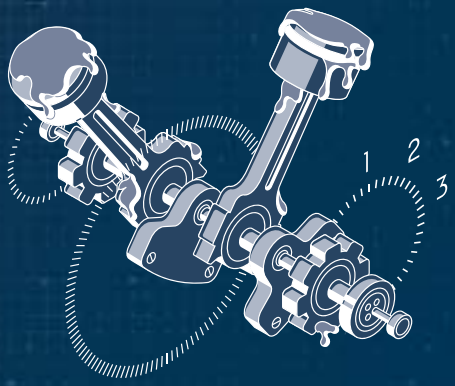

Curriculum for

Automotive Engineering

Bachelor of Engineering Program

2020

Pakistan Engineering Council
&
Higher Education Commission
Islamabad

CURRICULUM

OF

AUTOMOTIVE ENGINEERING

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Contents

PREFACE

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

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

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

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

This curriculum document would 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 fulfil our national, social and economic needs leading towards attainment of Sustainable Development Goals (SDGs-2030). It would also provide the level of competency specified in Pakistan Qualification Framework to make it compatible with international educational standards.

1. Engineering Curriculum Review & Development Committee (ECRDC)

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

1.	Engr Prof Dr Fazal Ahmed Khalid Convener, Metallurgy, Materials, Mining Engg & Allied Disciplines	Convener
2.	Engr Prof Dr M. Younus Javed Convener Electrical Engg & Allied Disciplines	Member
3.	Engr Malik Saleem Ullah Saeed Convener Chemical Engg & Allied Disciplines	Member
4.	Engr Dr Wasim Khaliq Convener, Civil Engg & Allied Discipline	Member
5.	Engr. Prof. Dr. Iftikhar Hussain Convener, Mechanical and Allied Engineering	Member
6.	Engr Dr Muhammad Ashraf Convener, Agricultural Engg & Allied Disciplines	Member
7.	Engr Prof Dr Jameel Ahmed Convener, Common to All (Non-Engg Component)	Member

8. Engr Muhammad Raza Chohan — 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

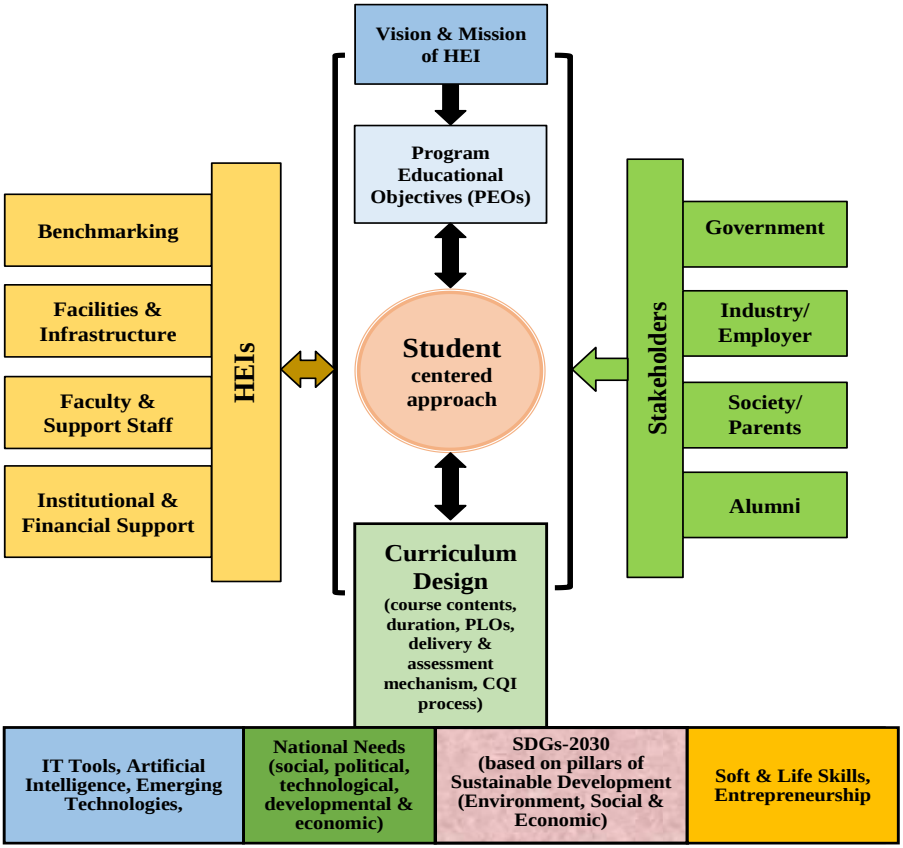
2. ECRDC Agenda

- 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

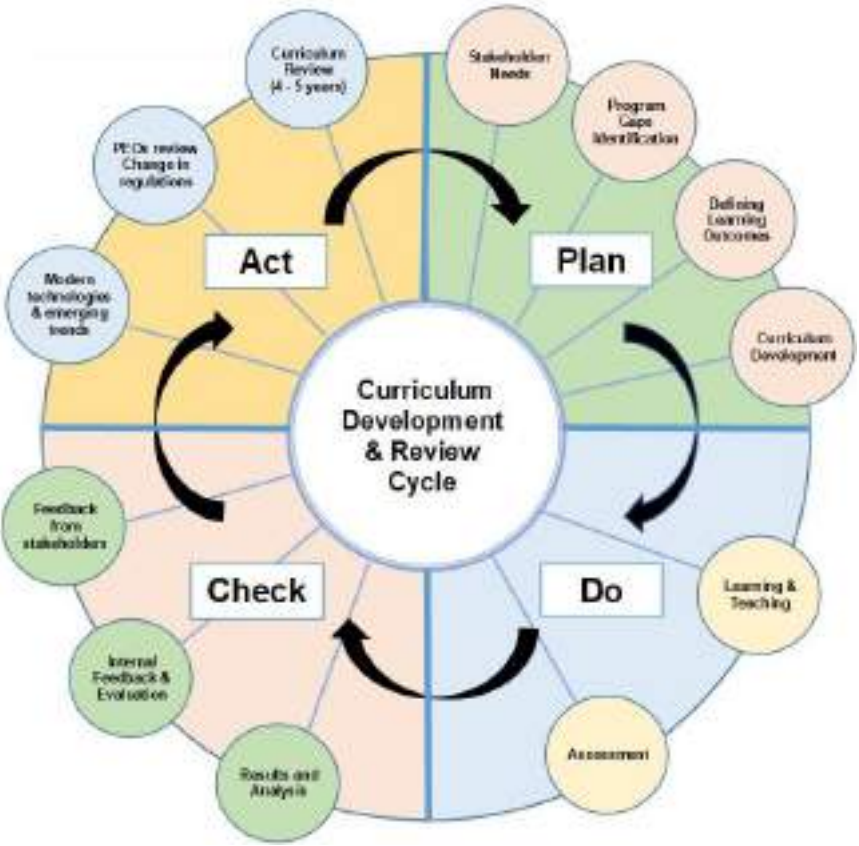
Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student-centred system which concerns what the students would know and be able to do as learning outcomes. The curriculum development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

Outcome-Based Education (OBE) - Curriculum Development Framework



4. PDAC 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 Mechanical and Allied Engineering Disciplines

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Mechanical and Allied Engineering Disciplines took up the task to review and update the curriculum for B.E Automotive Engineering degree program. The subject Committee had two meetings on 28-8-2019 and 22-1-2020 at PEC HQ Islamabad besides meeting of Sub-Group on Automotive Engineering at NED-UET, Karachi. The Committee consisted of following members:

1	Engr Prof Dr Iftikhar Hussain Vice Chancellor University of Engineering & Technology Peshawar	Convener
2	Engr Prof Dr Muhammad Tufail Pro Vice Chancellor NED UET, Karachi.	Member
3	Engr Prof Dr Syed Mushtaq Shah Dean Faculty of Engg. Baluchistan University of Engineering & Technology Khuzdar, Balochistan	Member
4	Engr. Prof. Dr. Shahab Khushnood Professor Faculty of Mechanical & Aeronautical Engineering UET, Taxila	Member

5	Engr Prof. Dr Javaid Iqbal Dean College of EME Peshawar Road Rawalpindi	Member
6	Engr. Meer Abdul Qayyum Babar Chief Engineer (Rtd) WAPDA , Jhelum	Member
8	Engr. Prof. Dr. Mohammad Pervez Mughal Chairman Department of Industrial & Manufacturing Engineering University of Engineering & Technology Lahore	Member
9	Engr Muhammad Shaukat Deputy Manager Mari Petroleum Islamabad	Member
10	Engr Prof. Dr Rizwan Mehmood Gul Professor, Faculty of Mechanical Engineering University of Engineering & Technology Peshawar	Member
11	Engr. Dr. Alam Zeb General Manager Project Management Organization (PMO) Rawalpindi	Member
12	Engr. Dr. Abdul Rahim Abbasi Principal Engineer Karachi Nuclear Power Plant (KANUPP) Karachi	Member
13	Engr. Dr Manzar Air Commodore Pakistan Aeronautical Complex Kamra, Distt. Attock	Member

14	Engr Prof. Dr Iqbal Hussain Professor Department of Mechanical Engineering UET, Lahore	Member
15	Dr Hamid Zaigham Professor Faculty of Materials Science and Engineering Ghulam Ishaq Khan Institute of Engineering Sciences and Technology Swabi	Member
16	Engr. Dr. Khalid Rahman Associate Professor Faculty of Mechanical Engineering Ghulam Ishaq Khan Institute of Engineering Sciences and Technology Swabi	Member
17	Engr. Dr. M. A. Irfan Mufti Dean Faculty of Mechanical, Chemical, Industrial, Mechatronics & Energy Engineering University of Engineering & Technology Peshawar	Member
18	Engr. Dr. Salim ur Rehman Vice Chancellor Sarhad University of Science & Information Technology, Peshawar	Member
19	Engr. Dr. Ajaz Bashir Janjua Dy. General Manager Heavy Mechanical Complex (HMC) Taxila	Member
20.	Engr. Prof Dr M. Naeem Professor Institute of Space Technology Islamabad	Member

21.	Mr. Hidayatullah Kasi Deputy Director Higher Education Commission Islamabad	Rep HEC
22.	Engr. Dr. Ashfaq Ahmed Sheikh Additional Registrar-CPD Paksitan Engineering Council Islamabad	Secretary
23.	Engr. Muhammad Kashif Ali Assistant Registrar-CPD Paksitan Engineering Council Islamabad	AR-CPD

5.1 Sub Group Automotive Engineering

1.	Engr. Prof. Dr. Muhammad Tufail Pro Vice Chancellor NED-UET Karachi.	Lead Sub-Group
2.	Engr. Prof. Dr Pervez Mughal Chairman Department of Industrial & Manufacturing Engineering University of Engineering & Technology Lahore	Member
3.	Engr. Prof. Dr Omer Masood Qureshi Professor Institute of Space Technology Islamabad	Expert
4.	Engr. Prof. Dr Mushahid Hussain Chairman Department of Automotive Engineering NED-UET, Karachi	Expert

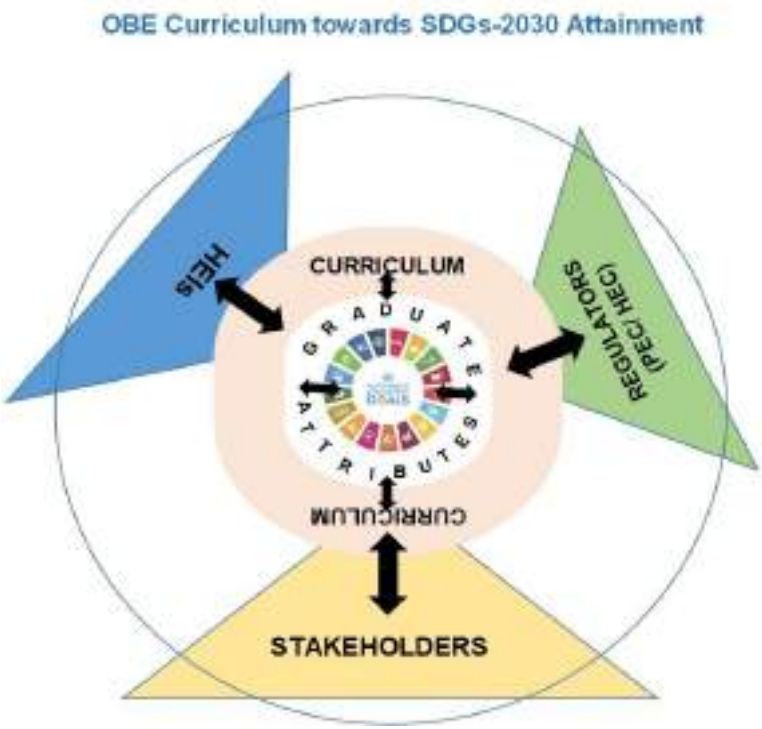
5.	Engr. Ihsan Hussain Tariq Farooqui Executive Director Tech & Projects Fecto Group of Industries, Karachi	Expert
6.	Mr. Hidayatullah Kasi Deputy Director Higher Education Commission Islamabad	Rep. HEC
7.	Engr. Dr. Ashfaq Ahmad Sheikh Additional Registrar-CPD Pakistan Engineering Council Islamabad	Secretary
8.	Engr. Muhammad Kashif Ali Assistant Registrar-CPD Pakistan Engineering Council Islamabad	AR-CPD

6. Agenda of ECRDC for Mechanical and Allied Engineering

- 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.
- Review of polices and stakeholders' feedback relating sector relevant to the respective discipline
- Comparative study of the curricula being offered at various engineering universities/institutions following the OBE-based system
- Development and finalization of complete scheme and curriculum for respective discipline including all aspects.

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

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



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

7. Program 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 Automotive 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 Automotive 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 and Goal-12

The graduates after graduation would be able to:

PEO-1: Apply knowledge, skills and attitude to solve complex engineering problems of industry.

PEO-2: Demonstrate management and communication skills complimenting technical competence.

PEO-3: Ability to use and improve upon contemporary and emerging technologies while focusing on lean methodologies.

PEO-4: Demonstrate professional, societal, ethical values and commitment towards continued professional development.

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 modelling, 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

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

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

- **Additional Course or Credit Hours Requirements:** Any addition of course or credit hour requirements as per direction or policy of the Government (Provincial or Federal), HEIs have leverage to cater such needs over and above the prescribed requirements in this document.
- Number of weeks per semester: 15 - 18
- Number of credit hours per semester: 15 - 18
- **Curriculum:** The engineering curriculum is the most important instrument for grooming the students based on 12 Graduate Attributes (GAs) encompassed under the Program Learning Outcomes (PLOs). In order to inculcate different dimensions of thinking – mathematical, computational, design and creative – among students in Cognitive, Psychomotor and Affective domains, the curriculum is based on the following knowledge profiles:

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

  WK2 - Mathematics and Computing: The concept-based mathematical thinking, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modelling 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 Sciences	Math	As per program requirements	12 – 15
WK-1		Physics	Applied Physics	6 – 9
		Chemistry	Applied Chemistry	
		Natural Science/ Math Elective	As per program requirements	
WK-7	Humanities	English	Written, communication and presentation skills	4 – 7
		Culture	Islamic Studies and Ethics	2
			Pakistan Studies and Global Perspective	2
		Social Science	Social and soft skills	2 – 6

	Management Sciences	Professional Practice	Professional and Project Management	2 – 6
Total (Non-Engineering Domain)				**min 30**
Engineering Domain				
WK-2/ WK-4/ WK-5/ WK-6	Computer and Information Science	ICT/AI/ Data Science/ Cyber Security		6 – 9
WK-3/ WK-2	Foundation Engg Courses		Specific to program objectives and outcomes	22 – 24
WK-4/ WK-2/ WK-1	Core Breadth of Engg discipline		Specific to program objectives and outcomes	23 – 24
WK-5/ WK-6	Core Depth of Engg Discipline		Specific to program objectives and outcome	22 – 24
WK-1/ WK-2/ WK-3/ WK-4	Multidisciplinary Engg Courses		Specific to program objectives and outcome	6 – 12
			Occupational Health and Safety (mandatory – 01 Cr Hr)	
WK-6/ WK-7/ WK-8	Final Year Design Project (FYDP)/ Capstone	Integration of innovative, creative, technical, management and presentation skills of a graduate towards final year.		6
WK-6/ WK-7	Industrial Training	at least 6 - 8 weeks mandatory internship		Qualifying
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	**Innovative and Critical Thinking (under relevant courses):** - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open Ended Labs - Problem Based Learning (PBL)			
Total (Engineering domain)				**min 85**
Total (Credit Hours)				**130 – 136**

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

- **Industrial Training:** Internship of at least 6 - 8 weeks is mandatory part of degree requirements towards 3rd to 4th year of program; must be supervised, monitored, evaluated, and reflected in the transcripts under a prescribed mechanism and with defined and mapped rubrics with program objectives;
  - Selection of internship in line with elective subjects/ specific streams
  - Qualifying weightage:70%
    - At least 75% attendance is mandatory 10%
    - Assessment report from the employer 50%
    - Evaluation at relevant HEIs/ Deptt – presentation 40%
- **Final Year Design Project (FYDP)/ Capstone:** FYDP aims to challenge innovative, creative, technical, management and presentation skills of a graduate to bring together the learning over the degree programme.
  - 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, modelling and simulation, AI (Artificial Intelligence) and computational data analytics, design and putting together various hardware, software, firmware and Algorithm Engineering / Informatics related to the program to demonstrate a functional concept including rapid prototyping, where applicable.
  - The FYDP shall include complex engineering problems and design systems, components or processes integrating core areas and meeting specific needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
  - A project of this nature should invariably lead to an integration of the knowledge and practical skills as mandated in the program outcomes. In this context, projects of multidisciplinary nature should be encouraged.
  - The FYDP should span over two consecutive semesters, i.e. semester 7 & 8, totalling 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 counselling 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 Automotive 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 Automotive Engineering

Knowledge Profile (WK-1 to WK-8)*	Knowledge Area	Subject Area	Course Title	Theory	Lab	Total
				Credit Hours		
Non-Engineering Domain						
WK-7	Humanities	Culture	Pakistan Studies and Global Perspective	2	0	2
			Islamic Studies and Ethics	2	0	2
		Language	Functional English	2	0	2
			Communication Skills	2	0	2
			Technical Writing and Presentation Skills	2	0	2
		Social Science	Sociology Elective I (Sociology for Engineers/ Sociology)	2	0	2
			Sociology Elective-II (Engg. Economics)	2	0	2
	Management Sciences	Professional Practice	Management Elective I (Entrepreneurship & Marketing)	2	0	2
			Management Elective II (Engineering Project Management/ Project Management)	3	0	3
WK-2/ WK-1	Natural Science	Chemistry	Applied Chemistry	2	1	3
		Physics	Applied Physics	2	1	3
		Mathematics	Calculus and Analytical Geometry	3	0	3
			Differential Equations	3	0	3
			Probability & Statistics	3	0	3
			Linear Algebra	2	0	2
			Multivariate Calculus and Transforms	3	0	3

			Numerical Analysis	2	0	2
Total (Non-Engineering)				**39**	**2**	**41**
Engineering Domain						
WK-2/ WK-4/ WK-5/ WK-6	Computer and Information Science	ICT/AI/ Data Science/ Cyber Security	Information and Communication Technologies	2	1	3
			Computer Programming	2	1	3
WK-3/ WK-2	Foundation		Engineering Drawing & Computer Graphics	1	1	2
			Engineering Mechanics	3	0	3
			Fluid Mechanics	2	0	2
			Introduction to Automotive Systems	2	0	2
			Materials & Metallurgy	3	0	3
			Mechanics & Materials Lab	0	1	1
			Mechanics of Materials	2	0	2
			Mechanical Workshop Practice	0	1	1
			Thermodynamics	3	0	3
			Thermo-Fluids lab	0	1	1
WK-4/ WK-2/ WK-1	Major Based (Core Breadth)		Automotive Propulsion	2	1	3
			Combustion, Emission & Pollution	3	0	3
			Design of Machine Elements	3	0	3
			Heat Transfer	2	0	2
			Design & Manufacturing Lab	0	1	1
			Design for Manufacturing	2	0	2

			Manufacturing Process	3	0	3
			Modelling & Simulation lab	0	1	1
			Automotive Embedded System	2	1	3
WK-5/ WK-6	Major Based (Core Depth)		Automotive Structure Design	2	0	2
			Chassis System Design	3	0	3
			Thermal Management for Automotive	2	0	2
			Vehicle Dynamics	2	0	2
			Vehicle Noise & Vibration	2	0	2
			Vehicle Ride & Handling lab	0	1	1
			Automotive Health Safety & Environment	2	0	2
			Operations Management	3	0	3
			Quality & Reliability Engineering	3	0	3
			Vehicle Development	2	0	2
			Automobile Instrumentation	2	0	2
			Engineering Elective I	3	0	3
			Engineering Elective II	3	0	3
			Engineering Elective III	3	0	3
WK-3/ WK-4/ WK-2/ WK-1	Multi-disciplinary Engineering courses		Basic Electrical Automotive	2	1	3
			Feedback Control Systems	3	0	3
			Fundamentals of Analogue & Digital Electronics	1	1	2

			Occupational Health and Safety (mandatory)*	1	0	1
WK-6/ WK-7/ WK-8	Final Year Design Project (FYDP)	Industrial/ Innovative/ Creative Project	FYDP (Part-I)	0	3	3
			FYDP (Part-II)	0	3	3
WK-6 WK-7	Industrial Training	6 -8 weeks Mandatory Internship		0	0	0
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	**Innovation and Critical Thinking (under relevant courses)** - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open Ended Lab - Problem Based Learning (PBL)					
Total (Engineering domain)				**76**	**19**	**95**
Total Credit Hours				**115**	**21**	**136**

* to be taught during 1st year of program.

10. Scheme of Study for Bachelor of Automotive Engineering

First Semester				
S. No.	**Course Title**	**Credit Hours**		**Credit Hours**
		Theory	**Lab**	
1	Applied Physics	2	1	3
2	Calculus & Analytical Geometry	3	0	3
3	Functional English	2	0	2
4	Introduction to Automotive Systems	2	0	2
5	Mechanical Workshop Practice	0	1	1
6	Information and Communication Technologies	2	1	3
7	Pakistan Studies	2	0	2
8	Engineering Drawing & Computer Graphics	1	1	2
Total		**14**	**4**	**18**
Second Semester				
1	Basic Electrical Automotive	2	1	3
2	Applied Chemistry	2	1	3
3	Communication Skills	2	0	2
4	Linear Algebra	2	0	2
5	Engineering Mechanics	2	0	2
6	Fluid Mechanics	2	0	2
7	Thermodynamics	3	0	3
8	Thermo-Fluid Lab	0	1	1
Total		**15**	**3**	**18**
Third Semester				
1	Computer Programming	2	1	3
2	Fundamentals of Analogue & Digital Electronics	1	1	2
3	Islamic Studies	2	0	2
4	Materials & Metallurgy	3	0	3
5	Mechanics & Material Labs	0	1	1

6	Mechanics of Materials	2	0	2
7	Differential Equations	3	0	3
Total		**13**	**3**	**16**
Fourth Semester				
1	Multivariate Calculus and Transforms	3	0	3
2	Automotive Propulsion	2	1	3
3	Design & Manufacturing Lab	0	1	1
4	Design of Machine Elements	3	0	3
5	Feedback Control Systems	3	0	3
6	Manufacturing Process	3	0	3
7	Modelling & Simulation Lab	0	1	1
Total		**14**	**3**	**17**
Fifth Semester				
1	Probability & Statistics	3	0	3
2	Automotive Embedded System	2	1	3
3	Technical Writing & Presentation Skills	2	0	2
4	Combustion, Emission & Pollution	3	0	3
5	Design for Manufacturing	2	0	2
6	Sociology Elective I	2	0	2
7	Heat Transfer	3	0	3
Total		**17**	**1**	**18**
Sixth Semester				
1	Numerical Analysis	2	0	2
2	Automobile Instrumentation	2	0	2
3	Automotive Structure Design	2	0	2
4	Chassis System Design	3	0	3
5	Entrepreneurship	2	0	2
6	Sociology Elective II	2	0	2
7	Vehicle Dynamics	2	0	2

8	Vehicle Noise & Vibration	2	0	2
9	Vehicle Ride & Handling Lab	0	1	1
Total		**17**	**1**	**18**
Seventh Semester				
1	Final Year Project I	0	3	3
2	Operations Management	3	0	3
3	Management Elective II	3	0	3
4	Technical Elective I	3	0	3
5	Technical Elective II	3	0	3
6	Thermal Management for Automotive	2	0	2
Total		**14**	**3**	**17**
Eighth Semester				
1	Final Year Project II	0	3	3
2	Automotive Health Safety & Environment	2	0	2
3	Quality & Reliability Engineering	3	0	3
4	Technical Elective III	3	0	3
5	Vehicle Development	2	0	2
Total		**10**	**3**	**13**

Electives for Social Science

- 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

Electives for Management Sciences

- 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

Courses for Computer Sciences

- Information and Communication Technologies (ICT)
- Artificial Intelligence
- Cyber Security
- Data Science
- Modelling and Simulation
- Computer Programming and Design

11. Program Specific Labs

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

- Combustion & Emission Lab
- Body & Suspension Lab
- Auto Electronics Lab
- Electronics & Instrumentation Lab
- Fuel Cell Lab
- Computer Lab
- Project & Research Lab

12. Course Details and Teaching-Assessment Approaches

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

12.1 Engineering Domain

Computer and Information Science Courses

Information and Communication Technologies (ICT)

Course Outline:

Introducing Computer Systems: Basic Definitions

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

Basic Operations and Components of a Generic Computer System

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

Processing Data

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

The Internet

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

Introduction to Embedded Systems

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

Networking Basics

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

Database Management

- Hierarchy of Data
- Maintaining Data
- Database Management Systems

Exposure to ICT Tools and Blogs (Student Assignment)

Protecting your Privacy, your Computer and your Data

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

- Threats to Data

ICT in Education

Future Trends in ICT

Final Presentations

Tools / Software Requirement

Microsoft Office, Windows, Virtual Box, Netbeans

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- "Introduction to Computers", Peter Norton, 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: Your Interactive Guide to the Digital World. Cengage Learning" Shelly GB, Vermaat ME, 2012 Ed.

Computer Programming and Design

Course Outline:

Introduction

Hardware, Software, data and people, buses, data movement , Data Processing, Transforming data into information, Number System, Data storage, Introduction to Object-Oriented Programming, Introduction to Programming, Installing and IDLE,

Data Processing, Introduction to database, DBMS and its application in different areas, storage, manipulation and retrieval of data. Structured, instructed database, Introduction to parallel processing as well as clusters, networking, types of networks, network topologies, client-server networking

Computer Programing

Numeric Data Types, Values, variables, expressions, Object-Oriented Programing, Control Statements, Loop and Iteration, If statements, if-else, Else-if construct, Functions or Procedures, Defining and accessing a function, Passing arguments and returning values to functions, Strings, String constants and variables, String Operations, Text Files, Arrays Lists, Dictionaries, Tuples, Operations, Debugging and exceptional Handling, Testing and debugging, Black box testing, Glass box testing, Handling Exceptions, Abstract data types and Classes, Designing using Abstract data types, Class Diagrams

Computer Application in Engineering

Introduction to Computer Aided Engineering (CAE), Computer Application in Engineering, Real world engineering problem solving, Mathematical tools, Plotting, model building and mathematical tools, Mathematical Arrays, Introduction to Mathematical libraries, mathematical operations on arrays, Objects and Classes, Awareness of dedicated software used in different engineering applications.

Teaching Methodology (Proposed as applicable):

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

Assessment:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Peter Norton, “Peter Norton's Introduction to Computers”, 6th Edition, McGraw- Hill Publications, 2005
- Lambert, Kenneth A. “The Fundamentals of Python: First Programs”, Cengage Learning, 2011

- John V. Guttag, "Introduction to Computation and Programming Using Python", MIT Press, 2013

Computer Aided Design

Course Outline:

- Introduction to AutoCAD
- Use basic drawing and text commands
- Use basic editing commands (move, copy, erase, etc.)
- Use advanced editing commands (mirror, fillet, etc.)
- Dimensioning capabilities of AutoCAD
- Create and use layers
- Print or plot a drawing
- Create and using blocks
- Be familiar with hatching capabilities of 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 2017 and AutoCAD LT 2017 by George Omura with Brian Benton, (latest edition), 2016.

- AutoCAD® 2015 And AutoCAD Lt® 2015 No Experience required by Donnie Gladfelter.

Introduction to Modelling and Simulation

Course Outline:

Simulation

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

Modeling

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

Tools/ Software Requirement

- Matlab

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Engineering Foundation Courses

Introduction to Automotive Systems

Course Outline:

Introduction

Definition of automobiles; Classifications of automobiles: based on wheels, based on intended use; national and international classifications; Historical development: From basic carriages to modern vehicles, Growth and refinements.

Engines

Types of engines: Spark ignition engines, Compression ignition engines, Two and four stroke engines; Arrangement and functions of the main components of the engine: Cylinder head assembly, Cylinder block assembly, Intake and exhaust, Turbo charger / Super chargers, Valves.

Fuel Delivery System

Basic principles and operations of fuel delivery system, Carburetor system, Electronic fuel injection (EFI) system, Fuel pump and filter, Fuel tanks and piping.

Lubrication System

Basic purpose of lubrication, Elements of lubrication system: Types of bearings and their function, Lubricants types and selection for optimal use.

Cooling System

Elements of cooling system: Coolants and additives, Water pump, Radiators, Fan and shroud, Hoses.

Transmission and Drivelines

Functions and configurations of transmission and drives, Elements of drive train: Friction clutches, Gear theory and types, Manual transmissions, Automatic transmissions, Continuously Variable Transmission (CVT), Drive shafts, Transmission case, Four / All wheel drives.

Steering System

Classification of steering systems: Worm and wheel, Rack and pinion, Power steering. Steering Dynamics, Vehicle rollover, Steering geometry.

Suspension System

Classification of suspension systems: Solid axle, Independent, Macpherson struts; Suspension system components: Leaf springs, Coil springs, Torsion bars, Pneumatic springs, Dampers / Shock absorbers; Suspension roll center analysis.

Brakes and Tires

Introduction of braking systems, braking dynamics, Types of brakes: Mechanical brakes, Hydraulic brakes, Anti-locking Braking System (ABS), Traction Control System (TCS); Tires: Types / Construction, Tire designation, Tire force and tire wear; Wheels: Steel wheel and rims, Alloy wheels; Wheel balancing.

Automotive Bodies and Chassis

Body structure, Body materials, Body finishing, chassis Types, Automotive glasses, Body locking systems, Safety parameters crash tests.

Overview of the Automotive Industry

Issues faced by the industry: Fuel prices, Emissions, Safety. Stake holders in the automotive industry, Global automotive industry, Regional automotive industry, National automotive industry, and SWOT 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, Assignments, Project Report, Quizzes, Final Term

Suggested Books:

- James Halderman, "Automotive Technology- Principles Diagnosis and Service", Prentice Hall, 2011
- RK Rajput, "A Text Book of Automobile Engineering" Firewall Media, 2008
- Tom Denton, "Automobile Mechanical and Electrical System", Routledge, 2011

Mechanical Workshop Practice

Course Contents:

Fabrication Shop:

Bench fitting practice, exercise in marking and fittings; use of measuring instruments, Smith's forge; exercise in bending, upsetting and swaging.

Wood Work Shop:

Use of carpenter's tools; exercise in preparing simple joints.

Machine Shop:

Simple machine shop processes, such as turning, shaping, milling and sheet metal work.

Welding Shop:

Familiarizing the students with the following processes, soldering and brazing, heat treatment, moulding and casting.

Automotive Shop:

Use of Automotive workshop tools such as hand tools, measuring tools, special service tools and testing kits; fault diagnosis by inspection & testing of mechanical systems of a vehicle i.e. cooling, lubricating. Special service tools (SST).

Auto Electrical & Electronics Shop:

Exercises in checking Electrical & Electronic circuits & their components of a light vehicle; automotive battery testing; Lighting system; detecting fault codes and their interpretation using scanner.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- K C. John, "Mechanical workshop practice", PHI Learning Pvt. Ltd., 2010
- Tom Denton, "Automobile Electrical and Electronic Systems", Butterworth, 2004
- Charles White, "Automotive Diagnostic Fault Codes Techbook", Hayned Publishing, 1998.
- James d. Halderman, "Automotive Technology Principles, Diagnosis, And Service", Pearson, 2012
- W A J Chapman, "Workshop Technology Part-I", Butterworth Heinemann, 2019
- Delmar's Test Preparation Series (A1,A6), Thomson Learning, Inc., 2001

Fluid Mechanics

Course Outline:

Introduction and properties of Fluid

Properties of Fluid, viscosity, surface tension, vapour pressure and cavitation, Classification of Fluid flow.

Fluid Statics

Center of pressure, Hydrostatic forces on submerged surfaces, Buoyancy and stability.

Fluid Dynamics

Velocity and acceleration field, Static, dynamic and stagnation pressure, Bernoulli's equation; Energy equation for steady and incompressible flow, laminar and turbulent flow in circular pipes; Hydraulic losses and correction factor, Introduction of Dimensional Analysis.

Governing Equations of Fluid Flow

Eulerian and Lagrangian viewpoints; Continuity equation, Navier-Stokes Equation, Reynold's Transport theorem for continuity, linear momentum and Angular Momentum.

Potential Flow Theory

Irrotational flow field; stream function, velocity potential function, vorticity and circulation relation, basic potential flows; uniform flow; two dimensional source and sink; simple vortex; the doublet; lift and drag forces.

Boundary Layer Theory

Boundary layer theory; laminar boundary layer; turbulent boundary layer, boundary layer thicknesses; drag, lift and airfoil cascades.

Fluid Machinery

Euler's equation of turbo-machine, classification of turbo-machines; centrifugal pumps and turbines, affinity laws, specific speed, performance curves

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, Final Exam, Quizzes, Assignments, Presentation

Suggested Books:

- Munson, "Fundamentals of Fluid Mechanics", John Wiley, 2014
- Frank M, "Fluid Mechanics", McGraw-Hill India, 2017
- Çengel, "Fluid Mechanics-Fundamentals and Applications", McGraw-Hill, 2018
- Robert W. Fox, "Introduction to Fluid Mechanics", Wiley, 2016
- Joseph Katz, "Introduction to Fluid Mechanics", Cambridge University Press, 2010

Thermodynamics

Course Outline:

Introduction to Thermodynamics

Concept of Equilibrium, Continuum, Pressure and Temperature; Zeroth Law of Thermodynamics, Properties of Pure Substances, PVT surfaces, Use of steam table, conservation of mass, pressure and temperature measurement devices.

Equation of state, Ideal gas law, Vander Wall equation, Law of corresponding states, Virial equation of state.

Laws of Thermodynamics

Work, Heat, Law of conservation of Energy, First law of thermodynamics for closed and open system, Second law of thermodynamics, Heat engine, Refrigeration and heat pump, Carnot Cycle, Entropy, Clausius Inequality, Isentropic relations, Thermodynamic process and cycles. Introductory concept of Mechanical Exergy.

Thermodynamic Power Cycles

Thermal Efficiency, Air standard Otto, Diesel and Dual Cycle; Brayton Cycle, Rankine Cycle.

Reciprocating Compressors

Condition for minimum work, Isothermal efficiency, volumetric efficiency, multi-stage compression, Energy balance for a two stage machine with intercooler.

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, Final Exam, Quizzes, Assignments, Presentation

Suggested Books:

- Cengel, "Engineering Thermodynamics", McGraw-Hill, 2019
- Moran Shapiro, "Fundamentals of Engineering Thermodynamics", Wiley, 2019.
- Yunus A. Çengel, "Fundamental of Thermal-Fluid Sciences", McGrawHill, 2016.

Thermo-Fluids Lab

Course Outline:

Measurement of pressure, temperature, humidity, flow rate, Fluid flow visualization, Hydrostatics, hydraulic and pneumatic, Thermal conductivity and heat transfer parameters, Gas laws, Fluid machinery, Refrigeration and Air-Conditioning, Cabin climate control.

Teaching Methodology (Proposed as applicable):

Safety Instructions, Lectures on Procedures, Lab Preparation under Supervision, Definition of Deliverables, Open Ended Labs.

Assessment:

Performance Rubrics, Lab Manual/Workbook

Engineering Drawing & Computer Graphics

Course Outline:

Engineering Drawing

Drawing equipment and the use of instruments, Basic drafting techniques, standards and dimensioning, Freehand sketching of automotive systems and engine components, Geometrical curves including plane curves: cycloid, hypocycloid, and the involutes, Projection, intersections and development of surfaces of geometrical bodies such as prism, pyramids, cylinders and cones, Orthographic projection and Isometric projection of automotive systems and components, Concept of working drawing of component parts of machines and engines: size, description, dimensions, and specification; limit dimensioning and geometric tolerances; limits; fits and tolerances; conventional symbols

Computer Aided Graphics

Introduction to CAD and the available CAD software, Methods for creating drawing entities, common editing features, dimensioning with variable setting, printing and plotting, Introduction to wire framing and solid modelling.

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, Final Exam, Quizzes, Assignments, Presentation

Suggested Books:

- K Morling, “Geometric and Engineering Drawing”, London : Routledge, 2012
- N.D Bhatt, “Engineering Drawing and Graphics”
- Abbot, “Practical Geometry & Engineering Graphics”, Springer, 2013

- G. R. Bertoline, E. N. Wiebe, "Technical Graphics Communication", McGraw-Hill, 2003
- D.F. Rogers, J.A. Adams; "Mathematical Elements for Computer Graphics", McGraw-Hill
- C Parkinson, "A First Year Engineering Drawing"

Engineering Mechanics

Course Outline:

Introduction

Definition of Statics, Kinetics and Kinematics, Scalar, Vector quantities, Fundamental principle of engineering mechanics, System of units.

Fundamental of Statics

Force and Effect of forces, Types of force and force systems, Moment, Couple and its characteristics, Law of parallelogram of forces , Law of polygon of forces , Varignon's principle Types of Supports and Loads, Support reactions and problems related to theories.

Truss Structures

Plane truss, Methods of joints, Methods of sections

Equilibrium

Concept of Free body diagram, Lami's theorem and its applications.

Centre of Gravity

Definition of Centroid center of gravity, Moment area method for finding out center of gravity for 1D and 2D problems, Composite sections.

Moment of Inertia

Concept of MI, Methods for finding out MI, Theorem of Parallel Axis and Perpendicular axis and related problems.

Friction

Terminology, Friction on inclined smooth and rough surfaces, Ladder friction.

Kinematics

Terminology, Combined motion of rotation and translations, Case of Crank and Shaft, Instantaneous center and its location, Single degree free vibrations

Kinetics

Newton's law of motions, De-Alembert's Principle, Motion of connected bodies on plane and inclined surfaces, Related 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 Exam, Final Exam, Quizzes, Assignments, Presentation

Suggested Books:

- R. C. Hibbeler, "Engineering Mechanics, Statics and Dynamics", Prentice Hall, 2010
- J. L. Meriam, "Engineering Mechanics, Statics", Wiley Publications, 2018
- J. L. Meriam, "Engineering Mechanics, Dynamics", Wiley Publications, 2018
- S. Timoshenko, "Engineering Mechanics", McGraw Hill Edition, 2013

Materials & Metallurgy

Course Outline:

Introduction to Materials Engineering

Types of materials, Source of materials and their extraction, Crystalline and amorphous materials, Application and selection of materials (basic criteria for different environments.

Metallic Materials

Pure metals and alloys, Nature and properties of metals and alloys, Major properties of metal and alloys, Single crystal and polycrystalline metals, Crystal defects and the

mechanism of deformation and fracture, Plastic flow in polycrystalline materials, Structure property relationship, Macro and micro examination, Structural aspect of solidification and solid phase transformation in binary systems, Ferrous and non-ferrous metals, steel making processes, Heat treatments, TTT diagram, Surface hardening coatings, Powder Metallurgy, Non-destructive testing.

Ceramics, Glasses and Refractory Materials

Compositions, Properties, Structures of various non-metallic materials, Application of ceramics, Glasses, Refractory materials, Methods of manufacture.

Polymers and Rubbers

Polymerization, Structural feature of polymers, Thermoplastic polymers, Thermo setting polymers, Additives, Major mechanical properties, Rubber (Elastomers), Synthesis of rubber.

Composites

Introduction to composite materials, Types of composite materials, Method of fabrication of composite Materials, Property averaging, Major mechanical properties.

Environmental Degradation

Metal degradation by atmosphere, Aqueous and galvanic corrosion, Stress corrosion cracking, Methods of Corrosion prevention, Behavior of metal at elevated temperature pyrometer, Oxidation, Scaling and creep, Chemical degradation of ceramic and polymers, Radiation damage of surface, Improvement against Degradation.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- William D. Callister, Jr., Materials Science and Engineering An Introduction, John Wiley & Sons, Inc., HOBOKEN, USA, 2019.

- Foundations of material Science and engineering by William F Smith and Javed Hashemi, 4th edition.
- MF Ashby, "Materials Selection in Mechanical Design", Fourth Edition, Butterworth-Heinemann, 2010.

Mechanics of Materials

Course Outline:

Stress-Strain Relations

Stress, Deformation, strain, elastic, stress-strain behavior of materials, Poisson's ratio, General stress method, Thermal stress and strain, statically indeterminate system, volume changes, constrained materials, Beams and frames.

Stress and Strain Transformations and Relationship

Two-directional stress systems; Mohr's stress circle; principal stresses and planes; Combined bending and torsion; Two-directional strain analysis; Normal and shear strain in terms of coordinate and maximum shear strains; Relationship between elastic constants.

Theory of Torsion

Torsion of thin-walled cylinder; Torsion of a solid circular shaft; Hollow shafts, Non-uniform and composite shafts, tapered shaft, torsion of thin rectangular strip; torsion in helical springs.

Bending Stresses

Simple bending theory; General case of bending; Composite Beams; Eccentric end load; Shear stresses in bending.

Bending: Slope and Deflection

Deflection curve of the neutral axis; Double Integration and super-position methods.

Theory of Columns

Euler's theory of buckling; Eccentric loading of long columns. Behavior of ideal and real struts. Struts with initial curvature; Crinkling; Members subjected to axial and transverse loading.

Elastic Strain Energy

Strain energy under direct stress and in pure shear; Strain energy in bending and torsion; Maximum Stress due to a suddenly applied load and due to impact; Bending deflection of a beam from an impact, shear deflection; Theorems of Castgliano and Maxwell's theorem.

Theories of Yielding

Maximum Principal Stress Theory; Maximum Principal Strain Theory; Maximum Shear Stress Theory, Total Strain Energy Theory.

Thin Plates and Shells

Deflection of thin plates, bending of circular plates with symmetrical loading. Plates with uniform loading. Solid plate with different loading conditions. Axi-symmetrical thin shells, bending stresses in thin shells.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Russell C. Hibbeler, "Mechanics of Materials", Pearson, 2018
- Barry J. Goodno, "Mechanics of Materials", Cengage Learning, 2016
- James M Gere, "Mechanics of Materials", Stamford, Conn. : Cengage Learning, 2013

Mechanics & Materials Lab

Course Outline:

Equilibrium, Torque, Truss, Centripetal Force, Gyroscope, Flywheel, Moment of Inertia of Rotating Bodies, Coriolis force, Mechanical Properties of engineering materials, stress-strain curve, deformation measurement, yield strength, fracture, creep, fatigue, grain structure, crystallization, heat treatment.

Teaching Methodology (Proposed as applicable):

Safety Instructions, Lectures on Procedures, Lab Preparation under Supervision, Definition of Deliverables, Open Ended Labs.

Assessment:

Performance Rubrics, Lab Manual/Workbook

Engineering Breadth Courses

Automotive Propulsion

Course Outline:

Introduction

Introduction to four stroke spark and compression ignition engines; speed and load control in SI and CI engines; two stroke engines; supercharging, Real ICE cycle; regenerative cycle.

Power Measurement

Measurement of engine torque and power, dynamometer principle; measurement of brake and indicated horse power; use of indicator diagram.

Systems

Fuel systems; petroleum and non-petroleum fuels; characteristics of SI and CI engine fuels; LPG and CNG as IC engine fuel; Octane and Cetane number; lubrication systems and lubricants; Working of carburettor; gasoline and CI injection systems; CI engine nozzles.

Engine Performance Parameters

Volumetric efficiency, pumping losses, scavenging. Engine friction. Heat transfer and Engine valve timing diagram, Performance characteristics of SI and CI engines.

Low Carbon Propulsion

Introduction to Fuel cells; types of fuel cell and their application in automobiles; limitations of fuel cells; Introduction to Stirling engines and hybrid power plants for automobiles, downsizing, hybridization, EV propulsion.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- John B. Heywood, "Internal Combustion Engine Fundamentals", McGraw-Hill, 2018
- "Internal Combustion Engines", R K Rajput, Laxmi Publications, 2005
- Colin R Ferguson; Allan Kirkpatrick, "Internal combustion engines- Applied thermosciences", Wiley, 2016.

Design of Machine Elements

Course Outline:

Fundamental Aspects of Design

Basic Design Process and Design Methodologies, Role of Brain-Storming in design, Uncertainty in Design, Standards and Codes.

Failure Prevention

Failure Resulting from Static Loading, Failure Theories for Ductile and Brittle Materials, Selection of Failure Criteria.

Shafts

Shaft materials, shaft design for stress, deflection considerations, shaft design for combined loading, design of shafts based on rigidity.

Welded Connections

Welding symbols, fillet and butt welds, stresses in welded joints in torsion and bending, strength of welded joints based on static and fatigue loading.

Helical Springs

Stresses in helical springs, deflection of helical springs, spring materials, fatigue loading and design of helical compression springs,

Rolling Contact Bearings

Bearing types, bearing life, bearing load life and rated reliability, Weibull distribution, combined radial and thrust loading, variable loading, design assessment of rolling contact bearing.

Lubrication and Journal Bearings

Types of lubrication, viscosity, thick film lubrication, hydrodynamic theory, design consideration of bearings, bearing clearance.

Spur Gears

Types of gears, gears nomenclature, conjugate action, Lewis bending equation, AGMA stress equations, AGMA strength equations, geometry factors, factors affecting gear strength, design criteria of spur gears.

Clutch and Brakes

Static analysis of clutch and brakes, design of friction clutch, design of disk and band brakes.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem

Suggested Books:

- Richard G Budynas; J Keith Nisbett; Joseph Edward Shigley, "Shigley's Mechanical Engineering Design", McGraw-Hill, 2020.
- Ansel C. Ugural, "Mechanical Design of Machine Components", CRC Press, 2015
- Nortan, "Machine Design", Pearson, 2000
- Khurmi & Gupta, "of Machine Design", Eurasia Publishing House, 2005

Manufacturing Process

Course Outline:

Introduction

Basic concepts of manufacturing processes

Casting and Moulding

Metal casting processes and equipment, Powder metallurgy, Plastics

Forming

Extrusion and drawing, sheet metal forming, forming and shaping plastics and composite materials

Machining

Conventional and non-conventional machining processes

Joining

Welding, brazing, soldering, sintering, adhesive bonding, fastening, Press fitting

Painting

Immersion Coating Processes, Cleaning, Rinsing, Conversion and Phosphate Baths, Paint Curing Processes

Static Aspects of Manufacturing Processes

Layout Strategies, Process-oriented Layout, Cell-based Layout Design, Product-based Layout, Lean Manufacturing

Operational Aspects of Manufacturing Processes

Aggregate Production Planning, Master Production Scheduling (MPS), Material Requirement Planning (MRP), Production Line Control and Management

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem

Suggested Books:

- M. P. Groover, "Fundamental of Modern Manufacturing: Materials, Processes and Systems", John Wiley & Sons, 2020
- M. A. Omar, "The Automotive Body Manufacturing Systems and Processes", John Wiley & Sons, 2011

Design & Manufacturing Lab

Course Outline:

- Linkages, basic machine elements, Lathe operations, Jigs and Fixtures,
- Milling operations, Shearing, Bending Press, Casting, Tools and Dies, Metrology,
- CNC machining (programming, operation, and flexibility),
- Welding and other joining processes,
- Design, fabricate & test a prototype.

Teaching Methodology (Proposed as applicable):

Safety Instructions, Lectures on Procedures, Lab Preparation under Supervision, Definition of Deliverables, Open Ended Labs.

Assessment:

Performance Rubrics, Lab Manual/Workbook

Modelling & Simulation Lab

Course Outline:

Principles of Modelling and Simulation

Introduction to Modelling and Simulation, Defining the Need for Models and Simulation, Developing Models and Simulation, Study of CAD software, Parametric modelling, Study design documentation

Modelling

Construction of a simple 3d model, Construction of a sketch using constraints, Construction of axisymmetric models, standard holes, Drafting of CAD model, using special views, Construction helical features, sweep features, assembly, Application of advance assembly, Drafting of assembly using exploded view

Simulation

Identify the stress concentration, in Trusses, at different points, using different loads, using different boundary conditions, Deformation in a rectangular geometry, when different loads are applied, at different points, Deformation in a rectangular geometry with a fixed hole in the centre, when different loads are applied, at different points

Teaching Methodology (Proposed as applicable):

Safety Instructions, Lectures on Procedures, Lab Preparation under Supervision, Definition of Deliverables, Open Ended Labs.

Assessment:

Performance Rubrics, Lab Manual/Workbook

Suggested Books:

- D J. Cloud, “Applied Modelling and Simulation”, McGraw-Hill, 1998

Automotive Embedded System

Course Outline:

Introduction

Basic components of embedded systems, applications in automotive.

Microcontroller and Programming

Internal architecture; controller memory organization; special function registers; addressing modes; programming instructions (arithmetic, data transfer, logical, Boolean and branching); timer operation; serial port operation and modes of operation, interrupts; programme design using interrupts, assembly language programming.

Memory and Storage

Basics of semiconductor memory, Random Access Memory (RAMs), Read-Only Memory (ROMs), Programmable ROMs (PROMs and EPROMs), flash memories, memory expansion, special types of memories, magnetic and optical storage, testing memory chips.

CAN and Communication Networks

Introduction to CAN; Network fundamentals and advantages of communication and network modules; Types of communication, 03 common types of networks in vehicles (Ring link, star link , ring/star hybrid); Network classification based on SAE, Vehicles Applications of CAN, Automotive embedded software applications.

Teaching Methodology (Proposed as applicable):

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

Assessment:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Nicolas Navet, “Automotive Embedded Systems Handbook”, CRC Press, 2017
- Scott Mackenzie, “The 8051 Microcontroller”. Prentice Hall, 1999

- Ronald J. Tocci, "Digital Systems Principles and Application", Prentice Hall, 2004
- J.D. Halderman, "Automotive Technology", Prentice Hall, 2005

Combustion, Emission & Pollution

Course Outline:

Combustion Theory:

Definitions, Chemical equations, First law of thermodynamics, Chemical equilibrium/ Second law of thermodynamics, Computer solution techniques

Applied Combustion:

Combustion processes in Spark ignition (SI) engine and Compression ignition (Cl) engine, Combustion characteristics, Combustion chamber design for Diesel engine and Petrol engine including Stratified charge and Lean burns, Phenomenon of knocking and auto-ignition

Gaseous Pollution:

Formation of gaseous exhaust emissions and toxicity, Legislation on exhaust emissions, Methods of control of Carbon-mono-oxide (CO), Hydrocarbon (HC), Nitric-oxide (NO), Diesel smoke and Engine particulates, Effect of fuel quality on noise and emissions, Lean burn and exhaust gas catalysers, Oxygen sensors and control, Smoke formation, Basic dispersion factors, Effect of pollutants on plant and human life

Noise Pollution:

Vehicle internal and external noise characteristics, Vehicle noise legislation, Vehicle noise sources, Effect of operating parameters on engine and vehicle noise, Engine noise, Linear engine combustion noise model, Noise excitation characteristics of engine combustion systems, Tire noise sources and effect of road surface on generated tire noise, Traffic noise

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- John B. Heywood, "Internal Combustion Engine Fundamentals", McGraw-Hill, 2018
- Rowland S. Benson & N. D. Whitehouse, "Internal Combustion Engine Vol. I and Vol. II", Elsevier, 2013
- D. A. Bies and C. H. Hansen, Unwin Hyman, "Engineering Noise Control Theory And Practice", 1988

Design for Manufacturing

Course Outline:

Design and Manufacturing

Parts and Assemblies, Products and Machines, Product Family and Platforms, Industrial-Engineering-Production Design, Tolerances

Theory of Sheet Metal Forming

Material properties, sheet deformation processes, simplified stamping analysis, simplified analysis of circular shells, cylindrical deep drawing, stretching of circular shells, combined bending and tension of sheets

Design of Sheet Metal Dies

Design of Piercing Die, Design of Blanking Die, Design of Shearing Die, Design of Bending Die, Design of Forming Die, Design of Drawing Die, Relative Tooling Cost, Total Relative Part Cost

Plastic Injection Moulding Technology

Main properties of plastics, design of injection moulds, types of injection moulds, injection moulding process; filling-packing-cooling stages, different types of injection moulds, Relative Tooling Cost, Total Relative Part Cost

Design of Moulds

Design of Moulds for plastic parts, Design of Moulds for rubber Parts, Design of Pressure Die Casting

Jigs and Fixtures

Basic Design principles and Classification Materials for jig and fixture development, Consideration for mounting jigs and fixtures

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- C. Poli, "Design for Manufacturing: A Structured Approach" Elsevier Science Books, 2001
- C. Poli, "Design for Manufacturing: A Structured Approach" Elsevier Science Books, 2001
- J. Nee, "Fundamentals of Tool Design", 6th Edition, Society of Manufacturing Engineers, 2010
- Z. Marciniak, "Mechanics of Sheet Metal Forming", 2nd Edition, Butterworth-Heinemann, 2002
- D. O. Kazmer, "Injection Mold Design Engineering" 2nd Edition, Hanser Publications, 2007
- K. Lange (Editor), "Handbook of Metal Forming", McGraw-Hill, 1985

Heat Transfer

Course Outline:

Introduction to Heat Transfer

Heat and Heat transfer, thermal conductivity, mechanism of heat conduction, Fourier's law of heat conduction, Advection and Convection, Newton's law of cooling, Thermal radiation band, Stefan's Boltzmann law.

Conduction

Heat conduction equation, Boundary conditions, Steady state heat conduction for simple geometries; Electrical Analogy and thermal resistance, Composite walls and cylinder, Overall heat transfer coefficient, critical thickness of insulation, Unsteady state heat transfer for simple geometries; lumped heat capacity method; Extended surface heat transfer-fins, performance parameters for fins.

Heat Exchanger

Types and Classification of Heat Exchangers (HX), Fouling factor, Energy Analysis of HX, LMTD Method, NTU-Effectiveness Method.

Thermal Radiation Exchange

Basic concepts; laws of thermal radiations, surface characteristics blackbody; grey body, emission in defined wave band; radiation intensity; Irradiation, Radiosity, energy exchange in black and grey bodies through electrical network.

Convective Heat Transfer

Basic concepts; energy equation for convective flows, thermal boundary layer and dimensionless numbers; analytical solution for pipe flow problem; laminar and turbulent flow correlations; heat transfer over flat plate for laminar, turbulent and mixed flow; Correlations for Natural convection and heat transfer with change in phase; boiling; and condensation.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- T L Bergman; Adrienne Lavine; Frank P Incropera, "Fundamentals of Heat and Mass Transfer", Wiley, 2019.
- Frank Kreith, "Principles of Heat Transfer" 7ed.
- Younus Çengel,"Heat transfer: A practical approach".
- S.P. Sukhatme , "A textbook on heat Transfer, 4ed"
- J.P. Holman., "Heat and mass transfer"

Engineering Depth Courses

Automobile Instrumentation

Course Outline:

Electronic Instrumentation & Testing Meters

Basic electronic instrumentation key components, (Analog /digital) voltmeters, ammeters, ohmmeter and other multi-meter functions, logic analyzers, measurement error handling.

Sensors and Transducers

Transducers (resistive, capacitive, inductive), optical measurement system, Automobile air flow rate sensor, engine crankshaft angular position sensor, typical coolant sensor.

Solid State Sensors and Transducers

Magnetic measurement, temperature measurement, measurement of different physical quantities.

Actuators

Solenoids & relays, electric motors, automobile fuel injection, exhaust gas circulation actuators, digital engine control system.

Basics of Electronic Engine Control

Engine performance terms (power, BSFC, torque, volumetric & thermal efficiency, air/fuel ratio, spark timing); electronic fuel control system, and electronic ignition.

Vehicle Motion Control

Typical cruise control system, antilock braking system, electronic suspension system, and electronic steering system.

On-Board Diagnosis

On-board diagnosis system components, on-board diagnostic and troubleshooting procedures.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- William B. Ribbens, “Understanding Automotive Electronics-Engineering Perspective”, Elsevier, 2012.
- Ali Emadi, “Handbook of Automotive Power Electronics and Motor Drives", CRC Press, 2017
- Najamuz Zaman, “Automotive Electronics Designs Fundamentals”, Springer, 2015
- Tom Denton, “Automobile Electrical and Electronics”, Routledge, 2007

Automotive Structure Design

Course Outline:

Body Structural Requirements

Vehicle loads and their estimation, terminology, torsion and bending stiffness, Stiffness optimization, fatigue analysis, body concept for design in automotive structures; design criteria; basic assumptions regarding structural element interactions and stress distributions; standard loading cases;

Body Structural Elements

Analysis of trusses by method of joints, analysis of frames, Types of automotive structures, Body-OnChassis, Ladder Frame, Grillage Frame, Backbone, Monocoque, Space frame, unitary body structures,

Production of Automotive Structures

Design aspect and design procedures for vehicle structures, Manufacturing and assembly techniques used in production of the vehicle structures, Surface engineering, diffusion techniques, deposition methods, high and low energy beam; surface treatments.

Body Structural Design

Design for body bending, Design for body torsion, Design for crashworthiness, Design for vehicle and styling integration, Design for vibration, Design and analysis of body sub-assemblies and model variants, sizing of sections and joints

Vehicle Mass and Crashworthiness

Engineering Materials and their incorporation into vehicle design, Material property charts Material selection, Crashworthiness and its influence on vehicle design. Fracture strength and crack propagation: Their effect on safe life and flaw tolerant design

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- D. E. Male, “Fundamentals of automobile body structure design”, SAE International. 2011
- J. Happian-Smith, "Introduction to Modern Vehicle Design", Society of Automotive Engineers. 2002

Chassis System Design

Course Outline:

Wheels and Tires

Tire operation, Rolling radius, Rolling resistance, Static Forces, Longitudinal Force, Cornering forces, Interaction between longitudinal and side forces, Testing

Suspensions System

Independent suspensions, Semi-independent suspensions, Rigid axle suspensions, Industrial vehicles suspensions, Testing of wheel

Steering System

Steering mechanism, Rack and pinion steering box, Screw and sector steering box, Steering column, Power steering, Testing of Steering

Brake System

Car brakes, Industrial vehicle brakes, Testing of Brake System

Transmission System

Manual gearbox, Shifting mechanisms, Start-up devices, Differentials and final drives, Automatic Gearbox, Car CVTs, Testing of transmission

Chassis Design

Design of sub-systems through selecting appropriate constructions, determining basic parameters based on design principles, physical laws, standards, design criteria and constraints.

Chassis Evaluation

Evaluation of vehicle chassis and corresponding sub-systems based on constructional and functional design, Influence of automotive chassis on vehicle performance

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- G. Genta, "The Automotive Chassis Volume 1: Components Design", Springer Science & Business Media, 2009
- G. Genta, "The Automotive Chassis Volume 2: System Design", Springer Science & Business Media, 2018

Vehicle Ride & Handling Lab

Course Outline:

Simple Pendulum, Forced Damped Vibration, Vehicle Simulation, Rotary balancing, Noise measurement, Wheel alignment parameters (Camber, Caster, Toe-in and out) Hydraulic Lifter, Suspension and Shock Absorber Characteristics, Dampers, Sprung and un-sprung mass characteristics, Wheel balancing, NVH, , Chassis Dynamometer, Tyre pressure, friction and stiffness, Steering and Cornering, Ergonomics and human comfort.

Teaching Methodology (Proposed as applicable):

Safety Instructions, Lectures on Procedures, Lab Preparation under Supervision, Definition of Deliverables, Open Ended Labs.

Assessment:

Performance Rubrics, Lab Manual/Workbook

Vehicle Dynamics

Course Outlines:

Introduction to Vehicle Dynamics:

Lumped Mass, Sprung & Unspring Mass, Aerodynamics, Forces on Vehicle, One-mass and Two mass Approximation.

Forward Vehicle Dynamics

Determination of centre of mass location of a vehicle, tilting conditions for a vehicle in parking on inclined surfaces, applications of Newton's 2nd law of motion to vehicle acceleration, finding failure conditions for vehicles during acceleration, determination of centre of mass location on banked road conditions.

Tire Dynamics

Effect of speed on rolling friction coefficient of tire, effect of inflation pressure and load on the rolling friction coefficient, effect of Sideslip Angle on Rolling Resistance, effect of camber angle on Rolling Resistance, longitudinal, lateral and camber force effect on tire.

Steering Dynamics

Kinematic steering, vehicle with more than two axles, vehicle with trailer, space requirement for a vehicle, four wheel steering.

Driveline Dynamics

Engine dynamics, driveline and efficiency, gearbox and clutch dynamics, gearbox design, geometric ratio, gearbox design, progressive ratio gearbox design.

Suspension Dynamics

Roll centre and roll axis, camber variation of double A-arm suspension system, car tire relative angles and their effect on suspension dynamics.

Applied Dynamics

Four bar linkage, slider-crank dynamics, instant centre of rotation, universal joint dynamics.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Thomas D. Gillespie, "Fundamentals of Vehicle Dynamics", SAE, 1992.
- Reza N. Jazer., "Vehicle Dynamics Theory and Applications", Springer, 2008
- Giancarlo Genta; Alessandro Genta, "Road vehicle dynamics: fundamentals of modelling and simulation", World Scientific, 2017.

Vehicle Noise & Vibration

Course Outline:

Introduction to Vibration

Components of vibratory system, vibration analysis procedure, damping and natural frequency, harmonic analysis.

Single Degree of Freedom Systems

Undamped free vibrations of linear and torsional systems; energy method, damped free vibrations of linear and torsional systems, undamped free and forced vibrations of linear and torsional system.

Vibration Control

Base excitation and vibration isolation.

Two Degree of Freedom Systems

Undamped and damped free vibrations; Undamped and damped steady state forced vibrations, Modal Analysis.

Methods for Finding Natural Frequencies

Rayleigh method, Holzer method.

Fundamentals of Acoustics

General sound propagation, plane wave propagation, effect of reflecting surfaces on sound propagation, human response to sound.

Automotive Noise Criteria

Drive by noise tests, interior vehicle noises, and exterior noises.

Automotive Noise Sources

Engine, transmission, intake and exhaust, aerodynamic, tire and braking noise.

Automotive Noise Control Principles

Sound in enclosures (interior sound), sound energy absorption, sound transmission through barriers.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Thomas D. Rossing, "Principles of Vibration and Sound", Springer, 2013.
- Rao, "Mechanical Vibrations", Pearson, 2016.
- Julian Happian-Smith, "Modern Vehicle Dynamics", Butterworth Heinemann, 2002.
- Matthew Harrison, "Vehicle Refinement", Elsevier, 2004.

Operations Management

Course Outline:

Introduction to Operations Management

Introduction to industrial management and administration, System concept, Functions of Management, Managerial decision making, Models as decision aids.

Process Selection and Facility Layout

Factors affecting location, Multi-plant location, Location analysis, Plant layout, Types of layout, Material handling consideration in layout, Internal and External balancing, product and process layout analysis, Layout comparison.

Product and Service Design

Product design, Pre-production planning, Production control for intermittent and continuous process; MRP (Material Requirements Planning), ERP (enterprise resource planning), MRP inputs and outputs, Types of MRP; Job shop scheduling; Machine arrangement problems; Control for maximum profit; Scheduling techniques.

Management of Quality

Sampling risk and economics of sampling; OC (operating characteristic) curve and sampling plan; Average outgoing quality; Sampling methods; Attribute and variable sampling, Concept of control chart, Process Variability. Process chart; Man-Material flow charts; Work station flow charts; Man-Machine charts. Motion study; Principles of motion economy; Applications, Simo chart. Stop watch time study procedures, Timing methods, Performance rating, Total normal time, Allowance factors, Continuous production study, Work sampling procedures, Predetermined motion time techniques. Wage incentive plan and job evaluation.

Inventory Management

Inventory Control, Functions of Inventory, Economic order quality model, its limitations, Economic lot size, Safety stock, Stock out cost, Inventory systems, Inventory system under uncertainty, Quantity discount; Forecasting; Moving average and weight moving average; Capacity Planning.

Project Management

CPM (Critical Path Method) and PERT (Project Evaluation and Review Technique)

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- William J. Stevenson, "Operations Management" McGraw-Hill, 2017.
- Barry Render, "Operations Management", Pearson Hall, 2013.

Thermal Management for Automotive

Course Outline:

Introduction:

- Thermal Management in automotive
- Automotive Components/Systems requiring thermal management.

Refrigeration, Air-Conditioning and Heating Systems:

- Vapor Compression Refrigeration system
- Performance estimation of vapour compression refrigeration systems
- Refrigerant and its properties
- Psychometric analysis
- Air distribution inside cabin
- Temperature and humidity control to maintain comfort zone
- Heating and cooling load calculation with available usage of software.
- Effective heating inside cabin
- Electrical heating

Engine Cooling and Waste Heat Utilization:

- Engine cooling requirement
- Types of engine cooling systems
- Automotive liquid cooling circuit architecture and components
- Waste heat recovery systems
- Utilization of waste heat for automotive heating and cooling systems

Battery Thermal Management in Hybrid/Electric Vehicle:

- Electric vehicle battery technologies

- Battery thermal management using air, liquid, refrigeration, phase change material and vapour chamber
- Energy and exergy analysis of battery thermal management system

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, Final Exam, Quizzes, Assignments, Presentation

Suggested Books:

- G.D Mathur, "Vehicle thermal Management", SAE, 2004
- S. Daly, "Automotive Air Conditioning and Climate Control Systems", Elsevier, 2011
- C. P Arora, "Refrigeration and Air conditioning", McGraw-Hill, 2000
- Dincer, H. S. Hamut, N. Javani, "Thermal Management of Electric Vehicle Battery Systems", John Wiley, 2017

Automotive Health Safety & Environment

Course Outline:

Introduction of Health and Safety

Industrial Safety: introduction objectives of Safety, Importance of Safety in an industry, Industrial accidents, Effects of accidents, Types of accidents incidence of fire. Fire prevention and control.

Techniques of Safety Management

Principles of accident prevention, hazard analysis. Legal, humanitarian and economic reason for action. Safety inspection procedures. Safety training, First aid and emergency procedures.

Environment and Health

Introduction: importance of clean environment, Scale of Environmental Pollution. Environmental Act. Health and Safety Act.

Safety and Environmental Standards

ISO Standards (ISO 14000), Total Safety Management (TSM), OSHA Standard, Emission Standards and Regulations (EURO compliance), Environmental Protection Agency (EPA) standards, Overview of Pakistan Motor Vehicle Act, Highway Safety Standards.

Vehicle Safety

Concepts and Principles of Vehicle Safety, Adaptive Cruise Control (ACC), Traction Control System (TCS), Electronic Stability Program (ESP), Braking Systems and Antilock Braking systems (ABS).

Occupant Safety

Restraint Systems(Seat Belts, Airbags), Head Restraints, Child Restraint System, Multipoint Restraint Systems, Passive Restraints, Occupant Sensing Methodologies.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- J. Ridley and J. Channing, “Safety at Works”, Routledge, 2004
- Amit Kumar Gupta, “Industrial Safety and Environment”, Laxmi Publications, 2008
- Barbara J. Peters and George A. Peters, “Automotive Vehicle Safety”, SAE International and Taylor & Francis, 2002.
- Lothar Wech/Ulrich W. Seiffert, “Automotive Safety Handbook”, SAE International, 2007.

Quality & Reliability Engineering

Course Outline:

Introduction to Quality

Definition and dimensions of quality, Quality control and Assurance, Cost of quality and its related indices, Vision, Mission and Quality Policy, Customer satisfaction and feedback system.

Statistical Process Control

Controls charts for mean standard deviation and proportion defective, process capability indices, Acceptance sampling, single and multiple sampling, introduction to six-sigma, DMAIC.

Japanese Production System

Principles and operating strategies, Takt-time, Quality circle, Kanban 5S, Pokayoka, Cost concept, 3M (Mura, Muri, Muda).

TQM

Pareto, Flow chart, Cause and Effect diagram, Failure Mode & Effect Analysis (FMEA), Improvement Strategies, Lean concepts and waste reduction methods, PDCA Cycle, KAIZEN, Quality Function Deployment(QFD), Introduction to Quality Management System (ISO9000).

Reliability

Definition, failure rate functions, Hazard functions, Reliability function, Weibull distribution, Bath-tub curve, series parallel reliability network, MTBF, MTTR, Availability, Product liability and warranty.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Dale H Besterfield, “Total Quality Management: International Edition”, Pearson, 2015
- Renyan Jiang, “Introduction to Quality and Reliability Engineering”, Springer, 2015.
- Douglas C Montgomery, “Introduction to Statistical Quality Control”, Wiley, 2009.
- Amitava Mitra, “Fundamentals of Quality Control and Improvement”, Wiley, 2016.
- D. L. Goetsch, "Quality Management: Introduction to Total Quality Management for Production, Processing, and Services", Pearson Prentice Hall, 2006
- ISO, “Quality management systems - Requirements”, International Organization for Standardization, 2015

Vehicle Development

Course Outline:

Vehicle Development Projects

Design Level, Design Content, Innovation Level, Options and Country Versions, Platforms and Model Lines, Product Evolution Process (PEP), Vehicle Project Management, Product Strategy,

Phases of the Product Evolution Process

Initial Phase, Technical Feasibility, Economic Feasibility, Concept Phase, Vehicle Concept Design, Target Agreement, Series Development Phase, Component Design, Complete Vehicle Integration, Prototype Build, Launch Preparation, Series Support and Further Development, Design to Ramp Up Production

Management of Vehicle Development

Target Management, Complete Vehicle Requirements, Design Problem Management, Release and Change Management, Quality Management, Definition of Quality, Pre-delivery (Internal) Quality Assessment, Post-delivery (External) Quality Assessment, Quality Management Systems, Quality Costs

Vehicle Characteristics

Registrability, Total Vehicle Costs and Cost of Ownership, Design Appeal, Cabin Comfort, Infotainment, Agility, Passive Safety, Theft Deterrence, Reliability, Sustainability

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- J. Weber, "Automotive development processes : processes for successful customer oriented vehicle development", Springer, 2009
- J. Happian-Smith, "Introduction to Modern Vehicle Design", SAE International, 2002
- J. Quigley, "Project Management for Automotive Engineers", SAE International, 2016

Technical Electives

Additive Manufacturing

Course Outline:

- Various additive manufacturing processes and their principles
- Additive Manufacturing Process Chain
- Computer-aided design and path planning for additive manufacturing processes
- Materials used in additive manufacturing processes and their properties
- Vat Photopolymerization Processes
- Powder Bed Fusion Processes, Extrusion Based Systems
- Printing processes
- Material Jetting

- Binder Jetting
- Sheet Lamination Processes
- Directed Energy Deposition Processes
- Direct Write Technologies
- Determining and optimizing process parameters and conditions
- Process-related limitations and constraints and applications of Additive Manufacturing
- Postprocessing
- Direct Digital Manufacturing
- Design for Additive Manufacturing
- Automotive Applications for Additive Manufacture

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Ian Gibson, David, "Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing", Springer, 2014
- Hod Lipson, Melba Kurman, "Fabricated: The New World of 3D Printing", John Wiley, 2013
- Ian Gibson, "Software Conversion and Rapid Prototyping", Wiley, 2006.
- L. Jyothish Kumar, "3D Printing and Additive Manufacturing Technologies", Springer, 2018

Automotive Paints and Coatings

Course Outline:

Introduction

Paints and coatings, Classification of Paints and coatings, Scope of Automotive Paint Industry, Current Paint Manufacturers.

Automotive Painting Processes

General Painting Process, Pretreatment, Sand and Shot blasting Sequence of Treatment, Degreasing, Activation, Zinc Phosphating, Baking Oven, Passivation, Pre-Treatment of multi-metal car bodies, Pre-Treatment of Plastic Parts, Car Body Pre Treatment Lines, Primer Surface, Sealing and Underbody Protection, Top Coats and Clear Coats.

Electro Deposition (ED) Coatings

Types of ED coatings. Difference between Anodic and Cathodic ED Paint Process. Layout of an ED Paint Shop. Design of Car ED Lines. General Functions and Equipment of an Electro-coat Line.

Paint Shop Design and Quality Aspects

Typical Layout of an Automotive Paint Shop, The designing of an Automotive Paint Shop, Design capacity of Paint Shop, Quality Aspects, measurement of Paint thickness, measurements of basic paint properties (Viscosity, scratch resistance, stone chip resistance), Leak and shower test.

Paint Defects during Applications and their Prevention

Paint Defects, Why defect appears and How to repair the defects, Prevention of paint defects.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Hans-Joachim Streitberger; Karl-Friedrich Dössel, "Automotive paints and coatings", Wiley-VCH, 2008.
- Stephanie M Sarrica, "Paints: types, components, and applications", Nova Science, 2011.

Automotive Software Engineering

Course Outline:

Introduction to Software Engineering

Distributed and Networked Systems, Real-Time Systems, Dependable Systems, Mobile Networks, Software Architectures, Software Platforms for Automotive Systems, AUTOSAR (Automotive Open System Architecture)

Real-Time Systems

Global Time, Real-Time Communication, Real-Time Operating System, Real-Time Scheduling, Timing-Triggered Systems, Timing-Aware Programming for Embedded Systems

Automotive Software Development

V-Model of Automotive Software Development, Requirements in Automotive Software Development, Variant Management, Configuration, Compilation, Practical Variability Management, Integration Stages of Software Development, Testing Strategies, Construction Database

Automotive Software Architectures

Detailed Design of Automotive Software, Evaluation of Automotive Software Architectures, Metrics for Software Design and Architectures, Functional Safety of Automotive Software, Current Trends in Automotive Software Development

Artificial Intelligence

AI methodology and fundamentals; intelligent agents; search algorithms; game playing; supervised and unsupervised learning; decision tree learning; neural networks; nearest neighbour methods; dimensionality reduction; clustering; kernel machines; support

vector machines; uncertainty and probability theory; probabilistic reasoning in AI; Bayesian networks; statistical learning; fuzzy logic, Connected & Autonomous vehicle (CAV)

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- J. Schäuffele, "Automotive Software Engineering: Principles, Processes, Methods, and Tools", SAE International, 2016
- M. Staron, "Automotive Software Architectures: An Introduction", Springer, 2017
- H. Kopetz, "Real-Time Systems: Design Principles for Distributed Embedded Applications", Springer, 2011

Computational Fluid Dynamics

Course Outline:

Overview of Computational Fluid Dynamics (CFD)

Defining CFD, Scope of CFD, how CFD works, CFD Applications, Numerical vs Analytical vs Experimental, Modelling vs Experimentation, Finite difference method, Finite element method, Finite volume method, merits and demerits of each method.

Governing Equations: Governing Equations of Fluid Dynamics

mass, momentum and energy, Mathematical classification of Partial Differential Equations (PDE), Physical and Illustrative examples of elliptic, parabolic and hyperbolic PDE.

Initial and Boundary Conditions

Symmetry, inlet, outlet, open boundary condition, wall, cyclic boundary conditions and its mathematical description for steady and unsteady flows, incompressible flows, compressible flows, subsonic and supersonic flows.

Discretization Schemes

Central differencing scheme, Upwind, Hybrid scheme, QUICK and higher order differencing schemes, Properties of differencing schemes: Conservativeness, Boundedness, Transportiveness, Pressure-Velocity, Staggered and Collocated grid, Algorithms for Pressure-Velocity Coupling: SIMPLE, SIMPLE-R, SIMPLE-C, PISO; Implicit, fully explicit and Crank-Nicholson scheme, Transient SIMPLE and PISO algorithms.

Numerical Solutions

Segregated versus coupled solver methods, residuals and imbalances, Accuracy of numerical schemes, Types of Errors, false diffusion, stability criterion, relaxation methods, Grid Independent study.

Introduction of Turbulence and Modelling

Turbulence transport equations, and Turbulence models based on Reynolds Average Navier-Stokes equation (RANS), application of different turbulence models. Relevant case studies and benchmark problems to be solved using available computational tools.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Versteeg and W. Malalasekra, " An Introduction to Computational Fluid Dynamics: The Finite Volume Method ", Pearson, 2007.
- J.D. Anderson, Jr., “Computational Fluid Dynamics: The Basic with Applications”, McGraw Hill, Inc., 2010.

- Hirsch, C, "Numerical Computation of Internal and External Flows", 2nd ed., Butterworth Heinemann, 2007.

Computer Integrated Manufacturing

Course Outline:

Introduction to CIM

Computer Aided Design (CAD) Systems, Computer Aided Process Planning (CAPP) Systems, Computer Aided Manufacturing (CAM) System, CIM Information modelling

Automated Systems

Conventional Numerical Control, NC Part Programming, Robotic Systems, Automated Material Handling Systems, Automated Inspection Systems

Group Technology and Process Planning

Part families, methods for developing part families; parts classification and coding, Hierarchical code, Attribute code, Hybrid code, introduction to various available classification and coding systems, Selecting a coding system, production flow analysis, benefits of group technology, machining cells. The role of process planning in CAD / CAM integration, Approaches to process planning: Manual approach, Variant approach, Generative approach; introduction to various process planning systems.

Implementation of CIM in Automotive

Organizational issues, Operational Issues, Behavioural Issues, Technology Issues, Case Study

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- M. P. Groover, "Automation, Production Systems, and Computer-Integrated Manufacturing", 2nd Edition, Prentice Hall Inc., 2000
-]. U. Rembold, "Computer Integrated Manufacturing and Engineering", 1st Edition, Addison-Wesley Inc., 1993

Electric and Hybrid Electric Vehicles

Course Outline:

Architecture / Configuration of Electric and Hybrid Electric Vehicle

Economic and Environmental Impact of EVs & HEVs, Configurations of EVs, Architecture of Hybrid Electric Vehicle Drive Trains, Analysis and design principles of Series HEV and Parallel HEV Drive Train, Power Flow in HEVs, Analysis of Series and Parallel HEV Drive Train.

Electric Propulsion Systems (Traction Motors)

Types of traction motors for EVs / HEVs, Induction Motor Construction and Classification, Induction Motor Drives, Control and Applications in EVs/HEVs, Permanent Magnet Motor Configuration and Optimization, Permanent Magnet Motor Drives, Control and Applications in EVs/HEVs, Role of Switch Reluctance Motors and present issues.

Converters for EVs / HEVs

AC-DC rectifier, DC-AC Inverter for EV and HEV Applications, Buck (Step-down) converter, Boost (Step-up) Converter, Buck-Boost Converter.

Energy Storage System

Architecture of the electrical energy management system: Battery System, High speed Flywheels, Ultra-capacitors, Energy Storage System, Types of Batteries and performance parameters, Charging and Discharging rate calculations, Battery technology for automotive applications.

Teaching Methodology (Proposed as applicable):

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

Assessment:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- James Larmine, "Electric Vehicle Technology Explained", John Wiley & Sons, 2012
- Mehrdad Ehsani, "Modern Electric, Hybrid Electric and Fuel Cell Vehicles, Fundamentals, Theory and Design", CRC Press, 2009
- Iqbal Hussain, "Electric and Hybrid Vehicles-Design Fundamentals", CRC Press, 2011
- Sandeep Dhameja, "Electric Vehicle Battery System", Elsevier, 2001

Metrology & Quality Assurance

Course Outline:

Principle of Engineering Metrology

Introduction to metrology, standards of measurement, terminology of measurement, accuracy and precision, measuring errors, abbe's principle of alignment, general care of measuring instruments.

Linear Measurements

Need for linear measurement, Least count, linear measuring instruments-engineer's steel rule, Callipers ,datum and reference surfaces, surface plates, vee block, combination set, gauges, Vernier caliper, Vernier height gauge, Vernier depth gauge, Micrometers, Bore gauge, Telescopic gauge, Slip gauges, length bars, calibration of linear measuring instruments.

Geometric Feature Control

Straightness, Flatness, Circularity, Cylindricity, Profile of a line, Profile of a surface, Perpendicularity, Angularity, Parallelism, Symmetry, Position, Concentricity, Circular run-out, Total run-out

Standardization

Standardization Organizations and their Standards related to metrology, Classification for metrology Standards, Interchangeability, and Measurements, Common Gauges & Measurement Instruments Special Gauges and application, Gauge Selection and handling and use, Surface Plate Tools and Techniques, Specialized Inspection Equipment, Calibration Surface texture Measurement System analysis: Process Variability). Variability in Measurement Process.

Quality Assurance

Introduction: Statistical Methods in metrology, Defining Quality & its Philosophies, defining, Quality Management System (TS 16949), Documentation Requirements, Quality Manual, Control of documents, Engineering Specification, Control of records, Records retention

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- E. Doeblin, “Measurement Systems Applications and Design”, McGraw Hill, 2004
- Fundamentals of quality control and improvement by Amitava Mitra
- Introduction to Statistical Quality Control by Douglas C. Montgomery
- J F W Gayler and Charles R Schotbolt, “Metrology for Engineers”, Cengage Learning EMEA; 5th Revised edition.

On-Board Diagnosis

Course Outline:

Diagnostic Techniques

Introduction, diagnostic process, Mechanical diagnostic techniques, Electrical diagnostic techniques, Fault codes, on-off board diagnostics

Engine System Diagnostics

Diagnostics of; fuel system, ignition system, emissions, fuel injection systems, diesel injection system, combined fuel and injection control systems, air supply and exhaust systems, cooling and lubrication, starting and charging system faults.

Chassis System Diagnostics

Diagnostics of; Brakes, Anti-lock-brakes, traction control, steering and tyres, suspension.

Electrical System Diagnostics

Electronic components and circuit testing, lighting system faults, auxiliary system faults, diagnosing of in-car entertainment, security and communications, instrumentation and body electrical system faults.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Tom Denton, “Advanced Automotive Fault Diagnosis”, Routledge, 2012
- Keith McCord, “Automotive Diagnostic Systems –Understanding OBD-I & OBD-II”, CarTech Inc, 2011
- Ronald K. Jurgen , “On- and Off-board Diagnostics”, SAE, 2000

Vehicle Aerodynamics

Course Outline:

Basic Principles

Conservation Laws, Kinematics and Dynamics of Flow Fields, Continuity Equation, Euler Equation, Bernoulli Equation, Potential Theory, Navier-Stokes Equation, Integral Forms of the Conservation Laws, Dynamics of Inviscid Flow, Interpreting Streamline Patterns, Planar Model Flows, Vortex Flows, Dynamics of the Frictional Flow, Reynolds Number, Prandtl Boundary Layer Concept, Boundary Layer Separation, Boundary Layer Turbulence, Drag of Simple Bodies

Incompressible Flow Over Bodies

High Reynolds Number Incompressible Flow Over Bodies, Automobile Aerodynamics, Inviscid Irrotational Flow, Potential Flow Equations, Principle of Superposition, Two-Dimensional Elementary Solutions, Polynomial Solutions, Two-Dimensional Source (or Sink) , Two-Dimensional Doublet , Two-Dimensional Vortex, Fluid Mechanic Drag, Drag of Simple Shapes, Drag of More Complex Shapes, Periodic Vortex Shedding, Case for Lift, A Cylinder with Circulation in a Free Stream, Two-Dimensional, Flat Plate at a Small Angle of Attack (in a Free Stream), Center of Pressure, Lifting Surfaces: Wings and Airfoils, Two-Dimensional Airfoil, An Airfoil's Lift, An Airfoil's Drag, An Airfoil Stall, The Effect of Reynolds Number, Three-Dimensional Wings

Aerodynamics and Race Cars

The Impact of Aerodynamics on Vehicle Shape, Aerodynamic Down force and Performance, Creating and Measuring Aerodynamic Forces, How Aerodynamics Shapes Race Cars, The Impact of Racing Aerodynamics on Production Cars, Ground Effect, Generic Automobile Shapes and Vortex Flows, Down force and Vehicle Performance, Tools used for Aerodynamic Evaluations

Aerodynamics of Vehicle

Tire Performance, Vehicle Dynamics, The Effect of Aerodynamics on Performance, Basic Vehicle Body Concepts Flow Over Wheels, Sliding Seals and Skirts, Under body Channels (Venturis), Simple Add-ons: Spoilers, Strakes, and Wickers, Internal Flow, Race Car Wings

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- T. C. Schuetz, "Aerodynamics of Road Vehicles", SAE International, 2015
- J. Katz, "Automotive Aerodynamics", Wiley, 2016
- J. Katz, "Race Car Aerodynamics: Designing for Speed", Robert Bentley, 1996

Vehicle Safety

Course Objective:

This course examines both active safety (prevention of accidents) and passive safety (injury mitigation). Through the course, students will develop an understanding of vehicle safety development and engineering based on mechanical and human factors.

Course Outline:

Accident Analysis

Introduction to Vehicle Safety, Driving Forces for Increased Vehicle Safety, Safety Legislation, Accident Data, Recent technologies for pre-crash and crash safety

Accident Avoidance

Human Factors, Comfort and Ergonomics, Acceleration and Braking, Adaptive Cruise Control (ACC), Brakes, Brake-by-Wire, Vehicle Dynamics, Information Systems

Biomechanics

Injury Tolerance Limits, External Injuries, Internal Injuries, Concussion, Spinal Injuries, Chest Injuries, Criteria in the Rule-Making Process, Head Protection, Chest Protection, Neck Injury, Performance Criteria for the Rule Making

Occupant Protection

Vehicle Compartment, Restraint Systems, Seat Belts, Airbags, Airbags for Frontal, Side Protection by Airbags, Additional Airbag, Applications, Sensors for Restraint Systems, Child Restraints

Pedestrian Protection

General protection, European NCAP-Test, Legislation Activities, Technical Solutions for Vehicles in Accidents

International Standards

ISO 26262 requirements, functional safety in automotive development, safety management processes, risk analysis, Safety-oriented hardware and software development, methodical approach to safety 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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- L. Wech, “Automotive Safety Handbook”, 2nd Edition, SAE International, 2003
- ISO, “Road vehicles – Functional safety”, International Organization for Standardization, 2011

Automotive Assembly Plant Facility Development

Course Outline:

Introduction to Automotive Assembly Process

Study of different types of automobile assembly process, which includes stamping, welding, Electro Deposition (ED) process, painting, engine assembly, vehicle assembly, vehicle testing line.

Plant Equipment and Machines

Plant equipment and machines necessary for the assembly of selected model.

Planning for the Setting-up of New Automotive Plant

Product selection, estimated sales volumes and costing, mandatory localization and facilities available, organization, marketing and after sales strategy, land requirement and approval process, utilities requirement and approval process, man power requirement, automotive policies and pre requisites for project approval, environment protection and other prevailing policies, facility capacity and layout planning, assembly plant building and infrastructure, facilities developers (consultant and contractors), sourcing of equipment.

Feasibility Report Preparation

Preparation of feasibility report considering the above information to work out the viability of the project keeping in view of different ratio analysis, capital requirement, cash in hand, partners equity etc.

Business Plan and Business Model Development

Preparation of B-Plan and B-Model required for physical implementation and execution of projects keeping in view of different scenarios.

Agreements JV or TCA with Principal

Drafting of Joint Venture (JV) or Technical Cooperation Agreement (TCA) with important clauses.

Implementation

Operations management involvement, writing of terms of reference, selection of consultant, and contractors, follow ups, project scheduling and monitoring, project

management for execution of project, procurement and contract management, approvals from competent authorizes.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Nick T Thomopolus, "Assembly line planning and control" Springer, 2016
- Bertrand Medioni "Tomorrow's manufacturing facilities: the design of a car assembly plant for the 21st century", Thesis.

Automotive Service & Dealership

Course Outline:

Overview of Automotive Service

Role of Service, Dealer and Dealer Staff (Service Manager, workshop controller, service advisor, maintenance technician, diagnostic technicians, body & paint shop staff), standard automotive workshop areas (mechanical shop, body & paint shop, service station, auto parts warehouse, reception, parking area, AC repair pit, training area, mess, engine overall shop, library etc.), 3S Dealership.

Service Operation Management

Standard Service Transaction, Customer Appointments, Work Control, Customer Reception, Reception Diagnosis, Repair Orders, Quality Control, Active Delivery, Follow-up Calls, Customer Database, workshop Control, Vehicle Security and Immobilizer Systems, use of Workshop Manuals, Wiring Diagrams, Understanding the Periodic Maintenance Procedures as per Manufacturer's standards, Service Fast Track Processes and work Flow Management.

Development of Communication and Interpersonal Skills

Service Advisor's Role, Interpersonal Skills in Service Transactions, Positive First Impression, active listening and clear explanation, Complaint Handling, Business Strategies in after sales Industry, Manufacturer's Trainings for after sales Staff, Time Management, Technical Report, Service Bulletin, Warranty Reports.

Dealership Equipment Workshop and Compliance

Common tools, special service tools (SST), types of lifts, workshop equipment's, standard & quality control, certifications, Layout, health & safety requirements, flooring, Equipment Installation and Calibration.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- James D Halderman, "Automotive Technology Principles, Diagnosis and Service", Pearson, 2020.
- ASE Test preparation, "Automobile Certification Series-Service Consultant" 5th ed, Cengage Learning, 2012.

Automotive Vendor Development

Course Outline:

Overview of Vendor Development

Classification of Vendors or Suppliers, Tier 1, Tier2 etc., Supplier and Vendor Market, local and global scenario, Vendor-OEM synergy.

Supplier Development Programs

Introduction, Capability Development Process Overview, Technical & Management Aspects, Human Resource Development, Homologation with industry standards.

Supplier Qualification Process

Evaluation Matrix, Attributes & Assessment Criteria, and Certification Process.

Performance Monitoring

Factors for performance analysis, Performance scoring system, Performance feedback to supplier, compliance to standards.

Buyer-Supplier Relationship Management

Communication, Training Programs, Acquiring and sharing best practices and standardization.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Rajah Rasiah; Yuri Sadoi; Rogier Busser, "Multinationals, Technology and Localization in Automotive Firms in Asia". Taylor and Francis, 2013.
- Duane E Sharp, "Customer relationship management systems handbook" Boca Raton Auerbach Publications, 2003.

Supply Chain Management

Course Outline:

Introduction to Supply Chain Management

The Supply Chain's Strategic Importance, Core concepts of supply management, Supply Chain Drivers and Obstacles, Supply Chain Strategies, Alignment of supply chain and business strategies, The Bullwhip Effect, Measuring Supply Chain Performance, SCOR model, Future Trends in Supply Chain

Introduction to Logistic & Supply Chain Management

Internal and External Supply Chain

Inventory Management

Role of inventory in Supply Chain Management, Inventory Types and Characteristics, ABC analysis of Stock, Cycle Counting, Holding and Set up Costs, Various Models of Inventory Management Value of information

Logistics

Network design & Route Optimization, Freight Consolidation and Logistical Integration, Formulating Logistical Strategy, Transportation – Rail, Road, Sea and Air, Pipeline, Reverse Logistics

Global Supply Chain

Identifying Global Supply Chain Opportunities and Making Strategies, Globally dispersed supply and demand and the impact of free trade zones, Free Ports and trading blocs

MIS in Supply Chain & Process Improvement

Role of IT in Inventory, warehousing, order tracking and delivery coordination, Technologies for testing, data, operations and communications in supply chain management, Key considerations for supply chain design and continuous improvement

Teaching Methodology (Proposed as applicable):

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

Assessment:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem

Suggested Books:

- Sunil Chopra, Peter Meindl, D. V. Kalra, "Supply Chain Management, Strategy, Planning and Operation", Pearson, 2010
- J. R. Tony Arnold, "Introduction to Material Management", Prentice Hall, 2001.

Urban Transport Development

Course Outline:

Impacts of Motorization on Land Use and the Environment

Infrastructure Investment and Land Use, Transport Infrastructure Investment and Economic Development, Key Issues in Transport and Urban Development

Global Issues in Transport Sustainability

Global Cities, Car-dependence and technological forces, The economy of cities, Governance and urban growth, Changing urban values, The Peak of Oil, Pollutants from vehicle engines, New vehicle technologies

Urban Studies

Sustainable Transportation Policy in the North America, Transport & Sustainability in the European Union, Implications of Privatization of the National Railways, Public Transport in Developing countries, Transport and Land Use in OBOR Countries, Barriers to Sustainable Transport in Pakistan

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- D. Banister, "Transport and Urban Development", E & FN Spon, 2003
- N. Low, "Making Urban Transport Sustainable", Palgrave Macmillan, 2003
- G. Jönson, "Urban Transport Development: A Complex Issue", Springer, 2005

Multidisciplinary Engineering Courses

Feedback Control Systems

Course Outline:

Introduction

Introduction to control systems, examples and classifications, Feedback and its characteristics. Nature and representation of control system problem, block diagram fundamentals, terminology of block diagram for a feedback control system, block diagram representation of various control systems.

Linear Systems and Differential Equations

Methods of writing differential equations of various physical systems such as static electric circuits, mechanical translational and rotational systems, thermal systems, hydraulic linear and rotational transmission systems, electromechanical dynamic systems DC and AC speed control systems.

Time-Response of Linear Systems

Types of standardized inputs to linear systems, steady state response and transient response of systems to standard inputs, response of second order systems time response specifications.

Laplace Transforms

Definition, derivation of Laplace transforms of simple functions, Laplace transform theorems, transformations of differential equations of physical systems, inverse transformation techniques, stability, Routh's stability criterion.

Block Diagram Algebra

Transfer functions of physical systems, canonical and unity feedback forms of control system block system block diagram, block diagram reduction techniques, signal flow graph algebra, block diagram reduction using signal flow graphs.

Control System Characteristics

Classification of feedback systems by type, analysis of system types, error coefficients, error constants, sensitivity.

Root Locus

Introduction, rules for construction of root locus, qualitative analysis of root locus, the spirule, analysis of performance characteristic of systems in time domain, dominant pole zero approximations, gain margin and phase margin, root locus compensation. Phase & gain compensation, root locus compensation, PID controller.

Frequency Response

Introduction, transfer function of systems in frequency domain, magnitude and phase angle frequency response of plots of closed loop control systems.

Introduction to Digital Control

Computer as control device, Single-loop digital control system, Digital control: pros and cons, Data Converters.

Linear Difference Equations (LDE) and Z-transform

Scalar difference equation, z-transform of simple sequences and inversion, solving LDE using partial fraction and z-transform, z-domain transfer function and impulse response, relation between S and z-domain.

Digital Control System Design Techniques

Digital control strategies and implementation, closed-loop characteristic equation, z-domain design considerations, General PID digital control algorithm, Tuning procedure for PID controller.

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:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Richard C. Dorf, “Modern Control Systems”, Prentice Hall, 2008
- Morris R. Driels, “Linear Control Systems Engineering”, McGraw-Hill, 1996

Fundamentals of Analogue & Digital Electronics

Course Outline:

Diode and Applications:

P-N junction, Semiconductor theory, doping and energy bands, diode models, diode data sheet understanding, diode rectifier, clipper and clamper circuits.

Amplifiers:

Introduction to Amplifier, amplifier properties, configurations and classifications; BJT based amplifiers: common base, common emitter, common collector, differential and multistage configuration. FET based amplifiers: Common source, common gate, common drain configurations; Operational Amplifiers and their applications.

Logic Gates:

Universality of NAND and NOR gates. SOP and POS forms and simplification through Boolean and DE Morgan's theorems.

Integrated Circuit Logic Families:

Digital IC terminology; (current & voltage parameters, propagation delay, speed-power product); TTL and CMOS logic family and IC data sheets understanding; interfacing with analogue world; Analog-to-digital and digital-to-analog converters; ADC & DAC data sheet understanding. decoders; BCD to 7- segment decoders/drivers; encoder; multiplexer and demultiplexer with their applications.

Teaching Methodology (Proposed as applicable):

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

Assessment:

Written Tests, Mid Exams, Assignments, Final Exam, Complex engineering problem.

Suggested Books:

- Thomas L.Floyd, "Electronic Devices", Pearson Hall, 2018
- Robert T.Paynter, "Introductory Electronic Devices and Circuits", Pearson Hall, 2006

- Theodore F.Bogart, "Electronic Devices and Circuits", Pearson Hall, 2004
- Ronald J.Tocci, "Digital Systems Principles and Application", Pearson Hall, 2004
- Thomas L.Floyd, "Digital Fundamentals", Pearson Hall, 2010

Basic Electrical Automotive

Course Outline:

DC Circuit Analysis

Series and Parallel electric circuits: Kirchhoff's voltage law (KVL) and Kirchhoff's current law (KCL), voltage divider and current divider rules; series parallel circuits; Y-Delta conversions.

Methods of Circuit Analysis

Mesh analysis and nodal analysis.

Network Theorems

Superposition, Theremin's Norton's and maximum power transfer.

Magnetic Circuits

magnetic fields, flux density, permeability, reluctance, magnetizing force, hysteresis, Ampere's Circuital law; capacitors and inductors: electric field and dielectric strength; charging and discharging phase of capacitor; capacitor types; faraday's law of electromagnetic induction; Lenz's Law; charging and discharging phase of an inductor.

AC Circuit Analysis and Poly Phase Systems

General format of sinusoidal voltage and current; phase relations; average power and power factor, frequency response of basic elements (Resistor, Capacitor and Inductor); rectangular and polar form conversions.

Series-parallel circuits with phasor diagrams; mesh analysis and nodal analysis; Network theorems.

Passive Filters

low pass, high pass, pass band, stop band filters, resonance: series resonant and parallel resonant circuits, poly phase systems.

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

Assessment:

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

Suggested Books:

- Robert Boylestad, "Introductory Circuit Analysis", Pearson, 2015
- William Hart Hayt., "Engineering Circuit Analysis", McGraw-Hill, 2007
- Theodore F. Bogart, "Electric Circuits", Glencoe, 1992

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:

1. Identify hazards in the home, laboratory and workplace that pose a danger or threat to their safety or health, or that of others.
2. Control unsafe or unhealthy hazards and propose methods to eliminate the hazard.
3. 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.
4. Demonstrate a comprehension of the changes created by WHMIS and OSHA legislation in everyday life.

Course Outline:

Health and Safety Foundations

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

Fostering a Safety Culture

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

Recognizing and Communicating Hazards

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

Finding Hazard Information

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

Accidents & Their Effect on Industry

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

Assessing and Minimizing the Risks from Hazards

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

Preparing for Emergency Response Procedures

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

Stress and Safety at Work environment

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

Incident Investigation

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- The A-Z of health and safety by Jeremy Stranks, 2006.
- The Manager's Guide to Health & Safety at Work by Jeremy Stranks, 8th edition, 2006.
- Occupational safety and health law handbook by Ogletree, Deakins, Nash, Smoak and Stewarts, second edition, 2008.

12.2Non-Engineering Domain

English Courses

Functional English

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outlines:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Communication Skills

Area Scope:

The knowledge units in this area collectively encompass the following:

1. Communicate effectively using intermediate- to-advanced level English while developing the understanding of essentials of communication skills.
2. 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:

1. The students will be able to write technically correct statements, assignments, final year project report, project proposal, short report and research paper
2. The students would be able to their write CV, cover letter and business/ professional Correspondence meeting all criteria
3. 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:

1. To comprehend basic concepts of Linear Algebra and optimization
2. 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:

1. To develop a clear understanding of fundamental concepts of single variable calculus
2. 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 Integrall
- 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:

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

Course Outline:

Basic Concepts and Modelling

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

Analytical Methods of Solution for First-order ODEs

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

Mathematical Models Based on Second-order ODEs

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

Analytical Methods of Solution for Second-order ODEs

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

Series Solution for Second-order ODEs

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

Laplace Transform

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

Partial Differential Equations

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Numerical Analysis

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline

Error Analysis and Interpolation

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

Interpolation versus least square approximation, Relevant engineering case studies

Numerical Differentiation and Integration

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

Methods of Solution a System of Linear Equations

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

Iterative Methods for Linear and Nonlinear Equations

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

Numerical Methods for IVPs and BVPs

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

Numerical Methods for Computing Eigenvalues

- Eigenvalues and Eigenvectors of matrix: power method,
- Inverse power method, Shifted inverse power method.

- Applications of eigenvalues in engineering disciplines.

Numerical Optimization

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Probability & Statistics

Area Scope:

The knowledge units in this area collectively encompass the following:

1. To understand the basic concept of Statistics and Probability and their need in engineering.
2. To Describe properties and classifications of probability density functions, regression analysis and interval estimation
3. To Apply different probability and statistics techniques in engineering problems

Course Outline

Basic Statistics

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

Data Presentation

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

Measure of Central Tendency

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

Measure of Dispersion

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

Simple Regression, Correlation and Curve Fitting

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

Probability and Random Variables

- Probability review, Laws of probability, Conditional probability, Bayesian theorem, independent, dependent events.
- Random variables, Discrete and Continuous random variables, Probability mass and density functions, Distribution functions, Mathematical expectation,

- Variance of random variable, Bivariate distribution, Joint probability distribution, Moment generating function

Probability Distributions

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

Sampling and Sampling Distributions

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

Statistical Inference and Testing of Hypothesis

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Introduction to Statistical theory part 1, by Sher Muhammad Chuadary (Latest Edition)

- Advanced Engineering Mathematics, by Erwin Kreyszig (Latest Edition)
- Probability and Statistics for Engineers and Scientists, by Antony Hayter.
- Elementary Statistics, by Bluman.

Complex Variables & Transforms

Area Scope:

The knowledge units in this area collectively encompass the following:

1. Explain the concept of complex number system, complex function, limit, continuity, differentiability and integral of complex valued functions
2. Utilize the theory of complex integration and power series (Taylor series. Laurent series) to solve problems from the area of residue calculus
3. 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:

1. To develop a clear understanding of fundamental concepts of multivariable variable calculus
2. To describe of the concept of gradient, multiple integrals in rectangular, polar, cylindrical and spherical coordinates, directional derivatives, and optimization problems
3. 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.

Mechanics:

Newton Laws and their Applications(Simple Accelerometer, Banked Curve and Rotor), Frictional Forces and determination of Co-efficient of Friction, Work-Energy Theorem, applications of law of Conservation of Energy, Angular Momentum, Centre of Mass of two-particles, Many-particles and Solid Object.

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)

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.

Conduction of Electricity in Solids:

The electrical properties of solids, Energy level in a crystalline solid, 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.

Applied Chemistry

Area Scope:

The knowledge units in this area collectively encompass the following:

1. To know Reaction mechanism and industrial applications of organic compounds and their reactions
2. To understand chemical process industry, Industrial Chemical Analysis and primary raw materials used in various industries
3. To infer the knowledge of synthesis and basic reactions of polymers
4. To learn Synthesis characterization and applications of Paints, pigments, dyes and coating

Course Outline:

- Industrial Aspects of Inorganic Chemistry, study of selected inorganic industries, Sulphur industry, Industry dealing with nitrogen, phosphorus, chloralkaline and titanium oxide.

- Reaction mechanism and industrial applications of organic reactions such as sulfonation, Nitration, Hydrogenation, Amination, Halogenation, oxidation, polymerization.
- An overview of chemical process industry and primary raw material, Industrial Pollution Prevention, Industrial Chemical Analysis, Chemical Explosives and propellants, Synthetic polymers, Polymeric materials, Corrosion, chemical analyses of materials, Improved Paints pigments and industrial coatings, Dye: Chemistry and Applications, Chemical manufacturing processes and production methods

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:

- Applied Chemistry and Chemical Engineering" A. K. Haghi, Devrim Balkose, Omari V.
  - Mukbaniani, Andrew G. Mercader, Apple Academic Press, 2018
- Comprehensive Analytical Chemistry; Molecular Characterization and Analysis of
  - Polymer, John M. Chalmers, Robert J. Meier, Elsevier (2008)
- Green Chemistry in industry Mark Anthony Benvenuto, Heinz Plaumann, De Gruyter,
  - Volume 3, 2018
- Polymers, Polymer Blends, Polymer Composites and Filled Polymers, G. E. Zaikov,
- Nova (2006)
- Biodegradable Polymer Blends and Composites from Renewable Resources, Long Yu, Wiley (2008)
- Sustainable Industrial Chemistry: Principles, Tools and Industrial Examples.

- Fabrizio cavani, Gabriele Centi, Siglinda Perathoner , Wiley Publishshers, 2009
- Pavia, Lampman, Introduction to Spectroscopy, 4th edition, Brooks/Cole, 2009
- H. Kuhn, Principles of Physical Chemistry, 2nd edition, Wiley, 2009
- G.D. Christian, Analytical Chemistry, 7th edition, 2014, Wiley
- D. W. H. Rankin, Norbert Mitzel, Carole Morrison, Structural Methods in Molecular Inorganic chemistry, Wiley, (2013)
- Gary Wulfsberg, Foundations of Inorganic Chemistry, University Science Books, 2017 David Klein, Organic Chemistry , Wiley, 2017

Social Sciences Courses

Sociology for Engineers

Area Scope:

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

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

Course Outline:

Fundamental Concepts and Importance of Sociology for Engineers

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

Cultural Impacts of Engineering Projects on Society

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

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

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

Understanding of Societal & Ethical Norms and Values for Engineers

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

Organizational Social Responsibility (OSR) of Engineers

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

Engineers, Society and Sustainability

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

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

Industrial & Organizational Psychology Interpersonal Relations

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

Climate Change and Ecological Friendliness from Engineering Perspective

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

Social Approaches and Methodologies for Development Administration & Stakeholders Analysis:

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

SIA (Social Impact Assessment):

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

Engineering Intervention for Social Stratification.

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

Case Studies of Different Development Projects in Social Context

Teaching Methodology (Proposed as applicable):

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

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

Assessment:

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

Suggested Books:

- Godhade, J. B., and S.T. Hunderkari. 2018. Social Responsibility of Engineers. International Journal of Academic Research and Development. Vol. 03; Special Issue. March, 2018.
- Nichols, S.P. and Weldon, W.F. 2017. Professional Responsibility: The Role of Engineering in Society Center for Electro-mechanics, The University of Texas at Austin, USA.
- Aslaksen, E.W. 2016. The Relationship between Engineers and Society: is it currently fulfilling its potential? Journal and Proceedings of the Royal Society of New SouthWales, Vol.148.Nos.455-456. Gumbooya Pty Lte, Allambie Heights, Australia.
- Bell, S. Engineers, Society and Sustainability. Synthesis Lectures on Engineers, Technology, and Society. Edited by Caroline Baillie, University of Western Australia. Morgan and Claypool Publishers
- Jamison, A., Christensen, S.H., and Lars, B. 2011. A Hybrid Imagination: Science and Technology in Cultural Perspective.
- Vermaas, P., Kroes, P., Poet, l., and Houkes, W. 2011. A Philosophy of Technology: From Technical Artefacts to Socio technical systems.
- Mitcham, C., and Munoz, D. 2010. Humanitarian Engineering. Morgan and Claypool Publishers.
- Riley, D. 2008.Engineering and Social Justice. Morgan and Claypool Publishers.
- Bugliarello, G. 1991. The Social Functions of Engineering: A Current Assessment, A Chapter in “Engineering as A Social Enterprise”.

Sociology

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline:

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

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Henslin, Sociology: A Down-to-Earth Approach, 11th edition.
- D. Kendall, Sociology in our Times. Wadsworth Pu

Social Psychology

Area Scope:

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

Course Outline:

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

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Community Services

Area Scope:

Community service-learning provides a variety of benefits to the students and the community service has a unique way of developing an individual's leadership skills, sense of community, civic ethic, self-esteem, and other personal characteristics. Every service activity benefits a specific individual or group. Whether it is building homes for

the poor, serving victims of chronic or terminal illness, tutoring children, addressing environmental needs or any other service, there is a person or group who ultimately benefits from your time. Finally, the organization where you conduct your service benefits enormously. Volunteers can make important contributions to Community benefit agencies (non-profit) and government programs in their attempt to deal with the complex and growing needs of society.

Course Outline:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Schools and Community: The Communitarian Agenda in Education By James Arthur; Richard Bailey, Falmer Press, 2000.
- Studying Service-Learning: Innovations in Education Research Methodology by Shelley H. Billig, Alan S. Waterman , Lawrence Erlbaum Associates, 2003

Organizational Behavior

Course Outline:

Introduction to Organizational Behavior

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

Structure and Control in Organization

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

Individual and Work Learning

- Learning Theories
- Learning and Work

Stress

- Types of Stress and Work
- Occupational Stress Management

Individual Differences

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

Motivation and Job Satisfaction

- Needs at Work

- Theories of Motivation and job satisfaction
- Correlates of Job satisfaction

Group and Work

- Social Interaction
- Dramaturgy and impression Management
- Social Skill

Group and Inter group Behavior

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

Leadership

- Leadership as an attribute
- Leadership Style

Patterns of Work

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

Organizational Culture

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Finchan, R., & Rhodes, P. (2003), Principles of Organizational Behaviour, 3rd Oxford.
- Noe, R., Hollenbeck, J. Gerhart, B., & Wright, P. (2006), Human Resource Management, 5th ed., McGraw Hill.
- Newstrom John W. (2007), Organizational Behaviour, (12th Ed), McGraw Hill.
- Luthan Fred, (2005), Organizational Behaviour, McGraw Hill Inc.
- Robins, Stephen, (2005), Organizational Behaviour, McGraw Hill Inc.

Engineering Economics

Area Scope:

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

Course outline

Engineering Economics

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

Interest Rate and Economic Equivalence

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

Understanding Money and Its Management

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

Present-Worth Analysis

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

Annual Equivalent-Worth Analysis

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

Rate-of-Return Analysis

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

Cost Concepts Relevant to Decision Making

- General Cost Terms; Classifying Costs for Financial Statements

- Cost Classifications for Predicting Cost Behavior
- Future Costs for Business Decisions
- Estimating Profit from Production

Depreciation and Corporate Taxes

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

Developing Project Cash Flows

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

Project Risk and Uncertainty

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

Special Topics in Engineering Economics

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Professional Ethics

Area Scope:

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

Outlines:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Cultural Courses

Islamic Studies and Ethics

Course Description:

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

Area Scope:

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

Course Outline:

Islam – Religion of Peace and Harmony

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

Islamic Culture and Civilization

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

Social System of Islam

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

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

Professional Ethics and Morality

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

Islam and Science

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

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Pakistan Studies and Global Perspectives

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course outline: **Time Duration**

Historical and Ideological Perspective **5 hrs**

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

Constitution of Pakistan **4 hrs**

- An overview of constitutional development in Pakistan
- Salient features of the Constitution of 1973
- Constitutional Amendments
- Fundamental Rights and Responsibilities of Citizens

Contemporary Pakistan **4 hrs**

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

Economy of Pakistan **4 hrs**

- An overview of Economy
- Services, Manufacturing and Agricultural Profile of Pakistan
- Regional Economic Cooperation
- One Belt One Road (OBOR) – CPEC

Land of Opportunities **4 hrs**

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

Pakistan's Foreign Policy **5 hrs**

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

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

- SDGs-2030 - Pakistan Goals
- Commitments on Climate Change
- 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 11th Edition, Harold Kerzner
- Bennett, F. Lawrence. 1996. The management of engineering. New York: Wiley.
- Cleland, David. Field guide to project management. New York: Wiley.
- Eisner, H. Essentials of project management and systems engineering management. New York: Wiley.
- Frame, J. D. Managing projects in organizations. San Francisco: Jossey-Bass
- Goldratt, Eliyahu. Critical chain. North River Press.
- Haynes, M.E. Project management: From idea to implementation. Los Altos, CA: Crisp Publications.

- Lewis, James, Project planning, scheduling & control. New York: McGraw-Hill
- Lewis, James, P. 1998. Mastering project management. New York: McGraw-Hill
- Lientz, Bennet & Rea, Kathryn. 1995. Project management for the 21st century. San Diego: Academic Press.
- Miller, Roger & Lessard, Donald. 2000. The strategic management of large engineering projects. Cambridge, MA: MIT Press.
- Nicholas, J.M. Managing business & engineering projects. Englewood Cliffs, NJ: Prentice Hall.
- Shtub, Avraham, Bard, Jonathan, & Globerson, Shlomo. 1994. Project management: Engineering, technology, and implementation. Englewood Cliffs, Prentice-Hall.
- Project Management by Adrienne Watt
- J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons. New York. 2019. (Reference).

Entrepreneurship

Area Scope:

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

Course Outlines

- Basic Concept-Entrepreneurship
- Innovation and Entrepreneurship
- Basic Plan Development Cycle
- Intellectual Rights
- Financial and Legal Modalities
- Marketing
- Industrial Competiveness

- Gap Analysis, Critical Thinking and Idea Generation
- Business Plan Development
- Successful Case Studies (local)

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Michael J Etzel, Bruce J Walker, William J Stanton, Marketing, McGraw-Hill 2010
- William D. Bygrave and Andrew Zacharak, Entrepreneurship 2nd Edition, Wiley, 2012.
- Entrepreneurship by Hisrich, McGraw- Hill, 2009
- Principles of Marketing, Cotrell McGraw- Hill 2012
- Paul Burns and Jim Dew Hurst: Small Business and Entrepreneurship
- P.N. Singh: Entrepreneurship for Economic Growth
- Peter F. Drucker: Innovation and Entrepreneurship Peter F. Drucker
- John B. Miner: Entrepreneurial Success
- “Marketing that Works: How Entrepreneurial Marketing Can Add Sustainable Value to Any Sized Company”, by Leonard Lodish, Howard Morgan, Shellye Archambeau and Jeffrey Babin, Pearson FT Press
- "Entrepreneurial Marketing," Lessons from Wharton's Pioneering MBA Course, Morgan, H. L., A. Kallianpur, and L. M. Lodish, John Wiley & Sons, 2001

Principles of Management

Area Scope

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

Course Outline:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Engineering Management

Course Outline

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

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