

# Curriculum for Transportation Engineering

## Bachelor of Engineering Program

# 2020



Pakistan Engineering Council  
&  
Higher Education Commission  
Islamabad







**CURRICULUM  
OF  
TRANSPORTATION ENGINEERING**

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## PREFACE

The curriculum, with varying definitions, is said to be a roadmap or plan of teaching-learning process that students of an academic program are required to undergo. It includes objectives and learning outcomes, course 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 designated as the competent 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.

The Transpiration Engineering (TE) provides the necessary technical skills in Transportation and engineering design/analysis as well as mathematics and basic sciences consistent with accreditation standards and national development needs. A graduate of this program would be able to undertake planning, design, construction, operations and maintenance of urban and rural transportation infrastructure by applying his/her knowledge in all stages of inter-disciplinary projects.

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

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

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

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

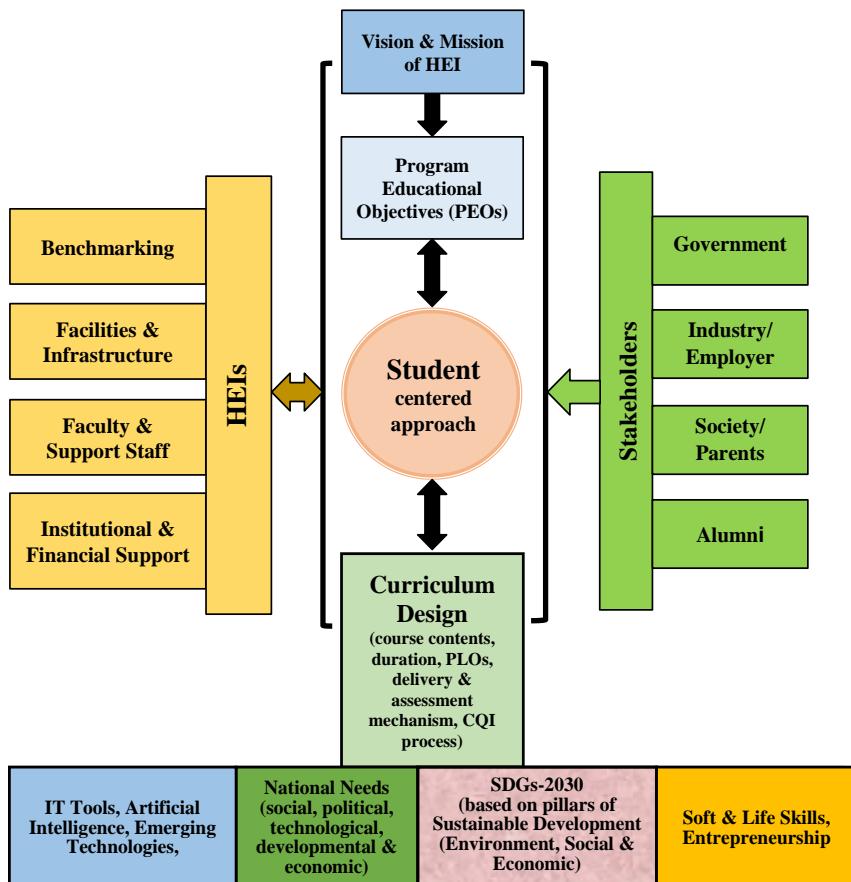
## **2. ECRDC Agenda**

- 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

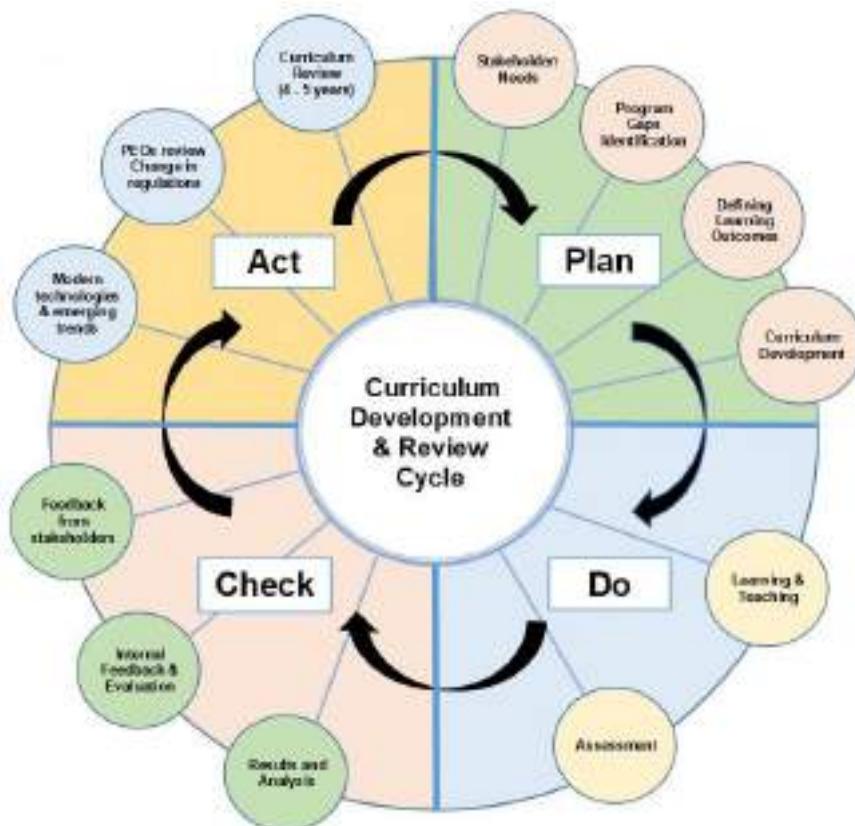
Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student's centered system which concerns what the students will know and be able to do as learning outcomes. The curriculum development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

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



#### **4. PDCA Approach to Curriculum 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 Civil & Allied Engineering**

The PEC Engineering Curriculum Review and Development Committee (ECRDC) Civil and Allied Engineering took up the task to review and update the curriculum for Bachelor of Transportation Engineering degree program. The subject Committee had three meetings held on 29-8-2019, 11-12-2019 and 14-01-2020 at PEC Head Office, Islamabad besides meetings of Sub-Groups for Transportation Engineering. The Committee consisted of following members:

- |   |          |
|---|----------|
| 1. Engr Dr Wasim Khaliq<br>Associate Professor<br>NICE<br>National University of Sciences and Technology (NUST)<br>Islamabad                        | Convener |
| 2. Engr Prof Dr Abdul Jabbar Sangi<br>Associate Professor<br>Department of Civil Engineering<br>NED University of Engineering & Technology, Karachi | Member   |
| 3. Engr Dr Majid Ali<br>Associate Professor<br>Department of Civil Engineering<br>Capital University of Science and Technology, Islamabad.          | Member   |

4. Engr Prof Dr Hamza Farooq Gabriel Member  
Professor, NICE  
National University of Sciences and Technology (NUST)  
Islamabad
5. Engr Prof Dr Habib Ur Rehman Member  
Professor  
Department of Civil Engineering  
UET, Lahore
6. Engr Prof Dr M Jamaluddin Thaheem Member  
Assistant Professor  
Construction Engineering and Management  
National University of Sciences and Technology (NUST)  
Islamabad
7. Engr Prof Dr Muhammad Zubair Abu Bakar Member  
Dean, Professor  
Department of Geology Engineering  
UET, Lahore
8. Engr Dr Mazhar Iqbal Arshad Member  
Associate Professor  
Transportation and Geotechnical Engineering Department  
Military College of Engineering (Sage)  
MCE, Risalpur
9. Engr Dr Imran Hafeez Member  
Professor  
Department of Civil Engineering  
UET, Taxila
10. Engr Haider Ali Khan Member  
Principal  
Faculty of Engineering  
Lahore Leads University, Lahore
11. Engr Dr Izhar Ul Haq Member  
Ex-President IEP  
Lahore

12. Engr Ijaz Ahmed Cheema Member  
Chief Engineer  
Planning & Development  
Provincial Highway Department, Lahore
13. Engr Prof Dr Bashir Alam Member  
Professor  
Department of Civil Engineering  
UET, Peshawar
14. Engr Prof Dr Abdullah Saand Member  
Dean, Faculty of Engineering  
Quaid-e-Awam University of Engineering, Science &  
Technology, Nawabshah
15. Engr Prof Dr Tauha Hussain Ali Member  
Pro-Vice Chancellor  
Mehran University of Engineering & Technology  
Jamshoro
16. Engr Prof Dr Syed Mohammad Ali Member  
Director, Earthquake Engineering Center (EEC)  
University of Engineering and Technology (UET)  
Peshawar
17. Engr Prof Dr Muhammad Ashraf Tanoli Member  
HoD, Deptt. of Civil Engineering  
Ghulam Ishaq Khan Institute of  
Engineering Sciences and Technology, Swabi
18. Engr Tariq Mehmood Member  
Chief Engineer  
WAPDA House, Lahore
19. Engr Abdul Qadeer Member  
General Manager/Head  
NESPAK House, Islamabad

20. Engr. Prof. Dr. Ali Rizwan Bukhari Member  
Professor  
Department of Civil Engineering  
FAST University, Lahore
21. Mr Hidayatullah Kasi Rep HEC  
Deputy Director  
Higher Education Commission, Islamabad
22. Engr. Dr. Ashfaq Ahmed Secretary  
Additional Registrar  
Pakistan Engineering Council, Islamabad
23. Engr. Muhammad Kashif Ali AR-CPD  
Assistant Registrar  
Pakistan Engineering Council, Islamabad

### **5.1 Sub Group Transportation Engineering**

1. Engr. Dr. Imran Hafeez Lead Sub-Group  
Professor  
Taxila Institute of Transportation Engineering  
UET, Taxila
2. Engr. Dr. Zia ur Rehman Expert  
Associate Professor  
Department of Transportation Engineering and  
Management UET, Lahore
3. Engr. Dr. Hamamd Hussain Awan Expert  
Professor  
IPFP/HEC  
Lahore
4. Engr. Dr. Muneeb Abid Expert  
Assistant Professor  
College of Engineering & Technology  
University of Sargodha, Sargodha

5. Mr Hidayatullah Kasi  
Deputy Director  
Higher Education Commission  
Islamabad
6. Engr Dr Ashfaq Ahmed Sheikh  
Additional Registrar, CPD  
Pakistan Engineering Council  
Islamabad
7. Engr. Muhammad Kashif Ali  
Assistant Registrar-CPD  
Pakistan Engineering Council  
Islamabad

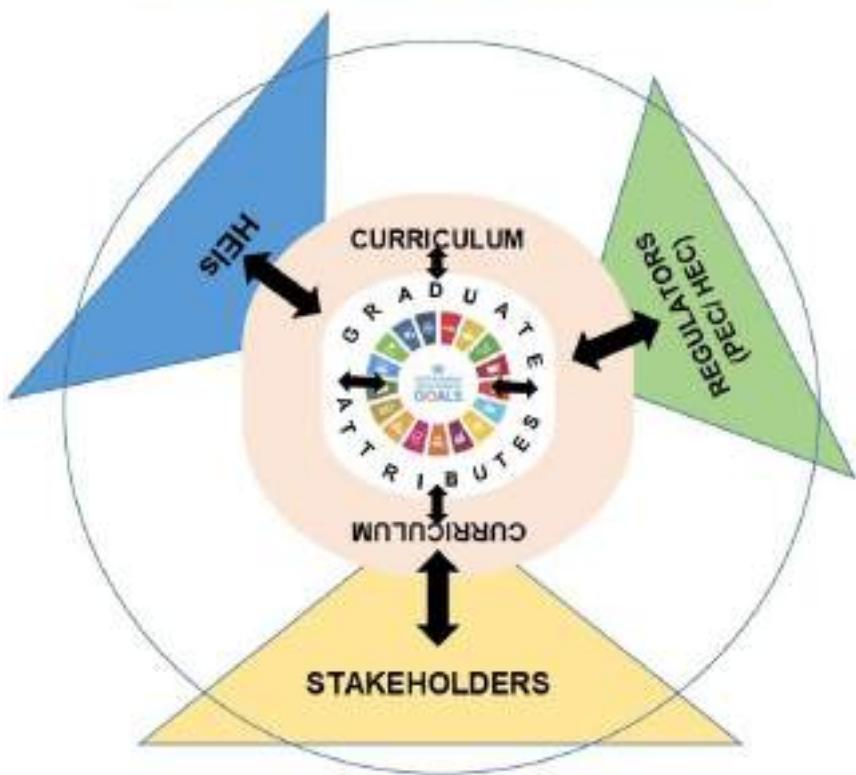
## **6. Agenda of ECRDC for Civil and Allied Engineering Disciplines**

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

Engr Dr. Wasim Khaliq, 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 a useful input and suggestions covering new developments to be incorporated in the curriculum. He also highlighted the importance of the field of Transportation Engineering for achieving sustainable development while addressing socio-economic issues and challenges envisaged in SDGs-2030 as under and well mapped with courses;

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

## OBE Curriculum towards SDGs-2030 Attainment



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

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

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

Transportation engineering professionals will:

1. Actively engage in problem-solving using transportation engineering principles to address the evolving needs of the society.
2. Be able to succeed in positions in transportation engineering practice or research, they choose to pursue and enroll in advanced studies
3. Make ethical decisions and demonstrate a commitment to service to the profession and society.
4. Acquire a position or degree that values adaptability and innovation in their chosen profession.

### **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. The program must demonstrate that by the time of graduation the students have attained a certain set of knowledge, skills and behavioral traits, at least to some acceptable minimum level.

The sample Program Learning Outcomes (PLOs) of Transportation Engineering are based on graduate attributes of PEC Accreditation Manual 2019 and are given below:

- **PLO-01: Engineering Knowledge:** Ability to apply knowledge of mathematics, science, architecture and engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
- **PLO-02: Problem Analysis:** Ability to identify, formulate, research literature, and analyze complex architectural and engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
- **PLO-03: Design/Development of Solutions:** Ability to design solutions for complex engineering problems and design systems, components, or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
- **PLO-04: Investigation:** Ability to investigate complex architectural and engineering problems in a methodical way including literature survey, design and conduct of experiments, analysis and interpretation of experimental data, and synthesis of information to derive valid conclusions.
- **PLO-05: Modern Tool Usage:** Ability to create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex engineering activities, with an understanding of the limitations.
- **PLO-06: The Engineer and Society:** Ability to apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional architectural and engineering practice and solution to complex architectural and engineering problems.
- **PLO-07: Environment and Sustainability:** Ability to understand the impact of professional architectural and engineering solutions in societal and environmental contexts and demonstrate knowledge of, and need for, sustainable development.
- **PLO-08: Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of architectural and engineering practice.
- **PLO-09: Individual and Team Work:** Ability to work effectively, as an individual or in a team, on multifaceted and/or multidisciplinary settings.
- **PLO-10: Communication:** Ability to communicate effectively, orally as well as in writing on complex architectural and engineering activities with the engineering community and with society at large, such as being able to

comprehend and write effective reports and design documentations, make effective presentations, and give and receive clear instructions.

- **PLO-11: Project Management:** Ability to demonstrate management skills and apply architectural and engineering principles to one's own work, as a member and/or leader in a team to manage projects in a multidisciplinary environment.
- **PLO-12: Lifelong Learning:** Ability to recognize importance of, and pursue lifelong learning in the broader context of innovation and technological developments.

## **8. Program Salient Features**

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

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

(HEIs have flexibility of 15-21 Credit Hours to add courses either in Engineering, Non-Engineering or both Domains to fulfill the program objectives in line with the overall Vision/ Mission of the Institute concerned).
- **Additional Course or Credit Hours Requirements:** Any addition of course or credit hour requirements as per direction or policy of the Government (Provincial or Federal), HEIs have leverage to cater such needs over and above the prescribed requirements in this document.
- **Number of weeks per semester:** 15 - 18
- **Number of credit hours per semester:** 15 - 18
- **Curriculum:** The engineering curriculum is the most important instrument for grooming the students based on 12 Graduate Attributes (GAs) encompassed under the Program Learning Outcomes (PLOs). In order to inculcate different

dimensions of thinking – mathematical, computational, design and creative – among students in Cognitive, Psychomotor and Affective domains, the curriculum is based on the following knowledge profiles:

- WK1 - Natural Sciences:** A systematic theory-based understanding of natural sciences applicable to the discipline.
- WK2 - Mathematics and Computing:** The concept-based mathematical thinking, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modeling applicable to the discipline.
- WK3 - Engineering Fundamentals:** A systematic, theory-based formulation of engineering fundamentals required in an engineering discipline.
- WK4 - Engineering Specialization:** The knowledge of engineering specialization that provides theoretical frameworks and bodies of knowledge for the accepted practice areas that are at the forefront in a discipline.
- WK5 - Engineering Design:** The Design Thinking Knowledge that supports engineering design in a practice area of an engineering discipline.
- WK6 - Engineering Practice:** The Knowledge of engineering practices (technology) in different practice areas of an engineering discipline.
- WK7 - Engineering in Society:** A systematic, comprehension-based knowledge of the role of engineers in a society and the professional issues related to practicing engineering profession in a discipline: ethics and the professional responsibility of an engineer to public safety including the impact of an engineering activity i.e. economic, social, cultural, 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
<b>Non-Engineering Domain</b>				
WK-2		Math	As per program requirements	12 - 15
WK-1	Natural Science	Physics	Applied Physics	6 - 9
		Chemistry	Applied Chemistry	
		Natural Science/ Math Elective	As per program requirements	
WK-7	Humanities	English	Writing, 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
<b>Total (Non-Engineering Domain)</b>				<b>min 30</b>
<b>Engineering Domain</b>				
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-8/ WK-7	Final Year Design Project (FYDP/ Capstone	Integration of innovative, creative, technical, management and presentation skills of a graduate towards final year.		6		
WK-6/ WK-7	Industrial Training	at least 6 - 8 weeks internship		Qualifying		
WK-4/ WK-5/ WK-6/ WK-7/ WK-8/ WK-2	<b>Innovative and Critical Thinking (under relevant courses):</b> <ul style="list-style-type: none"> <li>- Complex Problem Solving</li> <li>- Complex Engineering Activities</li> <li>- Semester Project</li> <li>- Case Studies</li> <li>- Open Ended Labs</li> <li>- Problem Based Learning (PBL)</li> </ul>					
<b>Total (Engineering domain)</b>				<b>min 85</b>		
<b>Total (Credit Hours)</b>				<b>130 - 136</b>		

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

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

- **Final Year Design Project (FYDP)/ Capstone:** FYDP aims to challenge innovative, creative, technical, management and presentation skills of a graduate to bring together the learning over the degree program.
  - A final year design project (FYDP) is the confluence of an engineering program. Undertaking a final year design project is a compulsory requirement. It should mainly comprise literature search, individual analysis, modeling and simulation, AI (Artificial Intelligence) and computational data analytics, design and putting together various hardware, software, firmware and Algorithm Engineering / Informatics related to the program to demonstrate a functional concept including rapid prototyping, where applicable.
  - The FYDP shall include complex engineering problems and design systems, components or processes integrating core areas and meeting specific needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
  - A project of this nature should invariably lead to an integration of the knowledge and practical skills as mandated in the program outcomes. In this context, projects of multidisciplinary nature should be encouraged.
  - The FYDP should span over two consecutive semesters, i.e. semester 7 & 8, totaling 6-credit hours and should be fully supervised, assessed and reflected in the transcripts under a prescribed mechanism so as to prepare for joining industry after graduation.
- **Faculty:** The faculty must be trained for the Outcome-Based Education (OBE) system. Their familiarity with the program objectives and outcomes, understanding of the Outcome-Based Assessment (OBA) cycle, enthusiasm for developing an effective program, and the ability to become an active player in this regard are the keys to ensure the attainment of program objectives. The faculty is expected to have the ability to ensure proper implementation of the program, and to develop processes for evaluation, assessment and CQI. A formal training program to groom the faculty should be instituted to become effective instructors in applying pedagogical skills in all aspects of Teaching, Learning and Assessment covering all domains of Knowledge, Skills and Attitude.
- **Personal Grooming:** Personal Grooming of young faculty members and students is very important in order to develop and support their professional skills. Therefore, it is required that HEIs should conduct/ arrange sessions or

counseling hours on regular basis to provide guidance for personal grooming. Personal Grooming is important for positive self-image and increasing the confidence level of the individuals. It would help in enhancing students' self-esteem and would go a long way in developing an attractive personality by adopting habits like personal hygiene, clothing, appearance, interaction and expressive skills, etc. The students should be motivated and equipped to be entrepreneurs in their relevant field.

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

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

Knowledge Profile (WK-1 to WK-8)	Knowledge Area	Sub Area	Name of Course	Theory	Lab	Total	Total Courses	Total Credits	
				Credit Hours					
<b>Non-Engineering Domain</b>									
WK-7	Humanities	English	Functional English	2	0	2	3	6	
			Technical Writing & Presentation Skills	2	0	2			
			Communication Skills	1	1	2			
		Culture	Islamic Studies and Ethics	2	0	2	2	4	
			Pakistan Studies and Global Perspectives	2	0	2			
	Management Sciences	Social Sciences & Ethics	Professional Ethics	2	0	2	2	4	
			Engineering Economics	2	0	2			
		Professional Practice	Entrepreneurship for Engineers	2	0	2	2	5	
			Engg Project Management	3	0	3			
WK-2	Natural Sciences	Math	Calculus and Analytical Geometry	3	0	3	7	17	
			Differential Equations	3	0	3			
			Probability & Statistics	2	0	2			
			Numerical Analysis	2	0	2			
WK-1		Physics	Applied Physics	2	1	3			
		Chemistry	Chemistry for Engineers	2	0	2			
		Earth Sciences	Applied Geology	2	0	2			
<b>Total (Non- Engineering Domain)</b>				<b>34</b>	<b>2</b>	<b>36</b>	<b>16</b>	<b>36</b>	

Engineering Domain								
WK-2/ WK-4/ WK-5/ WK-6	Computer and Information Sciences	ICT/AI/ Data Science/ Cyber Security	Introduction to ICT	1	1	2	2	5
			Artificial Intelligence	2	1	3		
WK-3/ WK-2	Engineering Foundation		Construction and pavement Materials	2	1	3	10	30
			Transportation Engg Drawing and Graphics	1	2	3		
			Engineering Mechanics	2	1	3		
			Surveying – I	2	1	3		
			Mechanics of Solids	2	1	3		
			Structural Analysis	3	0	3		
			Geotechnical Engineering-1	2	1	3		
			Pavement Drainage System and Design	2	1	3		
			Traffic Engineering – I	2	1	3		
			Environmental Engineering	2	1	3		
WK-4/ WK-2/ WK-1	Major Based Core (Breadth)		Surveying – II	2	1	3	8	21
			Geometric Design	3	0	3		
			Plain and Reinforced Concrete (PRC)	2	1	3		
			Traffic Engineering – II	2	1	3		
			Geo-technical Engineering – II	2	1	3		
			Railway Engineering – I	2	0	2		
			Introduction to Airport Engineering	2	0	2		
			Harbour and Docks Engineering	2	0	2		
WK-5/ WK-6	Major Based Core (Depth)		Pavement Evaluation and Rehabilitation	3	0	3	8	22
			Pipe way Engineering	2	0	2		
			Railway Engineering – II	2	1	3		

**Curriculum of Transportation Engineering**

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			Advance Airport Engineering	3	0	3				
			Bridge and Tunnel Engineering	3	0	3				
			Transport Infrastructure, Planning and Management	3	0	3				
			Pavement Design	2	1	3				
			Port and Harbour Structures	2	0	2				
			Elective-I	3	0	3	2	6		
			Elective-II	3	0	3				
WK-1/ WK-2/ WK-3/ WK-4	Multi-Disciplinary Engineering Courses		Geographical Information System in Transportation Planning	2	1	3	4	10		
			Electrical Systems for Transport Infrastructure	2	1	3				
			Automotive Engineering	2	1	3				
			Occupational Health and Safety (Mandatory)	1	0	1				
WK-6/ WK-7/ WK-8	Final Year Project (FYP)/ Capstone	Industrial/ Innovative/ Creative Project	FYDP (Part-I)	0	3	3	1	6		
			FYDP (Part-II)	0	3	3				
WK-6/ WK-7	Industrial Training	6 -8 weeks Mandatory Internship		0	0	0	0	0		
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	<b>Innovative and Critical Thinking (under relevant courses)</b> - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open Ended Labs - Problem Based Learning (PBL)									
<b>Total (Engineering Domain)</b>				<b>73</b>	<b>27</b>	<b>100</b>	<b>34</b>	<b>100</b>		
<b>Total Credit Hours</b>				<b>107</b>	<b>29</b>	<b>135</b>	<b>50</b>	<b>136</b>		

## 10. Scheme of Study for Bachelor of Transportation Engineering

Semester 1					
S. No.	Course Title	Theory	Lab	Total	
		Credit Hours			
1	Engineering Drawing	0	2	2	
2	Applied Physics	2	1	3	
3	Islamic Studies	2	0	2	
4	Calculus and Analytical Geometry	3	0	3	
5	Applied Chemistry	2	0	2	
6	Introduction to ICT	2	1	3	
7	Functional English	2	0	2	
8	Workshop Practice	0	1	1	
<b>Total</b>		<b>13</b>	<b>5</b>	<b>18</b>	
Semester 2					
S. No.	Course Title	Theory	Lab	Total	
		Credit Hours			
1	Surveying-I	2	1	3	
2	Computer Programming	2	1	3	
3	Engineering Mechanics	2	1	3	
4	Communication Skills	1	1	2	
5	Differential Equations	3	0	3	
6	Applied Geology	2	0	2	
7	Pakistan Studies	2	0	2	
<b>Total</b>		<b>14</b>	<b>4</b>	<b>18</b>	
Semester 3					
S. No.	Course Title	Theory	Lab	Total	
		Credit Hours			
1	Surveying-II	2	1	3	
2	Professional Ethics	2	0	2	
3	Mechanics of Solids	2	1	3	
4	Construction and Pavement Materials	2	1	3	

**Curriculum of Transportation Engineering**

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5	Electrical Systems for Transport Infrastructure	2	1	3
6	Reinforced Concrete	2	1	3
<b>Total</b>		<b>12</b>	<b>5</b>	<b>17</b>
<b>Semester 4</b>				
S. No.	Course Title	Theory	Lab	Total
		<b>Credit Hours</b>		
1	Structural Analysis	3	0	3
2	Technical Writing and Presentation Skills	2	0	2
3	Traffic Engineering - I	2	1	3
4	Probability and Statistics	2	0	2
5	Automotive Engineering	2	1	3
6	Geotechnical Engineering-I	2	1	3
7	Engineering Economics	2	0	2
<b>Total</b>		<b>15</b>	<b>3</b>	<b>18</b>
<b>Semester 5</b>				
S. No.	Course Title	Theory	Lab	Total
		<b>Credit Hours</b>		
1	Environmental Engineering	2	1	3
2	Geotechnical Engineering-II	2	1	3
3	Traffic Engineering - II	2	1	3
4	Introduction to Airport Engineering	2	0	2
5	Engineering Project Management	3	0	3
6	Numerical analysis	2	0	2
<b>Total</b>		<b>13</b>	<b>3</b>	<b>16</b>
<b>Semester 6</b>				
S. No.	Course Title	Theory	Lab	Total
		<b>Credit Hours</b>		
1	Pavement Design	2	1	3
2	Geometric Design	3	0	3
3	Transport infrastructure, Planning and Management	3	0	3
4	Railway Engineering-I	2	0	2
5	Harbour and Dock Engineering	2	0	2

6	Entrepreneurship for Engineers	2	0	2
7	Pipeway Engineering	2	0	2
<b>Total</b>		<b>16</b>	<b>1</b>	<b>17</b>
<b>Semester 7</b>				
S. No.	Course Title	Theory	Lab	Total
		<b>Credit Hours</b>		
1	Advance Airport Engineering	3	0	3
2	Pavement Drainage system and Design	2	1	3
3	Geographical Information System in Transportation Planning	2	1	3
4	Elective-I	3	0	3
5	Bridge and Tunnel Engineering	3	0	3
6	Senior Project (Part-I)	0	3	3
<b>Total</b>		<b>13</b>	<b>5</b>	<b>18</b>
<b>Semester 8</b>				
S. No.	Course Title	Theory	Lab	Total
		<b>Credit Hours</b>		
1	Pavement Evaluation and Rehabilitation	3	0	3
2	Ports and harbor Structures	2	0	2
3	Railway Engineering-II	2	1	3
4	Elective-II	3	0	3
5	Senior Project (Part-II)	0	3	3
<b>Total</b>		<b>10</b>	<b>4</b>	<b>14</b>
<b>Total (Credit Hours)</b>				<b>136</b>

### **Electives for Major Streams**

(A total of two depth elective courses are suggested. Out of following subjects, students can choose two courses of his/ her liking (keeping in mind the total credit hours)

S. No.	Course Title	Credit Hours
1	<b>Railway Engineering:</b> • Railway Systems Engineering and Integration • Railway Track Renewals, Planning & Drainage	<b>3 (3-0)</b> <b>3 (3-0)</b>
2	<b>Airport Engineering:</b> • Airport Geographic Information Systems • Airport Pavement Design, construction and evaluation	<b>3 (3-0)</b> <b>3 (3-0)</b>
3	<b>Port and Harbour Engineering:</b> • Port and Harbour Management • Coastal Engineering	<b>3 (3-0)</b> <b>3 (3-0)</b>

### **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;

- Asphalt and Concrete mix Design Lab
- Geomaterials Testing Lab
- Transportation Material Improvement Lab
- Traffic Engineering Lab
- Transportation Computer Aided Design Lab
- Motor Vehicle Examination Lab
- Railway Engineering Lab
- Geomatics 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 Sciences 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**

### **Course Outline**

#### **Introduction to Programming**

- Introduction to Programming Language C++ / Visual BASIC (VB)
- The character set
- Constants, variables and keywords
- Rules of constructing integer
- Real and character constants
- Flow charts and Algorithms

#### **The Loop Control Structure**

- The for loop, Nesting of loops
- Multiple initializations in the for loop
- The while loops
- The break statements
- The continue statement
- The do-while loop

#### **The Case Control Structure**

- Decisions using switch
- Switch versus if-else ladder
- The go to keyword

#### **Functions**

- Function definition
- Passing values between functions
- Functions declaration and prototypes

#### **Arrays and Strings**

- Introduction to arrays and strings
- 2D arrays

#### **Programming Languages**

#### **Programming for various Engineering Problems**

## **Miscellaneous**

- Introduction to pointers
- File handling
- Structures

## **Introduction to MS Office with advanced applications of MS Excel**

### **Use of MATLAB**

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

Lecturing, Written Assignments/ Quizzes, Case Studies, 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:**

- Gottfried, BS Programming with Structured Basics (Schaum Series), McGraw-Hill. (Latest Edition)
- Deitel & Deitel, T.R. Nieto, Visual C++ 6 (Latest Edition)
- Steven Holzner , Black Book of C++ (Latest Edition)
- Evangelos Petroutsos, Mastering Visual Basic 6, Sybex Computer Books Inc. USA, 1998
- Stephen J. Chapman, MATLAB Programming for Engineers (Latest Edition)

## **Computer Aided Design**

### **Course Outline:**

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

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

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

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

**Assessment:**

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

**Suggested Books:**

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

**Introduction to Modelling and Simulation**

**Course Outline:**

**Simulation**

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

## **Modeling**

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

## **Tools/ Software Requirement**

- Matlab

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

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

## **Assessment:**

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

## **Suggested Books:**

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

## **Artificial Intelligence**

### **Course Outline**

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

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

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

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

### **Assessment:**

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

**Suggested Books:**

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

## **Engineering Foundation Courses**

### **Construction and Pavement Materials**

#### **Course Outline**

##### **Materials and their Properties**

- Introduction of materials
- Construction materials
- Physical, mechanical and chemical properties
- Electrical and thermal properties

##### **Binding Materials (Cement and Lime)**

- Introduction and manufacture of Ordinary Portland Cement
- Constituents of cement
- Types of cement and their use
- Properties and field tests of cement
- Special cements
- Introduction and preparation of lime
- Setting and hardening of lime
- Applications of lime
- Comparison (cost and characteristics) of lime and cement

##### **Fine & Coarse Aggregates and Stones**

- Definition and introduction of aggregates
- Mechanical and physical properties of aggregates
- Importance and methods of grading of aggregates
- Introduction, types, applications, characteristics of good building stones
- Artificial stones

##### **Cementitious Materials**

- Introduction and methods of preparation of paste
- Properties and application of paste
- Introduction and methods of preparation of mortars
- Properties and application of mortars
- Introduction about concrete

- Components and manufacture of concrete, properties of concrete
- Types of concrete

### **Metals (Steel and Aluminum)**

- Introduction to steel
- Mechanical and physical properties of steel
- Application of steel in various engineering projects
- Introduction to aluminum
- Mechanical and physical properties of aluminum

### **Ceramics, Bricks and Blocks**

- History and evolution of ceramics
- Manufacture of ceramics
- Properties and applications of ceramics in buildings
- History and evolution of bricks
- Properties and applications of bricks
- Dimensions, manufacture and classification of bricks
- History and evolution of blocks
- Properties and applications of blocks
- Dimensions, manufacture and classification of blocks

### **Glass and Wood**

- Constituents of glass and methods of manufacture.
- Types, use and significance of glass
- Advantages and drawbacks of glass
- Structure of tree and general characteristics
- Types, seasoning and preservation of wood
- Lamination of wood

### **Pavement Materials**

- Bitumen
- Asphalt
- Road Metal

### **Steel and its Tests**

### **Miscellaneous Construction Materials**

- Asbestos, Plaster of Paris, Abrasives
- Rubber, Cork, Plastics
- Paint
- Thermometry and acoustics
- Bamboo
- Natural, artificial and steel fibers
- Modern Materials (Fiber reinforced polymer etc.)

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

Lecturing, Written Assignments/ Quizzes, Case Studies, 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 Allen, Joseph Iano, (2013), Fundamental of Building Construction Materials and Methods, 6th Edition, John Wiley & Sons. NY
- William F., Smith, (2009), Foundation of Materials Science & Engineering, 5th Edition, McGraw Hill.
- Duggal, S. K. (2010), Building Materials, New Age International.

## **Transportation Engineering Drawing and Graphics**

#### **Course Outline:**

- Introduction to the subject and drawing equipment
- Introduction to Transportation Engineering drawings

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

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

**Assessment:**

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

**Suggested Books:**

- Fundamentals of Engineering Drawings 11/E(PB) by Luzadder
- Engineering Drawing 6/E (PB) by Pal

**Engineering Mechanics**

**Course Outline:**

- Mechanics, fundamental concept of space, time, mass, velocity and acceleration, units of measurement, law of motion, law of gravitation & numerical calculations
- Vector addition of forces, addition of a system of coplanar forces: scalar & cartesian vector notation
- Coplanar force resultant using law of parallelogram, triangle law, polygon law, simple case of resultant and resolution of forces in space, dot product
- Three-dimensional force system, equation of equilibrium, analytical and graphical formulations and related examples
- Constraints & statical determinacy & equilibrium of two force and three force bodies
- Second moment of area, principle axes and radius of gyration, work, work done by varying forces

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

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

**Assessment:**

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

**Suggested Books:**

- Understanding Basic Mechanics by Frederick Rief
- Engineering Mechanics by R.K Bansal

**Surveying – I**

**Course Outline:**

- Introduction to land surveying: definitions, branches and their application. Reconnaissance
- Chain Surveying: Type of tapes, chains, and methods of chain surveying
- Levelling: Reduction of levels, temporary and permanent adjustments of level, precise levelling
- Theodolite: Types, use, and adjustments. Traversing with compass and theodolite. Tachometry with staff and sub tense bar
- Plane Table Surveying: Parts and accessories, Methods of plane table survey, two and three-point problems
- Contouring: Methods and applications
- Area and Volumes: Computation by various methods, cross section and L-section of roads, Layout of buildings and structures

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

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

**Assessment:**

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

**Suggested Books:**

- Anderson, J.M. & Mikhail, E.M. 1997; “Surveying theory and Practice.” McGraw-Hill.
- Kavanagh, B.F. 2001 “Surveying with Construction Application” McGraw-Hill 4th ed.
- Surveying and Levelling by N. N. Basak

- Surveying and Levelling by T.P. Kanetkar& Kulkarni

### **Mechanics of Solids**

#### **Course Outline:**

- Types of stresses and strains, stress-strain behavior of ductile and brittle materials. Statically determinate and indeterminate problems, compound bars. Temperature stresses.
- Bending moment and shear force diagrams for determinate beams for general loading. Principle of superposition, relationship between load, shear force and bending moment.
- Theory of simple bending, distribution of bending and shear stresses in beams of symmetrical sections. Differential equation of beam deflection and deflection of beams using the double integration, Singular Functions moment area and conjugate beam methods. Strain energy due to direct loads, shear and bending. Castiglioni's theorems and their application to find deflections and rotations.
- Combined bending and axial stresses. Columns, types of columns, stability of columns, Euler and other formulae for elastic critical load, eccentrically loaded short columns.
- Torsion of solid and hollow circular sections. Strain energy due to torsion and impact loads.

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

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

#### **Assessment:**

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

#### **Suggested Books:**

- Engineering Mechanics Volume 1 by Mariam J L
- Engineering Mechanics of Composite Materials by Isaac M.

## **Structural Analysis**

### **Course Outline:**

- Introduction to structures and analysis. Types of structures, structural idealization and loads. Redundancy and stability of structures.
- Analysis of Determinate in Jointed Structures: by method of joints, method of sections, method of moment and shears and graphical method.
- Analysis of Statically Determinate Rigid Jointed Plane Frames: Shear force, bending moment and axial force diagrams for these structures.
- Moving Loads: Influence lines for reactions, shear force and bending moment in statically determinate beams and panelled girders, influence lines for member forces in pin jointed frames. Calculation of maximum stress function (reaction, shear bending moment, axial force) in these structures.
- Three Hinged Arches. Cables and Suspension Bridges: Basic considerations in analysis and design. Moving loads on three hinged arches and suspension bridge.
- Moment Distribution Method, Stiffness Method.

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

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

### **Assessment:**

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

### **Suggested Books:**

- Leet & Uang. Fundamentals of Structural Analysis. 2004, 2nd Edition, McGraw-Hill.

## **Geo-Technical Engineering – I**

### **Course Outline:**

#### **Introduction:**

Soil, rock, their types and formation. Physical properties of soil; water content, voids ratio, porosity, degree of saturation, specific gravity, unit weight and their determination, mass-volume relationships.

#### **Soil Classification:**

Importance of classification, classification tests. Atterberg's limit, grain size distribution, Stokes law, classification systems.

#### **Geotechnical Investigation:**

Soil exploration, purpose and methods of soil exploration. Probing, test trenches and pits, auger boring, wash boring, rotary drilling, and geophysical methods, soil samplers, disturbed and undisturbed samples. Introductions to geotechnical report writing.

#### **Permeability and Seepage:**

Darcy's law, factors affecting permeability, capillary and its effects. Seepage force. Introduction to flow net. Estimation of seepage quantity, Quick sand condition, Sand boiling, Filters.

#### **Compaction:**

Fundamentals, moisture-density relationship, compaction standards, factors affecting compaction,

#### **Consolidation:**

Mechanics of consolidation, theory of one dimensional consolidation, assumptions and validity, compression index, co-efficient of compressibility, time factor, coefficient of volume change and degree of consolidation, primary and secondary consolidation. Normal and pre-consolidated soils

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

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

**Assessment:**

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

**Suggested Books:**

- Fundamentals of Soil Mechanics (M. Siddique Qureshi and Aziz Akbar).
- Geotechnical Engineering (Donald P Coduto).
- Soil Mechanics in Engineering Practice (Carl Terzaghi, Ralph B Peck, GholamrezaMesri

### **Pavement Drainage System and Design**

**Course Outline:**

- Planning, design and estimation of drainage system.
- Drainage problems in road sections and its effects.
- Evaluation and analysis of highway drainage system.
- Components of road drainage system.
- Rehabilitation of existing drainage system.
- Sub-surface drainage structures and maintenance
- Sustainable drainage

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

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

**Assessment:**

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

**Suggested Books:**

- Pavement Drainage Theory and Practice by G.L SivaKumar Babu

## **Traffic Engineering – I**

### **Course Outline:**

- Introduction to Traffic Engineering
- Road User and Vehicle Characteristics
- Traffic Data Collection and Reduction Methodologies
- Volume Studies and Characteristics
- Speed, Travel Time, and Delay Studies
- Highway Traffic Safety: Studies, Statistics, and Programs
- Traffic signage and its design
- Road markings, theory and practices
- Concept of Traffic Round about
- Parking studies
- Traffic Calming Techniques
- Conflicts and road accident
- Road Safety audits
- Intelligent Transportation System (ITS)

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

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

### **Assessment:**

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

### **Suggested Books:**

- Traffic Engineering 4th Edition by Roger P. Roess
- Principles of Highway Engineering and Traffic Analysis by Mannering

## **Environmental Engineering**

### **Course Outline:**

- Introduction to the environmental Engineering.
- Water consumption for various purposes, Estimation demands for water supply, variation in demand. Fire demand. Forecasting population.
- Water distribution system.
- Use of Hazen William formula for design purpose.
- Distribution network design service Reservoirs.
- Different types of pipes and pipe material. Pipe joints, service connection, valves and other appurtenances.
- Water survey: tracing leakages.
- Relationship of sewerage and water supply system.
- System sewerage.
- Quantity and quality of sanitary sewage.
- Storm sewage.
- Sewer hydraulics.
- Design of sewer system. Material and construction of sewers. Sewer appurtenances and sewage pumping.
- Air Pollution, Air Pollutants and Meteorological Conditions affecting Air pollution, atmospheric Dispersion Model, Vehicular Air Pollutions.
- Noise Pollution, Sound Power, Sound levels, Sound Intensity, Ambient Noise Standards, Noise Level During Festivals.
- Sampling and Analysis of Air and Water Pollutants,
- Water Pollution Control, Preliminary and Primary Treatment Processes, Biological Treatment, Drinking Water treatment.

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

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

**Assessment:**

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

**Suggested Books:**

- Introduction to Environmental Engineering 5th Edition by Davi & Cornwell, McGraw Hill (2012)
- Water Supply & Sewerage by E.W Steel and McGhee 6th Edition (1991)
- Environmental Engineering Laboratory, by Dr. Khurshid Ahmad
- Waste Water Engineering, Treatment, disposal, Reuse by Metcalf and Eddy, 3rd Edition.(1991)
- Environmental Assessment in Practice by D. Owen Harrop & J. Ashley Nixon (1999).
- Integrated Solid Waste Management by George Techobanogloous, Hilary Theisen & Samuel A. Vigil (1993)
- Elements of public health engineering by K.N Duggal (1983)
- Water and Waste Water Engineering 3rd Edition by Fair & Gayer (2010)
- Water and Wastewater Technology 7th Edition by Mark J, Hammer (2012)

## **Engineering Breadth Courses**

### **Surveying – II**

#### **Course Outline:**

- Introduction to advanced surveying and its application. Triangulation, trilateration, field procedures and application. EDM. Strength of figure, computation and plotting
- Theory of Errors and Weights, quality of observations, weighted observations, distribution and adjustment of errors. Most probable value
- Tunnel Surveying: Use of gyroscope
- Hydrographic Surveying: Horizontal and vertical controls, submarine surface contours. Discharge measurement, reservoir capacity calculation
- Field Astronomy, Solar and stellar observations for position and azimuth determination
- Photogrammetry: Introduction, definition and application of aerial and terrestrial photogrammetry. Mapping. Introduction to Satellite Remote Sensing (SRS)

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

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

#### **Assessment:**

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

#### **Suggested Books:**

- Anderson, J.M. & Mikhail, E.M. 1997; “Surveying Theory and Practice.” McGraw-Hill.
- Allan, A.L. 1997 “Practicals: Surveying and Computations.” Butterworth-Heinemann. Rev. 2nd edition.
- Surveying and Levelling by N. N. Basak
- Surveying and Levelling by T.P. Kanetkar& Kulkarni

## **Plain and Reinforced Concrete**

### **Course Outline:**

- Plain Concrete: Constituent materials of concrete and their properties. Hydration of cement. Properties of fresh and hardened concrete and factors affecting them. Curing of concrete and its significance. Modulus of elasticity of concrete: types, determination and significance. Alkali aggregate reaction, carbonation and sulfate attack. Additives and admixtures for concrete. Cracks in concrete.
- Mechanics of Reinforced Concrete: Basics of composite action of steel and concrete. Stress-strain curves of steel and concrete. Actual, simplified and equivalent stress blocks.
- Behavior of reinforced concrete members including columns, beams and slabs at working and ultimate loads. Specifications, codes of practice and design loads.
- Analysis design and detailing of: Simply supported rectangular and T-beams by ultimate strength design method, simply supported and continuous one way and two-way slabs. Reinforced concrete members for axial compression and tension. Tied and spiral columns. ACI Code provisions for design of columns. Shear and diagonal tension in concrete, design and detailing of flexural members for shear. Corner reinforcement in slabs. Assessment of crack width in flexural members.
- Introduction to alternate method of design with applications.

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

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

### **Assessment:**

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

### **Suggested Books:**

- Plain and Reinforced Concrete by Z. A. Siddiqui
- Design of Concrete Structure by Arthur H. Nilson

## **Harbour and Docks Engineering**

### **Course Outline:**

- Water transportation and sea
- Natural Phenomena: wind, wave and cyclones
- Types of Harbors, Ports and open sea jetty
- Break Water and its design
- General classification, design and construction of Docks
- Dry or Repair Dock
- Lochs
- Channel, Basin and Births
- Appurtenances of a Harbour
- Apron, Transit Sheds and Ware Houses
- Dredging/Dredgers and Disposals
- Navigational Aids
- Shore Protection Works
- Fenders
- Active and passive earth pressure and differential water pressure
- Cofferdams and Caissons

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

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

### **Assessment:**

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

### **Suggested Books:**

- Harbour, Dock and Tunnel Engineering by R. Srinivasan, 29th edition, 2018.
- Dock and Harbour Engineering by Hasmukh P. Oza & Gautam H. Oz, 8th Edition, 2018.

## **Geometric Design**

### **Course Outline:**

- Elements of Highway Cross Section
- Factors Affecting Selection of Highway Route
- Transferring Topographic Data to Computers
- Alignment and Profile of Highways (geometric design)
- Design Controls and Guidelines
- Planning and development (financing, environmental impact, safety)
- Basic Freeway Segments and Multilane Highways
- Two-Lane Highways
- Capacity and level of service
- Elements of Intersection Design and Layout
- Intersection Design Objectives and Considerations
- A Basic Starting Point: Sizing the Intersection
- Signing and Marking for Freeways and The Intersection
- Geometric Design of off-street and onstreet Parkings

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

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

### **Assessment**

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

### **Suggested Books:**

- Geometric Design Projects for Highways: An Introduction (Second Edition) by John Schoon
- Rogers, Martin (2002). Highway engineering. Oxford, UK: Blackwell Science. ISBN 978-0-632-05993-5
- Principle of highway engineering and traffic analysis, 5th edition by Fred L. Mannering

- O'Flaherty, edited by C.A. (2002). Highways the location, design, construction and maintenance of road pavements (4th ed.). Oxford: Butterworth-Heinemann. ISBN 978-0-7506-5090-8.
- Johnston, Ian. "Highway Safety." The Handbook of Highway Engineering. Ed. T.W. Fwa. CRC Press, 2005
- Cheu, R.L. "Highway Geometric Design." The Handbook of Highway Engineering. Ed. T.W. Fwa. CRC Press, 2005.

## Railway Engineering – I

### Course Outline:

- History of Rail
- Rail Resistances
- Railway Gauge
- Railway Ballast
- Rail Fastenings
- Railway Switches
- Rolling Stock
- Station Layout
- Railway Ticketing System
- Railway Signals
- Electric and Magnetic Levitation Trains
- Train Dynamics
- Energy electrification
- Rail systems integration
- Train control systems
- Rolling resistance
- Railway infrastructure, rolling stock and crew management

### Teaching Methodology (Proposed as applicable):

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

## **Assessment**

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

## **Suggested Books:**

- Railway Management and Engineering 4th Edition by Profillidis

## **Geo – Technical Engineering – II**

### **Course Outline:**

#### **Shear Strength:**

Concept, parameters, Coulomb's law, shear strength of cohesive and non-cohesive soils. Factors affecting shear strength of soil and its applications in engineering.

#### **Stress Distribution in Soils:**

Geo-static stresses, Total stress and pore pressure, Effective stress, Vertical stresses induced due to structural loads; Westergaard and Boussinesq's theories. Pressure bulb, Stress distribution diagrams on horizontal and vertical planes. Stress at a point outside the loaded area. Newmark's influence charts, Fadum. Steinnbrenner charts.

#### **Settlement Analysis:**

Definition, total settlement, differential settlement, angular distortion, consolidation settlement, elastic or immediate settlement. Settlement calculations, Primary and secondary consolidation settlements, Immediate settlement of cohesive and non-cohesive soils, Causes of settlements and methods of controlling settlement, Limits of allowable total and differential settlement.

#### **Earth Pressure:**

Definition, pressure at rest, active and passive earth pressures, Coulomb's and Rankin's theories. Trial wedge and Culmann's method. Earth pressure diagrams for different configurations loading.

### **Bearing Capacity of Soils:**

Definition of ultimate and safe bearing capacities, allowable bearing capacity, gross and net bearing capacities, Methods of obtaining bearing capacity: Presumptive values from codes (merits and demerits), From plate load test, Bearing capacity theories,

### **Introduction to Foundation Engineering:**

Design of shallow and Deep Foundations.

### **Slope Stability:**

Types of slopes, Factors affecting stability and remedies. Types of failure Methods of analysis; Swedish circular method; Taylor's slope stability number and Bishop's Methods.

### **Introduction to various Soil Improvement Techniques**

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

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

### **Assessment:**

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

### **Suggested Books:**

- Fundamentals of Soil Mechanics by M Siddique Qureshi and Aziz Akbar
- Fundamentals of Soil Mechanics by M Siddique Qureshi and Aziz Akbar
- Foundation Analysis and Design by Joseph E. Bowls
- Soil Engineering by Merlin G Spangler and Richard L Handy
- Engineering Principles of Ground Modification by Manfred R. Hausmann, McGraw-Hill Inc., USA.
- An Introduction to Geotechnical Engineering by Robert D. Holtz and William, Prentice Hall Inc., New jersey, USA.
- D. Kovacs Foundation Engineering Handbook by Hsai-Yang Fang, CBS Publishers, India.

## **Introduction to Airport Engineering**

### **Course Outline:**

- Introduction to Airport Engineering: Systems Planning, Design, and Management.
- Airport Site Characteristics, Layout of Runways and Taxiways, Design of Passenger Buildings
- Analysis of Environmental Impact sand the Planning for Ground Access to the Airport.
- Air traffic control, Management of Congestion and Queues, Financing, Pricing and Demand Management.
- Geometric and Structural Design of Pavements and Airside. The following will also be studied:
  - Analyze the effect of airport environmental variables on aircraft operations.
  - Estimate the capacity of any airport configuration and understand the influence of weather, aircraft mix, and other operational parameters in capacity.
  - Estimate the delays at an airport given certain supply and demand factors.
  - Estimate the economic benefits and impacts of airports in the community.
- A final presentation is required on the project assigned.

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

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

### **Assessment:**

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

### **Suggested Books:**

- Planning and Design of Airports by Robert Horonjeff and Francis X. McKelvey, Edition: 4th, Publisher: McGraw-Hill.
- Airport Design and Operation by Antonin Kazda and Robert E. Caves, Second Edition, Publisher: Elsevier.
- Published documents: International Civil Aviation Organization (ICAO) and Federal Aviation Administration (FAA)

## **Traffic Engineering – II**

### **Course Outline:**

- Fundamental Concepts for Uninterrupted Flow Facilities
- Basic Freeway Segments and Multilane Highways
- Intersection Channelization
- Basic Principles of Intersection Signalization
- Design: Pre-timed Signals
- Actuated Signals
- Analysis of Signalized Intersections
- Synchronization of traffic signals
- Intelligent Transportation Systems in Support of Traffic Management and Control
- Signal Coordination for Arterials and Networks: Under saturated Conditions
- Signal Coordination for Arterials and Networks: Oversaturated Conditions
- Analysis of Streets in a Multimodal Context
- Planning, Design, and Operation of Streets
- Traffic Impact Analysis
- Microsimulation
- Queuing theory
- Route assignment
- Study of delays and congestions
- Applications of Geomatics Engineering in Transportation

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

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

### **Assessment:**

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

**Suggested Books:**

- Traffic Engineering 4th edition by Roger P. Roess
- Principle of highway engineering and traffic analysis, 5th edition by Fred L. Mannering
- Highway Capacity Manual 2010
- AASHTO Green Book, latest edition

## **Engineering Depth Courses**

### **Pavement Evaluation and Rehabilitation**

#### **Course Outline:**

- Introduction to Pavement evaluation techniques
- Pavement Management system
- Pavement Materials and their characteristics
- Pavement Distresses, identification tools and rating
- Pavement Evaluation
- Pavement Rehabilitation and Maintenance
- Pavement Design and Construction
- Pavement Maintenance Process
- Non-destructive testing, equipment and data analysis
- Introduction to Asset Management; The Challenge of Managing Transportation Assets; Key issues; Related Terminologies;
- Information Management and Decision Support System: Database Management; Data Needs, Analysis and Inventory; Historical and Environmental Data, In-Service Monitoring and Evaluation Data.

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

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

#### **Assessment:**

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

#### **Suggested Books:**

- Principles of Pavement Engineering by ‘Nick Thom’
- Asphalts in Road Construction by Asphalts in Road Construction by Dr ‘Robert. Robert N Hunter’
- Pavement Engineering by ‘Mallick El-Korchi’
- Pavement Analysis and Design by Huang
- Pavement Evaluation by R. Shrinivasa Kumar.

## **Bridge and Tunnel Engineering**

### **Course Outline:**

#### **Bridge**

- Highway and railway bridge structures and components
- Project inception, funding and design standards
- Bridge inspection and site survey
- Geotechnical investigation for bridge structures
- Design loads, internal forces and load distributions
- Design methods and Load rating
- Managing the design process
- Contract documents
- Bridge management systems

#### **Tunnel**

- Definition, purpose and Classification of Tunnels
- Geotechnical Investigation for tunnels, Analysis and Design of tunnels, Alignment of Tunnels Drilling
- Blasting
- Tunneling; Shafts
- Ventilation, lighting and Drainage of Tunnels
- Tunnel Lining
- Safety in Tunnels
- Case Histories

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

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

### **Assessment:**

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

### **Suggested Books:**

- Bridge Engineering 3rd Edition by Jim Zhao

- Roads, Railways, Bridges, Tunnels and Harbour-Dock Engineering by B. L. Gupta and Amit Gupta, 5th Edition.
- Handbook of Tunnel Engineering, First Edition by Bernhard Maidl, Markus Thewes, Ulrich Maidl

## **Railway Engineering – II**

### **Course Outline:**

- Railway Transportation System
- Rail road track design and maintenance
- Railway Construction management
- Rail car and locomotive design and maintenance
- Advance Railway signalling
- Rail road transportation logistics
- Network planning and operations
- Concept of Tramway, Metro and Monorail
- Suburban railway
- Highspeed trains, system and operations
- Railway safety

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

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

### **Assessment:**

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

### **Suggested Books:**

- Railway Transportation Systems: Design, Construction and Operation, Book by Christos N. Pyrgidis
- Railway Engineering: Book by M. M. Agarwal and Satish Chandra
- Practicals: Railway Engineering, Textbook by Clifford F. Bonnett
- Modern Railway Track, Book by Coenraad Esveld

## **Advance Airport Engineering**

### **Course Outline:**

- Geometric and Structural Design of Pavements and Airside.
- Runway Orientation
- Estimate the capacity of any airport configuration and other operational
- Parameters in capacity.
- Ground Access and Parking
- Passenger Terminal Area (configuration, design, operation)
- Aircraft Movement System (capacity analysis and design)
- Ground Service Area Design (Hangers, Apron, Fueling, Baggage)
- Imaginary Surfaces
- Runway Drainage systems and design

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

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

### **Assessment:**

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

### **Suggested Books:**

- Airport Engineering: Planning, Design and Development, 4th Edition Norman Ashford, Saleem Mumayiz and Paul H. Wright.
- Airport Operations 3rd edition, Norman Ashford, Pierre Coutu, John Beasley, ISBN:978-0071775847
- Practical Airport Operations, Safety and Emergency Management by Jeffrey Price, ISBN:978-0128005156

## **Transport Infrastructure, Planning and Management**

### **Course Outline:**

- Communication through road, water, air, and their influence upon national, regional and local development. Historic evolution of cities with parallel evolution of urban transportation networks. Introduction to Transportation Planning.
- Nature and purposes of planning surveys. Basic concept of variables, traits and indicators. Identification of goals and objectives of planning studies. Survey sampling types and methods. Tools for data collections, questionnaires, interview schedule, observation sheet, etc. Techniques for conducting various planning surveys such as land use, socio-economic and housing, health, education, industry, commerce, facility and services.
- Role of public transport in urban development. Basic components of public transport service. Modes of urban passenger transport. Vehicle dimension, vehicle capacities and accommodations. Geometric and right of way characteristics. Public transportation system performance: capacity, productivity, efficiency and utilization. Public transport surveys. Regulations of public transport. General principles of route planning. Route location, stop location. Formation of route, schedules, vehicle and labor schedules. Route evaluation. Control of operations. Fare system and structures. Environmental aspects of urban transport modes. Vehicle operating costs. Measures to assist efficient operation of urban/public transport.
- Transportation Planning Process: Travel Demand Forecasting, including trip generation, trip distribution, and modal split, and network assignment; Evaluation, including environmental impact and economic comparison; Introduction to use of related Computer Software.
- Planning Law: Legislation relating to city and regional planning in Pakistan including various acts, orders, ordinances and bylaws concerning Area Development Schemes, Land Acquisition, Housing, Building Control, Transport, and Environmental Protection. BRT, MRTS, MBA etc.
- Introduction to Transportation planning related softwares like; VIPER, CUBE, TRANPLAN, TRASCAD, SIDRA, TRIPS etc.
- Introduction to Geomatics Engineering: Elementary Surveying and Future Challenges.
- Road Transportation Management using GIS

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

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

**Assessment:**

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

**Suggested Books:**

- Urban Transport Planning by Michael Meyer
- Transportation Engineering and Planning by C.C. Papacostas and P.D. Prevedouros
- Transportation Planning and Traffic Engineering by CAO Flahert
- Engineering Economy by William G. Sullivan Elin, M. Wicks, C. Patrick Koelin.
- Transportation Engineering an Introduction by Khisty and Lal.

**Pavement Design**

**Course Outline:**

- Introduction to pavement
- Pavement design philosophy
- Pavement design methodologies
- Principle of pavement design
- Traffic Loading and Volume.
- Material Characterization.
- Flexible Pavement Design (using different methods)
- Rigid Pavement Design (using different methods)
- Stresses and Strains in Flexible Pavements.
- Stresses and Deflections in Rigid Pavements.
- Mechanistic design of pavement
- Design of Overlays.
- Highway construction Operations

- Flexible pavement construction
- Rigid pavement construction

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

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

### **Assessment:**

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

### **Suggested Books:**

- Pavement Analysis and Design by Huang 2nd Edition
- Principle of Highway Engineering and Traffic Analysis, 5th edition by Fred L. Mannering

## **Port and Harbour Structures**

### **Course Outline:**

- Port planning Layout of ports,
- Design wave height, tide,
- Storm surge and Tsunami,
- Naval hydrographic chart and design of entrance channel and turning circle,
- Types of berthing structures,
- Loads on berthing structures and codal requirements,
- Berthing force, mooring force and seismic force, Load combination, WSD and LSD,
- Analysis of container berth, Analysis of oil jetty,
- Coastal erosion and accretion,
- Design of sea wall and groynes,
- Dry dock, Slipway, Ship lift,
- Modernization of existing ports,
- Case studies on effect of earth quake and Tsunami, Case studies on retrofitting and rehabilitation.

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

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

**Assessment:**

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

**Suggested Books:**

- Port Design - Guidelines and recommendations by C. A. Thoresen, Tapir Publications.
- Design of Marine Facilities for the Berthing, Mooring and Repair of Vessels by J. W. Gaythwaite, Van Nostrand.
- Handbook of Offshore Engineering by S.K. Chakrabarti, Elseviers, 2005.

## **Pipe-way Engineering**

**Course Outline:**

- Introduction to Pipeline Systems
- Geotechnical Investigation for pipeline systems, Hydraulic Design, Mechanical Design
- Operation and Maintenance Design
- Stress Analysis for Pipelines
- Pressure Design of Piping System
- Case studies

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

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

**Assessment:**

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

**Suggested Books:**

- Pipelining Design & Engineering per ASME B 31.4.

**Major Based Core Elective (Depth Electives)**

**Track Renewal, Planning and Drainage**

**Course Outline:**

- Structure of the railway industry
- Planning processes used for railway projects
- Permanent Way
- Railway structures and electrification
- Environmental impact
- Integration of railways in the transport network and future developments
- Purpose of drainage and its elements
- Track drainage systems, types, and materials
- Inspection of drainage systems
- Drainage Design (General requirements, Standards, Key issues, Hydraulic design, Whole life costs)
- Maintenance of drainage systems
- Railway asset management using GIS; GPS –GIS Integrated systems in Transportation Engineering; Various Case studies (i.e. Real Time Freeway Speeds Tracked with GIS; Finding the best route for the buses;
- Developing a Web-Based GIS for Hajj Traffic Plans; Analyzing Pedestrian Movement Using GPS and GIS to Support Space Redesign).

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

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

**Assessment:**

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

**Suggested Books:**

- Railway Management & Engineering 4th edition, by V. Profillidis
- Railway Transport System by Christos N. Pyrgidis
- Railroad Engineering 2nd edition by William W. Hay.

**Airport Geographic Information Systems**

**Course Outline:**

- Introduction to GIS System
- Difference between CAD and GIS
- Geodetic control
- GIS and background to airports GIS
- Data collection and data standards
- Data visualization, Integration and analysis
- Surface analysis
- DFW examples of Flight track analysis
- RFQ, Scoping and statement of work

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

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

**Assessment:**

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

**Suggested Books:**

- Geographic Information Science and Systems 4th edition, by Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind and Wiley.
- Introductory Geographic Information System by John R. Jensen and Ryan R. Jensen

## **Airport Pavement Design, construction and evaluation**

### **Course Outline:**

- Function of airport pavement system
- Soil investigation and evaluation
- Flexible Pavement Design
- Rigid Pavement Design
- Pavement Rehabilitation
- Pavement structural evaluation
- Non Destructive Testing
- Pavement Design for Shoulders

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

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

### **Assessment:**

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

### **Suggested Books:**

- Principles of Pavement design 2nd edition by E.J Yodr M.W
- Design of Concrete Airport Pavement by Robert G. Packard.
- Airport Pavement Design and Evaluation by U.S Department of Transportation Federal Aviation Administration.
- Pavement Analysis and Design by Huang 2nd Edition

## **Multidisciplinary Engineering Courses**

### **Electrical Systems for Transport Infrastructures**

#### **Course Outline:**

- Introduction of electricity, charge, voltage, current, power, energy & battery and its types
- Calculations of power & energy for electrical gadgets & households, simple billing calculations
- Electricity supply: definition & characteristics of AC & DC voltages and their currents and their applications
- Resistors, color coding of resistors and its types. Parallel and series circuit resistors and their numerical problems applications
- Electricity wiring system and safety, importance of electricity safety, shock current, common sources of hazards, safe practice
- RL & RC and RLC circuit AC circuit systems: definition pf phase 1, phase 2, phase 3, circuit system, voltage and current relationship b/w the circuit systems
- Electricity supply: electricity utilities & functional roles. Electricity generation sources, hydropower generation process, transmission process, distribution process to users
- Power factor: definition and relevance, active power, reactive power & apparent power calculation of power factor and connection

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

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

#### **Assessment:**

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

#### **Suggested Books:**

- Basic Electronics by BernadGrob
- Basic Electrical & Electronics Engineering by K Vinoth Kumar

## **Geographical Information System in Transportation Planning**

### **Course Outline:**

- Geographic Information System (GIS): History of Development, Components of GIS, Functional Subsystems of GIS,
- Projections and Coordinate systems: Cartography; Latitude / longitude; Earth models: Ellipsoid / Geoids; Coordinate System; Projections; Datum.
- Remote Sensing: Basics of Remote Sensing; Remote Sensing in GIS.
- Global Positioning System (GPS): Working Mechanism of GPS; GPS Dilution of Precision and its effects on GPS accuracy; Way point and Position fixReal time differential GPS.
- GIS-T Functionality
- Application of GIS in:
  - Pavement management system.
  - Bridge management.
  - Maintenance management.
  - Safety management.
  - Transportation system management (TSM)
  - Travel demand forecasting
  - Corridor preservation and right-of-way
  - Construction management
  - Hazardous cargo routing
  - Overweight/oversize vehicles permit routing.
  - Accident analysis
  - Environment impact
  - Land side economic impact and value-capture analysis and Others.

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

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

### **Assessment:**

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

**Suggested Books:**

- Basics of Geomatics by Mario A. Gomarasca.
- Infrastructure Management by Hudson, Haas, Waheeduddin.
- Introduction to Geographical Information System by Aronoff.
- Transportation GIS by Laura Lang.
- Designing Geodatabases for Transportation by Allison Butler.
- GIS for Urban Environment by Juliana Maantay and John Ziegler.
- Transportation Asset Management Guide, by AASHTO.

**Automotive Engineering**

**Course Outline:**

- Shop Safety
- Environmental and Hazardous Materials
- Fasteners and Thread Repair
- Hand Tools
- Power Tools and Shop Equipment
- Vehicle Lifting and Hoisting
- Measuring Systems and Tools
- Service Information
- Gasoline, Alternative Fuels, and Diesel Fuels
- Diesel Engine Operation and Diagnosis
- Coolant
- Cooling System Operation and Diagnosis
- Engine Oil
- Lubrication System Operation and Diagnosis
- Engine Starting and Charging Systems
- Ignition System Operation and Diagnosis
- Emission Control Devices Operation and Diagnosis
- Turbocharging and Supercharging
- Engine Condition Diagnosis
- In-Vehicle Engine Service
- Engine Removal and Disassembly
- Engine Cleaning and Crack Detection

- Cylinder Head and Valve Guide Service
- Valve and Seat Service
- Camshafts and Valve Trains
- Engine Blocks
- Crankshafts, Balance Shafts, and Bearings
- Gaskets and Sealants
- Balancing and Blueprinting
- Engine Assembly and Dynamometer Testing
- Engine Installation and Break-In

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

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

**Assessment:**

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

**Suggested Books:**

- James D. Halderman, Automotive Engines: Theory and Servicing, 8th Edition
- Thermodynamics an Engineering Approach by Younis A. Cengel & Muchael A. Boles
- Internal Combustion Engine Fundamentals by Jone B. Heywood

**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.

## **12.2 Non-Engineering Domain**

### **Applied Geology**

#### **Course Outline:**

- The fundamentals of general/structural geology, importance of geology for transportation engineers, introduction to engineering geology.
- Engineering properties of geological materials and rocks and their correlation with transportation engineering projects, classification of rock masses, discontinuous of rocks and determination of shear strength of rock discontinuity, Determination of elastic properties of rocks, wave propagation through rocks.
- Geological Subsurface Investigation: Brief introduction of subsurface investigation with respect to geological aspects. Introduction to tectonic plates, causes of earthquake, determination of shear wave modulus, and construction of response spectrum.
- Stability of Rock Slope: various types of rock failures and factors affecting the stability of rock slopes, analysis and calculation of safety factors, causes of landslides and remedial measures.

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

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

#### **Assessment:**

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

#### **Suggested Books:**

- Fundamental of Engineering Geology, 4th Edition, by Tony Waltham
- Principles of Engineering Geology by Gokhale

## **English Courses**

### **Functional English**

#### **Area Scope:**

The knowledge units in this area collectively encompass the following:

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

#### **Course Outlines:**

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

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

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

#### **Assessment:**

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

### **Suggested Books:**

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

### **Communication Skills**

#### **Area Scope:**

The knowledge units in this area collectively encompass the following:

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

#### **Course Outlines:**

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

#### **Writing Skills**

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

#### **Reading Skills**

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

### **Listening Skills**

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

### **Speaking Skills**

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

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

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

### **Assessment:**

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

### **Suggested Books:**

- Anchor in English-II (Lessons 1-5), A SPELT Publication
- Christopher Fry, “Summary Writing (Book-I)”, Oxford University Press
- College Essays by John Langland
- Barron’s TOEFL 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:

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

#### **Course Outline:**

##### **System of Linear Equations and Applications**

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

##### **Vector Spaces and Transformations**

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

## **Eigenvalues and Eigen Vectors**

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

## **Linear Programming**

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

## **Application of Linear Algebra in Dynamical Systems**

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

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

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

### **Assessment:**

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

### **Suggested Books:**

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

## **Calculus and Analytical Geometry**

### **Area Scope:**

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

### **Course Outline:**

#### **Analytical Geometry:**

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

#### **Functions Limit and Continuity:**

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

#### **Differentiation:**

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

#### **Applications of Derivatives:**

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

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

### **Integration:**

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

### **Applications of Integration:**

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

### **Improper Integrals:**

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

### **Infinite Sequence and Series:**

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

### **Power and Taylor Series:**

- Power series
- Maclaurin and Taylor Series and its Applications

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

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

### **Assessment:**

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

### **Suggested Books:**

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

## **Differential Equations**

### **Area Scope:**

The knowledge units in this area collectively encompass the following:

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

### **Course Outline:**

#### **Basic Concepts and Modeling**

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

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

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

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

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

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

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

### **Series Solution for Second-order ODEs**

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

### **Laplace Transform**

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

### **Partial Differential Equations**

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

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

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

### **Assessment:**

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

### **Suggested Books:**

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

## **Numerical Analysis**

### **Area Scope:**

The knowledge units in this area collectively encompass the following:

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

### **Course Outline**

#### **Error Analysis and Interpolation**

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

Interpolation versus least square approximation, Relevant engineering case studies

### **Numerical Differentiation and Integration**

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

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

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

### **Iterative Methods for Linear and Nonlinear Equations**

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

### **Numerical Methods for IVPs and BVPs**

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

## **Numerical Methods for Computing Eigenvalues**

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

## **Numerical Optimization**

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

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

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

### **Assessment:**

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

### **Suggested Books:**

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

## **Probability & Statistics**

### **Area Scope:**

The knowledge units in this area collectively encompass the following:

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

### **Course Outline**

#### **Basic Statistics**

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

#### **Data Presentation**

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

#### **Measure of Central Tendency**

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

#### **Measure of Dispersion**

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

## **Simple Regression, Correlation and Curve Fitting**

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

## **Probability and Random Variables**

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

## **Probability Distributions**

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

## **Sampling and Sampling Distributions**

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

## **Statistical Inference and Testing of Hypothesis**

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

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

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

**Assessment:**

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

**Suggested Books:**

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

## **Complex Variables & Transforms**

**Area Scope:**

The knowledge units in this area collectively encompass the following:

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

### **Course Outline**

**Introduction:**

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

### **Complex Differentiation and Integration:**

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

### **Power Series:**

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

### **Laplace Transformation:**

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

### **Special functions and Fourier Transforms:**

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

### **Z-Transformation:**

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

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

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

### **Assessment:**

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

**Suggested Books:**

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

**Multivariate Calculus**

**Area Scope:**

The knowledge units in this area collectively encompass the following:

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

**Course Outline:**

**Geometry of Space:**

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

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

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

**Partial Differentiation:**

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

### **Applications of Partial Derivatives:**

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

### **Multiple Integrals:**

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

### **Vectors in 3 Space:**

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

### **Integration in Vector Fields:**

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

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

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

### **Assessment:**

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

### **Suggested Book:**

- 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, Rotational inertia of solid bodies.

#### **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. Line and Surface Integrals with applications, Simple Harmonic Oscillator, Damped Harmonic Oscillation, Forced Oscillation.

#### **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, X-rays and Moseley's Law, Atomic Nucleus and Properties of Nucleus, Radioactive Decay and Radioactive Dating.

**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:

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

**Course Outline:**

- Basic organic and in-organic chemistry (at least two chapters)
- Composition of Bitumen (SARA)
- Hydrogen and carbon compounds
- Asphalt chemistry and performance
- Rheology of asphalt

- Aging of asphalt (adhesion and moisture damage)
- Asphalt modifications (Polymers/rubber, additives, emulsion foamed bitumen, etc.)
- Effects of different metals on bitumen chemistry
- Bitumen manufacturing

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

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

**Assessment:**

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

**Suggested Books:**

- Chemistry: The Molecular science, Olmsted and William (1994)
- Applied Chemistry: A textbook for Engineers and Technologists by Roussak and Gesser (2013)
- Chemistry, The Molecular Nature of Matter and Change with Advanced Topics Martin S. Silberberg and Patricia G. Amateis, McGraw-Hill Education, 8th Edition (2017)
- Environmental Chemistry, Colin Baird and Michael Cann, 3rd Edition (2005)
- General Chemistry, Kenneth W. Whitten et al. 6th Edition (2000)
- Chemistry, The Central Science, Theodore L. Brown et al. 13th Edition (2014)
- Water Chemistry, Stanley E. Manahan, CRC Press (2011)
- General Chemistry by Donald A. McQuarrie et al , 4th ed. 2011

## **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 & their interface with Engineering Project/services, Sociology & Impact of Technology & Engineering Products/Projects on Society.

#### **Cultural Impacts of Engineering Projects on Society**

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

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

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

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

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

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

- Extent to which development intends to sensitize societal and under-privileged needs
- Gender inclusiveness and balance
- Special and Disadvantaged Community of the Area
- Planning for community inclusiveness
- Societal Obligation of Engineers

### **Engineers, Society and Sustainability**

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

### **Industrial & Organizational Psychology**

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

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

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

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

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

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

**SIA (Social Impact Assessment):**

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

**Engineering Intervention for Social Stratification.**

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

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

**Teaching Learning Approaches:**

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

**Assessment:**

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

**Suggested Books:**

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

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

## Sociology

### **Area Scope:**

The knowledge units in this area collectively encompass the following:

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

- To develop the confidence and competence of the students as learners and to assist them in taking some responsibility for their own learning through directed study and reading.

### **Course Outline:**

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

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

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

**Assessment:**

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

**Suggested Books:**

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

**Engineering Economics**

**Area Scope:**

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

**Course Outline:**

**Engineering Economics**

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

**Interest Rate and Economic Equivalence**

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

## **Understanding Money and Its Management**

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

## **Present-Worth Analysis**

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

## **Annual Equivalent-Worth Analysis**

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

## **Rate-of-Return Analysis**

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

## **Cost Concepts Relevant to Decision Making**

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

## **Depreciation and Corporate Taxes**

- Asset Depreciation: Economic versus Accounting

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

### **Developing Project Cash Flows**

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

### **Project Risk and Uncertainty**

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

### **Special Topics in Engineering Economics**

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

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

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

### **Assessment:**

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

### **Suggested Books:**

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

## **Social Psychology**

### **Area Scope:**

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

### **Course Outline:**

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

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

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

### **Assessment:**

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

### **Suggested Books:**

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

## **Community Services**

### **Area Scope:**

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

### **Course Outline:**

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

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

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

**Assessment:**

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

**Suggested Books:**

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

## **Organizational Behavior**

**Course Outline:**

**Introduction to Organizational Behavior**

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

**Structure and Control in Organization**

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

**Individual and Work Learning**

- Learning Theories
- Learning and Work

## **Stress**

- Types of Stress and Work
- Occupational Stress Management

## **Individual Differences**

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

## **Motivation and Job Satisfaction**

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

## **Group and Work**

- Social Interaction
- Dramaturgy and impression Management
- Social Skill

## **Group and Inter group Behavior**

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

## **Leadership**

- Leadership as an attribute
- Leadership Style

## **Patterns of Work**

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

## **Organizational Culture**

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

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

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

## **Assessment:**

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

## **Suggested Books:**

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

## **Professional Ethics**

### **Area Scope:**

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

### **Course Outline:**

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

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

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

### **Assessment:**

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

**Suggested Books:**

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

## **Cultural Courses**

### **Islamic Studies and Ethics**

#### **Course Description:**

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

#### **Area Scope:**

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

#### **Course Outline:**

##### **Islam – Religion of Peace and Harmony**

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

##### **Islamic Culture and Civilization**

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

##### **Social System of Islam**

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

- Social Rights – Neighbors, Relatives and Society
- Equality and Brotherhood
  - 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 Verses 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 (selected text).
- Sayyid Tāhir Rasūl Qādri دروس قرآن 52 (Karachi: Islamic Research Academy, 7<sup>th</sup> 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، تبیر القرآن (Lahore: Farān Publications, 2005).
- Khawaja Abdul Waheed، موضوعات قرآن و انسانی زندگی (Islamabad: Islamic Research Institute, 3<sup>rd</sup> ed., 1997).
- Khurram Murad, رب کا پیغام (Lahore: Manshūrat, Mansoora, 2000)
- Hameed ullah Muhammad, “Emergence of Islam”, Islamic Research Institute (IRI), Islamabad
- Hameed ullah Muhammad, “Muslim Conduct of State” Sh Muhammad Ashraf, Kashmir Bazar, India (Latest Edition)
- Hameed ullah Muhammad, “Introduction to Islam” Compiled by The CSS Point, [www.thecsspoint.com](http://www.thecsspoint.com)
- Hussain Hamid Hassan, “An Introduction to the Study of Islamic Law” leaf Publication Islamabad, Pakistan, (Latest Edition).
- H.S. Bhatia, “Studies in Islamic Law, Religion and Society” Deep & Deep Publications New Delhi (1989).
- Islamic Education by A. S. Bukhari & M. D Zafar, Latest Edition.
- Muslim’s character by M. Al-Ghazali, Latest Edition.

## **Pakistan Studies and Global Perspective**

### **Area Scope:**

The knowledge units in this area collectively encompass the following:

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

### **Course Outline:**

**Time Duration**

#### **Historical and Ideological Perspective**

**5 hrs**

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

#### **Constitution of Pakistan**

**4 hrs**

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

#### **Contemporary Pakistan**

**4 hrs**

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

<b>Economy of Pakistan</b>	<b>4 hrs</b>
a. An overview of Economy	
b. Services, Manufacturing and Agricultural Profile of Pakistan	
c. Regional Economic Cooperation	
d. One Belt One Road (OBOR) – CPEC	
<b>Land of Opportunities</b>	<b>4 hrs</b>
a. Physical features: diversity and beauty	
b. Natural resources - mineral, water, energy, agriculture & livestock, and marine resources	
c. Tourism and Culture	
<b>Pakistan's Foreign Policy</b>	<b>5 hrs</b>
a. Foreign Policy – Principles and Objectives	
b. Relations with Neighbors	
c. Major Economies	
d. Muslim World	
e. Geo-political and strategic significance of Pakistan in Regional and Global Politics	
<b>Pakistan in pursuit of Global Agenda</b>	<b>4 hrs</b>
a. SDGs-2030 - Pakistan Goals	
b. Commitments on Climate Change	
c. Peace and Security	

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

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

**Assessment:**

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

**Suggested Books:**

- Khalid B. Sayeed, Pakistan: The Formative Phase 1857 – 1948, Pakistan Publishing House, 1960
- Gulam Allana, Quaid-e-Azam: the story of Pakistan, Ferozsons, 1967.
- Shahid M. Amin, Pakistan's Foreign Policy: A Reappraisal, Oxford University Press, 2010.
- S. Akbar Zaidi, Issues in Pakistan's economy, Oxford University Press, 2003.
- Hamid Khan, Constitutional & political history of Pakistan, Oxford University Press, 2003
- Rafi Raza, *Pakistan in Perspective 1947-1997*, Oxford University Press, 2003
- Sharif-ul-Mujahid, *The Ideology of Pakistan*, Progressive Publishers, 1974.
- Ziring Lawrence, *Pakistan in the Twentieth Century*, Oxford University Press, 1997 -
- Burke S. M. & Ziring Lawrence, *Pakistan's Foreign Policy*, Oxford University Press, 1973. Mohammad Qadeer , Pakistan
- Climate Change Policies-Ministry of Climate Change, Islamabad-  
<http://mocc.gov.pk/>
- Sustainable Development Goals (SDGs)- [www.pc.gov.web/sdg/sdgpak](http://www.pc.gov.web/sdg/sdgpak)
- Economic Survey of Pakistan- [http://finance.gov.pk/survey\\_1617.html](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](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:**

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

#### **Course Outline:**

#### **Project Management Concepts**

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

#### **Project Proposal Development**

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

## **Project Feasibility**

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

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

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

## **Project Contract & Procurement Management**

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

## **Project Planning and Scheduling**

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

## **Project Costing & Estimation**

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

## **Project HRM & Communication Management**

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

## **Project Risk Management**

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

## **Computer Application in Project Management**

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

## **Project Quality Management**

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

## **Project Closure & Termination**

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

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

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

### **Assessment:**

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

### **Suggested Books:**

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

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

## **Entrepreneurship**

### **Area Scope:**

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

### **Course Outlines:**

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

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

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

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

**Assessment:**

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

**Suggested Books:**

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

## **Principles of Management**

### **Area Scope**

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

### **Course Contents:**

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

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

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

### **Assessment:**

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

### **Suggested Books:**

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

## **Engineering Management**

### **Course Outlines**

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

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

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

### **Assessment:**

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

### **Suggested Books:**

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





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

