

Curriculum for

Agricultural Engineering

Bachelor of Engineering Program

2020



Pakistan Engineering Council
&
Higher Education Commission
Islamabad





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PREFACE

The curriculum, with varying definitions, is said to be a plan of teaching-learning process that students of an academic program are required to undergo. The curriculum design is a critical component and backbone of the educational structure for any nation. It includes objectives and learning outcomes, course contents, scheme of studies, teaching methodologies and methods of learning assessment. In the advent of fast technological advancements and emergence of new disciplines; it requires 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 existing curricula after every three to five years 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 PEC Act 1976 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 following Outcome-Based Education (OBE) System. PEC has therefore constituted an Engineering Curriculum Review and Development Committee (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, in consultation with all relevant stakeholders. 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 level stakeholders and industrial consultation workshops by engaging HEIs, industry, technical and consulting organizations. The experts’ feedback and suggestions were translated into the curriculum review process taking into consideration the dynamics of technological advancement, industrial needs and management-cum-soft skills for engineering graduates.

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

1. Engineering Curriculum Review & Development Committee (ECRDC)

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

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

8.	Engr Muhammad Raza Chohan Director General, HEC	Member
9.	Engr Dr Nasir Mahmood Khan Additional Registrar (Accreditation), PEC	Member
10.	Engr Dr Ashfaq Ahmed Sheikh, Additional Registrar, CPD	Secretary

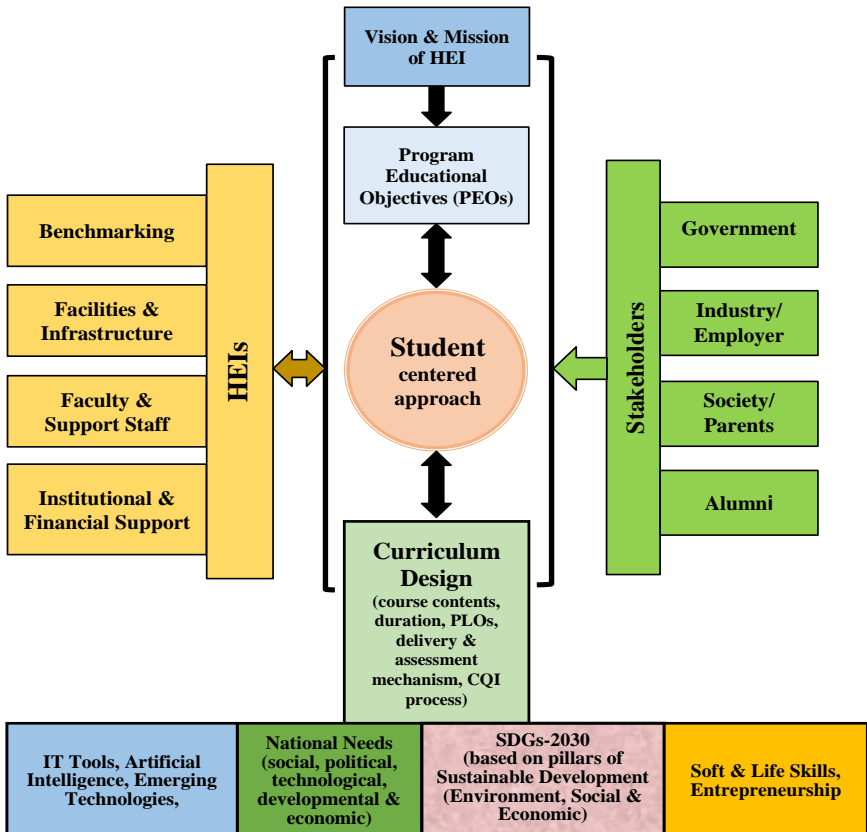
2. ECRDC Agenda

- The ECRDC is responsible for overseeing 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. Outcome Based Education (OBE) - Curriculum Development Framework

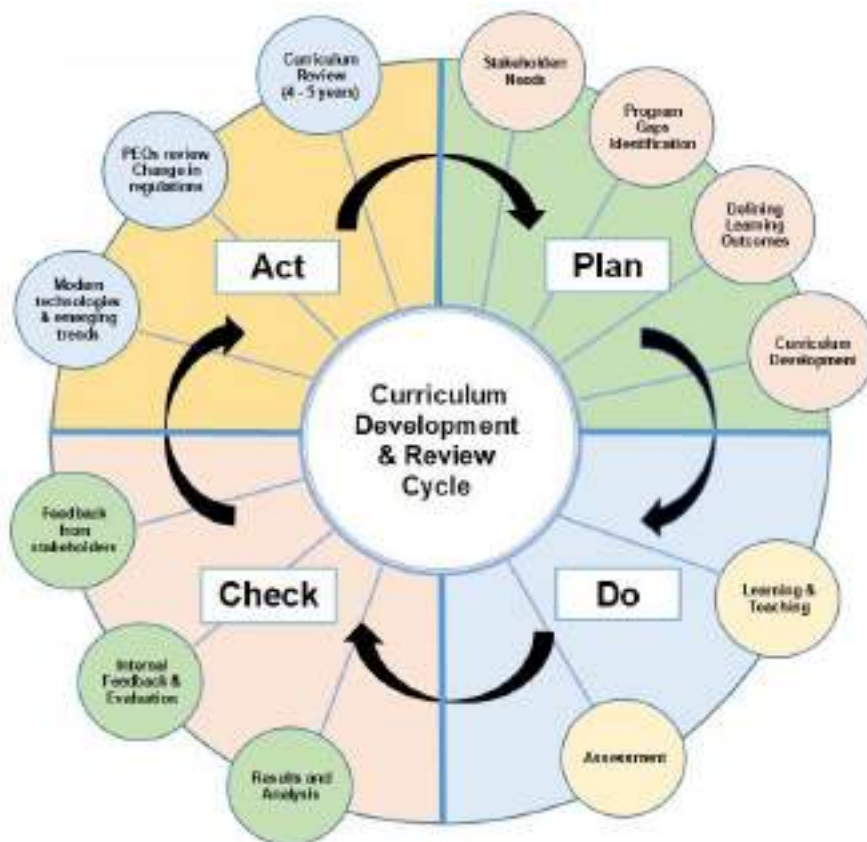
Outcome Based Education (OBE) is an approach of teaching and learning that focuses on what students should be able to attain at the end of the educational program. OBE is a student-centered system which concerns what the students would know and be able to do as learning outcomes. The curriculum development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

Outcome-Based Education (OBE) - Curriculum Development Framework



4. PDCA Approach to Curriculum Design and Development

The process of curriculum design and development constitutes various interconnected elements with the objective of achieving the intended purpose of the program. The Plan-Do-Check-Act approach (PDCA) as explained below has been followed in the curriculum development and review process.



Plan. This stage begins with an analysis of the stakeholders' needs of faculty, current and past students, employers and society in general. The stakeholders' needs are translated into human resource terminology i.e. graduate competencies which in turn translated into educational taxonomy i.e. learning outcomes. Based on the learning outcomes, curriculum is designed backward to meet them.

Do. The plan stage is implemented where curriculum is delivered and learning outcomes are assessed to gauge the achievement of them.

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 Agricultural, Food & Allied Engineering Disciplines

The PEC Engineering Curriculum Review and Development Committee (ECRDC) of Agricultural, Food and Allied Engineering Disciplines took up the task to review and update the curriculum for Bachelor of Agricultural Engineering degree program. The Subject Committee held three meetings on 8-8-2019, 4-10-2019 and 19-12-2019 at PEC Headquarters Islamabad besides one meeting of Deans from all major HEIs (having the same program) at the University of Agriculture, Faisalabad from 22-23 November, 2019. The Committee comprised of the following members:

- | | | |
|---|--|----------|
| 1 | Engr Dr Muhammad Ashraf
Chairman
Pakistan Council of Research in Water Resources, Islamabad | Convener |
| 2 | Engr Dr. Allah Bakhsh
Prof. Dean, Faculty of Agri. Engg & Technology
University of Agricultural, Faisalabad | Member |
| 3 | Engr. Prof. Dr. Khalil Ahmed Ibupoto
Dean Faculty of Agri Engg Sindh
Agri University Tando Adam Sindh | Member |
| 4 | Engr Prof. Dr. Taj Ali Khan
Department of Agricultural Engineering
Faculty of Civil, Agricultural and Mining Engineering
University of Engineering & Technology, Peshawar | Member |

5	Engr Prof. Dr. Daulat Khan Vice Principal Gandhara Institute of Science and Technology, Peshawar	Member
6	Engr. Dr Zahid Mahmood Khan Prof & Chairman Department of Agricultural Engineering Bahauddin Zakriya University, Multan	Member
7	Engr Dr. Nadeem Amjad Former Chairman Pakistan Agricultural Research Council, Islamabad	Member
8	Engr Qamar Mahmood Deputy General Manager Marketing Millat Tractors Ltd, Lahore	Member
9	Engr Dr. Khawaja Altaf Hussain Associate Professor (R)/Visiting Faculty as Subject Expert University of Agriculture, Faisalabad	Member
10	Engr. Muhammad Tahir Director Environment Protection Department, Lahore	Member
11	Engr Dr. Ghulam Nabi Associate Professor Center of Excellence in Water Resource Engineering (CEWRE), Engineering University, Lahore	Member
12	Engr Dr Muhammad Nawaz Bhutta Consultant/ Former Director General, IWASRI, Lahore	Member
13	Engr Dr Muhammad Azam Khan Chairman, Department of Farm Machinery and Power Faculty of Agricultural Engineering and Technology, University of Agriculture, Faisalabad	Member

14	Engr Dr Ghani Akbar Program Leader Integrated Watershed Management Program NARC/PARC, Islamabad	Member
15	Engr Dr Muhamad Yasin Faculty of Agricultural Engineering & Technology University of Arid Agriculture, Rawalpindi	Member
16	Engr Dr Maazullah Khan Principal Engineer Nuclear Institute for Food & Agriculture (NIFA), Peshawar	Member
17	Mr Hidayatullah Kasi Deputy Director Higher Education Commission, Islamabad	HEC Representative
18	Engr. Dr. Abdul Ghafoor Assistant Professor Department of Farm Machinery and Power Faculty of Agricultural Engineering and Technology, University of Agriculture, Faisalabad	Special Invitee
19	Engr Dr Muhammad Usman Lecturer Faculty of Agricultural Engineering & Technology University of Arid Agriculture, Rawalpindi	Special Invitee
20	Engr. Dr. Ashfaq Ahmad Sheikh Additional Registrar-CPD Pakistan Engineering Council, Islamabad	Secretary
21	Engr. Muhammad Kashif Ali Assistant Registrar CPD Pakistan Engineering Council, Islamabad	AR-CPD

6. Agenda of ECRDC for Agricultural, Food & Allied Engineering Disciplines

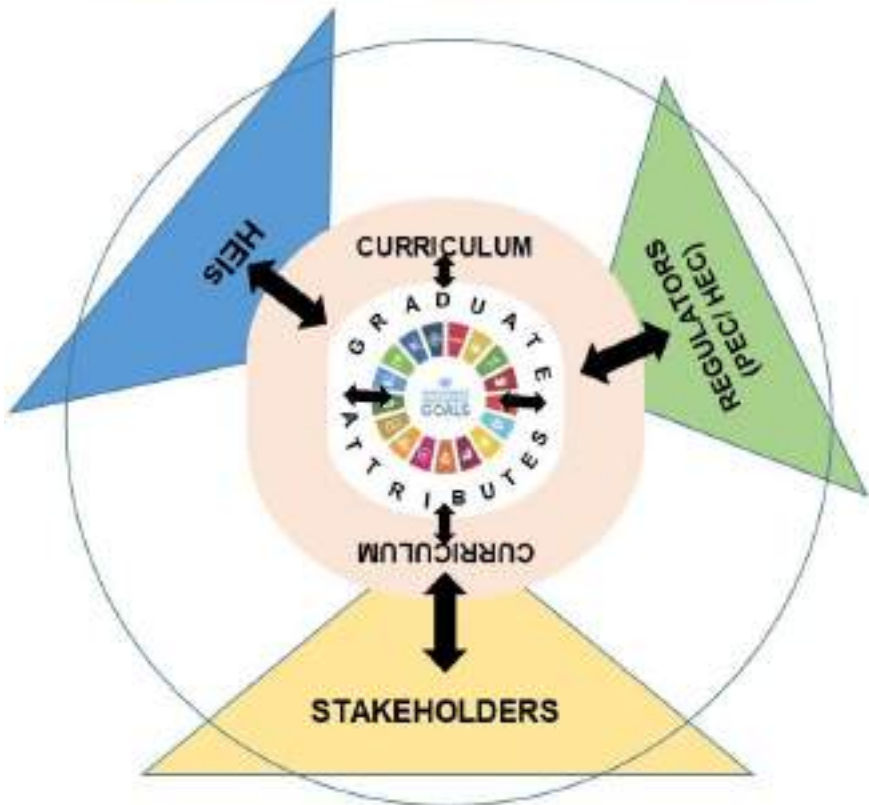
- The Subject ECRDC will work under the overall directions and supervision of main ECRDC, comprising of all Conveners
- The key driving lines for the development of engineering curriculum for each discipline will be the overall policy of Pakistan Engineering Council in connection with international commitments (Washington Accord, IPEA etc.) and Government policies
- Review of policies and stakeholders' feedback relating to the 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. Muhammad Ashraf, 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 apprised that the Committee comprising professionals and experts from academia, industry and R&D institutions, has provided useful input and suggestions covering new developments to be incorporated in the curriculum. He also highlighted the importance of the field of Agricultural Engineering for achieving sustainable water, energy, and food needs while addressing socio-economic issues and challenges envisaged in Sustainable Development Goals (SDGs) as under and well-mapped within the curriculum;

- Goal-1: No Poverty
- Goal-2: Zero Hunger
- Goal-3: Good Health and Well-being
- Goal-4: Quality Education
- Goal-5: Gender Equality
- Goal-6: Clean Water and Sanitation
- Goal-7: Affordable and Clean Energy
- 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 should be 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 Agricultural Engineering Program. The HEIs should have their own program objectives (PEOs) and PLOs 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 agricultural 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-6, Goal-7, Goal-8, Goal-9, Goal-12, and Goal-13.

After graduation, the Agricultural Engineers are expected to;

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

7.2 Program Learning Outcomes (PLOs)

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

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

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

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

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

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

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

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

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

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

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

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

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

8. Program Salient Features

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

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

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

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

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

- WK2 - Mathematics and Computing:** The concept-based mathematical thinking, numerical analysis, statistics and formal aspects of computer and information science to support analysis and modeling applicable to the discipline.
- WK3 - Engineering Fundamentals:** A systematic, theory-based formulation of engineering fundamentals required in an engineering discipline.
- WK4 - Engineering Specialization:** The knowledge of engineering specialization that provides theoretical frameworks and bodies of knowledge for the accepted practice areas that are at the forefront in a discipline.
- WK5 - Engineering Design:** The Design Thinking Knowledge that supports engineering design in a practice area of an engineering discipline.
- WK6 - Engineering Practice:** The Knowledge of engineering practices (technology) in different practice areas of an engineering discipline.
- WK7 - Engineering in Society:** A systematic, comprehension-based knowledge of the role of engineers in a society and the professional issues related to practicing engineering profession in a discipline: ethics and the professional responsibility of an engineer to public safety including the impact of an engineering activity i.e. economic, social, cultural, environmental and sustainability
- WK8 - Research Literature:** Engagement with selected knowledge in the research literature of the discipline.

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

Knowledge Profile (WK-1 to WK-8)*	Knowledge Area	Sub-Area	Courses	Credit Hours
Non-Engineering Domain				
WK-2	Natural Science	Math	As per program requirements	12 - 15
WK-1		Physics	Applied Physics	6 - 9
		Chemistry	Applied Chemistry	
		Natural Science/ Math Elective	As per program requirements	
WK-7	Humanities	English	language, communication, writing skills	4 - 7
		Culture	Islamic Studies and Ethics	2
			Pakistan Studies and Global Perspective	2
		Social Science	social and Soft skills	2 - 6
	Management Sciences	Professional Practice	Professional and Project Management	2 - 6
Total (Non-Engineering Domain)				min 30
Engineering Domain				
WK-2/ WK-4/ WK-5/ WK-6	Computer Science	ICT/AI/ Data Science/ Cyber Security		6 - 9
WK-3/ WK-2	Foundation Engg Courses		Specific to Program objectives and outcomes	22 – 24
WK-4/ WK-2/ WK-1	Core Breadth of Engg discipline		Specific to Program objectives and outcomes	23 – 24

WK-5/ WK-6	Core Depth of Engg Discipline		Specific to Program objectives and outcomes	22 – 24
WK-1/ WK-2/ WK-3/ WK-4	Multi- disciplinary Engg Courses		Specific to Program objectives and outcomes	6 – 12
			Occupational Health and Safety (Mandatory – 01 Cr Hr)	
WK-6/ WK-7/ WK-8	Final Year Design Project (FYDP)/ Capstone	Integration of innovative, creative, technical, management and presentation skills of a graduate towards final year.		6
WK-6/ WK-7	Industrial Training	at least 6 - 8 weeks mandatory internship		Qualifying
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	Innovative and Critical Thinking (under relevant courses): - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open Ended Labs - Problem Based Learning (PBL)			
Total (Engineering domain)				min 85
Total (Credit Hours)				130 – 136

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

- **Industrial Training:** Internship of at least 6 - 8 weeks is mandatory part of degree requirements towards 3rd to 4th year of program; must be supervised, monitored, evaluated, and reflected in the transcripts under a prescribed mechanism and with defined and mapped rubrics with program objectives;
 - Selection of internship in line with elective subjects/ specific streams
 - Qualifying weightage:

At least 75% attendance is mandatory	70%
Assessment report from the employer	10%
Evaluation at relevant HEIs/ Deptt – presentation	50%
	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 Agricultural 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 Agricultural Engineering

Knowledge Profile	Knowledge Area	Sub-Area	Course Title	Theory	Lab	Total
				Credit Hours		
Non-Engineering Domain						
WK-7	Humanities	English	Functional English	2	0	2
			Communication Skills	2	0	2
			Technical Writing and Presentation Skills	2	0	2
		Culture	Islamic Studies and Ethics	2	0	2
			Pakistan Studies and Global Perspective	2	0	2
		Social Science	Elective-I (Professional Ethics/ Sociology for Engineers/ Society and Development)	2	0	2
			Elective-II (Economics for Engineers)	2	0	2
	Management Sciences	Professional Practice	Elective-I (Engg Project Management/ Engg Management)	2	0	2
			Elective-II (Entrepreneurship)	2	0	2
WK-2	Natural Sciences	Mathematics	Calculus and Analytical Geometry	3	0	3
			Linear Algebra	3	0	3
			Differential Equations	3	0	3
			Probability and Statistics	3	0	3
			Numerical Analysis	2	0	2
WK-1		Physics	Applied Physics	2	1	3
		Chemistry	Industrial Chemistry	1	1	2
		Agri. Sciences	Basic Agriculture	1	1	2
			Soil Science	2	1	3
Total (Non-Engineering Domain)				38	4	42

Engineering Domain						
WK-2/ WK-4/ WK-5/ WK-6	Computer and Information Science	ICT/ AI/ Data Sciences/ Cyber Security	Information and Communication Technologies (ICT)	2	1	3
			Artificial Intelligence (AI)	1	1	2
WK-3/ WK-2	Engineering Foundation		Engg Mechanics	2	1	3
			Engg Drawing & Graphics	1	1	2
			Metallurgy and Workshop Practices	1	1	2
			Engineering Materials	1	1	2
			Applied Thermodynamics	2	1	3
			Fluid Mechanics	2	1	3
			Surveying and Leveling	2	1	3
			Instrumentation and Control	2	1	3
WK-4/ WK-2/ WK-1	Core Breadth of Engg discipline		Soil Mechanics	2	1	3
			Strength of Materials	2	1	3
			Engineering Hydrology	2	1	3
			Earth Moving Machinery	1	1	2
			Solid Waste Management	2	1	3
			GIS and Remote Sensing	1	1	2
			Agricultural Process Engineering	2	1	3
			Manufacturing Engineering	1	1	2
			Rural Electrification	1	1	2
			Environmental Engineering	2	1	3
			Engg Elective-I	1	1	2
WK-5/ WK-6	Core Depth of Engg discipline		Machine Design	2	1	3
			Farm Machinery and Automation	2	1	3

			Open Channel Hydraulics	2	1	3
			Pumps and Tubewells	1	1	2
			Irrigation Engineering	2	1	3
			Drainage Engineering	2	1	3
			IC Engines and Tractors	2	1	3
			Farm Structures and Control Sheds	2	1	3
			Engg Elective-II	2	1	3
			Engg Elective-III	2	1	3
WK-3/ WK-4/ WK-2/ WK-1	Multi-disciplinary engineering courses (MDE)		MDE-I (Wastewater Engineering)	2	1	3
			MDE-II (Alternate and Renewable Energy(ARE))	1	1	2
			Occupational Health and Safety (Mandatory)	1	0	1
WK-6/ WK-7/ WK-8	Final Year Design Project (FYDP)/ Capstone	Industrial/ Innovative/ Creative Project	FYDP (Part-I)	0	3	3
			FYDP (Part-II)	0	3	3
WK-6/ WK-7	Industrial Training	At least 6 -8 weeks Mandatory Internship		0	0	0
WK-2/ WK-4/ WK-5/ WK-6/ WK-7/ WK-8	Innovative and Critical Thinking (under relevant courses) - Complex Problem Solving - Complex Engineering Activities - Semester Project - Case Studies - Open Ended Labs - Problem-Based Learning (PBL)					
Total (Engineering domain)				55	39	94
Total (Credit Hours)				93	43	136

10. Scheme of Study for Bachelor of Agricultural Engineering

Year-1					
First Semester					
S No.	Title	Cr. Hr.	Theory	Lab	Total
1	Applied Physics	3(2-1)	2	1	3
2	Calculus and Analytical Geometry	3(3-0)	3	0	3
3	Information and Communication Technologies (ICT)	3(2-1)	2	1	3
4	Engineering Drawing & Graphics	2(1-1)	1	1	2
5	Functional English	2(2-0)	2	0	2
6	Basic Agriculture	2(1-1)	1	1	2
7	Islamic Studies and Ethics	2(2-0)	2	0	2
Total			13	4	17
Second Semester					
1	Fluid Mechanics	3(2-1)	2	1	3
2	Linear Algebra	3(3-0)	3	0	3
3	Communication Skills	2(2-0)	2	0	2
4	Surveying and Leveling	3(2-1)	2	1	3
5	Metallurgy and Workshop Practices	2(1-1)	1	1	2
6	Industrial Chemistry	2(1-1)	1	1	2
7	Engineering Materials	2(1-1)	1	1	2
Total			12	5	17
Year-2					
Third Semester					
1	Pakistan Studies and Global Perspective	2(2-0)	2	0	2
2	Strength of Materials	3(2-1)	2	1	3
3	Applied Thermodynamics	3(2-1)	2	1	3
4	Engineering Mechanics	3(2-1)	2	1	3
5	Manufacturing Engineering	2(1-1)	1	1	2
6	Soil Science	3(2-1)	2	1	3
Total			11	5	16

Curriculum of Agricultural Engineering

Fourth Semester					
1	Soil Mechanics	3(2-1)	2	1	3
2	Artificial Intelligence (AI)	2(1-1)	1	1	2
3	Environmental Engineering	3(2-1)	2	1	3
4	Machine Design	3(2-1)	2	1	3
5	Differential Equations	3(3-0)	3	0	3
6	Instrumentation and Control	3(2-1)	2	1	3
Total			12	5	17
Year-3					
Fifth Semester					
1	Probability and statistics	3(3-0)	3	0	3
2	IC Engines and Tractors	3(2-1)	2	1	3
3	Social Sci Elective-I (Sociology for Engineers)	2(2-0)	2	0	2
4	Open Channel Hydraulics	3(2-1)	2	1	3
5	Numerical Analysis	2(2-0)	2	0	2
6	Pumps and Tubewells	2(1-1)	1	1	2
7	Technical Writing and Presentation Skills	2(2-0)	2	0	2
Total			14	3	17
Sixth Semester					
1	Engineering Hydrology	3(2-1)	2	1	3
2	Earth Moving Machinery	2(1-1)	1	1	2
3	MDE Elective-I (Wastewater Engineering)	3(2-1)	2	1	3
4	Social Sci Elective-II (Economics for Engineers)	2(2-0)	2	0	2
5	Irrigation Engineering	3(2-1)	2	1	3
6	Rural Electrification	2(1-1)	1	1	2
7	Management Elective-I (Project Management/ Engg Management)	2(2-0)	2	0	2
Total			12	5	17
Year-4					
Seventh Semester					
1	Solid Waste Engineering	3(2-1)	2	1	3

2	Agricultural Process Engineering	3(2-1)	2	1	3
3	GIS & Remote Sensing	2(1-1)	1	1	2
4	Farm Machinery and Automation	3(2-1)	2	1	3
5	Engg Elective-I	2(1-1)	1	1	2
6	Management Elective-II (Entrepreneurship)	2(2-0)	2	0	2
7	Final Year Design Project (FYDP)-I	3(0-3)	0	3	3
Total			10	8	18
Eighth Semester					
1	Farm Structures and Control Sheds	3(2-1)	2	1	3
2	Drainage Engineering	3(2-1)	2	1	3
3	MDE Elective-II (Alternate and Renewable Energy(ARE))	2(1-1)	1	1	2
4	Engg. Elective-II	3(2-1)	2	1	3
5	Engg. Elective-III	3(2-1)	2	1	3
6	Final Year Design Project (FYDP) -II	3(0-3)	0	3	3
Total			9	8	17
Total (Credit Hours)			93	43	136

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

Courses for Engineering Elective Streams

Water Resources Engineering

- Farm Irrigation Systems (ID)
- Farm Water Management (ID)
- Groundwater Hydrology (Elective ID)
- Soil Dynamics (Elective ID)
- Water Resources Assessment and Management (ID)
- Soil and Water Conservation (ID)

Farm Machinery and Power

- Boiler Engineering and Power Plants (FMP)
- Energy in Agriculture (FMP)
- Agro-Industrial Engineering (FMP)
- Precision Agriculture (FMP)
- Robotics in Agriculture (FMP)
- Design of Agricultural Machinery (FMP)
- Post-Harvest Technologies (FMP/SEE)
- Hydraulic Machinery and Automation
- Emerging Farm Engineering Systems (FMP)
- Electronics Engineering (FMP)

Farm Structures and Environment

- EIA and EMS for Industries (SEE)
- Sustainable Environment (Elective SEE)
- Environmental Modeling and Simulation (SEE)
- Environmental Impact Assessment (SEE)
- Cleaner Production Techniques (Elective SEE)
- Landscape Engineering (SEE)
- Quantity Survey and Cost Estimation (SEE)

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
- Computer Programming
- Modeling and Simulation

11. Program Specific Labs

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

- Soil Mechanics Lab
- Fluid Mechanics Lab
- Strength of Materials Lab
- Irrigation and Drainage Engineering Lab
- Farm Machinery Lab
- Machine Shop
- Thermodynamics and Energy Lab
- I.C. Engines Lab
- Instrumentation Lab
- High Efficiency CAD/CAM Lab
- Environmental Engineering Lab
- Surveying and leveling Lab
- Computer and GIS Lab
- Engineering Drawing Hall
- Engineering Mechanics Lab
- Final Year Project Exhibition Hall

12. Course Details and Teaching-Assessment Approaches

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

12.1 Engineering Domain

Information and Computer 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 Projects, Guest Speaker, Industrial/ Field Visits, Group discussion, Report Writing

Assessment:

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

Suggested Books:

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

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

Computer Programming

Course Outline:

- Introduction to Programming and languages
- Algorithms, Flowcharts and pseudocode
- Overview of programming (C, C+, Python)
- Writing, compiling and debugging
- Coding style
- Statements
- Variables and data types
- Operators and expressions
- Selection
- Relational operators
- Conditional Statements

- Conditional operators
- Switch, break, continue
- Logical operators
- Modular programming
- Structures in functions and Arrays
- File pointers
- Error handling
- Revision
- Project Demos

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Paul J. Deitel and Harvey M. Deitel, C: How to Program, Prentice Hall, 2010.
- The C Programming Language (2nd Ed.) by Kernighan and Ritchie, 1988.
- Code Complete (2nd Ed.) by Steve McConnell, 2004.
- The Art of Computer Programming (TAOCP) by Donald E. Knuth, 1968.

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 2017 and AutoCAD LT 2017 by George Omura with Brian Benton, (latest edition), 2016.
- AutoCAD® 2015 And AutoCAD Lt® 2015 No Experience required by Donnie Gladfelder.

Introduction to Modeling and Simulation

Course Outline:

Simulation

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

- Simulation Guidelines & Best Practices

Modeling

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

Tools/ Software Requirement

- Matlab

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Engineering Foundation Courses

Engineering Mechanics

Course Outline:

Introduction:

- Concept of measurement of mass, force, time and space,
- Systems of units, Fundamentals and Derived units, Conversion of units, required
- Accuracy of results, General Principles of Statics

Force Systems - FBD

- Vector addition, Subtraction and Products,
- Resultant of Distributed (Linear and Non-linear) force Systems
- Equilibrium: General conditions of equilibrium of Co-planer forces, Laws of Triangle, Parallelogram and Polygon of forces

Distributed Forces

- Types of beams, Supports and Loads,
- Simple cases of Axial forces, Shear forces and Bending Moment diagrams

Friction

- Problem involving friction on Flat surfaces,
- Geometrical Properties of Plane Areas

Work and Energy: Work, Energy and Power

- Impulse and Momentum: Impulse,
- Momentum, Conservation of Momentum and Energy

Kinematics of Particles

- Rectilinear and Curvilinear motions,
- Tangential and Normal Components of Acceleration, Simple Harmonic motion

Dynamics Analysis of components/System

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:

- Singer, F.L. 2000. Engineering Mechanics. Harper and Row Publishers, New York.
- Meriam, J.L. and L.G. Kraige. 1993. Engineering Mechanics. Vol.I Statics. John Willy and Sons, New York.
- Higdon, A. and W.B. Stile. 1986. Statics and Dynamics. Prentice-Hall, Inc. Englewood Cliffs, N. J., USA.
- Riley, W. and Struges, C.d. 1996. Engineering Mechanics, Statics and Dynamites, John Wiley and Sons Inc., New York.
- Bedford, A. and Fowler, W., 1994 Engineering Mechanics: Statics and Dynamics, Addison-Wesley Publishing Company. New York.
- McGill. D.J. and King, W.W., 1994 Engineering Mechanics: Statics and Dynamics, PWS publishing Co., New York.

Engineering Drawing and Graphics

Course Outline:

- Introduction to engineering drawing, various types of lines,
- Basic geometrical constructions, conic sections,
- Theory of orthographic projection, dimensioning and lettering,
- Introduction to tolerance,
- Projections off points, projections of straight lines,
- Projections of planes and solids in simple position, sectioning of solids,
- Isometric projections, development of surfaces

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:

- French, T. E. and Vierch, C. J. (2000). A Manual of Engineering Drawing. McGraw Hill Book Co. New York.
- Parkinson A.C. 1998. A First year Engineering Drawing, Sir Isaac Pitman and Sons Ltd., England.
- James, H. Earle. 1992. Engineering Design Graphics, Addison-Wisley Publishing Co. Reading, Massachusetts.

Engineering Materials

Course Outline:

Introduction and Classification of Materials

Stones:

- Classification and characteristics of good building stones.
- Tests of stones. Quarrying and dressing of stones.
- Artificial stones and its varieties, preservation of stone work.

Tiles and Bricks:

- Different kinds of tiles.
- Manufacturing and uses of tiles.
- Coloring and glazing of tiles.
- Fire tiles and bricks kiln (traditional and zigzag technology).
- Qualities of good bricks. Refractory bricks and ceramics.

Lime and Cement:

- Classification of lime. Properties and applications of lime.
- Types of cement. Manufacturing process of cement.
- Determination of initial and final setting time. Normal consistency.

Concrete and Mortars:

- Aggregates for concrete and mortars.
- Types of concrete. Water-cement ratio. Workability of concrete. Compaction and curing of concrete. Types and uses of mortars. Tests for mortars.
- Timber: Classification of trees, growth of timber trees.
- Methods of seasoning and sawing. Decay and preservation of timber, laminated materials.

Metals: Composition and Properties of Ferrous and Non-Ferrous Metals

- Methods of corrosion control, comparison of construction materials strength.

Paints

- Plasters and Varnishes
- Composition, preparation, properties, tests and uses of paints, plasters, varnishes and distemper.

Miscellaneous Materials:

- Composition, varieties, properties and uses of glass, plastics, Laminates and adhesive. Properties and uses of asphalt, rubber and asbestos.

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:

- Haider, S.Z. 1985 Materials of Construction (2nd edition), Oxford University Press, Pakistan
- Surendra S. 1990 Engineering Materials. Vikas Publishing House (Pvt.) Ltd. 5 Ansari Road, New Delhi 110002
- Kulkarni, G.J. 1980. Text Book of Engineering Materials. Union Book Stall, M.A Jinnah Road, Karachi.
- Zaman, M.A. 1987. A Text Book of Engineering Materials.

Surveying and Leveling

Course Outlines:

Introduction to Surveying and Leveling

Surveying Instruments:

- Chains, Tapes, Steel Bands, their Types and Uses
- Chain Surveying: Ranging and chaining of survey Lines.
- Fieldwork and plotting of chain survey.

Compass Surveying:

Prismatic Compass and Surveyor Compass, Uses, Bearing, Local Attraction, Fieldwork and Plotting

- Plane Table Surveying:
- Parts and Accessories,
- Methods of Surveying, Two Point and Three Point Problems

Leveling: General Principle

- Types of Levels and their temporary and Permanent
- Adjustments, Methods of Leveling, Reduction of Level, Precise Leveling and Trigonometric Leveling

Theodolite:

Types and uses of Theodolites, Temporary and Permanent Adjustments, Measurement of Horizontal and Vertical angles

Tachometric Surveying:

Methods of Tachometric Surveying.

- Fieldwork and computations.
- Traversing: Traversing with Prismatic Compass, Theodolite and Plane Table,
- Computations and Adjustments of Traverse, Transformation of Co-ordinates
- Calculation of Areas and Volumes: Earth work calculation, D.M.D method, Simpson rule and Trapezoidal rule

Total Station and GPS

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:

- Brinker, A.C. and Taylor, W.C. 2002. Elementary Surveying. International Text Book Co. Scranton, Pennsylvania, USA.
- Ramsay, J.P. Wilson. 2000. Land Surveying. Macdonald and Evans Ltd. Estover, Plymouth PL 6 7PZ.
- Clark, David. 1989. Plane and Geodetic Surveying for Engineers Vol. I. Constable and Co. Ltd. London, England.

Fluid Mechanics

Course Outline:

Introduction:

- Definition and branches of fluid mechanics,
- Distinction between solid and fluids.

Properties of Fluids:

- Density, viscosity, surface tension, specific weight, specific gravity, etc.,
- Bulk modules of elasticity, compressibility of fluids

Fluid Statics:

- Pressure variations in fluid, pressure measuring devices, gauges and manometers,
- Buoyancy and stability of submerged and floating bodies,
- Forces on plane and curved surfaces, center of pressure.

Fluid Kinematics:

- Continuity Equation
- Types of flow, dimensions of flow, streamlines, path lines,
- Flow patterns for different references, continuity equation,
- Source flow, sink flow, flow nets, uses and limitations of flownet.

Fluid Flow Measurements:

- Orifices, weirs, notches and venturi meter,
- Pitot tube, coefficient of contraction,
- Velocity and discharge, derivation of their discharge formulae,
- Calibration and their applications.

Energy Consideration in Steady Flow:

- General equations of steady flow, heads,
- Bernoulli's equation and its practical applications,
- Hydraulic and energy grade lines, power consideration in fluid flow,
- Cavitation, head losses, solution of flow problems.

Momentum and Forces in Fluid Flow:

- Impulse-momentum principle and application,
- Force exerted on a stationary and moving bodies (flat and curved),
- Relation between absolute and relative velocities, reaction of jet, jet propulsion

Similitude and Dimensional Analysis:

- Geometric, kinematic, dynamic similarity,
- Dimensionless numbers like Reynold Number,
- Froude number etc., and their application,

Steady Incompressible Flow in Pressure Conduits:

- Laminar and turbulent flow in circular pipes,
- Major and minor energy losses in pipes,
- Branching pipes, pipes in series, pipes in parallel and pipe network analysis

Turbines:

- Types of turbines, suitability of turbines,
- Components of turbines,

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:

- Cengel, Y.A., and J. Cimbala, 2013. Fluid Mechanics Fundamentals and Applications, 3rd Edition, ISBN-13: 978-0073380322
- Frank White, 2016. Fluid Mechanics, 8th edition, McGraw-Hill Series
- Franzini, J.B., and E.J. Finnemore. 2001. Fluid Mechanics with Engineering Application, 10th Edition, McGraw Hill Book Co. Singapore.

- Jain, A.K. 1990. Fluid Mechanics: A Text Book for Engineering Students. Khana Publishers, New Delhi, India.
- Streeter, V.L. 1988. Fluid Mechanics. McGraw Hill Inc., New York.

Applied Thermodynamics

Course Outlines:

Heating and Expansion of Gases:

- Units of heat, gases and vapors, constant volume and constant pressure,
- P-V diagram, specific heat of gases, internal energy of gas,

Laws of Perfect Gases:

- Law of conservation of energy, methods of heating and expanding gases and vapors,
- Heating of gases work done by gas in expanding
- Equations for different types of heating methods

Laws of Thermodynamics:

- Derivation of laws
- Practical applications of thermodynamics laws

Air Cycles:

- Cycles of operation, air standard efficiency of a cycle,
- Reversible process, reversible cycles, reversibility and efficiency,
- Carnot cycle, Otto cycle, diesel cycle,

Entropy of Gases:

- Entropy and heat, T-S diagrams,
- Carnot, Otto, diesel and dual combustion cycles on T-S diagrams

Air Compressors:

- Compressor functions and types,
- Reciprocating and rotary compressors,
- Single and multistage compressors,
- Cylinder clearance, work done, compressor efficiency

Compound Expansion:

- Advantages of compound expansion, tandem type of two-cylinder compound engine
- Receiver type compound engine; combined indicator diagram for compound engine
- Calculations for cylinder uniflow engine.

Refrigeration:

- Definition and principle
- Coefficient of performance, units of refrigeration, air compression refrigeration
- Vapor compression refrigeration, refrigeration cycles
- Quality of refrigerant and general considerations
- Heat pumps and components

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:

- Li, K., 2018. Applied thermodynamics: availability method and energy conversion. Routledge.
- Rajpot, R.K. 2015. Applied Thermodynamics. 2 edition, Jain Book Agency, New Delhi, India
- Nag. 2013. Engineering Thermodynamics. 5 Edition, Jain Book Agency, New Delhi, India.
- Khurmi, R.S. and J.K. Gupta. 2000. Thermal Engineering. S. Chand and Co. Ltd., New Delhi, India.
- Sontagg, R.E. and G.J. Van Wylen. 2003. Fundamentals of thermodynamics. 6 Ed, John Willey and Sons, Inc. New York, USA.

- Jones, J.B. and Hawkais, G.A. 2002. Engineering Thermodynamics. John Willey and Sons, Inc. N.Y., USA.
- Lewitt E. H. 2002. Thermodynamics applied to heat engines, Issac Pitman and Sons, London
- Eastop, T.D. 2004. Applied thermodynamics for engineering and technologists. 5th Ed. Pearson Education Singapore.

Metallurgy & Workshop Practices

Course Outlines:

Introduction

- Define the safety rules for workshop practices
- Identify the different tools available in the workshops (screw drivers, pliers, spanners, hammers and chisels etc.)
- Production and properties of common engineering materials
- Properties of ferrous metals and non-ferrous metals
- Manufacturing processes of Iron and steel

Non-metallic Materials

- Composition, properties and usage
- Plastics and rubber,
- Fiber glass and composite materials

Alloy Steel and Irons

- Effect of alloying elements,
- AISI/SAE alloy steel and their identification,
- Corrosion resistant steel, steel for high temperature services,
- Alloy steel.

Non-ferrous Metals

- Properties and usage
- Copper, aluminium, zinc, tin, nickel, and lead.
- Non- ferrous alloys, copper alloys. Aluminium alloys,
- Zinc base alloys, nickel base alloys.
- Lead-tin alloys, iron-carbon equilibrium diagram

Heat Treatment

- Heat treatment theory and process
- Heat treatment of steel
- Heat treatment equipment

Foundry

- Definition, importance, advantages and disadvantages of foundry,
- Casting, hand moulding tools, characteristics of moulding sand, foundry cores,
- Properties of core and, crucibles, handling and care,
- Copula furnace, construction, zone of copula and its advantages.

Welding

- Definition, types of welding process,
- Survey of welding equipment.
- Arc welding; welding materials
- Inspection and testing of welded joints.
- Gas welding

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:

- John, K.C. 2011. Mechanical Workshop Practice. PHI Learning Pvt. Ltd.
- Sharma, S. 2010. Manufacturing Processes. I.K. International Publishing House, New Delhi, India.
- Abbaschian, R., Abbaschian, L., and R.E. Reed-Hill, 2009. Physical Metallurgy Principles. 4th Ed. Cengage Learning, USA.
- Chapman, W.A.J. 2004. Workshop Technology Part-I and II. Viva Books Private Ltd., India.

- Ostwald, P.H. and J. Munoz. 2002. Manufacturing Processes and Systems, 9th Ed. John Wiley and Sons, New York. USA.

Instrumentation and Controls

Course Outline:

Introduction

- Basic terminologies, concepts related to instruments
- Instrument behavior application of instrumentation,

Functional Elements of Instruments

- Error of instrument, uncertainty analysis,
- Least square techniques, static and dynamic characteristics of instrumentation
- Signal conditioning and recording devices

Principles and Theory of Electrical Instruments

- Potentiometer, wheat stone bridge
- Strain analysis; strain measurement; strain gauges, types and their applications

Displacement, Velocity and Acceleration Measurement

- Sensors and transducers, displacement measurement sensors; potentiometer,
- LVDT, capacitance sensors, piezoelectric sensors.
- Velocity and acceleration sensors Force and Torque

Force Measurements

- Load cells, Torque measurements
- Torque cells.

Pressure Measurement

- Gauge, vacuum and absolute pressure
- Pressure measuring devices

Measurement of Temperature

- Resistance thermometer
- Thermocouples and radiation methods

Fundamentals of Mechatronics

- Introduction to electronics and sensors used in agricultural machinery
- Interfacing the machine and computers for response
- Controls and data logging
- Computer simulation of mechanical system

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Mahalik, N. P. 2003. Mechatronics, principles, concepts and applications. Tata McGraw-Hill, New Delhi, India
- Necsulescu, D. S. 2002. Mechatronics, Prentice Hall Inc., N.J., USA.
- Figliola, R. S. and D. E. Beasley. 3 Ed. 2004. Theory and design for Mechanical measurements. John Wiley and Sons (Asia) Pte, Inc. Singapore
- Dally, J. W., W. F. Riley and K. G. McConnel. 2003. Instrumentation for engineering measurements, 2 ed. John Wiley and Sons, Inc. Singapore
- Shetty, D. and R. A. Kolk. 2001. Mechatronics system design. Vikas Publishing House, Pvt, Ltd. New Delhi, India.

Breadth Engineering Courses

Strength of Materials

Course Outline:

Stress and Strains:

- Stress at a point, components of stress,
- Analysis of plane stress, principle stresses,
- Maximum shear stress, Mohr's circle.

Axial loading:

- Stress due to axial forces, strain,
- Properties of material under axial loading.

Bending and Torsion: Bending stresses in beams, shear and bending moment diagrams.

- Combined loading: Stresses due to axial, bending and torsional loading.
- Deflection: Moment-curvature relationship, deflection of beams by the method of double integration.
- Deflection of beams: Double integration method with singularity function, area moment method, Torsion: Shearing stress and angle of twist, hollow and circular shafts.

Buckling: Pin ended column, eccentrically loaded column, initially curved column, critical loads and critical stresses.

Curved Beams: Stresses in curved bars. Cylinders and spheres: Stresses in thin and thick walled cylinders.

Fatigue loading: Analysis and design.

Software applications

SAP 2000

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:

- Andrew Pytel, Ferdinand L. Singer. Strength of Materials
- Sarkar B.K. 2006. Strength of Materials, Tata McGraw-Hill Publishing Pvt. Ltd. New Delhi
- Muvdi, B.B. and J.W. McNabb. 2001. Engineering Mechanics of Materials. MacMillan Publishing Co. New York.

Solid Waste Management

Course Outline:

Solid Waste

- Sources and types of wastes
- Composition and generation rates
- Bio-chemical properties of Wastes
- Some typical wastes
- Identification of various agricultural wastes

Integrated Solid Waste Management

- Solid waste in history
 - Economics in Solid waste
 - Legislation and regulation
- Materials flow
 - Segregation
 - Reduction
 - Reuse
 - Recycling
 - Recovery
 - Disposal
 - Energy conversion
- Need of integrated solid waste management
- Municipal solid waste characteristics

Recycling and Management

- Recycling of wastes
- Recycling of plastics, batteries
- e-waste
- By products of cereals, legumes, oilseeds, fruits and vegetables
- Crop, livestock and aquatic waste utilization in various industries
- Fermentation of by-products and waste
- Furnaces and boilers run on agricultural wastes and by-products
- Green House Gas emission and emission modeling
- Generation of electricity using surplus biomass/energy recovery

Solid Waste Management Strategies

- Study and operation of equipment used for size reduction
- Mechanical-biological treatment
- Digesting and processing of wastes and by-products
- Study and operation of equipment/machines used for utilizing various wastes
- Composting
- Incineration
- Study of techniques for bio-gas production utilizing plant and animal waste
- Land-filling
- Utilization of agricultural wastes for production of manure and animal feed

Landfill

- Planning, siting and permitting of landfills
- Landfill processes
- Landfill design
- Landfill processes

Processing of Municipal Solid Waste (MSW)

- Refuse physical characteristics
- Storing of MSW
- Conveying

- Compacting
- Shredding
- Pulping, roll crushing and granulating

Material Separation

- Screens
- Float Separators
- Magnet and electrochemical separators
- Materials separation systems

Combustion and Energy Recovery

- Heat value of refuse
 - Ultimate analysis
 - Compositional analysis
 - Proximate analysis
 - Calorimetry
- Materials and thermal balances
- Combustion hardware used for MSW
- Undesirable effects of combustion

Biochemical Processes

- Methane generation by anaerobic digestion
- Composting
- Other biochemical processes

Current Issues in Solid Waste Management

- Life cycle analysis and management
- Flow control
- Financing solid waste facilities
 - Calculating annual cost
 - Calculating percent worth
 - Calculating sinking funds
 - Calculating capital plus O&M cost
 - Comparing alternatives
- Hazardous material

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:

- Worrell, W.A. and Vesilind, P.A., 2011. Solid waste engineering. Cengage Learning.
- Gottinger, H.W., 2018. Economic models and applications of solid waste management. Routledge.
- Worrell, W.A., Vesilind, P.A. and Ludwig, C., 2016. Solid waste engineering: a global perspective. Nelson Education.

Soil Mechanics

Course outlines:

Soil Formation:

- Soil and its Constituents,
- Weathering of Rocks and Types of Soils,
- Description and identification of soil (Visual-Manual Procedure),
- Mineralogy of Solids.

Physical Properties:

- Water Content, Void Ratio, Porosity, Degree of Saturation, Specific Gravity,
- Unit Weight and their determination,
- Atterburg's limits,

Classification of Soils:

- Sieve Analysis,
- Hydrometer and Pipette Analysis, Stoke's Law, Grain Size distribution.

- Grain Size Classification;
- Bureau of Soils, M.I.T. Unified, AASHTO and ASTM Classification systems.
- Textural Classification by Triangular Chart, Unified Soil Classification,
- AASHTO Soil Classifications.

Soil Stability Analysis:

- Retaining Walls, Definition, purpose and classification,
- Forces acting on earth retaining structures.
- Lateral earth pressure.

Compaction:

- Purpose and theory of Compaction,
- Moisture Content and Dry Density relationship,
- Standard Proctor Compaction Test, Modified Proctor Compaction Test,
- Degree of Compaction and its determination in the
- Field Methods of compaction in the field;
- Factors affecting compaction of soils.

Soil Permeability and Seepage:

- Darcy's law, Hydraulic conductivity
- Laboratory determination of Hydraulic Conductivity,
- Directional variation of permeability
- Equivalence hydraulic conductivity
- Continuity equation for solution of simple flow problems
- Flow nets and seepage calculation from flownet
- Seepage through and earthen dam on an impervious base

Vertical Stresses in Soils:

- Definition, Stresses caused by self-weight of soil,
- Geostatic stresses, stresses caused by Point Loads and Uniformly Distributed Loads:
- Boussinesq and Westergarrd theories,
- Pressure bulb, Stress distribution diagram on horizontal and vertical,
- Stress at a point outside loaded area, Newmark's charts and 2:1 Method.

Bearing Capacity of Soil:

- Definition of bearing capacity.
- Factors affecting bearing capacity,
- Classification of foundations.
- Stability requirements of a foundation.

Soil Exploration:

- Importance of Soil Exploration,
- Soil Exploration methods,
- Probing, Test Trenches and Pits,
- Auger boring, wash boring, rotary boring,
- dewatering
- Percussion drilling and Geophysical methods, Sol Samples, Disturbed and Un-disturbed samples, In-situ Tests (SPT, CPT and PLT).

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:

- Budhu, M. 2015. Soil Mechanics Fundamentals. John Wiley and Sons Ltd. United Kingdom.
- Das, B.M, and K. Sobhan, 2017, Principles of Geotechnical Engineering. Eighth Edition, SI, Cengage Learning, 200 First Stamford Place, Suite 400, Stamford, CT06902, USA
- Duncan, J.M. 2014. Soil Strength and Slope Stability. 2ndEdition, John Wiley and Sons, Hoboken, New Jersey.
- Jumikis, A.R. 1994. Soil Mechanics, D. Van Nostrand Company Inc., Princeton, New Jersey.
- Terzaghi, K. 1997. Soil Mechanics in Engineering Practice. John Wiley and Sons, New York.

Environmental Engineering

Course Outline:

- **Introduction:** basics definition of environment, Pollutants and their classification,
- Environmental Regulation and standards, EPA Act, NEQS, WHO Standards,
- **Water Environment:** Water/Wastewater Pollutants, Water Quality Standards, Agriculture and Water Environment Pollution, Dissolved Oxygen Sag, River Water Quality Management, Unit operations/processes for Pre-treatment, Preliminary, Primary, Secondary and Tertiary Treatments.
- **Solid Waste:** Agricultural and Municipal Solid Wastes (SW) Management; SW Categories, Composition and Characteristics (Physical, Chemical, Biological), 4R Integrated SW Management- Reduce, Recover, Reuse & Recycle, Physical, Chemical and Bio Processing of SW, Composting, Incineration, Landfilling, other techniques for safe disposal and reuse of SW.
- **Soil Contamination:** Soil Degradation and Soil, Biological Indicators of Soil Quality – Soil Respiration Rates, Physical Indicators of Soil Quality, Chemical Indicators of Soil Quality, Physical Soil Degradation, Soil Erosion, Soil Compaction, Soil Crusting and Sealing, Chemical Soil Degradation, Acidification, Salinization and Sodification, Major Types of Soil Pollutants, Heavy Metals and Their Salts, Heavy Metals and the Soil System, Transport of Heavy Metals within the Soil System, Bioavailability of Heavy Metals, Biochemical Effects of Heavy Metals, Major Environmental Accidents Involving Pollution by Heavy Metals, Other Inorganic Pollutants, Radionuclides, Speciation and Behavior of Radionuclides in the Soil System, Uptake of Radionuclides by Plants, Nuclear Debris from Weapon Tests and Belligerent Activities, Nuclear Debris from Major Nuclear Accidents (please reduce)
- **Air Pollution:** Smog, smoke, dust etc., environment system analysis
- **Monitoring and Assessment:** IEE and EIA, Instrumentation, Report formats

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:

- Davis, Mackenzie. Masten, Susan. 2004. Principles of Environmental Engineering and Science, MacGraw Hill International NY USA
- Mckenzie L. David A. Cornwell 1991. A text book of "Introduction to Environmental Engg"
- Ibrahim A. M. (2008). Soil Pollution: Origin, Monitoring and Remediation, 2nd Edition, Springer-Verlag Berlin Heidelberg
- Basak, N. N. 2003. Environmental Engineering
- Kumar, A. 2004. Industrial Pollution and Management
- Neelima R. and D.K. Markandey. 2005. Environmental Analysis and Instrumentation
- Vesilind, P.A. J.J. Peirce and R.T. Weiner. 1990. Environmental Pollution and Control Butterworth-Heinemann, London
- Techobenoglous, G. Hilary Theisen and Samuel Vigil, 1995, Integrated Solid Waste Management, McGraw Hill International NY
- Khan, I.H. and Ahsan, N. 2003. Textbook of Solid Waste Management. CBS Publishers & Diatributors, Darya Ganj N Delhi. 110002 India.
- Shuller, M. L. 1980. The Utilization and Recycle of Agricultural Wastes and Residues. CRC Press Inc. 2000 Corporate Blvd. N.W. Boca Raton Florida USA.

Rural Electrification

Course Outline:

- **Type of Electricity Production:** (Solar, Biogas, Biomass, Hydel, Wind, Fossil Fuels)
- **Benefits of Electricity in Agriculture:** elementary transmissions and distribution, transformation voltage; basic principles, ratio of transformation, iron and copper losses; regulation, auto-transformers, 3-phase transformers, delta star connections, scot connection, constructional features and cooling of transformers
- **Electrical Wiring Practices:** farmstead and farm houses
- **Radiation:** types of radiation and application in agriculture; Resistance heating: unit's advantages and applications.
- **Sensing Elements and Fundamentals of Control:** response to environmental factor like temperature, pressure, humidity, radiation etc.
- **Selection of Motors:** single and three phase; Selection of electrical wires and distribution types; Electrical wiring, electrical distribution systems, electrical panel boards, one-way and two-way wirings/connections, single phase and three phase connections.
- **Electricity Fundamentals:** Nature of electric current, resistance and voltage, effect of temperature on resistance, specific resistance, Ohm's Law, units of power, arrangements of resistor in series and parallel, Kirchhoff's Laws.
- **Electric Machines:**
- **DC Machines:** DC generator, working principle, construction and types. DC motors, working principle, construction and types.
- **AC Machines:** AC generators (Alternators), working principle and construction. AC motors operating principles, single and three phase motors, various types of motors.
- **Transformers:** Working principle, construction and types. EMF equation, ratio of transformation.
- **Electric Instruments:** Introduction to electric instruments, types and application of different electric instruments (Potential-meter, strain gauges, electric transducers).
- **Farmstead Distribution System:** Electric load, types of distribution centers, locating the distribution center, selection of wire for feeder lines.

- **Electricity for Water Supply and Cooling:** Horsepower required for pumping, wiring devices and control, energy cost of water system, refrigeration cycle and refrigeration Control, calculating the product load and space load.
- **Electricity for Heating:** Advantages and disadvantages of electric heating, electric heating elements, electric heating equipment, under heat brooders, infrared brooders, and electric hot bed.
- **Electrical Control and Special Equipment:** Switches, relays, push buttons, thermostats, time switches, floating switches, pressure switches, milk cooler, electric fences and feed processing equipment.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, 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:

- Farm electrical equipment handbook. 1950. Electrical institute. New York City USA.
- Hienton, T. 1958. Electricity in agricultural engineering. John Willey and Sons. N.Y USA.
- Bhagat, R. P. 1993. Rural Electrification and Development, ISBN: 8171004997 Deep and Deep Publications Pvt. Ltd. India.
- Theraja, B. L. (2000). A Textbook of Electrical Technology, 21st Ed., Publication Division of Nirja Const. and Development Co., Pvt. Ltd., Ram Nagar-India.
- Golding, E.W. and F.C. Widdis. (1990). Electric Measurements and measuring instruments, 5th edition. The English Language Book Society and Pitman Publishers.
- Brown, R. H. (1956). Farm Electrification. McGraw Hill Book Co. New York.
- Gustafson. (1980). Fundamental of Electricity for Agriculture. Van Nostrand Co.

Engineering Hydrology

Course Outline:

Hydrologic Processes:

Introduction, Hydrologic cycle and its components, importance of hydrology, climatic factors, estimation of precipitation, snow-cover and snow fall, stream flow, water stage, discharge, interpretation of stream flow data evaporation and transpiration, Evapotranspiration and its estimate using different methods.

Hydrologic Analysis:

Hydrograph and its characteristics, run off and its components, recessions, hydrograph separation, rainfall-runoff relations, phenomenon of runoff estimating the volume of storm runoff, estimating snow melt runoff, seasonal and annual runoff relations, hydrograph of runoff, unit hydrograph its derivation and application, overland flow.

Hydrologic Routing:

Introduction, river routing, level pool routing, linear reservoir model, Muskingum method.

Hydrologic Models:

Definition, classification of models, development, calibration, verification and application of models.

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:

- Awan, N.M. 1981. Surface Water Hydrology, National Book Foundation, Islamabad.

- Linsely, R.K., Kohler, J.L.H. Paulhyus 1996. Hydrology for Engineers, SI. Edition, McGraw Hill Kogakusha Ltd.
- Ward, R.C., Robinson, and M. 1990. Principles of Hydrology, McGraw Hill Book Co., London.
- Wilson, E. M. 1990. Engineering Hydrology, Macmillan Civil Engineering Hydraulics. N.Y.

Earth Moving Machinery

Course Outline:

Field Capacities and Cost Analysis

- Implements Types, Factors affecting field capacity
- Cost analysis

Hydraulics Controls

- Components of a hydraulic system, Types of hydraulic system
- Single, Parallel and Series cylinder systems, Limit control
- Automatic position and Draft control

Power Drives

- Hydrostatic Propulsion drives, PTO drives using two universal joints,
- Three- joints PTO drives, Loads imposed on P.T.O. shafts,
- Recommended PTO load limits

Agricultural Field Machinery and Systems

- Principles of operation, design and selection,
- Testing and evaluation of Functional and mechanical performances

Tillage Force Analysis

- Forces acting upon a tillage implement
- Mechanics of tillage, Tillage tool design factors
- Measuring and evaluating performance, Measuring draft of implements

Hitching

- Vertical and horizontal hitching of trailed implement,
- Hitches for mounted implements,
- Depth and draft control on hitches.
- Crop and soil interaction with machines.

Primary Tillage Implements

- Function and Types of Mold board plows
- Components of a mold board plow, Reaction of soils to mold boards
- Pulverizing action, Turning and inversion, Scouring
- Forces acting upon a plow bottom
- Effects of soil types, depth of plowing shape and design,
- Attachments and rear furrow wheel and speed on draft and performance.
- Functions, components and types of Disk plows, Rotary plows, Chisel and subsurface plows.

Secondary Tillage Implements

- Functions, components and types of Harrows, Cultivators
- Land rollers and Pulverizers
- Subsurface tillage tools and field cultivators

Equipment for Sowing and Planting

- Functions, components and types of planting equipment,
- Seed metering devices, Maize drills,
- Calibration of seed drill.
- Broadcasting machines, Fertilizer and insecticide placement.
- Transplanting machines, Spraying systems

Grain and Seed Harvesting

- Harvesting and threshing methods,
- Types and development of Combines, functional elements of a combine,
- Flow path of material, Types and sources of seed loss,
- Types of threshing cylinders, Threshing effectiveness, Cylinder adjustment,
- Testing of Combines and its power requirements, Windrowing

Earth Moving Equipment

- Principles and working of Bulldozers,
- Soil scrapers and ditchers, Crawler,
- Parts of Crawler,
- Comparison of wheel type and Crawler tractors

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:

- Kepner, R. A., R. Bainer and E. L. Barger. 2005. Principles of Farm Machinery. 3rd Edition, AVI Publishing Company, Inc. Westport, USA.
- Haycraft W. R. – 2002. The Story of the Earthmoving Equipment Industry. Library of Congress cataloging .USA
- Smith H. P. and L. H. Wilkes. (1976). Farm Machinery and Equipment, 6th Ed. McGraw-Hill, Inc. USA
- RNAM Test Codes and Procedures for Farm Machinery, 1995 Economic and Social Commission for Asia and the Pacific Regional Network for Agricultural Machinery, Second Edition C/o UN-EXCAP UN Building, Rajadamnern Nok Avenue, Bangkok, Thailand.

Agricultural Process Engineering

Course Outline:

Introduction

- Importance of Agricultural Process Engineering for value addition,
- Structure and composition of food grains and fruits,
- Physical, mechanical and thermal properties of agricultural materials

Fans

- Classification as to type and design of fans, fan theory,
- Fan performance, factors affecting fan selection,
- General performance and laws, fans in series and parallel, compression effect.

Material Handling and Transportation equipment

- Belt conveyors, chain conveyors
- Pneumatic conveyors, gravity conveyors
- Bucket elevators augers, trailer/ trucks

Cleaning, Sorting and Grading

- Grade factors, washing types and methods of washing
- Sorting fruits and vegetables, types of sorters, cleaning and sorting
- Grading, nuts and seeds, types of grain cleaners/sorter
- Aerodynamics of small particles, types of separators
- Machine vision and its applications in grading

Size Reduction

- Types of size reduction mills, fineness modulus,
- Value of ground feed, size relationships, energy requirements
- Size reduction procedures, reducing devices
- Performance and characteristics of size reduction devices
- Mixing and types of mixers

Cold Storages

- Need of cold storages, types of cold storages and their design
- Temperature and humidity controls, heat load
- Automation of cold storages
- Air conditioning, aeration, storage temperatures for various horticultural produce

Drying

- Drying and dehydration
- Moisture content determinations; primary methods, equilibrium moisture content,

- Drying processes, constant rate period, falling rate period, falling rate drying mechanism,
- Dynamics of equilibrium moisture content, effect of temperature upon the rate of drying,
- Effect of air rate upon the rate of drying, heat and mass balance limitation of the drying
- Equipment, types of driers psychometric chart, calculations
- Design of drying systems using computer simulation.

Milling and Extraction

- Grain handling systems. Corn wet and dries milling.
- Rice milling. Extraction of Canola and Cottonseed oils.

Packaging Material

- Packaging materials and techniques,
- Material properties, packing geometries.

Teaching Methodology (Proposed as applicable):

Lectures (audio/video aids), Written Assignments/ Quizzes, 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:

- Henderson, S.M. 2010. Agricultural Process Engineering. The AVI Publishing Company, Inc. Westport, Connecticut. USA.
- Dabhi, M.N. and N.K. Dhamsaniya. 2008. Agricultural Process Engineering. Agrotech Publishing Academy, India.
- Toledo, R.T. 2006. Fundamentals of Food Process Engineering. Food Science Text Series.
- Pandey, H. H. K. Sharma, R. C. Chauhan, B. C. Sarkar and M. B. Bera. 2004. Experiments in food process engineering. CBS Publishers and distributors, New Delhi, India

- Sahay, K. M. and K. K. Singh. 2002. Unit operation of agricultural processing. 2 Ed. Vikas Publishing House, New Delhi, India.
- Hanlon, J. F. 1992. Handbook of packaging engineering. 2nd Ed. John Wiley and Sons, N.Y., USA
- Henderson, S.M. 1986. Agricultural Process Engineering. The AVI Publishing Company, Inc. Westport. USA.

GIS and Remote Sensing

Course Outline:

Introduction to GIS

- Backgrounds and basic concept
- Scope and application area
- Mapping concept
- Map types
- Map elements and scales
- Mapping process

Fundamentals of GIS

- Types of datasets
- Formats of datasets
- Functional elements of GIS
- Spatial data models
- Raster and vector data structures
- Inter-conversion of raster and vector data structures

Introduction to Remote Sensing

- Concept of RS technology
- RS data types
- Satellite systems and sensors
- GPS and DGPS
- Spectral signatures

Spatial and Attribute Database Development

- Data query
- Attribute data handling
- Vector data based development
- Vectorization process
- Flat file description
- Spatial and attribute data linking
- Database management

Data Manipulation and Analysis

- Soil Geo-processing Techniques
- Interpolation using geo-statistics
- Reclassification technique
- Creating continuous surfaces from point data, global methods
- Creating continuous surfaces from point data, local methods
- Pixel sampling & Quantization

Introduction to Remote Sensing Image

- Image interpretation process (elements and strategies)
- Image processing techniques (data import, Geometric correction)
- Image interpretation & GPS technique: Visual and digital interpretation
- Global Positioning System (GPS) technique and process
- Image classification: Hybrid technique of image classification
- Supervised and unsupervised techniques

Remote Sensing Analysis

- Land cover/Land use classification and monitoring
- Ground truthing and field verification
- Integration of RS and GIS techniques, Land cover change detection
- Digital Elevation Model (DEM) techniques
- Topographic feature extraction and application\
- Digital Elevation Model utilization in watershed / Basin modeling
- Integration of DEM in GIS (Visualization and Mapping)

Natural Resources Management using Satellite Imagery

- Introduction to remotely sensed crop, soil, land and water information
- Normalized Difference Vegetation Index (NDVI)
- Normalized Difference Water Index (NDWI)
- Normalized Difference Built-up Index (NDBI)
- Normalized Difference Snow Index (NDSI)
- Moisture Stress Index (MSI)
- Relationships between radiations and earth features
- Time series crop health monitoring using vegetation indices

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:

- Barrett, E.C. and Curtis, L.F. 2014. Introduction to Environmental Remote Sensing, 4th Edition, Chapman and Hall, London.
- Foody, G. and Gurran, P. 1994. Environmental Remote Sensing from Regional to Global Scales. John Willey and Sons, England.
- Heywood, I., Cornelius, S., and S. Carver 2012. An introduction to geographical information systems, 4th Edition, Illustrated Published by Pearson Prentice Hall.
- Keith, C.C., Bradley O. Parts and Michael P.C. 2004. Geographic Information Systems and Environmental Modeling.
- McCoy, R. M., 2005. Field methods in remote sensing, Published by Guilford Press, ISBN 1593850794, 9781593850791 Manual of Remote Sensing.

Manufacturing Engineering

Course Outlines

Introduction

- Define manufacturing engineering
- Identify the common tools, processes and machines used in manufacturing engineering

Lathe Machines

- Describe turning and related operations commonly performed on lathe machines
- Demonstrate the different types and construction of lathe and its accessories
- Carry out different lathe operations
- Illustrate turret lathe and turret lathe tooling
- Demonstrate the mechanism of chip formation
- Describe different types of cutting tools and their materials
- Discuss the tool failure, tool life and the use of coolants

Drilling, Reaming and Grinding

- Explain and illustrate different types of drilling machines, drill bits and drill chucks
- Carry out counter boring and sinking
- Discuss and illustrate boring and reaming practices and tools
- Carry out the estimation of drilling time

Milling

- Describe the different types and working principle of milling machines
- Demonstrate and discuss milling operations and mill cutters
- Carry out the estimation of milling time

Shaping and Planning

- Discuss types and applications of shapers and planers
- Explain the shaper drive mechanism
- Demonstrate and describe shaper speeds and machining times
- Discuss the construction and types of planning machines

- Illustrate planer tools and work set up methods
- Demonstrate and discuss metal bending and sheet rolling processes

CAM and CIM Systems

- Describe CAM and CIM systems
- Discuss different types of CNC machines and their working principles
- Demonstrate programming for numerical control
- Illustrate the machine tool control

Additive Manufacturing

- Discuss 3D printing and its prospects
- Describe total quality management (TQM) in 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:

- Ram, M., J. P. Davim. 2018. Advanced Applications in Manufacturing Engineering. 1st Ed. Published by Woodhead Publishing, UK.
- Kalpakjin, S. and S. R. Schmid. 2016. Manufacturing engineering and technology. 6th Ed., Published by Pearson Publishing Co., London, UK.
- Nee, A.Y.C. 2015. Handbook of Manufacturing Engineering and Technology. Published by Springer-Verlag London, UK.
- Alavala, C. R. 2013. CAD/CAM: Concepts and Applications. Published by PHI Learning Pvt. Ltd., New Delhi, India.

Depth Engineering Courses

Farm Structures and Control Sheds

Course Outline:

- **Introduction:** Definition and types of farm service buildings, structural materials and their uses.
- **Farm Stead:** Definition, site selection developing a farmstead plan, arrangement of farmstead buildings
- **Farm Building Design:** Planning the farm homes, dairy cattle housing, poultry housing, sheep housing, care and maintenance of farm buildings.
- **Dairy Building:** Functional planning, Environment, Sanitation, Space requirements for animals and traffic, arrangement of space, Other considerations, Milking Parlors, Pen vs Stall Barns, Storage or feed, Milk and manure etc., Insulation and ventilation, Design of Dairy Building.
- **Poultry Housing:** Functional planning, Production practices, Environment, Space requirements, Arrangement or space, Insulation and ventilation, other considerations, Design of Poultry House.
- **Storage:** Characteristics of grains, fiber, fruits and vegetables, structural requirements for them, economics aspects of farm buildings and structures.
- **Estimating and Costing:** Need for Estimation and Costing, Procedure of Estimating or Method of Estimating, Data required to prepare an Estimate, Drawings, Specifications, Rates, Complete Estimate, Measurement of Materials & Works, Types of Estimates, Detailed estimate, Data, Methods of Preparation of Approximate Estimation, estimation of quantities of steel & RCC elements
- Farm Bridges, Roads, Fences, Green Houses, Gates, Feed lot Equipment and Animal Handling Equipment.

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:

- Barre, H. J., and Sommet, L. L. Farm Structure. John Wiley and Sons., Inc, New York, USA.
- Barnes, Amaurice M. and Mander Clive, 2000. Farm Building Construction. Farming Press, England
- Gray Horrold, E. 1985. Farm Service Building. McGraw-Hill Book Company, New York
- Neubauer, L.W. and Walker H.B. 1981. Farm Building Design. Prentice Hall Inc., Englewood Cliffs, N.J. Haider, S.Z. 1985. Materials of Construction. Oxford University Press, Pakistan

Pumps and Tube Wells

Course outline:

Introduction

- Functions of pumps and tubewells
- Importance of pumps and tube wells in irrigation and drainage
- Groundwater exploitation by tube wells Formulation

Well Hydraulics

- Flow through porous media
- Darcy's law
- Aquifers and its types
- Flow in confined and un-confined aquifers
- Wells near aquifer boundaries
- Multiple well system
- Specific capacity
- Well losses, Well efficiency
- Aquifer testing

Description of Tube Wells

- Components of a tube well
- Factors affecting selection of site
- Well drilling methods (percussion boring, straight and reverse rotary rigs)
- Well design,
- Well development methods
- Skimming wells, Scavengers Wells

Pumps

- Pump components
- Pump classification; centrifugal, jet, positive displacement, turbine pumps, submersible pumps, propeller and mixed flow pumps and air lift pumps- Types of impellers.
- Terminology in pumping systems- specific speed, priming, pumping energy, total dynamic head, pump problems and their remedies. Power requirement of pump

Characteristics of Pump

- Specific speed
- TDH-Q
- BP-Q
- NPSH-Q and Efficiency-Q curves
- Cavitation
- Net positive suction head(NPSH)
- Affinity laws
- Pump testing
- Maintenance of pumps

Pump System Design and Power Requirements

- Suction lift
- Delivery head
- Friction head loss
- Operating head-seasonal-variation in system head curve
- Pump selection
- Feasibility of prime mover selection

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:

- Ahmad, N. 1995. Tube Well Theory and Practices, Shahzad Nazir Publisher, Gulberg-III, Lahore.
- Colt Industries 1979. Hydraulic Handbook, 3601 Fairbank Avenue, Kanasa City, Kansas 661100, USA.
- Hunt, T., and N. Vaughan, 1997. Hydraulic Handbook, 9thEdition, Elsevier Science;
- Sterrett, R.J., 2007. Groundwater and Wells, Smyth Co. Inc., USA.

Open Channel Hydraulics

Course outline:

Basic Concepts of Free Flow

- Types, state and regimes of flow,
- Channel flow types, (steady, unsteady, uniform and non-uniform, mixed flow)
- Channel geometry,

Energy and Momentum Principle

- Basic equations,
- Specific energy and alternate depths,
- E-Y relationship,
- Criteria for a critical state of flow,
- Computation of critical flow,
- Control of flow,
- Application of flow control in rectangular channel,

- Momentum in open channel flow, specific momentum,
- Hydraulic jump,
- M-Y relationship.

Velocity Measurement in Channel

- Velocity distribution in channel and its coefficients,
- Pressure distribution in channel,
- Effect of slope on pressure distribution.

Uniform Flow

- Establishment of uniform flow.
- The Chezy's and Manning's equations,
- Resistance coefficient estimation,
- Normal depth and velocity,
- Normal and critical slopes,
- Free board,
- Determination of section dimensions.
- Best hydraulic section,

Rapidly Varied/ Turbulent Flow

- Characteristics of varied flow,
- Types of weirs, sharp crested weir and board crested weir,
- Aeration of the nappe crest shape
- Discharge over spillway,
- Type of the hydraulic jump,
- Characteristics of the hydraulic jump,
- Jump as energy dissipater,
- Flow through sudden transitions.

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:

- Chow, V.T. (1990). Open Channel Hydraulics. McGraw Hill International Book Company.
- French, R. H. (1996). Open Channel Hydraulics, McGraw Hill International Book Company.
- Henderson, F.M. (1990). Open Channel Flow. McMillan Publishing Co.

Irrigation Engineering

Course outline:

Introduction

- History of Irrigation
- Objectives of irrigation
- Scope of Irrigation Engineering

Water Resources for Irrigation

- Irrigation system of Pakistan
- Quantity and Quality of Rainfall, Surface Water and Groundwater
- Water budget of Pakistan
- Water Resources Issues and their solution
- Water resource for hydro power

Water Law Doctrines

- Transboundary Water Issues
- Indus Water Treaty
- Distribution of Indus River Water among the provinces
- Water apportionment Accord

Warrabandi System

- Objectives and types of Warrabandi System
- Formulation of Warrabandi Schedule
- Problems in Warrabandi System

Crop Water Requirements

- Crop period, base period, duty and delta, relationship between duty and delta, factors affecting duty, depth and frequencies of irrigation, Kharif-Rabi ratio, optimization of irrigation water,
- Irrigation efficiencies, uniformity coefficient,
- Consumptive use of water, effective rainfall,
- Net irrigation requirements, gross irrigation requirement,
- Estimation of consumption use, Blaney Criddle, Hargreaves Methods,

Irrigation System Management

- Responsibilities and jurisdiction of institutes managing the water
- Farmer's Organizations, Area Water Board (AWB)
- Assessment of irrigation water charges

Design of Irrigation Canal

- Design of stable channel,
- Regime channels, Kennedy's theory, Lacey's theory,
- Estimation of transported sediment, bed load equations,
- Design procedure for unlined non-erodible irrigation channel,
- Maintenance of lined and unlined channels

Hydraulic Control Structures

- Barrages, weirs, flow regulators, energy dissipaters
- Silt control structures in irrigations canals
- Cross drainage structures
- Canal falls
- Flow Measuring structures (gauges, telemetry, stilling wells and others)

Dams/Small Structures

- Classification of dams
- Modes of failure

- Stability analysis
- Design of small/mini dam, outlets

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:

- Ali, I., 2003, Irrigation Engineering. Theory, Design and Practice. Oxford University Press, London.
- Garg, S.K., 2009. Irrigation Engineering and Hydraulic Structures, Khanna Publishers
- Michal, A.M. 2003, Irrigation Theory and Practice. Vikas Publishing House (Pvt) New Delhi, India. Arora, R.K.
- Punmia, B.C., and Pande, B.B.L., 2016, Irrigation and Water Power Engineering, Published by Laxmi Publications (P) Ltd., New Delhi.
- Siddiqui, I. H. 2003, Irrigation and Drainage Engineering, Royal Book Company, BG-Rex Centre Fatima Jinnah Road, Karachi.

Drainage Engineering

Course outline

Introduction

- Definition, sources, history and adverse effects of agricultural drainage
- Salient features of drainage projects in Pakistan
- Desirable water table depth, Ground water table depth and crop yields
- Identification of drainage problems, Solution of the drainage problems,
- Comparison of different drainage systems

Soil Water Relations

- Soil hydraulic characteristics (types, pores spaces, water pressure distribution in the soil profile, Surface tension, capillary pressure, Saturated, Unsaturated hydraulic conductivity, Drainable pore space)
- Soil moisture retention curves

Waterlogging and Salinity

- Accumulation of salts at the soil surface
- Type of Salinity
- Treatment procedures

Theories of Sub-Surface Pipe Drainage

- Theory of ground water flow to drains,
- Steady state drainage design,
- Drainage system design equations (Hooghoudt equation, Partial penetration of drains, Kirkham solution, Ernst Equation, Donan equation, Modified Donan equation, Drainage design for anisotropic soils, Van beers formula, Drainage of artesian pressure, Unsteady state drainage equation, Glove-Dumm formula, De zeeuw-helinga model)

Sub-Surface Horizontal Drainage System

- Design, Construction and Operation, Drains system's layout
- Drain pipe, Pipe envelop
- Gravel envelope design, Synthetic envelop design, Placement of envelop materials
- Tile drainage system
- Construction of pipe drain system
- Drainage machinery
- Pipe installation below the water table
- Drainage structures
- Checking performance of pipe drainage systems, clogging of drain pipe, slots and envelop
- Pipe cleaning (operation and maintenance issues)
- Effluent disposal and re-use

Surface Drainage System Design

- Design variables and parameters BP-Q
- General procedure for drain design
- Drain alignment/location
- Drain design discharge
- Hydraulic grade line and hydraulic gradient
- Permissible flow velocities
- Drain structures, Operation and maintenance of drains

Vertical Drainage System

- Drainage mechanism
- Tube wells and groundwater drainage
- Advantages of tube well drainage
- Drainage coefficient for well drainage
- Tube well size selection
- Number of pumping tube wells
- Tube well layout
- Effluent disposal

Operation and Maintenance of Drainage System:

- Buried Pipe drainage system
- Open drainage system
- Drainage water disposal ponds
- Drainage observation well
- Policy and basic requirements, weed control and embankment stability

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:

- Ghosh, S.N., 2006. Flood Control and Drainage Engineering, 3rd Edition by Publisher Taylor and Francis
- Siddique, I. 2009. Irrigation and Drainage Engineering. A Oxford University Press
- Waller, P. and M. Yitayew. 2016. Irrigation and Drainage Engineering. CBS Publishers, New Delhi, India
- Tariq, Ata-ur-Rehman, 2012: Drainage Systems Engineering. Centre of Excellence in Water Resources Engineering, University of Engineering & Technology, Lahore

Machine Design

Course Outline:

Introduction

- Mechanical Engineering Design
- Safety and product reliability

Design Considerations

- Phases of design
- Codes and standards, evaluation and presentation.

Design of Shafts

- Design of shafts, torsion of circular shafts,
- Horsepower transmitted by the shafts,

Design of Clutches

- Design procedure
- Numerical problems

Design of Bearings

- Design procedure
- Numerical problems

Design of Gears

- Design procedure
- Numerical problems

Design of Flange

- Design procedure
- Numerical problems

Design of Couplings

- Design procedure
- Numerical problems

Design of Pulleys

- Design procedure
- Numerical problems

Design of Connecting Rods

- Design procedure
- Numerical problems

Design of Fasteners and Connections

- Different types of fasteners, Thread standards and definitions
- Mechanics of power screws. Bolts strength and selection of units
- Bolt preload, torque requirement, Bolted
- Riveted and welded joints loaded in shear
- Keys pins, and retainers

Elements of Rotary Power Transmission

- Belts, Stresses in belts, Chain and sprocket drives,
- Gears drives, Flexible shafts, Bearings

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:

- Kalpakjian, S., S. Schmid. 2007. Manufacturing Processes for Engineering Materials. 5th Edition, Prentice Hall Publishers.
- Blach, P.H. 2014. Machine Design. Edition, Tata-McGraw Publishing Company, New Delhi, India.
- Shigley, J.E. and C. R. Mischhe, (2000). Mechanical Engineering Design. Fifth Edition. McGraw Hill Publications Inc. USA.
- Parkinson, A.C. (1968). A First Year Engineering Drawing, sixth Ed., Sir Issac Pitman and Sons Ltd. London.
- Spotts, M.F. (1978). Design of Machine Elements. Englewood Cliff Prentice Hall, London

I.C Engines and Tractors

Course Outlines:

Introduction

- History of engine development, engine cycles
- Principles of operation, types of engines

Principal Parts of Engine

- Functions and construction
- Working mechanism

Fuels and Combustion

- Types and properties of engine fuels,
- Fuel tests and their significance, gasoline tests, antiknock test
- Engine emissions and their analysis

Fuel System

- Major components of fuel systems (petrol/diesel),
- Fuel classification and storage

- Theory and mechanism carburetor
- Fuel injection pump, injector/nozzles, electronic fuel injection
- Governing system, calibration of fuel injection pump
- Trouble shooting of fuel system

Ignition System

- Types of ignition, spark, magneto and compression ignition system
- Induction coils, distributor, spark plug, contact-breaker points, condenser
- Trouble shooting.

Cooling System

- Types, principle of operation, parts of air/water cooling system, line diagram
- Radiator, thermostat, water pump, fan, engine heating, types of coolants
- Repair and maintenance

Lubrication System

- Types of lubrication systems principle of operation
- Components of lubrication systems, line diagram
- Types of lubricants, trouble shootings and maintenance

Electrical System

- A.C. and D.C. voltage, alternator/dynamo,
- Battery, battery charging and maintenance,
- Self-starter, electrical gauges and controls, line diagram
- Repair and maintenance of electrical system

Intake and Exhaust System

- Air intake system, valve timing diagram,
- Air cleaner, super charger, turbo charger, inter-cooling,
- Construction of intake and exhaust manifolds, mufflers, flue gases

Mechanics of the Farm Tractor Chassis

- Kinematics and dynamics of tractor power applications,
- Force Analysis, Soil reaction, Drawbar pull and traction mechanism,
- Stability of tractors, Tipping and lateral stability.

Power Transmission System

- Clutch and Brakes, Transmission, Differentials, Power take-off
- Pulley drives, Power lift and hydraulic controls
- Tractors tests and performance

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Gupta, H.N., 2012. Fundamentals of internal combustion engines. PHI Learning Pvt. Ltd.
- Powar, A. G. and V. V. Aware. 2007. Farm Machinery and Power. New India Publishing Agency, New Delhi, India.
- Single, R.K. 2004. Internal Combustion Engines. S. K. Katana and Sons, Delhi, India.
- S.C. Jain and C.R. Rai. 2000. Farm Tractor Maintenance and Repair, Tata McGraw-Hill Publishing Company Limited, New Delhi.
- Halderman, J. C. D. Mitchell. 2005. Automotive Engines: theory and servicing. 5ed. Pearson Prentice Hall, Singapore.
- Promersberger and Bishop. 1996. Farm Power. Prentice Hall Inc. Englewood Cliffs, New Jersey U.S.A
- Paul W.G. James, H. Smith Jr and E. J. Ziruys. 1995. Fundamentals of Internal Combustion Engines, Ed. Oxford and IBH Publishing Company (Pvt) Ltd. New Delhi.

Farm Machinery and Automation

Course outlines:

Mechanization

- History of mechanization
- Objectives, constraints, and policy measure

Equipment for Sowing and Planting

- Functions, components and types of planting equipment,
- Seed metering devices, maize drills,
- Calibration of seed drill.
- Broadcasting machines,
- Transplanting machines,
- Sugar cane planter etc.

Equipment for plant protection (5 hours)

- Chemical plant protection,
- Mechanical plant protection,
- Dry chemical application equipment,
- Liquid chemical application equipment,
- Boom sprayer parts and working,
- Calibration of boom sprayer, nozzles and their types, precision sprayers.

Grain and seed harvesting (8 hours)

- Harvesting methods, reaper, mower, sugar cane harvester, cotton picker, corn/maize harvester, thresher,
- Types of threshing cylinders, threshing effectiveness, cylinder adjustment,
- Types and development of combines, functional elements of a combine, flow path of material,
- Types and sources of seed loss,
- Testing of combines and its power requirements.

Field capacities and cost analysis (3 hours)

- Field capacity, factors affecting field capacity, thorough put capacity,
- Cost analysis, fixed cost, and variable cost.

Precision agriculture equipment (8 hours)

- Introduction and utilization of direct rice drill,
- Rice trans-planter,
- Pneumatic seed drill, narrow seed drill,
- Precision planters
- Thematic mapper for soil analysis,
- Variable rate sprayer,
- Drones usage in precision agriculture.
- Auto-steering technology

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, Quizzes, Design Projects, Complex Problems, Final Term

Suggested Books:

- Haddock, K. 2017. Modern Earthmoving Machines, Enthusiast Books, Sofia, Bulgaria.
- Haycraft, W. R. 2002. The Story of the Earthmoving Equipment Industry. Library of Congress cataloging, USA.
- Mehta, M. L., S. R. Verma and S. K. Mishra. 2016. Testing and Evaluation of Agricultural Machinery, DAYA Publishing House, New Dehli India.
- Singh, T.P. 2016. Farm Machinery, PHI Learning Private Limited, Dehli, India.

Elective Courses for Irrigation & Drainage

Soil and Water Conservation Engineering

Course outline:

Introduction to Soil and Water Conservation

- Soil and Water Conservation
- Types of erosion
- Effects and importance

Water Erosion

- Erosion agents
- Geologic and accelerated erosion
- Damages caused by soil erosion
- Water erosion and its types
- Factors affecting water erosion
- Sedimentation and pollution in relation to water erosion
- Water erosion prediction equation
- Erosion control practices

Wind Erosion

- Factors affecting wind erosion
- Types of soil movement
- Mechanics of wind erosion
- Wind erosion control principles
- Wind erosion prediction equation

Rainfall and Runoff

- Rainfall intensity and duration
- Infiltration
- Factors affecting runoff
- Damages caused by floods
- Water harvesting

Cropping System and Agronomic Measures for Erosion Control

- Watershed management
- Plant cover
- Crop rotation
- Strip-cropping
- Conservation tillage
- Contour cultivation
- Land capability classification

Terracing

- Field terrace
- Classification of terraces
- Broad base terraces
- Bench terraces
- Terrace design
- Planning the terrace system
- Terrace construction and maintenance

Vegetated Outlets

- Use of vegetated outlets and water courses in the control of erosion
- Design of vegetated outlets
- Water-way construction and maintenance

Conservation Structures

- Drops Spillways
- Chutes and Pipes Spillways; their requirements, components and limitations

Water Conservation

- Definition of drought
- Effects of drought
- Water stored in soil
- Decreasing runoff
- Reducing evaporation
- Reducing deep percolation
- Preventing losses from storage

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Linsely, R.K. and Franzini, Joseph. 1996. Water Resources Engineering. McGraw-Hill. FAO.
- Schwab G. O., D.D Fangmeier, W. J. Elliot and R. K. Frevert. (2002). Soil and Water Conservation Engineering, 4th edition. John Wiley and Sons, N.Y.
- Suresh, R. 2012. Soil and water conservation engineering, standard publishers Distributors, 1705-B Nai Sarak, Delhi, India.

Farm Water Management

Course outline:

Watercourse Design and Improvement

- Introduction
- Planning for watercourse improvement
- Design criteria
- Hydraulics of watercourse design
- Different cross sections of watercourse
- Materials and procedures
- Moghas
- Construction of unlined and lined watercourses
- OFWM structures (conveyance, control)

Water Management through Precision Land Leveling

- Precision land leveling
- Objective

- Advantages and disadvantages of land leveling
- Farm assessment and layout
- Traditional survey layout procedure
- Adjustment of borrow and fill
- Procedure for sloping fields
- Land leveling maintenance

Water Storage Tanks

- Sizing a water storage tanks
- Considerations in sizing water storage tanks
- General criteria, Design of storage tanks
- Construction of water storage tank
- Preparatory works
- Materials and procedures
- Concrete base
- Brick or stonewalls
- Concrete walls
- Backfilling
- Stone pitching
- Quantities

Water Harvesting

- Introduction
- Goals and objectives
- Site selection
- Area appraisals
- Topographical surveys
- Land use plane and work plan
- Land development and conservation structures
- Leveling and terracing
- Improved bunds
- Improved tillage
- Field spillways
- Water ways
- Diversion ditches

- Storage structures
- Water balance
- Site investigation
- Water retention dams/ponds

Agronomy Practices for Water Management

- Development of Crops and Cropping Systems
- Principles of Crop Management
- Management of land and Soil
- Conjunctive Use of Water
- Conjunctive use of saline groundwater
- Effects of sediment and salinity on conjunctive use of water

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:

- On Farm Water Management Field Manuals, (Revised 1996-97)
 - Vol. IV Watercourse Design and Improvement.
 - Vol. V Land Development Precision Land Leveling and level Border Design.
 - Vol. VI Irrigation Agronomy.
 - Vol. VII Water Storage Tanks.
 - Vol. X Water Harvesting and Spate Irrigation
 - Ministry of Food, Agriculture and Livestock (Federal Water Management cell) Government of Pakistan, Islamabad.
- Hoffman, G. J, T.A. Howell and K.H. Solomon, 1992. Management of Farm Irrigation Systems. ASAE.

Farm Irrigation Systems

Course outline:

History of Irrigation:

- Scope of Irrigation in Pakistan
- Farm Irrigation Systems

Systems Design Fundamentals:

- Functions of farm irrigation systems
- Types of farm irrigation systems
- Conveyance methods
- Design of farm irrigation systems
- Data for design
- Water source evaluation
- Determination of daily design requirements

Crop Water Requirements:

- Pan Evaporation Method
- Blaney Criddle Method
- Hargreaves and Samani equation
- FAO Radiation
- FAO Blaney–Criddle Method
- Penman Monteith Method
- Jansen Haise Method
- Modified Penman Monteith Method (Cropwat Model),
- Water Balance Approach
- Crop Coefficients, Evapotranspiration,

Plant-Water-Soil Relationship:

- Infiltration Measurement Methods
- Green and Ampt Model
- Horton's Equation
- Kostiakov Method
- Richard's Equation
- Double Ring Infiltrometer Test
- Total Soil Moisture Potential

- Soil Moisture Retention Curves
- Soil Moisture Measurement Methods
- Soil Analysis
- Sieve Analysis, Pressure Membrane Apparatus.

Surface Irrigation:

- Different methods of surface irrigation
- Furrow irrigation
- Border irrigation
- Basin irrigation
- Design of furrow, border and basin irrigation systems

Design of HEIS Irrigation:

- History and Scope in Pakistan
- Components of Trickle irrigation system
- Head Unit
- Filtration system requirement for HEIS
- Fertigation system for HEIS
- Design of Trickle Irrigation System for different crops

Sprinkle Irrigation System:

- Types of sprinkler system
- Components of sprinkler system
- Pressure requirement of Sprinkler irrigation
- Design of Sprinkler Irrigation System

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Allen, R.G., Pereira, L.S, Raes, D. and Smith, M. 1998. Crop evapotranspiration (Guidelines for computing crop water requirements), FAO Irrigation and Drainage Paper 56, Rome, Italy.
- Laffan J. 2016, Irrigation: Centre Pivot and Lateral move. NSW Agriculture, Australia.
- Laycock A. 2007. Irrigation Systems: Design, Planning and Construction. CABI.UK
- Majumdar D.K., 2013, Irrigation Water Management: Principles and Practices. Prentice-Hall of India.
- OFWM. 1991. OFWM Field Manual 1-4, Federal Water Management Cell. Ministry of Food, Agriculture and Livestock, Islamabad, Pakistan.
- Tripathi N. 2014. Irrigation, Watershed and Drainage. Agrotech Press, India.

Groundwater Hydrology

Course outline:

Introduction

- Groundwater Resources of Pakistan – Potential and issues
- Hydrogeology
- Hydrological balance
- Soil water movement

Laws of Groundwater Movement

- Darcy's Law and its applications
- Groundwater flow equations
- Groundwater Monitoring

Aquifer Characteristics

- Types of aquifers
- Aquifer Heterogeneity
- Effective hydraulic conductivity

Groundwater Contamination

- Solute Transport Processes
- Dispersion and diffusion

Well Hydraulics

- Steady flow in confined and un-confined aquifers
- Steady and unsteady methods

Water Well Design

- Geophysical investigation
- Pumping Test Methods (steady and variable)
- Well design parameters
- Well drilling and development methods
- Design and placing of gravel pack
- Skimming wells
- Scavenger wells

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:

- Johnson, 1988. "Ground Water & Wells" Johnson and Co. USA
- Raghunath, H.M. 2007. "Ground Water" 2nd Edition, Willy Eastern Ltd. Singapore
- Rushton, K.R. 2007, Groundwater Hydrology: Conceptual and Computational Models, Willey, USA.
- Bouwer, H. 1996. "Ground water Hydrology" McGraw Hill Inc. New York
- Ahmad, N. 1985. "Ground water Resources of Pakistan" Shahzad Nazir Publisher, Gulberg-III, Lahore

Irrigation Water Management Techniques

Course outline:

Introduction:

- Concept of water management and its developments in Pakistan
- Components of water management

Water Distribution:

- Irrigation system management
- Warabandi-types
- Rotation system advantages and disadvantages
- Constraints of warabandi

Soil-Water Plant Relationship:

- Soil moisture and its types
- Soil moisture characteristics
- Field capacity
- Wilting point
- Total available water
- Management allowed deficit
- Infiltration rate
- Hydraulic conductivity

Efficiencies:

- Definition, conveyance
- Application and storage efficiencies
- Irrigation efficiency
- Irrigation system efficiency

Land Leveling:

- Importance of land leveling in water management
- Topographic survey
- System layout
- Determining cuts and fills
- Land leveling equipment
- Laser land leveling and use of total station

Discharge Measurement:

- Units of measurement, equipment and methods of measurement
- Interpretation of discharge data
- Water losses

Watercourse Design and Maintenance:

- Hydraulics of open channel flow
- Flow profiles
- Design of watercourse for a command
- Watercourse structures, cleaning and maintenance of watercourses

Watercourse Construction:

- Construction requirements and procedure
- Materials for construction
- Construction machinery
- Cost of watercourse lining and improvement

Lining of Watercourse:

- Materials of lining
- Lining techniques
- Cost estimate of lining

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:

- Allen, R.G., Pereira, L.S., Raes, D. and Smith, M. 1998. Crop evapotranspiration (Guidelines for computing crop water requirements), FAO 56, Rome, Italy.

- Jensen, M.E, 1981, Design and Operation of Farm Irrigation System. ASAE, Monograph, USA
- OFWM. 1991. OFWM Field Manual 1-4, Federal Water Management Cell. Ministry of Food, Agriculture and Livestock, Islamabad, Pakistan.

Quantity Survey and Cost Estimation

Course Outline:

Bill of Quantities (B.O.Q) & Measurement Book (M.B):

- Types and methods of estimates,
- Working out quantities, rates and cost analysis of construction materials; Valuation, depreciation and sinking fund.
- Contents and preparation of bills of quantities for different projects like irrigation, roads, sanitary, building etc. and maintaining of Measurement Books.
- Measurement, specification and costing of excavation and back filling, mass concrete retaining walls, beams, concrete piles, steel or wooden truss or steel framed gantry, estate road, sewer and water main pipe works, Priced bill of quantity.
- Tendering: Preparation of engineering contracts and tender documents. Introduction to claims and conflicts resolution e.g. escalation, indexation, arbitration and litigation. Evaluation of proposals and contracts.

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:

- E.W. Steel and Terence J. Mc GHEE, Estimating & Costing.
- S. Dutta, Estimating and Costing in Civil Engineering, 22nd PP ed. S. Dutta & Co. Lakhnow.

- D.D. Kohli, Estimating, Costing and Accounts, 9th PP ed. S. Chand & Co. Pvt. Ltd.

Landscape Engineering

Course Outline:

- Introduction, importance of landscaping, gardening and its design,
- Principles and elements of landscape design, landscape design materials,
- Types of designs; formal and informal garden designs, Chinese and Japanese gardening, rockeries, terrace, roof and water gardens,
- Plants suitable for various designs,
- Landscape designs for public and private buildings, parks and playgrounds etc.,
- Highway and roadside plantations,
- Developmental cost estimates for landscape.

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:

- Arora, J.S. 1992. Introductory Ornamental Horticulture. Kalyani Publishers, New Delhi.
- Booth, N.K. and W.H. Elsevier. 1983. Basic elements in Landscape Architecture Design. Science Publishing Co., New York.
- Khan, M.A. and T.A. Bader. 1992. Landscape Designs, Student Manual. University Printing Press, University of Agriculture, Faisalabad.
- McDaniel, G.L. 1982. Ornamental Horticulture. The Reston Publishing Company; Prentice Hall Co., Reston, Virginia.
- Raj, D. 2002. Floriculture and Landscaping. Kalyani Publisher, New Delhi.

Electives Courses for Farm Machinery Specialization

Boiler Engineering and Power Plants

Course Outline:

Introduction

- Boiler types, construction
- Mounting, accessories steam cycle

Steam Nozzles

- Supersaturated expansion in nozzles
- Heat drop in saturated and supersaturated expansion, steam injector

Steam Turbine and Impulse Turbine

- Work done, velocity diagram, work done in blading
- Velocity compounding, pressure compounding
- Heat account for boiler and turbine, amount of fuel burnt
- Acceptance tests, analysis and calorific value of fuel
- Analysis of flue gases, amount of steam produced

Pressure and Quality of Steam

- Design of boiler
- Pressure control system devices

Properties of Steam

- Enthalpy of water, dryness fraction, enthalpy of wet steam,
- Steam tables, superheated steam, internal energy of steam.

Steam Power Plants

- Introduction, general layout of modern steam plants,
- Steam generators, engines and auxiliary components,
- Back pressure and pass out turbines,
- Deviation of actual cycle from ideal,
- Turbine pump and condenser.

Gas Turbine and Power Plants

- Introduction, the gas turbine cycle, modification in basic cycle,
- Isentropic efficiency of Compressors and turbines,
- Inter-cooling and reheating,
- Explosion type gas turbine with solar heating,
- Development and improvement in gas turbine.

Jet propulsion Plant

- Introduction
- Comparison of steam and gas power plants.

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:

- Chattopadhyay, P. 2000. Boiler Operation Engineering. TATA McGraw HillPub. Co. Ltd., New Dehli, India.
- Kearton, W. J. 1999. Steam turbine theory and practice. 7th ed. CBS publishers & Distributors. New Delhi, India.
- Granet, I. and M. Bluestein. 2001. Thermodynamics and heat power, Pearson Education Asia.
- Cengel, Y. A. R. H. Turner. 2005. Fundamentals of thermal fluid sciences. McGraw Hill International.

Post-Harvesting Technologies

Course Outline:

Introduction

- Importance of cereal grains and other food products
- Food preservation, the food cycle
- Important factors of food production

Properties of Cereals

- Cereal grains and their structure,
- Physical properties, biochemical properties

Factors Affecting Grain Stability

- Physical factors, biological factors
- Chemical factors, thermal factors

Post-Harvest Losses

- Forms and measurement of post-harvest losses
- Measures to control losses

Pre-Storage Handling of Food Products

- Physiological maturity, harvesting, threshing
- Collection, transportation, and receiving system

Drying and Aeration

- Principle of drying, solar drying, artificial drying,
- Types of dryers, components of dryers, factors affecting drying rate,
- Natural aeration, artificial aeration,
- Methods of aeration, air conditioning/refrigeration

Storage

- Problems in grain storage
- Stored grain pests
- Control methods

Storage Structures

- Basic requirements for a storage structure, Classification of storage structure,
- Considerations in selecting type of storage structure
- Types of public storage structures, storage structure design,
- Temporary and permanent storage facilities, Non-conventional storage facilities,

Grades and Standards

- Importance of grades and standards, food quality,
- Establishing grades and standards,
- Assessing the grade, grade factors and their importance,
- Grading equipment, representative sampling,
- WTO, ISO and its regulation regarding quality control

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Ahay, K. M. and K. K. Singh. 2002. Unit operation of agricultural processing. 2 ed. Vikas Publishing House, New Delhi, India.
- Pandey, H. H. K. Sharma, R. C. Chauhan, B. C. Sarkar and M. B. Bera. 2004. Experiments in food process engineering. CBS Publishers and distributors, New Delhi, India.
- Toledo, R.T. 1980. Fundamentals of food processing engineering. AVI Pub. Co., Inc. Westport Connecticut.
- Mohsenin, N.N. 1980. Thermal properties of food and agricultural materials. Gordon and Breach, N.Y., USA.
- Mclean, K.A. 1980. Drying and storing combinable crops. Farming Press, Ltd. Wharfedale Road, Ipswich, Suffolk

Energy in Agriculture

Course Outline:

Introduction

- Overview of various types of energy sources
- Renewable and Non-renewable and their potential in the country

Energy Audit

- Energy utilization in agriculture
- Fertilizer (organic/inorganic), chemical controls, irrigation,
- Mechanization, post-harvest system and food consumption.
- Technological alternative for efficient energy management in agriculture

Energy from Agricultural Crops/Wastes

- Energy production from biomass
- Energy densities of biomass

Biogas

- Various types of biogas plants
- Design, installation
- Operation and management of biogas plants

Bio-Diesel

- Design, installation,
- Operation and management of bio-diesel plants

Solar Energy

- Solar radiation, basic earth-sun angles, time derived solar angles,
- Estimation of solar radiation, radiation measurements,
- Solar flat plate collectors for agricultural applications,
- Solar energy in agriculture (green houses and distillation)

Wind Energy

- Wind energy potential in the country.
- Application of wind energy (domestic / agriculture).
- Design of vertical and horizontal axis for wind mills

- Wind operated pumps for water lifting.

Energy Management:

- Energy conservation in tillage,
- Harvesting, threshing, and irrigation operations

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Sorensen, B. 2004. Renewable Energy. 2004. Elsevier Academic Press, UK
- Singh, M. P. 2005. International Encyclopedia of energy. DAYA Publishing House, Delhi, India
- Board, N. Handbook on biogas and its application. National Institute of Industrial Research, Delhi, India
- Pimental, D. 1993. Hand Book of Energy Utilization in Agriculture. CRC Press Inc. Florida, USA.
- Rai. G. D. 2001. Solar energy utilization. Khanna Publishers, N. Delhi, India
- Stout, B.A., 1990. Hand Book of energy for world agriculture. Elsevier Applied Science Ltd.

Emerging Farm Engineering Systems

Course outlines:

- Emerging Farm Systems
- Soil and crop mapping sensors,
- Machine vision technologies,
- Precision planters, pneumatic seed drill, direct seeding rice drill, real time data acquisition systems,
- Sensor integration technologies
 - a. Variable rate technology (VRT) sprayers,
 - b. Satellite imagery and advanced sensors,
 - c. Unmanned aerial vehicles (UAVs)/ drones
- Decision support systems (DSS),
- Crop stress and yield monitoring
- Vertical farming techniques (Tunnel and Hydroponic)
- Poultry mechanization
- Dairy mechanization
- Aquaculture mechanization
- Api and Seri culture

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:

- Stockel, W. M., M. T. Stockel and C. Johanson 2015. Auto Fundamentals. The Goodheart-Willcox Company, Inc. Tinley PBark, IL, USA.
- Zhang, Q. 2015. Precision Agriculture Technology for Crop Farming. CRC Press Publishers Pvt. Ltd. Taylor & Francis Group.

Hydraulic Machinery and Automation

Course outlines

Introduction

- Basic concepts and formation of hydraulic systems
- Overview of hydraulic control systems

Fluid Mechanics for Hydraulic Control systems

- Fluid properties and hydraulic fluids
- Fluid flow concepts and basic equations
- Inner flow in hydraulic systems
- Oil hammer
- Cavitation

Hydraulic Components

- Hydraulic pumps and motors
- Hydraulic actuators, hydraulic jacks
- External and internal hydraulic cylinders
- Hydraulic control valves, pressure control valves, directional control valves, and flow control valves
- Hydraulic system components

Hydraulic Control Systems

- Configuration of the components in hydraulic servo system
- Basic theory of control engineering
- Dynamic characteristics of a hydraulic component
- Design of a hydraulic control system

Hydraulic System Instrumentation

- Metering, measuring, and monitoring devices.

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:

- Noah, D. M., R. C. Fales. 2019. Hydraulic control systems. 2nd Ed. John Wiley & Sons, Inc., USA.
- Konami, S. 2016. Hydraulic control systems: Theory and practice. WSPC Publisher. US

Electronics Engineering

Course outlines

1. Introduction to Electronics
 - Conductors
 - Alternating current and direct current
2. Resistance, Capacitance and RC Time Constant
3. Inductance
4. Semiconductors
 - Diodes, Zener diode and DIAC
 - Transistors and their configurations
 - Field effect transistors
5. Rectifiers and Power Regulators
6. Amplifiers
7. Signals
 - Analog signals
 - Digital signals
8. Gates, Flip Flop and Registers (SISO, SIPO, PIPO, PISO)
9. Timers and Counters
10. Microcontrollers
 - Capabilities and structure
 - Basics of microcontroller programming
11. Circuit Designing and Simulation

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:

- Valchev, V. C. and A. Van den Bossche, 2018. Inductors and transformers for power electronics. CRC press, USA.
- Skvarenina, T. L. 2018. The power electronics handbook. CRC press, USA.
- Ioinovici, A. 2013. Power Electronics and Energy Conversion Systems: Fundamentals and Hard-switching Converters, Volume 1: John Wiley and Sons, NY, USA.

Robotics in Agriculture

Course outlines:

1. Introduction
2. Controller Types and Characteristics
3. Analog to Digital Converters
4. Digital to Analog Converters
5. Communication Protocols of Electronic Devices
6. Sensors and their Integration with Micro Controllers
 - Temperature sensor
 - Humidity sensor
 - Moisture sensor
 - pH and ORP sensors
 - Color sensor
 - Light sensor
 - Hall effect sensors (speed and flow sensors)
 - PID sensor

- Pressure sensor
 - Miscellaneous sensors
7. Actuators
- Electromagnetic actuators (gear, servo and stepper motors based actuators)
 - Hydraulic actuators (flow control valve, pressure regulator, pressure relief valve, hydraulic motor, hydraulic cylinder)
 - Pneumatic actuators (air pump, compressor, control valve, pneumatic cylinder)
8. Controller Designing and Simulation
9. Equipment Telematics, Agricultural Robotics and Robotic Farm Swarms,

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:

- Gieras, J. F., J. Piech, and B. Tomczuk, 2018. Linear synchronous motors: transportation and automation systems: CRC press, USA
- Blevins, T., W. K. Wojsznis and M. Nixon. 2013. Advanced control foundation: tools, techniques and applications: International Society of Automation (ISA).
- McMillan, G. K., C. M. Toarmina, 2011. Advanced Temperature Measurement and Control: International Society of Automation, USA.

Precision Agriculture

Course outlines:

- Explain precision agriculture
- Explain global positioning system
- Explain geographical information system
- Discuss soil fertility sensors
- Discuss yield monitors
- Explain Variable Rate Technology (VRT)
- VRT fertilizer applicators, plant protection VRT applicators
- Describe remote sensing
- Discuss application of remote sensing in precision agriculture
- Generate crop management zones and soil maps
- Discuss monitoring of crop health
- Discuss management decision support systems
- Discuss future prospects and developments

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:

- Precision Agriculture' 19 by John V. Stafford, ISBN: 9789086863372

Design of Agricultural Machinery

Course outline:

Philosophy of Design

- Formulating of procedure, importance of machine design in agricultural machinery, reliability
- Engineering standards, user economics.

Tolerance Design and Statistics

- Tolerance and allowances
- Application of statistics to manufacturing.
- **Stresses**
- Stress failure theory, design for deflection, strain determinations, stresses caused by impact.
- Power transmissions: V-belt forces, kinematics and design procedure, chain drive, forces, selection and design procedure. Universal joints,
- Description and functioning in agricultural machinery.

Linkages in Farm Machinery

- Velocity and acceleration determination,
- Four bar mechanism,
- Machinery mechanism,
- Forces on plows and discs.

Hydraulic Power System

- Hydrostatic drives and hydraulic pumps
- Pump performance and rating,
- Hydraulic motors performance and rating,
- Control valves, hoses and fitting, cylinders.

Design of Surfaces of Plow Bottoms

- Design of moldboard plow and disk plow.
- Stability of plows: Force equilibrium and stability,
- Supporting elements,
- Plow stability in horizontal plane,
- Procedure for measuring the quality and testing plows.

Teaching Methodology:

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, Quizzes, Design Projects, Complex Problems, Final Term

Suggested Books:

- Budynas, R.G. and J.K. Nisbett. 2015. Mechanical Engineering Design. 10th Edition. Published by McGraw Hill Education, NY, USA.
- Chen, G. 2018. Advances in Agricultural Machinery and Technologies. 1st Ed. Published by CRC Press, Taylor and Francis Group, USA.
- Sharma, D. N. 2013. Farm Machinery Design: Principles and Problems. Jain Brothers, New Dehli, India.

Agro-Industrial Engineering

Course outline:

Introduction:

- Industrialization and industrial policies of Pakistan; classification of agro-based industries, management,
- Operations research, system engineering, statistics,
- Ergonomics, manufacturing engineering,
- ISO and WTO regulations.

Production System Design:

- Mill and plant layout
- Line diagrams;
- Flow diagrams,
- Work measurement,
- General terminologies used in physical measurements.

Product System Control:

- Inventory control, production control, production planning, quality control, statistical process
- Control charts, sampling plan, total quality management.

Industrial Management:

- Definition of management, functions of management, personal management, human resource development,
- Policy formulation and decision making.
- Materials purchase and stores management.
- Cost management,
- Production routing,
- Scheduling and dispatch management.

Operations Research:

- Introduction, linear programming, graphical and algebraic method,
- Transportation algorithm, assignment algorithm,
- Queuing theory and simulation.

Engineering Economy:

- Pricing, costing, interest calculation, present worth, future worth, annual rate of return, annual cost method, return on investment, payback method,
- Cost control engineering.

Industrial Safety Engineering:

- Safety measures, accidents causes, job safety analysis.
- Machine guards and safety equipment
- Control of noise, contaminants and radiation/heat etc.
- Health hazards and safety management.
- Health and safety policies.

Industrial Environmental Communication and Pollution:

- Industrial environmental education,
- Factors affecting environment of different industries,
- Environmental planning,

- Monitoring and control strategies of recycling materials for ecological balance.
- Sources of pollution, e.g. natural sources, industrial sources, point sources and non-point sources.
- Industrial revolution and its impact on soil, water, air and human health.
- Effect of unplanned technological growth on environmental pollution.

Teaching Methodology:

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, Quizzes, Design Projects, Complex Problems, Final Term.

Suggested Books:

- Hicks. P. 1994. Industrial engineering and management. 2nd Ed, McGraw Hill International Edition, New York.
- Kumar, B. 2001. Industrial Engineering. Khanna Publishers, Nath Market, Delhi, India.
- Patil, S.B. 2008. Industrial Engineering and Management. Technical Publications, Pune, India.
- Reddy, C.N.M. 2007. Industrial Engineering and Management. New Age International Publishers, India.
- Telsang, M. 2004. Industrial Engineering and Production Management. Tata McGraw Hill. N. Delhi, India.

Multidisciplinary Engineering Courses

Wastewater Engineering

Course Outline:

Water Quality:

- Definitions and Terminology, Water Quality Indicators, key terms and Objectives
- Conventional and Emerging Water Pollutants and their Sources
- Drinking, Irrigation and Industrial Water Standards and Regulations (PEPA and WHO)
- Water Quality Status, Conveyance and Distribution Issues in Pakistan

Water Characteristics and Science

- Physical: Solids, Turbidity, Color, Taste and Odor, Temperature
- Chemical: pH, Total Dissolved Solids, Alkalinity, Hardness, Fluoride, Metals, Nutrients
- Biological: Bacteria, Viruses, Protozoa and other pathogens indicators
- Concepts of Water Cycle, Chemistry and Microbiology

Water Treatment Unit Operations and Processes

- Screening, Aeration, Sedimentation, Chemical Addition, Rapid and Slow Mixing, Flocculation, Filtration
- Coagulation, Neutralization, Disinfection, Fluoridation, Water Softening, Turbidity Removal, Re-carbonation, Disinfection, Taste and Odor Control
- Direct Filtration and Softening Water Treatment Plants

Advanced Water Treatment Processes

- Ion Exchange, Ozonation, Adsorption, Ultra Filtration
- Membrane Processes, UV and Ozone Disinfection

Wastewater Characteristics and Treatment

- Physical: Total Solids and Fractions (Suspended, Dissolved, Volatile and Fixed), Color, Temperature and Odor
- Chemical: pH, Dissolved Solids, COD and Fractions (particulate and dissolved), Alkalinity, Nutrients, Inorganics including Metals

- Biological: Biodegradable Organics, BOD fractions, microbial and pathogens indicators
- Terminologies and Definitions, Goals and levels of Wastewater Treatment
- Wastewater Treatment Regulations and Standards

Wastewater Collection and Treatment Processes

- Sewerage and Wastewater Collections Systems
- Physical Unit Operations, Chemical and Biological Unit Processes
- Preliminary Treatment: Screening, Shredding, Grit Removal, Pre-aeration, Equalization
- Sampling and Preliminary Treatment Process Control

Primary Wastewater Treatment (WWT)

- Sedimentation Process and Types of Sedimentation Tanks
- Clarifier loading and Process control,
- TSS and BOD Removal Performance, sludge pumping
- High rate and Chemically Enhanced Primary Treatment

Secondary Biological WWT

- Microorganisms and their role in wastewater treatment
- Types of biological processes for wastewater treatment
- Secondary Treatment Terminology and Process equipment
- Bacterial Growth kinetics (Monod equation) and Process Modelling

Suspended and Attached Growth Biological Treatment Systems (Aerobic & Anaerobic)

- Aerated Lagoons, Stabilization Ponds and Oxidation Ditches
- Activated Sludge Process, Factors affecting, Modifications and Process Control
- Sequencing Batch Reactors (SBR) and up flow Anaerobic Sludge Blanket (UASB)
- Trickling Filters and Packed-bed Reactors
- Secondary Clarification and Plant Performance

Advanced Treatment Systems

- Chlorine Disinfection, Ozonation and UV irradiation

- Chemical Treatment, Micro-screening, Filtration, Biological Nutrients Removal, Land Treatment and other options

Sludge Treatment and Disposal

- Sludge Thickening and Conditioning
- Sludge Stabilization (Aerobic and Anaerobic Digestion) and Dewatering

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:

- Mackenzie L. Davis, Susan J, Masten 2014. Principles of Environmental Engineering and Science. McGraw Hill
- Spellman, Frank R., 2003. Handbook of Water and Wastewater Treatment Plant Operations. Lewis Publishers. CRC Press Company, Boca Raton London New York Washington, D.C.
- Metcalf and Eddy, 2013. Wastewater Engineering: Treatment and Reuse, 4th ed. McGraw Hill, ISBN: McGraw-Hill.

Alternative and Renewable Energy

Course Outline:

History of Energy Usage, forms of energy, present energy consumption, environmental problems, and Current status of conventional and renewable energy sources: World and Pakistan scenario, energy and power;

Fossil Fuel Resources (Oil, Gas, Coal)

Solar Thermal Energy:

- a. Solar radiation resource,
- b. Passive and active solar heating,

- c. Solar Concentrators

Solar Photovoltaic:

- a. Components of PV systems and operation

Biomass:

- a. Biomass resource,
- b. Extracting biomass energy,
- c. Fuel crops,
- d. Anaerobic digestion,
- e. Landfill gas,
- f. Waste to energy

Hydroelectricity

- a. Hydro power Resource,
- b. Hydropower power equation,
- c. Introduction to turbines,
- d. Large and small scales systems,
- e. Pumped storage,
- f. Tidal Power, g. The tides, tidal resource, system operation, environmental factors

Wind Energy

- a. Generation of the winds,
- b. Wind resource,
- c. Basic aerodynamics (lift versus drag) and the fundamental power equation,
- d. Fundamental design concepts.

Wave Energy

- a. The wave resource,
- b. The fundamental power equation,
- c. Onshore and off-shore wave energy extraction systems

Geothermal Energy

- a. Nature of Fields,
- b. Classification of Geothermal Resources,
- c. Introduction to geothermal steam electric plants,

- d. Liquid Dominated System: Flashed Steam System, Total Flow Concept, and Geothermal exploration.

Fuel Cell

- a. Introduction and Classification,
- b. Reactions and Configurations

Nuclear Energy

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:

- Duffie, J.A. and W.A. Beckman. 2013. Solar Engineering of Thermal Processes, 3rd Edition, John Wiley & Sons.
- Boyle, G. Renewable Energy: Power for a Sustainable Future. 2nd Edition, OUP and Open University, 2004, ISBN 019926178-4.
- Boyle, G., B. Everett, and J. Ramage. 2003. Energy Systems and Sustainability, OUP and Open University, 2004, ISBN-13: 9780199261796.
- Scheer, H., A Solar Manifesto, James & James, 2004, ISBN 1 902916 24 7.
- Kalogirou, S.A. 2009. Solar Energy Engineering: Processes and Systems. 1st Ed. British Library. ISBN 978-0-12-374501-9. Printed in USA.
- B. Viswanathan, M. Aulice Scibioh. 2007. Fuel Cells: Principles and Applications. Taylor & Francis Group, 2007.

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:

- i. Identify hazards in the home, laboratory and workplace that pose a danger or threat to their safety or health, or that of others.
- ii. Control unsafe or unhealthy hazards and propose methods to eliminate the hazard.
- iii. 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.
- iv. 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

Agricultural Sciences

Basic Agriculture

Course Outline:

Introduction

Introduction to the Engineering Profession and its Fields of Specialization with particular emphasis on Agricultural Engineering.

Crop Production

Major crops of Pakistan, Factors affecting crop production and distribution. Requirements for agricultural development. Classification of field crops based on agronomic use, special purpose and other basis.

Seed Technology

Role of seed in crop production. Concept of seed technology. Seed Structure and growth, Dormancy, Seed Production and its quality, Seed Processing and Seed Storage.

Farming Systems and Tillage Practices

Crop rotation. Definition and computation of cropping intensity. Farming systems and its kinds. Objectives of tillage. Effect of tillage on soil conditions, plant diseases and insects.

Dry Land Farming

Introduction, Importance, Rainfall pattern, Barani cultivation practices, Barani Agro-ecological zones, Problems and constraints of dry land, Dry land improvement, Dry land management, Barani cropping system

Land Resources and Management

Soil zones and Soil resources of Pakistan. Sustainability of land resources. Managing soil resources

Agro-Meteorology

Introduction, Weather and climate, Climatic components, Classification of climates, Climatic factors and crop production

Agro-Ecology

Introduction, Agro-ecological Features of Pakistan, Agro-ecological zones, Agro-ecology of Punjab

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:

- Nazir, S. (1994). Crop Production. National Book Foundation, Islamabad.
- Martin, J. H., W. H. Leonard and D. L. Stamp. (1990). Principles of Field Crop Production, 3rd edition. Macmillan Co. Inc New York.

Soil Science

Outline:

Soil Perspective

What is soil? Edaphology and Pedology, A field view of soil, Soil profile, Subsoil and Surface soil, Mineral vs. Organic soils. Four major Components of Soils, Mineral constituents in soils, Soil organic matter, Soil water, Soil air, clay and humus.

Important Physical Properties of Mineral Soils

Soil texture and Soil Structure, Classification of soil particles, Physical nature of soil separates, Soil texture classes. Mechanical analysis, Preparation of the Sample, Factors affecting dispersion, Methods for obtaining dispersion, Fractionation of the sample, Sieve method. Stokes' Law. Sedimentation methods, Determination of soil class, Particle and Bulk Density, Pore Space, Structure of mineral soils, Aggregation and its promotion, Structural management of soil, Soil Consistence.

Soil Colloids

General constitution of Silicate clays, Adsorbed cations, Silicate clay structure, Classification of Silicate clays, Chemical Composition of silicate clays, Cation exchange capacity of soils, Plasticity, Cohesion, Swelling, Shrinkage, Dispersion and Flocculation.

Soil Water

Structure and related properties of water, Soil water energy concept, Soil Moisture content versus Suction, Measuring Soil moisture, Capillary Fundamentals, Types of soil water movement, Saturated flow through soils, unsaturated flow in soils, Retention of soil moisture in the field, Conventional soil moisture classification, Factors affecting amount and use of available soil moisture, Capillarity and root extension.

Soil Air and Soil Temperature

Soil aeration definition, soil aeration problems in the field, Composition of soil air. Factors affecting the composition of soil air, Fick's Law, Aeration in relation to soil and crop management. Soil temperature, Specific Heat of soils, Volumetric Heat Capacity, Thermal diffusivity, and Conductivity, Fourier's Law, Movement of Heat in soil, Soil temperature control.

Plant Nutrients and Fertilizers

Factors controlling the growth of higher plants, The essential elements from air, water and soil, Soil solution, Soil and plant interrelations, fertilizer elements, Nitrogen Fertilizers, Phosphates Fertilizers, Potassium Fertilizers, Mixed Fertilizers, Methods of applying solid fertilizers, Application of liquid Fertilizers.

Saline and Sodic Soils

Climate and salinity, Some basic terms, Saline, Saline alkali and Sodic Soils, Diagnosis of Saline and Sodic Soils, Reclamation Steps of Salt-affected soils, Leaching Requirements, Crop tolerance to Salinity.

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:

- Brady, N.C. (2008). The Nature and Properties of Soils (14th Edition). Macmillan Co. Ltd. USA.
- Rashid, A. and K. S. Memon. (1996). Soil Science. National Book Foundation, Islamabad.
- Tanji, K.K. 1990. Agricultural salinity assessment and management. ASCE No.71, New York, USA.
- Gupta, I.C. 1990. Use of saline water in Agriculture. Oxford and IBH Pub. Co., New Delhi, India.

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
- A. J. Thomson and A. V. Martinet. Practical English Grammar, “University Physics”, 13th Edition

Communication Skills

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outlines:

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

Writing Skills

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

Reading Skills

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

Listening Skills

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

Speaking Skills

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Technical Writing and Presentation Skills

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outlines:

- Introduction to Technical writing
- Proposal write-up and improvement strategies Introduction to research and research types choosing research problems and research advisors How to carry out research
- Formulation – Problem statement, Literature
- Review
- Design - Methodology
- Analysis - Data analysis and interpretation Good writing style techniques
- Uses of correct words
- Presenting and publishing research

- Write business/professional correspondence, cover letter and CV
- Writing meeting minutes

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Mathematics Courses

Linear Algebra

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline:

System of Linear Equations and Applications

- Overview of linear system of equations, Cases of unique solution, No solution and infinite solutions,
- Echelon form, Gauss elimination method, Inversion of matrix in the context of solution of system of equations, LU factorization, Row space and column space
- Relevant engineering case studies such as Network analysis, Traffic Flows, Balancing chemical reaction, Leontief Input-output model,

Finding max stress in compound cylinder, Applications of linear systems in force balancing of structures, Markov process

Vector Spaces and Transformations

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

Eigenvalues and Eigen Vectors

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

Linear Programming

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

Application of Linear Algebra in Dynamical Systems

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Calculus and Analytical Geometry

Area Scope:

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

Course Outline:

Analytical Geometry:

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

Functions Limit and Continuity:

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

Differentiation:

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

Applications of Derivatives:

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

Integration:

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

Applications of Integration:

- Applications of Integration
- Area under the curve
- Area between curves

- Solids of Revolution
- Volume of Solids of revolution by disk
- Washer, Cylindrical shell & Cross Section Methods
- Center of Pressure and Depth of Center of Pressure
- Center of mass
- Arc length

Improper Integrals:

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

Infinite Sequence and Series:

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

Power and Taylor Series:

- Power series
- Maclaurin and Taylor Series and its Applications

Teaching Methodology (Proposed as applicable):

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

Assessment

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

Suggested Books:

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

Differential Equations

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline:

Basic Concepts and Modeling

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

Analytical Methods of Solution for First-order ODEs

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

Mathematical Models Based on Second-order ODEs

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

Analytical Methods of Solution for Second-order ODEs

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

Series Solution for Second-order ODEs

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

Laplace Transform

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

Partial Differential Equations

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

Teaching Methodology (Proposed as applicable):

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

Assessment

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

Suggested Books:

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

Numerical Analysis

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline

Error Analysis and Interpolation

- Error analysis, Types of error, Sources of error, Norms of vectors and matrices, Computer arithmetic, Condition number of a matrix, Significant digits and loss of significant digits, Floating point arithmetic, Binary and decimal representation, Single and double precision

- Interpolation: Newton forward and backward difference formula for interpolation, Central difference interpolation formulae, Lagrange's interpolation, Error in interpolation, Linear least square approximation, Interpolation versus least square approximation, Relevant engineering case studies

Numerical Differentiation and Integration

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

Methods of Solution a System of Linear Equations

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

Iterative Methods for Linear and Nonlinear Equations

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

Numerical Methods for IVPs and BVPs

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

Numerical Methods for Computing Eigenvalues

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

Numerical Optimization

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

Teaching Methodology (Proposed as applicable):

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

Assessment

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

Suggested Books:

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

Probability & Statistics

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline

Basic Statistics

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

Data Presentation

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

Measure of Central Tendency

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

Measure of Dispersion

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

Simple Regression, Correlation and Curve Fitting

- Introduction to regression theory, Simple linear regression line, Line fitting by least square methods, Coefficient of determination,

- Simple correlation, coefficient of correlation, fitting of a first and second degree curve, fitting of exponential and logarithmic Curves, related problems.
- Principle of least squares.

Probability and Random Variables

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

Probability Distributions

- Discrete distributions
- Bernoulli distribution, Binomial, Geometric, Negative binomial, 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 Books:

- Thomas' Calculus by George B. Thomas, Jr., Maurice D. Weir, Joel R. Hass. Pearson, USA.

- George B. Thomas, Jr. and Ross L. Finney, Calculus and Analytic Geometry
- Swokowski, Onlinick & Pence: Calculus
- Robert T. Smith & Roland B. Minton: Calculus
- Calculus: Early Transcendental by James Stewart, Brooks/Cole USA.

Applied Physics

Course Outline:

Vectors:

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

Mechanics:

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

Thermodynamics:

Laws of thermodynamics and Heat Transfer Mechanisms, Heat and Work, Kinetic Theory of gases, Ideal gases, Mean Free path, distribution of molecular speeds, Change in Entropy and Irreversible processes.

Electricity & Magnetism:

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

Waves & Oscillations:

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

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.

Soil Physics:

Thermal and Physical properties of Soil; Factor affecting; heat flow equations, Transport of gases and water vapors through soil, Transport of inert, non-adsorbing and adsorbing chemicals in soil, Volatile organic compounds transport in soil.

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. Jewett, Jr. Physics for Scientists and Engineers with modern Physics, 9th Edition.
- G. B. Thomas, R. L. Finney, "Calculus and Analytic Geometry", 13th Edition.
- Hillel, D. 1998. Environmental Soil Physics. Elsevier Academic Press, San Diego, CA, USA.
- Hillel, D. 2004. Introduction to Environmental Soil Physics. Elsevier Academic Press, San Diego, CA, USA.

Applied Chemistry

Area Scope:

This chemistry course emphasizes the fact that engineers should have a significant understanding in basic sciences such as chemistry. The contents of the course are context based and are thoroughly related to real world problems such as clean energy devices, combustion, and environmental degradation. Throughout the course chemical calculations are emphasized so that our graduates are not handicapped on the workplace and be able to:

- Apply fundamental principles and laws of chemistry in carrying out chemical calculations.
- Connect chemical concepts to real-world applications through an adequate foundation in the fundamentals of chemistry for engineers.
- Discuss environmental pollution particularly air pollution in terms of the role of free radicals in forming acid rain, ozone, urban smog and global warming and describe fresh and wastewater treatment for public safety and water conservation.
- Get familiarized with high tech chemistry such as nano-chemistry and adhesive chemistry.

Course Outline:

- **Introduction:** Chemical calculations and stoichiometry, chromatography, thermogravimetry; algebraic method of balancing chemical equations.
- **Structure and Chemical Bonding:** Electronic configuration; metallic, ionic and covalent bonding; electronegativity, bond polarity, and bond strength, mass spectrometry and atomic mass unit.
- **Electrochemistry:** Laws of electrolysis, the electromotive force (EMF), galvanic cells, batteries, corrosion (theories, inhibition and protection).
- **Air pollution,** Interaction of solar radiation with atoms and molecules in the atmosphere,
- **Aqueous Solutions:** The equilibrium state, equilibrium constants, Le Chatelier's principle, quantitative calculations; acid-base equilibria, pH, buffers. Standardization of solutions for titration.
- **Nano-chemistry,** Thin films, Physical Vapor Deposition (PVD), Chemical Vapor Deposition (CVD)

- **Polymers and Adhesive Chemistry:** The systematic chemistry of carbon compounds; nomenclature and properties of common organic functional groups; fundamentals of polymer chemistry; adhesives and bonding fundamentals.

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:

- 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 intend 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 Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Godhade, J. B., and S.T. Hunderkari. 2018. Social Responsibility of Engineers. International Journal of Academic Research and Development. Vol. 03; Special Issue. March, 2018.

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

Sociology

Area Scope:

The knowledge units in this area collectively encompass the following:

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

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

Course Outline:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Social Psychology

Area Scope:

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

Course Outline:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Community Services

Area Scope:

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

Course Outline:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Organizational Behavior

Course Outline:

Introduction to Organizational Behavior

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

Structure and Control in Organization

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

Individual and Work Learning

- Learning Theories
- Learning and Work

Stress

- Types of Stress and Work
- Occupational Stress Management

Individual Differences

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

Motivation and Job Satisfaction

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

Group and Work

- Social Interaction
- Dramaturgy and impression Management
- Social Skill

Group and Inter Group Behavior

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

Leadership

- Leadership as an attribute
- Leadership Style

Patterns of Work

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

Organizational Culture

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Fincham, R., & Rhodes, P. (2003), Principles of Organizational Behaviour, 3rd Oxford.

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

Engineering Economics

Area Scope:

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

Course Outlines:

Engineering Economics

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

Interest Rate and Economic Equivalence

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

Understanding Money and Its Management

- Nominal and Effective Interest Rates

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

Present-Worth Analysis

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

Annual Equivalent-Worth Analysis

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

Rate-of-Return Analysis

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

Cost Concepts Relevant to Decision Making

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

Depreciation and Corporate Taxes

- Asset Depreciation: Economic versus Accounting
- Book and Tax Depreciation Methods (MACRS)
- Depletion
- Income Tax Rate to be used in Economic Analysis

- The Need for cash Flow in Engineering Economic Analysis

Developing Project Cash Flows

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

Project Risk and Uncertainty

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

Special Topics in Engineering Economics

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Professional Ethics

Area Scope:

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

Course Outlines:

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Cultural Courses

Islamic Studies and Ethics

Course Description:

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

Area Scope:

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

Course Outline:

Islam – Religion of Peace and Harmony

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

Islamic Culture and Civilization

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

Social System of Islam

- Basic Concepts of Social System in Islam
- Elements of Family and their Rights - Parents, Women, Husband & Wife, Children
- Inheritance – Rights and Laws
- Social Rights – Neighbors, Relatives and Society
- Equality and Brotherhood
 - Selected Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77)
- Concept of Welfare State – Period of Khilafat-e-Rashida

Professional Ethics and Morality

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

Islam and Science

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

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Al-Qur'ān القرآن (selected text).
- Sayyid Tāhir Rasūl Qādri 52 دروس قرآن (Karachi: Islamic Research Academy, 7th ed., 2017).
- Sayyid Hasan-uddin Ahmad, 2-تعلیمات قرآنی 2-vols., (Karachi: Jasarat Publications, 1998).
- Muhammad Shafī‘, معارف القرآن (Karachi: Dar-ul-Isha'at, 2000).
- Sayyid Abu'l A'la Mawdūdī, تفہیم القرآن 6vols., (Lahore: Islamic Publications, 1998). [Preambles of all (114) chapters.]
- Amin Ahsan Islahi, تدبرالقرآن (Lahore: Farān Publications, 2005).
- Khawaja Abdul Waheed, موضوعات قرآن و انسانی زندگی (Islamabad: Islamic Research Institute, 3rd ed., 1997).
- Khurram Murad, رب کا پیغام (Lahore: Manshūrat, Mansoor, 2000)
- Hameed ullah Muhammad, “Emergence of Islam”, Islamic Research Institute (IRI), Islamabad

- Hameed ullah Muhammad, “Muslim Conduct of State” Sh Muhammad Ashraf, Kashmir Bazar, India (Latest Edition)
- Hameed ullah Muhammad, “Introduction to Islam” Compiled by The CSS Point, www.thecsspoint.com
- Hussain Hamid Hassan, “An Introduction to the Study of Islamic Law” leaf Publication Islamabad, Pakistan, (Latest Edition).
- H.S. Bhatia, “Studies in Islamic Law, Religion and Society” Deep & Deep Publications New Delhi (1989).
- Islamic Education by A. S. Bukhari & M. D Zafar, Latest Edition.
- Muslim’s character by M. Al-Ghazali, Latest Edition.

Pakistan Studies and Global Perspective

Area Scope:

The knowledge units in this area collectively encompass the following:

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

Course Outline:

Time

Duration

Historical and Ideological Perspective

5 hrs

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

Constitution of Pakistan

4 hrs

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

Contemporary Pakistan

4 hrs

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

Economy of Pakistan

4 hrs

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

Land of Opportunities

4 hrs

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

Pakistan's Foreign Policy

5 hrs

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

Pakistan in pursuit of Global Agenda

4 hrs

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Khalid B. Sayeed, Pakistan: The Formative Phase 1857 – 1948, Pakistan Publishing House, 1960
- Gulam Allana, Quaid-e-Azam: the story of Pakistan, Ferozsons, 1967.
- Shahid M. Amin, Pakistan's Foreign Policy: A Reappraisal, Oxford University Press, 2010.
- S. Akbar Zaidi, Issues in Pakistan's economy, Oxford University Press, 2003.
- Hamid Khan, Constitutional & political history of Pakistan, Oxford University Press, 2003
- Rafi Raza, *Pakistan in Perspective 1947-1997*, Oxford University Press, 2003
- Sharif-ul-Mujahid, *The Ideology of Pakistan*, Progressive Publishers, 1974.
- Ziring Lawrence, *Pakistan in the Twentieth Century*, Oxford University Press, 1997 -
- Burke S. M. & Ziring Lawrence, *Pakistan's Foreign Policy*, Oxford University Press, 1973. Mohammad Qadeer , Pakistan
- Climate Change Policies-Ministry of Climate Change, Islamabad-
<http://mocc.gov.pk/>
- Sustainable Development Goals (SDGs)- www.pc.gov.web/sdg/sdgpak
- Economic Survey of Pakistan- http://finance.gov.pk/survey_1617.html
- Foreign Policies- Ministry of Foreign Affairs, Pakistan
<http://mofa.gov.pk/>
- Population Census of Pakistan- Economic Survey of Pakistan
http://finance.gov.pk/survey_1617.html
- Issues in Pakistan's Economy by S. Akbar Zaidi, ISBN: 0195790529.

- Pakistan's Foreign Policy: A Reappraisal by Shahid M. Amin. ISBN: 0195798015
- Newspapers editorial and selected journalistic writings on current affairs.
- Pakistan (Lands, Peoples, & Cultures) by Carolyn Black, Bobbie Kalman. ISBN: 0778797147

Management Sciences Courses

Engineering Project Management

Area Scope:

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

Core Objectives of this course are:

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

Course Outline:

Project Management Concepts

History of Project Management, Introduction to Project Management, Project, Program & Portfolio Management, Project characteristics, Objectives&

Requirements, Project Phases/Stages, Project Life Cycle, Project Environment, Project Scope & Project Charter, Project Manager, Project Stakeholder Analysis.

Project Proposal Development

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

Project Feasibility

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

Project Selection Criteria (Economic Analysis of Engineering Projects)

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

Project Contract & Procurement Management

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

Project Planning and Scheduling

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

Project Costing & Estimation

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

Project HRM & Communication Management

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

Project Risk Management

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

Computer Application in Project Management

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

Project Quality Management

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

Project Closure & Termination

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

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

- Project Management: A system Approach to Planning, Scheduling and Controlling 11th Edition, Harold Kerzner
- Bennett, F. Lawrence. 1996. The management of engineering. New York: Wiley.
- Cleland, David. Field guide to project management. New York: Wiley.
- Eisner, H. Essentials of project management and systems engineering management. New York: Wiley.

- Frame, J. D. Managing projects in organizations. San Francisco: Jossey-Bass
- Goldratt, Eliyahu. Critical chain. North River Press.
- Haynes, M.E. Project management: From idea to implementation. Los Altos, CA: Crisp Publications.
- Lewis, James, Project planning, scheduling & control. New York: McGraw-Hill
- Lewis, James, P. 1998. Mastering project management. New York: McGraw-Hill
- Lientz, Bennet & Rea, Kathryn. 1995. Project management for the 21st century. San Diego: Academic Press.
- Miller, Roger & Lessard, Donald. 2000. The strategic management of large engineering projects. Cambridge, MA: MIT Press.
- Nicholas, J.M. Managing business & engineering projects. Englewood Cliffs, NJ: Prentice Hall.
- Shtub, Avraham, Bard, Jonathan, & Globerson, Shlomo. 1994. Project management: Engineering, technology, and implementation. Englewood Cliffs, Prentice-Hall.
- Project Management by Adrienne Watt
- J.R. Meredith and S.J. Mantel. Project Management: A Managerial Approach. John Wiley and Sons. New York. 2019. (Reference).

Entrepreneurship

Area Scope:

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

Course Outlines

- Basic Concept-Entrepreneurship
- Innovation and Entrepreneurship
- Basic Plan Development Cycle

- Intellectual Rights
- Financial and Legal Modalities
- Marketing
- Industrial Competiveness
- Gap Analysis, Critical Thinking and Idea Generation
- Business Plan Development
- Successful Case Studies (local)

Teaching Methodology (Proposed as applicable):

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

Assessment:

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

Suggested Books:

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

Principles of Management

Area Scope

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

Course 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:
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