill, New York, 2005.
- Fundamentals of Engineering Economics, 3rd ed., by Chan S. Park
- Engineering Ethics: Concepts and Cases, 4th edition, by Charles E. Harris, Michael S. Pritchard, Michael J. Rabins, Wadsworth, 2008.
- The Seven Habits of Highly effective people by Stephan r. Covey
- Principle Centered Leadership Stephan r. Covey
- Change your lens change your life by (Faiez H. Seyal)
- How to Manage by Ray Wild
- Happiness by Richard Layard

Cultural Courses

Islamic Studies and Ethics

Course Description:

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

Area Scope:

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

Course Outline:

Islam – Religion of Peace and Harmony

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

Pakistan Studies and Global Perspective

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline: **Time Duration**

Historical and Ideological Perspective   **5 hrs**

    a. Pakistan Movement
- Aligarh Movement
- Two Nations Theory

    b. Founders of Pakistan
- Allama Muhammad Iqbal
- Quaid-e-Azam Muhammad Ali Jinnah
- Other Leaders (Women and other Pakistan Movement Leaders)

    c. Quaid's Vision for Pakistan
    d. Kashmir – An unfinished Agenda of Partition

Constitution of Pakistan   **4 hrs**

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

Contemporary Pakistan   **4 hrs**

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

Economy of Pakistan   **4 hrs**

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

Land of Opportunities   **4 hrs**

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

Pakistan's Foreign Policy   **5 hrs**

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

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

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

   •   Khalid B. Sayeed, Pakistan: The Formative Phase 1857 – 1948, Pakistan Publishing House, 1960

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

Management Sciences Courses

Engineering Project Management

Area Scope:

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

Core Objectives of this course are:

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

Course Outline:

Project Management Concepts

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

Project Proposal Development

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

Project Feasibility

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

Project Selection Criteria (Economic Analysis of Engineering Projects)

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

Project Contract & Procurement Management

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

Project Planning and Scheduling

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

Project Costing & Estimation

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

Project HRM & Communication Management

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

Project Risk Management

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

Computer Application in Project Management

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

Project Quality Management

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

Project Closure & Termination

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

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

Entrepreneurship

Area Scope:

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

Course Outlines

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Principles of Management

Area Scope

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

Course Contents:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Engineering Management

Course Outlines

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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