

CURRICULUM
OF
ENVIRONMENTAL ENGINEERING
BE/BS
ME/MS

(Revised 2012)



HIGHER EDUCATION COMMISSION
ISLAMABAD

CURRICULUM DIVISION, HEC

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PREFACE

The curriculum of the subject is described as a throbbing pulse of a nation. By viewing curriculum one can judge the stage and pace of socio-economic development of a nation. With the advent of new technology, the world has turned into a global village. In view of tremendous research taking place world over new ideas and information pours in like of a stream of fresh water, making it imperative to update the curricula after regular intervals, for introducing latest development and innovation in the relevant field of knowledge.

In exercise of the powers conferred under Section 3 Sub-Section 2 (ii) of Act of Parliament No. X of 1976 titled “**Supervision of Curricula and Textbooks and Maintenance of Standard of Education**” the erstwhile University Grants Commission was designated as competent authority to develop, review and revise curricula beyond Class-XII. With the repeal of UGC Act, the same function was assigned to the Higher Education Commission under its Ordinance of 2002 Section 10 Sub-Section 1 (v).

In compliance with the above provisions, the HEC undertakes revamping and refurbishing of curricula after regular intervals in a democratic manner involving universities/DAs, research and development institutions and local Chamber of Commerce and Industry. The intellectual inputs by expatriate Pakistanis working in universities and R&D institutions of technically advanced countries are also invited to contribute and their views are incorporated where considered appropriate by the National Curriculum Revision Committee (NCRC).

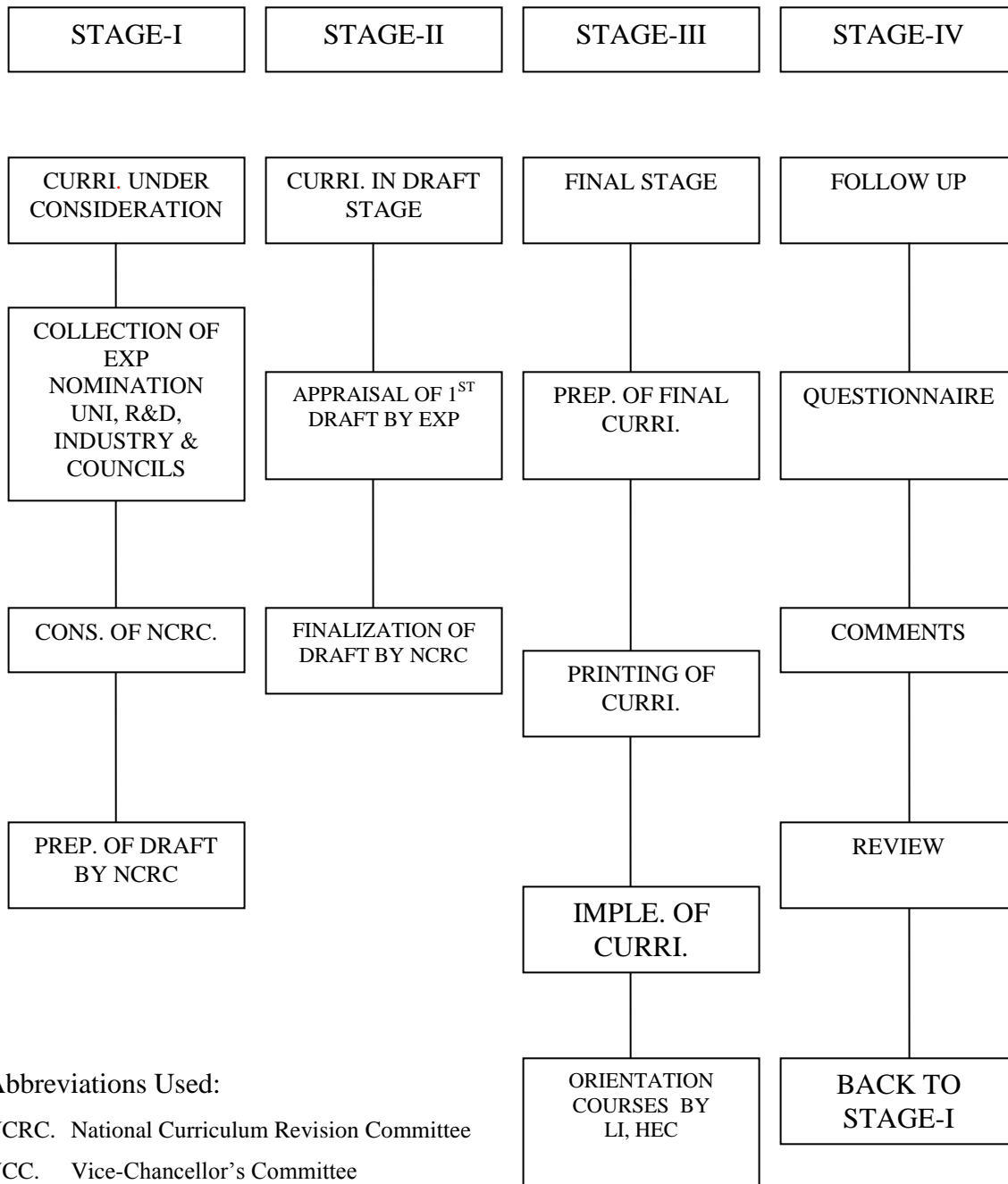
A committee of experts comprising of conveners from the National Curriculum Revision of HEC in Basic, Applied Social Sciences and Engineering disciplines met in April 2007 and developed a unified template to standardize degree programs in the country to bring the national curriculum at par with international standards, and to fulfill the needs of the local industries. It also aimed to give a basic, broad based knowledge to the students to ensure the quality of education. The BS degree shall be of 4-years duration, and will require the completion of 130-136 credit hours.

In line with above, NCRC comprising senior university faculty and experts from various stakeholders and the respective accreditation councils has finalized the curriculum for Environmental Engineering. The same is being recommended for adoption by the universities/DAs channelizing through relevant statutory bodies of the universities.

MUHAMMAD JAVED KHAN
Adviser Academics

April, 2012

CURRICULUM DEVELOPMENT



Abbreviations Used:

- NCRC. National Curriculum Revision Committee
- VCC. Vice-Chancellor's Committee
- EXP. Experts
- COL. Colleges
- UNI. Universities
- PREP. Preparation
- REC. Recommendations
- LI Learning Innovation
- R&D Research & Development Organization
- HEC Higher Education Commission

INTRODUCTION

The final meeting of National Curriculum Revision Committee on Environmental Engineering was held at HEC Regional Centre, Lahore from February 7-9, 2012 to review the BE/BS and ME/MS Environmental Engineering Curriculum 2008. The following members attended the meeting:

Dr. Zahir-ud-Din Khan Associate Professor & HOD Environmental Engineering, NUST, Islamabad.	Convener
Dr. Qaisar Mahmood (TI) Associate Professor, Department of Environmental Engineering, COMSATS Institute of Information Technology, Abbottabad.	Secretary
Engr. Dr. Nasir Mahmood Khan Additional Registrar, (Accreditation), Pakistan Engineering Council (PEC), Attaturk Avenue (East), G-5/2, Islamabad.	Member
Dr. Muhammad Saffar Mirjat Professor & Dean, Chairman Department of Energy & Environment, Sindh Agriculture University, Tandojam.	Member
Prof. Dr. Sajjad Haydar Professor, Department of Environmental Engineering, University of Engineering Technology, Lahore.	Member
Dr. Shahid Amjad Professor, Department of Environmental & Energy, Institute of Business Management, Korangi Creek, Karachi.	Member
Dr. Mansoor Imam Professor, Department of Civil Engineering, Sir Syed University of Engineering and Technology, University Road, Karachi.	Member

Engr. Shafiq Anwar, Member
Assistant Professor,
Department of Structures & Environmental
Engineering,
University of Agriculture, Faisalabad.

Dr. Arjumand Z. Zaidi, Member
Assistant Professor,
RS & GIS Department,
Institute of Space Technology, Karachi Campus.

The meeting started with recitation of verses from the Holy Quran by Mr. Muhammad Ishaq. Mr. Muhammad Raza Chohan, Director Higher Education Commission Regional Centre, Lahore formally welcomed all the participants. Malik Arshad Mahmood, Director Curriculum then briefed the participants on the aim and objectives of the meeting with a particular focus on revising the course contents of BE/BS (4-year) and ME/MS Environmental Engineering to meet the international standards and demands as well as ensuring the uniformity of academic standard within the country. The committee unanimously elected the following members to conduct the meeting formally.

1. Convener Dr. Zahir-ud-Din Khan, Associate Professor, IESE/NUST, Islamabad.
2. Secretary Dr. Qaisar Mahmood Associate Professor, COMSAT, Abbottabad.

Convener introduced the need for revision and stressed over the review of current syllabus in the light of National Environmental problems and International scenario. He suggested that we must include some practical courses, field visits to industries etc. in the current curriculum. His point was unanimously supported by all the NCRC members.

Regarding the teaching of English course NCRC decided that two courses should be offered instead of three. The existing courses English I and English II were renamed as:

- a. Communication Skills (3-0)
- b. Technical Writing Skills (2-0)

Members agreed that Technical Writing Skills must be taught to improve the technical writing capabilities of the graduating Environmental Engineers. If some university authorities feel that their students are weak in English, they can offer a zero credit English course during summer holidays.

The name of Islamiyat was changed to Islamic Studies.

Improvements were incorporated in following courses.

- a. Environmental Issues and Ethics
 - b. Environmental Chemistry
 - c. Environmental Engineering Lab Techniques
 - d. GIS and Remote Sensing
 - e. Energy Resources, Conservation and Management
 - f. Wastewater Engineering
 - g. Engineering Drawing and Computer Aided Drafting (CAD)
1. Members agreed that a new course from biology discipline should be included in current syllabus. It was decided that a new course named “Biological Principles of Environmental Engineering” should be introduced. Another course “Introduction to Microbiology” was also included.
 2. A new course “Entrepreneurship” of 2 credits was also included into current syllabus.
 3. Four courses of Mathematics were revised and following titles were assigned for Math I, II, III & IV:
 - a. Engineering Calculus
 - b. Linear Algebra and Ordinary Differential Equation
 - c. Numerical analysis
 - d. Probability and Statistical Analysis
 4. Water supply and wastewater Engineering was split into two courses as:
 - a. Water Supply Engineering
 - b. Wastewater Engineering
 5. In view of industrial demand all around the country a new course was incorporated as:
 - a. Water and Wastewater Treatment Plant Design
 6. A few new elective courses included were as under:
 - a. Marine Pollution Control
 - b. Mechanics of Solids
 - c. Environmental Modeling
 - d. Environmental Management in Emergencies
 - e. Transportation Engineering
 - f. Structural Analysis

7. Internship was incorporated as mandatory activity for Environmental Engineering students in terms of independent study/consultancy/working with an industry within engineering domain.
 - a. Total credit hours 136 (6 credit hours to this may be added by universities through an elective course by themselves)
 - b. Number of semesters 8
 - c. Percent engineering courses 66.17
 - d. Percent of non-engineering courses 33.83

Where annual system is in vogue, the scheme of study will be tailored accordingly.

The Committee re-examined the preliminary draft course contents and finalized them after incorporating necessary modifications.

8. After thorough deliberation the committee unanimously approved the draft curriculum of the BE/BS (4-year) and ME/MS Environmental Engineering degree programme. Malik Arshad Mahmood, Director Curriculum, HEC thanked the Convener, Secretary and all members of the Committee for sparing their valuable time and for their quality contribution towards preparation of the preliminary draft curriculum of the BE/BS (4-year) and ME/MS Environmental Engineering programme. He added their efforts will go long way in developing workable, useful and comprehensive degree programs in Environmental Engineering.
9. The committee highly appreciated the efforts made by the officials of HEC Regional Centre, Lahore, and Malik Arshad Mahmood, Director Curriculum for making comfortable arrangements to facilitate the working of the committee in Lahore. All members of NCRC appreciated the efforts of Director Curriculum for being available from day one to the end.
10. The meeting concluded with the vote of thanks to the HEC officials for providing an ideal environment to discuss the agenda. The convener of the NCRC also thanked the members for their inputs in reshaping the engineering teaching/learning landscape of the country to make it more practical, competitive and effective.

MISSION STATEMENT

There is an imperative need for promoting sustainable development of natural resources. Trained and expert manpower is needed from academic institutions in disciplines of Environmental Engineering, resources preservation, conservation and management of wasteful substances generated from industrial, municipal, agricultural, mining and other processes. The Environmental Engineering Curriculum is designed by experts in academia to develop critical thinking among students at undergraduate/graduate level to control and mitigate negative impacts on the environment and ecosystem through a well formulated engineering strategy and provide solutions that are in line with national and international norms.

FRAMEWORK FOR BE/BS IN ENVIRONMENTAL ENGINEERING

Duration: 4 years
 Semester: 8
 Number of weeks per semester: 18 (16 for teaching and 2 for examination)
 Total number of Credit Hours (CH): 130-136
 Number of Credit Hours (CH) per semester: 15 - 18 (17)
 Engineering Domain Courses: 65 - 70% (66.17)
 Non-Engineering Domain Course: 30 - 35% (33.83)
 Number of Contact hours: 199

SCHEME OF STUDIES FOR BS/BE ENVIRONMENTAL ENGINEERING

Non-Engineering Domain										
Knowledge Area	Subject Area	Name of Course	Lec CH	Lab CH	CR	Total Cour Ses	Total Credits	% Area	% over all	
Humanities	English	Communication Skills	3	0	3	2	5	10.87	3.68	
		Technical Writing & Presentation Skills	2	0	2					
	Culture	Islamic Studies	2	0	2	2	4	8.69	2.94	
		Pakistan Studies	2	0	2					
	Social Sciences	Environment & Anthropology Sociology of development Env. & Human Interaction Psychology Sustainable Urban Planning								
				2	0	2	1	2	4.34	1.47
			11	0	11	5	11	23.90	8.08	
Management Sciences		Engineering Economics	2	0	2	4	9	19.56	6.62	
		Ecological Management/ Sustainable Development	2	0	2					
		Project Planning & Management	3	0	3					
		Entrepreneurship	2	0	2					
			9	0	9	4	9	19.56	6.62	

Natural Sciences	Math	Engineering Calculus	3	0	3	4	12	26.09	8.82
		Linear Algebra & Ordinary Differential Equations	3	0	3				
		Numerical Analysis	3	0	3				
		Probability and Statistical Analysis	3	0	3				
	Physics	Applied Physics	3	1	4	1	4	8.69	2.94
	Chemistry	Environmental Chemistry	3	1	4	1	4	8.69	2.94
	Biology	Introduction to Microbiology	3	0	3	1	3	6.53	2.2
	Microbiology	Biological Principles of Environmental Engineering / Environmental Microbiology	2	1	3	1	3	6.53	2.2
				23	3	26	8	26	56.53
Sub-Total-I			43	3	46	17	46	100	33.83

Engineering Domain									
Knowledge Area	Subject Area	Name of Course	Lec CH	Lab CH	CR	Total Courses	Total Credits	% Area	% overall
Computing	Fundamental Programming	Computer Aided Learning	2	1	3	2	6	6.67	4.41
		Computer Programming	1	2	3				
			3	3	6	2	6	6.67	4.41
Engineering Foundation		Surveying and Leveling	1	2	3	8	26	28.89	19.11
		Engineering Mechanics	3	0	3				
		GIS & Remote Sensing	2	1	3				
		Fluid Mechanics	3	1	4				
		Soil Mechanics	3	1	4				
		Engineering Drawing & CAD	1	2	3				
		Introduction to Environmental Engineering	3	0	3				
		Elective	3	0	3				
			19	7	26	8	26	28.89	19.11
Major Based Core (Breadth)		Water Supply Engineering	3	1	4	9	32	35.55	23.53
		Wastewater Engineering	3	1	4				
		Water and Wastewater Treatment Plant Design/Water Pollution Control/Ground Water Pollution Control	3	0	3				
		Industrial Waste Management	3	0	3				
		Engineering Hydrology	3	1	4				
		Air & Noise Pollution Control	3	1	4				
		Solid Waste Management	3	0	3				
		Environmental Engineering Lab Techniques	2	2	4				
		Elective	3	0	3				
					26				

Major Based		Environmental Health & Safety	3	0	3				
Core (Depth)		Water Resources & Irrigation Engineering	3	0	3	5	13	14.44	9.56
		Environmental Impact Assessment	2	0	2				
		Cleaner Production Techniques	2	0	2				
		Energy & Environment/ Energy Resources Conservation & Management	3	0	3				
			13	0	13	5	13	14.44	9.56
Inter-disciplinary Engineering Breadth (Electives)		Applied Electrical Engineering	2	1	3	2	7	7.78	5.15
		Thermodynamics	3	1	4				
			5	2	7	2	7	7.78	5.15
Senior Design Project		Senior Design Project-I	0	3	3	2	6	6.67	4.41
		Senior Design Project-II	0	3	3				
			0	6	6	2	6	6.67	4.41
Internship		Optional	0	0	0	0	0	-	-
Sub-Total-II			66	24	90	28	90	100	66.17
Grant Total (I+II)			107	27	136	45	136		100

NOTE:

Universities have the option to add course of 3 credit hours in the engineering foundation and breadth domain.

SCHEME OF STUDIES
BE/BS Environmental Engineering
Semester wise

Semester-1

Course No.	Course Title	Lec.-CH	Lab- CH	Total- CH
1	Communication Skills	3	0	3
2	Linear Algebra and Ordinary Differential Equation	3	0	3
3	Introduction to Environmental Engineering	3	0	3
4	Computer Aided Learning / Fundamentals of ICT	2	1	3
5	Islamic Studies	2	0	2
6	Applied Physics	3	1	4
	Total	16	2	18

Semester-2

Course No.	Course Title	Lec.- CH	Lab - CH	Total- CH
1	Engineering Calculus	3	0	3
2	Environmental Chemistry	3	1	4
3	Engineering Mechanics	3	0	3
4	Pakistan Studies	2	0	2
5	Introduction to Computer Programing	1	2	3
6	Surveying and Leveling	1	2	3
	Total	13	5	18

Semester-3

Course No.	Course Title	Lec. -CH	Lab - CH	Total – CH
1	Introduction to Microbiology	3	0	3
2	Environment and Anthropology/ Sociology of Development/ Environment and Human Interaction/ Psychology / Sustainable Urban Planning	2	0	2
3	Probability and Statistical Analysis	3	0	3
4	Fluid Mechanics	3	1	4
5	Applied Electrical Engineering	2	1	3
6	Environmental Economics	2	0	2
	Total	15	2	17

Semester-4

Course No.	Course Title	Lec.- CH	Lab -CH	Total – CH
1	Biological Principles of Environmental Engineering / Environmental Microbiology	2	1	3
2	Ecological Management / Sustainable Development	2	0	2
3	Numerical Analysis	3	0	3
4	Engineering Drawing & CAD	1	2	3
5	GIS & Remote Sensing	2	1	3
6	Thermodynamics	3	1	4
	Total	13	5	18

Semester-5

Course No.	Course Title	Lec. - CH	Lab - CH	Total- CH
1	Water Supply Engineering	3	1	4
2	Environmental Impact Assessment	2	0	2
3	Soil Mechanics	3	1	4
4	Engineering Hydrology	3	1	4
5	Solid Waste Management	3	0	3
	Total	14	3	17

Semester-6

Course No.	Course Title	Lec.- CH	Lab - CH	Total – CH
1	Project Planning & Management	3	0	3
2	Wastewater Engineering	3	1	4
3	Technical Writing and Presentation Skills	2	0	2
4	Environmental Engineering Lab Techniques	2	2	4
5	Elective Course (University Option)	3	0	3
6	Elective Engineering Course	3	0	3
	Total	16	3	19

Internship (independent study/consultancy within engineering discipline)

Semester-7

Course No.	Course Title	Lec. - CH	Lab - CH	Total –CH
1	Water Resources and Irrigation Engineering	3	0	3
2	Water & Wastewater Treatment Plant Design / Water Pollution Control	3	0	3
3	Air & Noise Pollution Control	3	1	4

4	Entrepreneurship	2	0	2
5	Industrial Waste Management	3	0	3
6	Senior Design Project – I	0	3	3
	Total	14	4	18

Semester-8

Course No.	Course Title	Lec. - CH	Lab - CH	Total – CH
1	Environmental Health & Safety	3	0	3
2	Cleaner Production Techniques	2	0	2
3	Energy & Environment/Energy Resources Conservation & Management	3	0	3
4	Senior Design Project – II	0	3	3
	Total	8	3	11

Total Credit Hours

136

Elective Course:

- Marine Pollution Control (3-0)
- Mechanic of solids (3-0)
- Structural Analysis and Design (3-0)
- Environmental Modeling (3-0)
- Environmental Management in Emergencies (3-0)
- Transportation Engineering (3-0)

DETAIL OF COURSES

BE/BS in Environmental Engineering

1. COMPUTING

FUNDAMENTALS OF ICT

3 (2+1)

Objectives:

- Teach the structure, operation, programming, and applications of computers.

Contents:

- History, classification, basic components,
- CPU, memory, peripheral devices, storage media and devices,
- Physical and logical storage, data organization, file storage,
- Programs and software, system software, application software,
- Operating systems, programming languages, compilation and interpretation,
- Problem specification, algorithms, flow chart, pseudo code,
- Basic programming techniques, data types and declaration, header file and linkage,
- Variables and constants, arrays, input/output,
- Termination, remark, control structures, branching,
- Conditional structures, repetition and loops,
- Basic library functions, social impact of computer age,
- Computers in office, industry and education.

Lab Outline:

- Computation of number system,
- Implementation of Boolean functions,
- Basic machines organization including motherboard,
- Memory, I/O cards, networking devices,
- Use of flow charts, introduction to office tools, overview of different browsers including open-source browsers,
- Introduction to various operating systems, coding, executing and debugging simple programs,
- Implementation of simple control structures,
- Implementation of simple functions, implementation of different function styles.

Recommended Books: (Latest editions where possible)

- Brian Williams and Stacey Sawyer, "Using Information Technology," Ninth Edition, 2010, McGraw-Hill, ISBN: 0073516775
- William Stallings, "Computer Organization and Architecture: Designing for Performance," Ninth Edition, 2012, Prentice Hall, ISBN: 013293633X

INTRODUCTION TO COMPUTER PROGRAMING 3 (1+2)

Objectives:

- To learn computer languages,
- To enhance skills of computer programming applications.

Contents:

- Introduction to computer programing, Programme structure and flow charts.
- Programing Fundamentals: Arithmetic operations and functions, input/output statements,
- Decision making statements and loop functions and subroutines.
- Data and Data Files.
- Computer Languages: Fundamentals of FORTRAN, Visual BASIC and/or Visual C++ Programing.
- Applications: Programing of simple and elementary environmental engineering problems.
- Internet: Use of web as an academic tool.

Recommended Books: (Latest editions where possible)

- Gottfried, B. S. Programming with Structured Basics (Schaum Series), First Edition 1992, McGraw-Hill, ISBN: 0070238995
- Steve Holzner and Steven Holzner, C++ Black Book: A Comprehensive Guide to C++ Mastery, 2002, Paraglyph Press, ISBN: 1932111263
- Evangelos Petroustos, Mastering Visual Basic 6, Second Edition, 1998, Sybex Computer Books Inc. USA, ISBN: 0782122728

ENGINEERING DRAWING AND CAD 3 (1+2)

Objectives:

- To enable students to learn basics of engineering drawing.
- To enhance student skills to prepare and understand computer aided drawings for environmental engineering application.

Contents:

- Need and requirement of drawings for environmental engineering projects.
- General nature of drawings, components, symbols and nomenclature needed for specific drawings such as architectural, structural, plumbing, electrical, air-conditioning, roads and earth work etc.
- Drawings at different stages of projects, elements of perspective drawing.
- Types of lines, lettering, dimensioning, drawing instruments, planning of drawing sheet.
- Types of projections, orthographic projections, plane of projections.
- Isometric and pictorial projections of solids/machine parts,

- Sections of joints, pipe connections, preparation of pipelines and sewer profile (longitudinal section, etc.) drawings.
- Computer Aided Drawing & Drafting: General and basic know how related to computer aided drawing, e.g. co-ordinate system, drawings setup procedure, basic draw commands, basic edit commands,
- Layers, creating text and defining styles options, block and drawing import/export options, cross hatching, save and plot (2D) and isometric drawings.

Practical/Lab Work:

- Practicals related to the topics covered in theoretical Section.

Recommended Books: (Latest editions where possible)

- Thomas French, Charles Vierck and Robert Foster Engineering Drawing and Graphic Technology, Fourteenth Edition, 1993, McGraw-Hill Science, ISBN: 0070223475.
- George Ormura, Mastering Auto Cad 2012, First Edition, 2011 (or latest ed) Sybex, ISBN: 0470952881
- Frank M. Croft, Frederick D. Meyers, Edwin T. Boyer, Michael J. Miller, and John T. Demel, Engineering Graphics, First Edition 1989, Wiley & Sons , ISBN: 0471857882

2. ENGINEERING FOUNDATION

SURVEYING AND LEVELING

3 (1+2)

Objectives:

- To enable students to understand theory and practice of land surveying.
- To develop skills to use the modern survey instruments.

Contents:

- Introduction: Introduction to land surveying, terminology, instruments used branches and their application.
- Techniques: Chain surveying, compass surveying, theodolite types, use in traversing and triangulation, tachometry, plane table surveying. Two and three point problems. Computation of areas and volumes by various methods. Use of plani meter
- Modern Methods in Surveying: Principles of EDM operation, EDM characteristics, total stations, field procedures for total stations in topographic surveys, construction layout using total stations. Global Positioning System-GPS
- Leveling and Contouring: Reduction of levels, temporary and permanent adjustments of level, precise leveling methods and applications to contouring.

Field Work:

- Horizontal and vertical control, construction surveys, rail road, pipelines and other infrastructures. Layout of buildings and structures.

Recommended Books: (Latest editions where possible)

- Barry Kavanagh, Surveying: Principles and Application, Eighth Edition, 2008, Prentice Hall, ISBN: 013236512X.
- William H. Irvine, Surveying for Construction, Fifth Edition, 2002, McGraw-Hill, ISBN: 0077111141.
- Paul R. Wolf, Russel C. Brinker, Elementary Surveying, Ninth Edition, 1997, Land Surveyors Publications, ISBN: 0065003993.

ENGINEERING MECHANICS**3 (3+0)****Objectives:**

- To understand resolution of forces, statics and dynamics of physical processes.
- To develop skills to use the basic principles in engineering applications.

Contents:

- Basic Concepts: Concepts of space, time, mass, velocity, acceleration and force. SI and British Gravitational (BG-formerly FPS) units. Scalar and vector quantities, Newton's laws of motion, law of gravitation.
- System of Forces: Resultant and resolution of co-planer forces using parallelogram, triangle and polygon law. Simple cases of resultant and resolution of forces in space. Conditions of equilibrium of co-planer forces, analytical and graphical formulations.
- Equilibrium of Rigid Bodies: Free body concept, conditions of support and attachment to other bodies, Support reactions, Degree of restraint and static determinacy. Statically determinate problems especially of civil engineering importance, equilibrium of two-force and three-force bodies.
- Kinetics and kinematics: Work, energy and power. Virtual work formulation of equilibrium of coplanar force. Potential energy, energy criterion for equilibrium, stability of equilibrium, application to simple cases.
- Rigid Bodies: Geometrical properties of plane areas, first moment of area, centroid, second moment of area, principal axes, polar second moment of area and radius of gyration.
- Friction: Coulomb's theory of friction. Problems involving friction on flat and curved surfaces.

Recommended Books: (Latest editions where possible)

- Russell C. Hibbeler, Mechanics of Engineering, Eight Edition, 2010, Prentice Hall. ISBN: 0136022308.

- Ferdinand Leon Singer, Engineering Mechanics: Statics and Dynamics, Third Edition, 1975, Harper Collins Publishers, ISBN: 0060462310.
- Ferdinand Beer Jr., E. Russell Johnston, Elliot Eisenberg, Phillip Cornwell, and David Mazurek, Vector Mechanics for Engineers: Statics and Dynamics, Ninth Edition, 2009, McGraw-Hill, ISBN: 0077275551.

MECHANICS OF SOLIDS (Elective)

3 (3+0)

Objectives:

- To learn basics of strength of material.
- To enhance skills of utilizing material of appropriate strength for environmental engineering application.

Contents:

- Simple Stress and Strain: Kinds of stresses and strains, load extension diagrams for different materials, Hook's Law, moduli of elasticity, lateral strain, volumetric strain, Poisson's Ratio, thermal stresses and compound bars.
- Stresses in Beams: Theory of simple bending, moment of resistance and section modulus, application of flexure formula, shear stresses in beams, shear centre, shear flow, unsymmetrical bending.
- Column and Struts: Axially loaded columns, Euler's treatment, Rankin Gordon Formula for short and intermediate columns, slenderness ratio.
- Circular Shafts: Theory of torsion for solid and hollow circular shafts.
- Springs: Open coil springs, closed coil springs, leaf springs.
- Strain Energy: Strain energy due to direct loads, force, bending moments and torque, stresses due to impact loads.

Practical/Lab. Work:

- Practical related to the topic covered in theoretical section.

Recommended Books: (Latest editions where possible)

- Andrew Pytel, and Ferdinand L. Singer, Strength of Materials, Fourth Edition, 1987, Harper collins College Div, ISBN: 0060453133
- William Nash and Merle Potter, Schaum's Outline of Strength of Materials, Fifth Edition, 2010, McGraw-Hill ISBN: 0071635084

GEOGRAPHIC INFORMATION SYSTEMS (GIS) AND REMOTE SENSING

3 (2+1)

Objectives:

- To introduce the basic concepts of remote sensing and GIS and its application of Remote Sensing & GIS in environmental engineering
- To learn RS and GIS techniques using state-of-the-art software packages

Contents:

- Introduction to GIS and RS principles and techniques
- History and evolution of GIS and RS
- Satellites and sensors
- Interpretation of aerial photographs and satellite images
- Electromagnetic spectrum
- Resolution
- Image processing
- Sampling techniques
- Data sources
- Data structures and models
- Data acquisition, capturing, and conversion techniques,
- Map projections and coordinate systems,
- Visualization of spatial data (layouts)
- Spatial data queries and analysis
- Satellite navigation systems (GPS)
- Integration of GIS, RS and GPS
- Application of spatial information for natural resource and environmental management
- Hands-on experience using latest RS and GIS software in understanding and applying concepts introduced in this course

Recommended Books: (Latest editions where possible)

- Paul Bolstad. GIS Fundamentals, Third Edition, 2007, Atlas Books ISBN: 978-0-9717647-2-9
- Keith C. Clarke, Getting started with Geographic Information System, Fifth Edition, 2010, Prentice Hall, ISBN: 0131494988
- Paul A. Longley, Mike Goodchild, David J. Maguire and David W. Rhind, Geographic Information Systems and Science, Third Edition, 2011, John Wiley & Sons, ISBN: 0470721448
- Michael Kennedy, The Global Positioning System and GIS: An Introduction, Second Edition, 2002, Taylor & Francis, ISBN-0-415-28608-5
- Thomas Lillesand, Ralph W. Kiefer, and Jonathan Chipman, Remote Sensing and Images Interpretation, Sixth Edition, 2007, John Wiley & Sons, Inc., ISBN: 0470052457

FLUID MECHANICS

4 (3+1)

Objectives:

- To understand the basic concepts of fluid mechanics.
- To enhance skills of utilizing fluid mechanics principles for environmental engineering applications.

Contents:

- Introduction to fluid mechanics, hydrostatics, kinematics, hydrodynamics, and hydraulics

- Fluid Statics, pressure intensity and pressure head
- Buoyancy and floatation, equilibrium of floating and submerged bodies.
- Fluid Kinematics, steady and unsteady flow, laminar and turbulent flow, uniform and non-uniform flow
- Hydrodynamics, Bernoulli's equation, Energy equation and its application
- Flow Measurement
- Flow in pipes, Darcy-Weisbach equation for flow in pipes, Losses in pipelines, pipes in series and parallel, transmission of energy through pipes, Pipes network
- Uniform flow in open channels, Chezy's and Manning's equations. Bazin's and Kutter's Formula, Most economical rectangular and trapezoidal section

Recommended Books: (Latest editions where possible)

- Irving Shames, Mechanics of Fluid, Fourth Edition, McGraw-Hill, 2002, ISBN: 0072472103
- E. Finnemore and Joseph Fanzine, Fluid Mechanics with Engineering Applications, Tenth Edition, 2001, McGraw-Hill, ISBN: 0072432020

SOIL MECHANICS

4 (3+1)

Objectives:

- To learn characterization of soils
- To acquire basic knowledge of geotechnical investigation required in environmental engineering projects.

Contents:

- Significance. Soil, rock and their types and formation. Physical properties of soil: water content, voids ratio, porosity, degree of saturation, specific gravity, unit weight and their determination
- Mass-volume relationships (density; in-situ, bulk, field)
- Importance of classification tests. Atterberg's limits, grain size distribution (coarse & fine soils), classification systems (ASTM, AASHTO, Unified, etc.)
- Soil exploration, purpose and methods of soil exploration.
- Probing, test trenches and pits, auger boring, wash boring, rotary drilling, and geophysical methods, soil samplers.
- Disturbed and undisturbed samples. Introduction to geotechnical report writing, Bore log.
- Darcy's law, factors affecting permeability, laboratory and field determination of permeability, hydraulic conductivity, Surface tension, capillary and its effects, suction in soils.
- Seepage force. Introduction to flow net. Estimation of seepage quantity.
- Quick sand condition. Sand boiling, Filters (Slow and Rapid sand filters).
- Fundamental concepts and definitions moisture-density relationship (OMC Curve), compaction standards (Proctor Test), factors affecting compaction, field moisture control and measurements of in-situ density.

- Field compaction equipment (rolling, tamping, vibratory).
- Mechanics of consolidation, theory of one dimensional consolidation, assumptions and validity, types of foundation
- Compression index, co-efficient of compressibility, time factor,
- Coefficient of volume change and degree of consolidation,
- Primary and secondary consolidation. Normal and pre-consolidated soils. Creep, Differential Settlement.

Practicals:

1. Determination of Moisture Content/water content in soil by oven drying method
2. Determination of specific gravity of fine soil by pycnometer/relative density bottle
3. Determination of field density of soil by Sand Cone Apparatus
4. Determination of optimum moisture content and maximum density by Standard Compaction Test
5. Characterization of coarse grained soil by sieve analysis and developing particle size distribution curve
6. Characterization of fine grained soil by Hydrometer Analysis and developing PSD curve
7. Determine fineness of soil
8. Determine liquid limit of soils
9. Determining plastic limit of soils
10. Determine shrinkage limit of soils
11. Determine hydraulic conductivity of fine grained soil by variable head method
12. Determine hydraulic conductivity of coarse grained soil by constant head method

Recommended Books: (Latest editions where possible)

- R. Whitlow, Basic Soil Mechanics, Fourth Edition, 2000, Prentice Hall, ISBN: 0582381096
- Karl Terzaghi, Theoretical Soil Mechanics, First Edition, 1948, John Wiley and Sons, ISBN: 0471853054
- T. William Lambe and Robert V. Whitman, Soil Mechanics, International Edition, 1979, Wiley & Sons, ISBN: 0471024910

WATER POLLUTION CONTROL

3 (3+0)

Objectives:

- To learn about water pollution and its impacts on the environment.
- To learn methods for water pollution control.

Contents:

- Types of water pollutants: Organic and inorganic pollutants; nutrients, pesticides, heavy metals, toxic chemicals, salt, silt, and thermal pollution.

- Sources and causes of water pollution: point and non-point sources, contribution of domestic, industrial, agricultural, transport, and mining effluents to water pollution.
- Impacts of water pollution: Water pollution and human and ecological health, impacts through food chain.
- Water quality: Water quality criteria and requirements, water quality standards for various uses including drinking water, irrigation, recreation etc.
- Water quality management: Water quality management in rivers, lakes and groundwater. Streeter-Phelps model to manage river water quality model. Differences in water quality from surface and subsurface sources.
- Groundwater: groundwater contamination with leaking underground reservoirs.
- Water pollution control: Source reduction versus end of pipe treatment, water pollution prevention practices and techniques, water treatment
- Legislation and instruments for water pollution control: Legislation, regulation and instruments for water pollution control with particular reference to Pakistan.

Recommended Books: (Latest editions where possible):

- Water pollution control: A guide to the use of water quality management principles, edited by R. Helmer and I. Hespanhol, published on behalf of UNESCO, WHO and UNEP by E&FN Spon 2-6 Boundary Row, London SE1 8HN, UK ISBN 0419229108.
- Rhonda Lucas Donald, Water Pollution.
- Vigil, K. M. Clean Water: An Introduction to Water Quality and Pollution Control.
- Viessman Jr. W. and Hammer M. J. Water Supply and Pollution Control.
- Desai B. Water Pollution in India: Law and Enforcement.
- Krantz D. and Kifferson B., Water pollution and Society.
- Theodore, L., Handbook of Environmental Technology, John Wiley Inc.
- Government of Pakistan and IUCN. 1992. The Pakistan National Conservation Strategy, Islamabad.
- Government of Pakistan, Environmental Policy of Pakistan, Islamabad.

INTRODUCTION TO ENVIRONMENTAL ENGINEERING 3 (3+0)

Objective:

- To introduce basic concepts and issues related to the environment
- To highlight the professional practices in environmental engineering

Contents:

- Introduction to environment and factors affecting the environment.
- Environmental degradation processes and environmental pollution.

- Effects of pollution on human health, soil, surface and ground water environment.
- Direct and indirect environmental pollution. Point and non-point sources. Air, water and noise borne diseases and their remedies.
- Sustainable development, definition and inter-relationship between its components. Strategies for sustainable development.
- Introduction to national environmental problems related to human animals, agricultural and industrial waste solid and liquid wastes, water, air and radiological pollution.
- Global, regional and national environmental issues.
- Acid rain, global warming, ozone depletion.
- Key elements of Pakistan National Conservation Strategy.
- Environmental ethics
- Review of national and international codes and ethics in environmental engineering
- Safety and environmental risk assessment
- Risk benefit analysis, reducing risk, collegiality and loyalty

Recommended Books: (Latest editions where possible)

- Mackenzie L. Davis, and Susan J. Masten, Principles of Environmental Engineering and Science, Second Edition, 2002, McGraw-Hill, ISBN: 0073122351
- Mackenzie Davis, and David Cornwell, Introduction to Environmental Engineering, Fourth Edition, 2006, McGraw-Hill, ISBN: 0072424117
- Tom D. Reynolds, Paul A. Richards, Unit Operations and Processes in Environmental Engineering, Second Edition, 1995, CL-Engineering, ISBN: 0534948847

3. MAJOR BASED CORE (BREADTH)

WATER SUPPLY ENGINEERING

4 (3+1)

Objective:

- To provide the basic concepts of source selection, population estimation and limit operations based upon source quality.
- To make students apply the concepts of Fluid Mechanics and Hydraulic in designing the water supply networks/allied services.

Contents:

- Brief history of the water supply system
- Water consumption and factors affecting the water consumption of a community. Various water uses.
- Population forecasting for the design of water supply systems. Various methods of population forecasting i.e. linear method, geometric growth method and curve fitting method.
- Concept of design period and factors on which the design period of various water supply components depend. Design periods for various water supply components.
- Selection of water source based on ground water or surface water. Investigation to be carried out for the selection of source including electric resistivity surveys, electric well logging and installation of test tube wells to ascertain safe yield of the aquifer and safe inter tube well distance.
- Hydraulic design of water transmission lines from source to the point of distribution. Discussion on design criteria for water transmission lines. Various pipe types suitable for use in water transmission lines and their characteristics and design life.
- Design criteria for the design of water distribution systems and detailed design of water distribution system using latest software like EPANET. Various pipe types available for the water distribution systems; their hydraulic characteristics, C values, joint types and life.
- Various specials used in the water supply systems like air relief valves, altitude valve, sluice valves, tees, bends.
- Over head reservoirs in the water distribution system, their capacity and placement within the system. Concept of balancing reservoirs.
- Concept of water hammer in the big transmission lines and methods to avoid water hammer.

Recommended Books (Latest editions where possible):

- Mark. J. Hammer, Water and Waste Water Technology, Seven Edition, 2011 Prentice Hall, ISBN: 0135114047
- MWH, Water Treatment Principles and Design, Second Edition, 2005, John Wiley & Sons, ISBN: 0471110183
- Terence J. McGhee and E. W. Steel, Water Supply and Sewerage, Sixth Edition, 1991, McGraw-Hill, ISBN: 0070609381

Objectives:

- To introduce the students with the major components of wastewater collection system i.e. (1) Sewer network; (2) appurtenances; and (3) sewage disposal stations.
- To design criteria and detailed design of the above components.

Contents:

- Wastewater generation rates and characteristics of wastewater
- Estimation of average and peak wastewater flows for a community
- Concept of self cleansing velocity for sanitary and storm sewers
- Types of sewerage systems i.e. combined, separate and partially combined
- Design criteria for the sanitary and storm sewer network
- Hydraulic design of sewer and development of complete hydraulic statement for the sewer network for sanitary and storm sewer. Jointing of sewer. Inflow and infiltration problems into the waste water systems.
- Various materials for the sewer pipes and their characteristics
- Loads coming on sewers. Different types of bedding to be provided under sewers
- Various steps involved in the construction of sewers; especially how to shift levels to maintain correct gradient of sewers to allow flow under gravity.
- Various appurtenances in sewer system like manholes; drop manholes etc
- Design criteria for the sewage disposal station. Components of sewage disposal station including screens, wet well and dry wells. Design of screen, wet well and dry well.
- Various pumps types used for the pumping of wastewater
- Concept and design of septic tank and soakage pits for individual houses.

Recommended Books (Latest editions where possible):

- Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, Fourth Edition, 2002, McGraw Hill, ISBN: McGraw-Hill
- Terence J. McGhee and E. W. Steel, Water Supply and Sewerage, Sixth Edition, 1991, McGraw-Hill, ISBN: 0070609381

WATER AND WASTEWATER TREATMENT PLANT DESIGN

3 (3+0)

(Elective)

Objectives:

To learn to integrate various unit operations in water and wastewater treatment for a full scale treatment plant design

Contents:

- Focus on site selection for water and wastewater treatment plants including geotechnical considerations, and plant layout and landscape.
- **Water treatment plant design.**
- Basic design consideration. Raw water quality, treated water quality goals and treatment options.
- Design flow rates. Design of coagulation facilities including rapid mix units, flocculation tank and flocculation.
- Design criteria and design of sedimentation tanks for discrete and flocculent suspensions. Design criteria for filtration.
- Design of rapid and slow sand gravity filters.
- Design of disinfection facilities including dosing systems and contact facilities.
- **Wastewater treatment plant design.**
- Basic design consideration, wastewater characteristics, regulations, design flow rates, design mass loadings, process selection, and elements of conceptual process design, design of preliminary and primary treatment facilities including flow measurement, screens and grit chambers.
- Design of biological treatment units. Activated sludge process: design criteria, aeration tank design and design of mechanical and diffused aeration systems.
- Design of trickling filters and biological towers.
- Aerated lagoon design and wastewater stabilization ponds
- Design of secondary clarifiers.
- Design of treatment facilities for sludge treatment and disposal, disinfection of secondary treated wastewater.
- Hydraulic design and hydraulic profile of treatment plant. Process instrumentation and controls.
- Design of treatment plant control systems.
- Design reliability features, advanced wastewater treatment facilities.

Recommended Books (Latest editions where possible):

- Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, Fourth Edition, 2002, McGraw-Hill, ISBN: McGraw-Hill
- Syed R. Qasim, Treatment Plants: Planning, Design, and Operation, Second Edition, 1998, CRC Press, ISBN: 1566766885

- Manuel Marino and John Boland, An Integrated Approach to Wastewater Treatment: Deciding Where, When, and How Much to Invest, 1999, World Bank, ISBN: 0821344676

INDUSTRIAL WASTE MANAGEMENT

3 (3+0)

Objectives:

- To make students understand general pollution problems present in the industrial sector.
- To explain the pollution control strategies through examples and case studies

Contents:

- Definitions of industrial and hazardous wastes
- Types and characteristics of industrial wastes
- Industrial waste reduction and reuse
- Waste audits
- **Liquid waste management**
- Pollutant types
- General removal protocol
- **Solid waste management**
- General removal protocol
- Noise management
- Air pollution control
- Case study of industrial processes involved in tanneries and characteristics of wastes produce.
- Case study of industrial processes involved in textiles and characteristics of wastes produce.
- Case study of industrial processes involved in Agro based industries and characteristics of wastes produce.
- Case study of industrial processes involved in Pharmaceuticals and characteristics of wastes produce.
- Case study of industrial processes involved in food processing industries and characteristics of wastes produce.
- Case study of industrial processes involved in edible oil industries and characteristics of wastes produce.
- Case study of industrial processes involved in steel industries and characteristics of wastes produce.

Recommended Books (Latest editions where possible):

- Joseph A. Salvato, Joe E. Beck, Environmental Engineering and Sanitation, 1994 Supplement (Environmental Science and Technology), Fourth Edition, 1994, Wiley Interscience, ISBN: 0471063967
- W. Wesley Eckenfelder, Industrial Water Pollution Control, Third Edition, 1999, McGraw-Hill, ISBN: 0070393648

- Michael D. La Grega, Phillip L. Buckingham and Jeffrey C. Evans, Hazardous Waste Management, , Reissue Edition, 2010 Waveland Pr Inc, ISBN: 1577666933

UNIT OPERATIONS IN WATER AND WASTEWATER TREATMENT (Elective)

3 (3+0)

Objective:

- To understand the design principles of water and wastewater treatment systems.

Contents:

- Types of Reactors in environmental engineering: Batch and continuous flow reactors. Plug flow and completely mixed flow reactors. Completely mixed flow reactors with and without solids recycle.
- General process flow diagrams of water and wastewater treatment plants.
- Water Treatment: coagulation, flocculation, sedimentation. Filtration and Disinfection.
- Wastewater Treatment: Physical chemical and biological wastewater treatment processes.
- Biological wastewater treatment
- Stabilization ponds and lagoons
- Tricking filters and biological towers.
- Waste stabilization ponds. Biological nitrification and denitrification.
- Biological nutrients (N & P) removal aerobic and anaerobic treatment of biosolids.

Recommended Books: (Latest editions where possible)

- Tom D. Reynolds, Paul A. Richards, Unit Operations and Processes in Environmental Engineering, Second Edition, 1995, CL-Engineering, ISBN: 0534948847
- Gerard Kiely, Environmental Engineering, International Edition, 1998, McGraw Hill: ISBN: 0071164243,
- Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, Fourth Edition, 2002, McGraw Hill, ISBN: McGraw-Hill

ENGINEERING HYDROLOGY

4 (3+1)

Objective:

- To learn about the principles of hydrology and their conceptual use in environmental engineering

Contents:

- Definitions; Hydrology, hydrological cycle, importance and applications of hydrology.

- Atmosphere and its composition, solar radiation as a source of heat, air temperature. Relative humidity, dew point. Saturation deficit. Measuring devices for the above mentioned parameters. Global climate change; Green House Effect, Global Warming, Effects on hydrological regime.
- Precipitation: Types of precipitation, factors required for precipitation, measurement of precipitation, interpretation of precipitation data, computation of average rainfall over a basin. Effects of precipitation on the hydrological regime of a region.
- Evaporation and Transpiration: Factors affecting evaporation, measurement of evaporation, evapo-transpiration. Humidity-evaporation / transpiration relationship.
- Stream Flow: Water stage and its measurement, selection of site for stage recorder, selection of control and metering section, methods of measurement of stream flow, interpretation of stream flow data. Instrumentation (analogue & digital), monitoring of flow.
- Runoff & Hydrographs: Rainfall-Runoff relationship, Factors affecting runoff, estimating the volume of storm runoff. Characteristic of Hydrograph, components of a hydrograph, hydrograph separation, estimating the volume of direct runoff, introduction to unit hydrograph concept, S-curve, Application of probability in determining maxima/minima of discharge. Types of histogram and distribution, time of concentration.
- Stream Flow Routing Introduction to floods and its causes, frequency and duration analysis. Reservoir routing, channel routing. Flood Control – methods & management.
- Sub-surface / Groundwater: Introduction, sources and discharge of ground water. Water table and confined and unconfined aquifers, groundwater hydraulics, pumping test. Drawdown, yield. Methods for determining subsurface water storage.
- Emphasis can be placed on drinking water sources.

Recommended Book: (Latest editions where possible)

- Warren Viessman, Jr. and Gary L. Lewis, Introduction to Hydrology, Fifth Edition, 2002, Prentice Hall, ISBN: 067399337X
- Ray K. Linsley, Max A. Kohler, and Joseph L. Paulhus, Hydrology for Engineers, Third Edition, 1982, McGraw-Hill, ISBN: 0070379564
- Ray K. Linsley, Joseph B. Franzini, and David L. Freyberg, Water Resources Engineering, Fourth Edition, 1991, McGraw-Hill, ISBN: 0070380104

AIR AND NOISE POLLUTION CONTROL 4 (3+1)

Objectives:

- To learn about air and noise pollutants and their impacts on to the environment
- To learn mitigation techniques for air and noise pollution control

Contents:

- Stationary, mobile and other sources of air pollution.

- Important air pollutants and their impacts on human health and the general environment
- Air quality standards and legislation in Pakistan
- Vehicular exhaust emissions, test procedures
- Control of air borne emissions of: gases, aerosols, particulate matter and organic vapours
- Elementary study of dispersion models: Haze, smog, fog etc. Environmental impacts of EM Radiation
- Sources, causes and control of radioactive pollution
- Stationary, mobile and other sources of noise pollution,
- Impact of noise pollution on human health and the general environment
- Noise standards and legislation in Pakistan
- Measurement and control of noise pollution

Practical/Lab. work:

1. Determination of PM₁₀
2. Determination of PM_{2.5}
3. Determination of oxides of carbon
4. Determination of oxides of nitrogen
5. Determination of oxides of sulfur
6. Determination of noise pollution
7. Determination of indoor pollution quality parameters and validation of NEQS values
8. Determination of radiations (radon)
9. Field visit

Recommended Books: (Latest editions where possible)

- Noel. D. Nevers, Air Pollution Control Engineering, Second Edition, 1999, McGraw-Hill, ISBN: 0070393672
- Debi Prasad Tripathy, Noise Pollution, 2011, APH Publishing Corporation, ISBN: 8131303403
- C. David Cooper and F. C. Alley, Air Pollution Control: A Design Approach, Fourth Edition, 2010, Waveland Pr Inc, ISBN: 157766678X

SOLID WASTE MANAGEMENT

3 (3+0)

Objectives:

- To enable to perform characterization of solid waste (biodegradable and non biodegradable) with a view to study its impacts on the environment
- To study the methods of solid waste management.

Contents:

- Sources and type of solid wastes (integrated, municipal-residential, commercial, institutional waste, etc.),

- Types, generation rate and composition, climatic and socioeconomic factors affecting these parameters, properties: physical, chemical and biological.
- Regulatory requirements for management and disposal of waste. Waste minimization (reduce, recover, reuse and recycle).
- Waste storage, handling, collection, transfer, scavenging, transport and disposal. Safe Disposal and Management Techniques:
- Composting/biodegradation and its types, incineration and its impacts, immobilization, waste to energy, refuse derived fuel, pyrolysis.
- Landfill types, methods, siting and design considerations, landfill as bioreactor, control of landfill leachate & gases, environmental monitoring system for landfills. Landfill closure and use.
- Sources and nature/characteristics of hazardous waste (industrial, hospital, nuclear)-impact on environment,
- Biological waste; hospital, pathological, slaughter house, animal/poultry/farmhouse waste.
- Chemical waste, Industrial, Nuclear, Radioactive,
- Methods of Disposal of hazardous waste, underground storage tanks construction, installation closure, sea burial, deep rock injection.

Recommended Books: (Latest editions where possible)

- Frank Kreith (Author), George Tchobanoglous, Handbook of Solid Waste Management, Second Edition, 2002. McGraw Hill, ISBN: 0071356231
- Kanti L. Shah, Basics of Solid and Hazardous Waste Management Technology, First Edition 1999, Prentice Hall, ISBN: 0139603786.
- Chang, H. Oh, Hazardous and Radioactive Waste Treatment Technologies Handbook, First Edition, 2001, CRC Press, ISBN: 0849395860
- Shoukat Hayat and Sajjad Hyder, Solid Waste Management, First Edition, A-One Publishers

ENVIRONMENTAL SPACE ENGINEERING LABORATORY TECHNIQUES

4 (2+2)

Objective:

- To learn about various techniques used for analysis of water and wastewater.

Contents:

- Introduction to standard methods of analysis. Quality assurance and quality control programs. Collection and preservation of samples. Principles and methods for monitoring and discrete/composite sampling of environmental media, including surface water, ground water, and wastewater (theory part).
- Gravimetric and volumetric methods of analysis for main groups of pollutants (theory part).

- Determination of various parameter of interest in water which include pH, TDS, hardness, sulphates, alkalinity, turbidity, electric conductivity, Ca^{+2} , Mg^{+2} , Chlorides, sulphide, total and fecal coli forms and E-Coli etc according to the Standard Methods (Lab practicals).
- Determination of various parameter of interest in wastewater which include pH, Total suspended solids, Dissolved Oxygen, BOD, COD, Kjeldahl nitrogen and Phosphorous according to the Standard Methods (Lab practicals).
- Data management methods, data quality objectives, data presentation and interpretation (theory part).
- Theory and principles of instrumental techniques such as liquid chromatography, AAS, FTIR, spectrophotometry, radiometry, polarimetry, gas chromatography, HPLC, and oil analyses (theory part).
- Application of selected instrumental techniques for the determination of pesticides, toxic / radio-toxic metals and other trace organics. Use of field instruments and test kits (e.g. conductivity meter, pH meter, detection and measurement of radioactivity by instruments, track detectors) are also covered (Lab practicals).

Note: The theory part of this course will be covered in short lectures. Furthermore, instruction for performing lab practical will also be delivered in class while practicals will be conducted in the laboratory.

Recommended Books: (Latest editions where possible)

- American Public Health Association, Standard Methods for the Examination of Water and Wastewater, 2009, American Public Health Association, ISBN: 1151367729

4. MAJOR BASED CORE (DEPTH)

ENVIRONMENTAL HEALTH AND SAFETY

3 (3+0)

Objective:

- To have a better understanding of EHS related rules and regulation
- To enhance awareness about the principles of environmental health and safety

Contents:

- Basic principles of public health;
- Communicable & non communicable water borne diseases, food borne, air borne and sanitation related diseases and control measures.
- Introduction to safety, health and environment relationship, safety management, human and equipment safety,
- Industrial/nuclear hygiene and safety,

- Accident prevention and elimination plans,
- Fire protection techniques,
- Occupational health and safety in Pakistan,
- Labour code of Pakistan (1986),
- Industrial-nuclear and occupational rules and regulations in Pakistan
- Agricultural Pesticides Rules, 1973,
- Agricultural Pesticide Ordinance, 1971,
- OHSAS-18001, Pakistan Nuclear Regulatory Authority (PNRA) Regulations Pak/904 “Regulation on Radiation Protection-2004”
- Introduction to the principles of toxicology as applied to environmental engineering. Health hazards and toxic effects of chemicals
- Radioactivity; transport, storage & use of toxic chemicals-radio nuclides, occupational health programs

Recommended Books: (Latest editions where possible)

- Mark A. Friend and James P. Kohn, Fundamentals of Occupational Safety and Health, Fifth Edition, 2010, Government Institutes, ISBN: 1605907065
- Sandy Cairncross and Richard G. Feachem, Environmental Health Engineering in the Tropics: An Introductory Text, Second Edition, 1993, John Wiley & Sons, ISBN: 0471938858.

WATER RESOURCES & IRRIGATION ENGINEERING 3 (3+0)

Objective:

- To enhance the knowledge of water resources and their management
- To apply the concept of water resources management on irrigation and drainage control

Contents:

- Basic concepts in water resources
- Surface and groundwater resources of Pakistan
- Water resources consumption in domestic, industrial, agricultural sectors and losses due to seepage, evaporation and evapotranspiration
- Rainwater harvesting
- Planning and development of water resources
- Indus Water Treaty and Water Accord 1991 (IRSA)
- Classification of dams, barrages and head works
- Limnology: phosphorus as the limiting nutrient
- Elementary concept about canal head works, selection of their site and layout, weirs and barrages, various components and functions
- Sedimentation control in dams, rivers and canals
- Canal head regulators, falls, flumes, canal outlets. Cross drainage works: types and functions. Canal lining. Maintenance of irrigation canals. Monitoring of flows-telemetry system

- Design of weirs on permeable foundations, sheet piles and cut off walls
- Definition and types of irrigation. Merits and demerits of irrigation, Indus Basin Irrigation System (IBIS)
- Design of irrigation channels, Kennedy's and Lacey's Theories. Rational methods for design of irrigation channels, comparison of various methods, computer Aided design of irrigation channels
- Irrigation methods (sprinkler, drip) and practices,
- Irrigation scheduling
- Causes and effects of water logging and salinity
- Reclamation of water logged and saline soils, drains and tube wells. Causes and effects of salinity and alkalinity of lands in Pakistan
- Understanding the concepts of drainage, land reclamation, surface drainage, subsurface drainage, cross-drainage structures, disposal of drainage effluents

Recommended Books: (Latest editions where possible)

- Ray K. Linsley, Joseph B. Franzini, and David L Freyberg, Water Resources Engineering, Fourth Edition, 1991, McGraw-Hill, ISBN: 0070380104
- Iqtidar H. Siddiqui, Irrigation and Drainage Engineering, 2003, Oxford University Press, ISBN: 9780195473568
- Sharma, R. K. and T. K. Sharma, Text Book of Irrigation Engineering: Irrigation and Drainage, Vol-I to V. 1991, Oxford and IBH Pub. Co., ISBN: 8120405080 (Vol-I)

ENVIRONMENTAL IMPACT ASSESSMENT

2 (2+0)

Objectives:

- To provide basic knowledge of environmental impacts of development projects and their mitigation
- To prepare Initial Environmental Examination (IEE), Environmental Impact Assessment (EIA) statements and Environmental Management Plans (EMPs)

Contents:

- Introduction to Environmental Impact Assessment: IEE & EIA
- Role of governments and EIA legislation
- Environmental impact assessment process
- Screening and scoping techniques
- Alternatives
- Importance of baseline data.
- Impact identification methods and techniques.
- Mitigation measures.
- Environmental- Management Plan (EMP)
- Role of public consultation and participation in EIA Process

- Environmental impact statement-layout
- Impact assessment methodologies (ad hoc, checklists, matrices, networks, overlays, GIS techniques, simulation models, cost-benefit analysis)
- Economic factors: relocation, redesign, retrofit
- Environmental impact assessment and management of selective development projects - Case Studies

Recommended Books: (Latest editions where possible)

- Chris Wood, Environmental Impact Assessment: A Comparative Review, Second Edition, 2002, Prentice Hall, ISBN: 058236969X
- M. I. Khan, B. A. Tahir, and N. Akhtar, Integrated Environmental Management: Urban and Rural, 2004, Allama Iqbal Open University.
- Betty B. Marriott, Environmental Impact Assessment: A Practical Guide, 1997, McGraw-Hill, ISBN: 0070404100

CLEANER PRODUCTION TECHNIQUES 2 (2+0)

Objective:

- To impart know-how for resource optimization, pollution control and corporate competitiveness

Contents:

- Cleaner production and sustainable development;
- Cleaner production principles and phases;
- Cleaner production plans and strategies for implementing cleaner production plans
- Cleaner production and eco-efficiencies;
- Environmental management systems – ISO 14001
- Environmental risk management
- Environmental audit
- Closed loop operations
- Detailed chemical/material flow analysis
- Renewable energy resources
- Corporate social responsibility by Industry
- Life cycle design and impact assessment
- Waste minimization, reuse of waste products, specific examples from industry where the methods of cleaner production have been applied.

Recommended Books: (Latest editions where possible)

- Kenneth L. Mulholland, Identification of Cleaner Production Improvement Opportunities, 2006, Wiley-Blackwell, ISBN: 0471794406
- Promoting Cleaner Production in Developing Countries: The Role of Development Co-operation, 1995, Organization for Economic Co-operation and Development (OECD), ISBN: 9264146318

- Ruth Hillary, Environmental Management Systems and Cleaner Production, 1997, Wiley-Blackwell, ISBN: 0471966622
- Paul M. Randall, Engineer's Guide to Cleaner Production Technologies, 1997, Technomic Publishing Co., Inc., ISBN: 1566764238

ENERGY RESOURCES CONSERVATION & MANAGEMENT 3 (3+0)

Objective:

- To enhance the knowledge of conventional and renewable energy resources and their effective utilization through management principles

Contents:

- Energy and Power: Sources of Energy and Forms of energy; mechanical, electrical, chemical, nuclear and thermal energy, Alternate and renewable energy resources (hydel, wind, geothermal, tidal, solar, geomagnetic, etc.).
- Perspectives of world & local energy production and consumption, availability of energy resources (renewable & non renewable, conventional & non conventional) to masses, losses, cost, infrastructure required.
- Principles of efficient utilization of resources, cost effective design and solution optimization for energy considerations in environmental projects.
- Economic incentives of energy resources theory and application of different energy resources (i.e. i) biomass, direct combustion of biomass, ii) solar energy, iii) wind energy technology, iv) energy from hydropower, v) geothermal, tidal and other natural sources, vi) fossil fuels).
- Environmental impacts of energy production and consumption.
- Importance of energy conservation, Energy conservation, principles and techniques
- Electric power conservation in buildings
- Reducing heat losses-Thermal insulation (materials and methods)
- Energy audit

Recommended Books: (Latest editions where possible)

- Robert A. Ristinen, Jack P Kraushaar, Energy and Environment, Second Edition, 2006, Willey & Sons, ISBN: 0471739898
- Richard Wolfson, W. W. Norton, Energy, environment and Climate, Second Edition, 2011, W. W. Norton & Co., ISBN: 0393912744
- John Twidell and Tony Weir, Renewable Energy Resources, Second Edition, 2005, Taylor & Francis, ISBN: 0419253300

5. INTER-DISCIPLINARY ENGINEERING BREADTH (ELECTIVE)

APPLIED ELECTRICAL ENGINEERING

3 (2+1)

Objectives:

- To learn basic knowledge of electrical technology.
- To broaden engineering sense of environmental engineers.

Contents:

- Electrical Elements: Electric current, voltage, power and energy, Ohm's law, inductance, capacitance.. Introduction to node voltage and loop current methods, AC single and polyphase system, DC machines, AC Synchronous Machines, AC Induction Machines, Transformers, and Converting Machines.
- Electrical and Magnetic Circuits: Electric Circuits, Kirchoff's Laws, Superposition Theorem, Substitution Theorem Thevenin's Theorem Norton's Theorem, Rosen's Theorem of Star/mesh Transformation, Proof for DC circuits and their application to Circuit Analysis, Magnetic Circuits, Series and Parallel circuits, Principles of calculation of Ampere-turns for Magnetic Circuits of Electromagnets, Transformers, Bipolar and Multi-polar DC machines, Inductances in Series and Parallel, Hysteresis Loss, Eddy Current Loss, Lifting Power of a Magnet.
- Machines: Slip and its effect on Motor Current Quantities, Losses, Efficiency and Performance Curves, Starting, Full Load and Maximum Torque relations, Torque Slip Characteristics.
- Converting Machines: Rotary Converters, Construction, Principle of Working, Transformer Connections, Voltage and Current Ratings of Single and 3 Phase Converters, Mercury Arc Rectifiers, Construction, Operation, transformer Connections, Voltage and Current Ratios of Single Phase and 3 Phase Rectifiers
- Power Plant Installations and Distribution System: Power Systems layout, generation, transmission, distribution and utilization of electric power, Introduction to domestic electrification.

Recommended Books: (Latest editions where possible)

- T. K. Nagsarkar and M. S. Sukhija, (2005), Basic Electrical Engineering, Oxford University Press.
- S. A. Nasar & Jimmie J. Cathey, (1996) Shaum's Outline of Basic Electrical Engineering, McGraw-Hill Inc. 2nd Edition,

THERMODYNAMICS

4 (3+1)

Objectives:

- To learn fundamentals of thermodynamic principles.
- To study environmental dependence of processes in engineering.

Contents:

- Thermodynamic Properties: Working Substance, System, Pure Substance, PVT Surface, Phases, Properties And State, Units, Zeroth Law, Processed and Cycles, Conservation of Mass.
- Energy and its Conservation: Relation of Mass and Energy, Different Forms of Energy, Internal Energy and Enthalpy Work, Generalized Work Equation Flow and Non-Flow Processes, Closed Systems, First Law of Thermodynamics, Open Systems and Steady Flow, Energy Equation for Steady Flow, System Boundaries, Perpetual Motion of the First Kind.
- Energy and Property Thermodynamic Equilibrium, Reversibility, Specific Heats and their relationship, Entropy, Second Law of Thermodynamics, Property relations from Energy Equation, Frictional Energy.
- Ideal Gas: Gas Laws, Specific Heats of an Ideal Gas, Dalton's Law of Partial Pressure, Thermodynamic Processes.
- Fundamentals of Conduction and Convection, Radiation, Thermal Conductivity,
- Heat Transfer: Overall Heat Transfer Coefficients, Practical Equations.
- Thermodynamic Cycles: Cycle Work, Thermal Efficiency Carnot Cycle, Reversed and Reversible Cycles, Most Efficient Engine.
- Two-Phase Systems: Two-Phase System of a Pure Substance, Changes of Phase at Constant Pressure, Steam Tables, Superheated Steam, Liquid and Vapour Curves, Phase Diagrams, Rankine Cycle, Components of Steam Power Plant.
- Internal Combustion Engines: Otto Cycle, Diesel Cycle, Dual Combustion Cycle, Four-stroke and Two-stroke Engines, and Types of Fuel.
- Reciprocating Compressors: Condition for Minimum Work, Isothermal Efficiency, Volumetric Efficiency, Multi-Stage Compression, Energy Balance for a Two-Stage Machine with Intercooler.
- Introduction to HVAC System: Heating and Cooling Load and its calculations, Comfort Charts, Outline of A.C. Systems, Consideration for Air-Conditioning in Buildings, Natural Ventilation, Insulating Materials.

Practical/Lab. Work:

- Practical related to the topic covered in theoretical section.

Recommended Books: (Latest editions where possible)

- T. D. Eastop and Ma Conkey, Applied Thermodynamics for Engineering.
- Rayner Joel, Technologist Basic Engineering Thermodynamics
G. F. C. Rogers and Y. R. Mayhew Engineering Thermodynamics, Work and Heat Transfer.

Part-2

Non-Engineering Courses Compulsory Courses

1. HUMANITIES

FUNCTIONAL ENGLISH

3 (3+0)

Objectives:

- To enhance language skills and develop critical thinking

Contents:

- Basics of Grammar
- Parts of speech and use of articles
- Sentence structure, Active and passive voice
- Practice in unified sentence
- Analysis of phrase, clause and sentence structure
- Transitive and intransitive verbs
- Punctuation and spelling

Comprehension

- Answers to questions on a given text

Discussion

- General topics and every day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students)

Listening

- To be improved by showing documentaries/films carefully selected by subject teachers)

Translation skills

- Urdu to English

Paragraph writing

- Topics to be chosen at the discretion of the teacher

Presentation skills

- Introduction

Note: Extensive reading is required for vocabulary building

Recommended Books: (Latest editions where possible)

- Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492
- Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506

- Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 20-27 and 35-41.
- Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.

2. TECHNICAL WRITING AND PRESENTATION SKILLS 2 (2+0)

Objectives:

- To enhance language skills and develop critical thinking

Contents:

1. Presentation skills

- Essay writing
 - Descriptive, narrative, discursive, argumentative
- Academic writing
 - How to write a proposal for research paper/term paper
 - How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency)

2. Technical Report writing

3. Progress report writing

Note: Extensive reading is required for vocabulary building

Recommended Books: (Latest editions where possible)

- Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing).
- College Writing Skills by John Langan. McGraw-Hill Higher Education. 2004.
- Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press.

Reading

The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharon. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).

COMMUNICATION SKILLS

3(3+0)

Objectives:

- To enable the students to meet their real life communication needs

Contents:

- Paragraph writing
 - Practice in writing a good, unified and coherent paragraph
- Essay writing
 - Introduction
- CV and job application

- Translation skills
 - Urdu to English
- Study skills
 - Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension
- Academic skills
 - Letter / memo writing and minutes of the meeting, use of library and internet recourses
- Presentation skills
 - Personality development (emphasis on content, style and pronunciation)

Note: Documentaries to be shown for discussion and review

Recommended Books: (Latest editions where possible)

- Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.
- Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Françoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 Pages 45-53 (note taking).
- Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).
- Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
- Reading and Study Skills by John Langan
- Study Skills by Richard Yorky.

ISLAMIC STUDIES (Compulsory)

2 (2+0)

Objectives:

- To provide basic information about Islamic Studies and to enhance understanding of the students regarding Islamic civilization
- To enhance the skill of the students for understanding of issues related to faith and religious life.

Contents:

- Introduction to Quranic studies: basic concepts of Quran, history of Quran, Uloom-ul-Quran

INTRODUCTION TO QURANIC STUDIES

- Basic concepts of Quran
- History of Quran
- Uloom-ul -Quran

STUDY OF SELECTED TEXT OF HOLY QURAN

- Verses of Surah Al-Baqra Related to Faith (Verse No-284-286)
- Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18)
- Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11)
- Verses of Surah al-Furqan Related to Social Ethics (Verse No. 63-77)
- Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154)

STUDY OF SELECTED TEXT OF HOLY QURAN

- Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No. 6,21,40,56,57,58.)
- Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment
- Verses of Surah Al-Saf Related to Tafakar, Tadabar (Verse No-1,14)

SEERAT OF HOLY PROPHET (S.A.W) I

- Life of Muhammad Bin Abdullah (Before Prophet Hood)
- Life of Holy Prophet (S.A.W) in Makkah
- Important lessons derived from the life of Holy Prophet (SAW) in Makkah

SEERAT OF HOLY PROPHET (S.A.W) II

- Life of Holy Prophet (SAW) in Madina
- Important events of life of Holy Prophet (SAW) in Madina
- Important lessons derived from the life of Holy Prophet (SAW) in Madina

INTRODUCTION TO SUNNAH

- Basic concepts of Hadith
- History of Hadith
- Kinds of Hadith
- Uloom–ul-Hadith
- Sunnah & Hadith
- Legal position of Sunnah

SELECTED STUDY FROM TEXT OF HADITH

INTRODUCTION TO ISLAMIC LAW & JURISPRUDENCE

- Basic concepts of Islamic law & jurisprudence
- History & importance of Islamic law & jurisprudence
- Sources of Islamic law & jurisprudence
- Nature of differences in Islamic law
- Islam and sectarianism

ISLAMIC CULTURE & CIVILIZATION

- Basic concepts of Islamic culture & civilization
- Historical development of Islamic culture & civilization
- Characteristics of Islamic culture & civilization
- Islamic culture & civilization and contemporary issues

ISLAM & SCIENCE

- Basic concepts of Islam & science
- Contributions of muslims in the development of science
- Quranic & science

ISLAMIC ECONOMIC SYSTEM

- Basic concepts of Islamic economic system
- Means of distribution of wealth in Islamic economics
- Islamic concept of riba
- Islamic ways of trade & commerce

POLITICAL SYSTEM OF ISLAM

- Basic concepts of Islamic political system
- Islamic concept of sovereignty
- Basic institutions of government in Islam

ISLAMIC HISTORY

- Period of Khlaft-e-Rashida
- Period of Ummayyads
- Period of Abbasids

SOCIAL SYSTEM OF ISLAM

- Basic concepts of social system of Islam

- Elements of family
- Ethical values of Islam

Recommended Books: (Latest editions where possible)

- Hameedullah Muhammad, “Emergence of Islam” , IRI, Islamabad
- Hameedullah Muhammad, “Muslim Conduct of State”
- Hameedullah Muhammad, ‘Introduction to Islam
- Mulana Muhammad YousafIslahi,”
- Hussain Hamid Hassan, “An Introduction to the Study of Islamic Law” leaf Publication Islamabad, Pakistan.
- Ahmad Hasan, “Principles of Islamic Jurisprudence” Islamic Research Institute, International Islamic University, Islamabad (1993)
- Mir Waliullah, “Muslim Jurisprudence and the Quranic Law of Crimes” Islamic Book Service (1982)
- H. S. Bhatia, “Studies in Islamic Law, Religion and Society” Deep & Deep Publications New Delhi (1989)
- Dr. Muhammad Zia-ul-Haq, “Introduction to Al Sharia Al Islamia” Allama Iqbal Open University, Islamabad (2001)

PAKISTAN STUDIES

2 (2+0)

Objectives:

- To develop vision of Historical Perspective, Government, Politics, Contemporary Pakistan, ideological background of Pakistan.
- To study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Contents:

- Historical Perspective: ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah.
- Factors leading to Muslim separatism
- People and Land: Indus civilization, Muslim advent, location and Geo-physical features.
- Government and Politics in Pakistan, political and constitutional phases:
 - a. 1947-58
 - b. 1958-71
 - c. 1971-77
 - d. 1977-88
 - e. 1988-99
 - f. 1999 onward
- Contemporary Pakistan
 - a. Economic institutions and issues
 - b. Society and social structure

- c. Ethnicity
- d. Foreign policy of Pakistan and challenges
- e. Futuristic outlook of Pakistan

Recommended Books: (Latest editions where possible)

- Akbar, S. Zaidi. *Issue in Pakistan's Economy*. Karachi: Oxford University Press, 2000.
- Amin, Tahir. *Ethno-National Movement in Pakistan*, Islamabad: Institute of Policy Studies, Islamabad.
- Ziring, Lawrence. *Enigma of Political Development*. Kent England: Wm Dawson & sons Ltd, 1980.
- Afzal, M. Rafique. *Political Parties in Pakistan*, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
- Haq, Noor ul. *Making of Pakistan: The Military Perspective*. Islamabad: National Commission on Historical and Cultural Research, 1993.

**ENVIRONMENT AND ANTHROPOLOGY
OR
SOCIOLOGY OF DEVELOPMENT
OR
ENVIRONMENT & HUMAN INTERACTION
OR
PSYCHOLOGY**

ENVIRONMENT AND ANTHROPOLOGY 2 (2+0)

Objectives:

- To introduce anthropological concepts and research techniques for promoting participation of major groups in environmental management
- To apprise potential engineers about social factors that contribute towards enhancing their professional performance for the good of society and the country
- To enhance understanding about the determinants of human behavior, which ultimately will result in improved individual efficiency

Contents:

- Introduction to cultural anthropology and its relationship with other social sciences
- Participatory approaches to environment and development;
- Participation of major groups: women, youth and others in the management of various types of ecosystems
- Culture and Related Concepts
 - Definition of Culture
 - Types of Culture

- Elements of Culture
- Role of Culture in Organization
- Socialization and Personality
- Population Dynamics
 - World Population Growth and Distribution
 - Population Dynamics in Pakistan
 - Causes and Consequences of Urbanization
 - Population Policy in Pakistan
 - Population and Development
 - Population Forecasting

Recommended Books: (Latest editions where possible)

- Shepherd A., Sustainable Rural Development, St. Martin Press, Inc., 1998
- Dr. Khan M I, Tahir B A, Amir S, and Akhtar N, 2004. Toward Participatory Management, Allama Iqbal Open University.36 Curriculum Division.
- Hafeez, S., Changing Pakistan Society. Karachi, Royal Book Company.
- Maser, C., Sustainable Community Development: Principles and Concepts. St. Lucie Press, 1997
- Syed, S. H., The State of Migration and Multiculturalism in Pakistan: The Need for Policy and Strategy. Islamabad, UNESCO Report, 2003

SOCIOLOGY AND DEVELOPMENT

2 (2+0)

Objectives:

- To apprise potential engineers about social factors that contribute towards enhancing their professional performance.
- To enhance understanding about the determinants of human behavior, which ultimately will result in improved individual efficiency.

Contents:

- Introduction to Sociology, Nature, Scope, and Importance of Sociology
- Social Interactions, Social Groups, Social Institutions,
- Culture and Related Concepts, Definition, Types, Elements of Culture
- Role of Culture in Organization, Socialization and Personality
- Interpersonal Relations, Interpersonal Behavior, Formation of Personal Attitudes
- Language and Communication, Motivations and Emotions, Public Opinion
- Social Stratification, Factors of Social Stratification
- Caste and class, Power, Prestige, and Authority
- Social Mobility, Migration
- Human Ecology, Ecological Processes, Ecosystem and energy, Ecosystem and Physical Environment

- Solid Waste Disposal, Pollution, Population Dynamics, World Population Growth and Distribution, Population Dynamics in Pakistan
- Causes and Consequences of Urbanization, Population Policy in Pakistan, Population and Development, Community Development, Meaning, Scope, and Subject Matter of Community Development, Processes of Community Development, Community Development Programs in Pakistan, Community Organization and Related Services, Cooperation and Conflict in Community Development
- Deviance and Crime, Crime as a Social and Cultural Phenomenon, Crime and Social Organization, Organized Crime, Culture Based Crime, Economics of Crime
- Sociology of Change and Development, What is Social Change and Development?, Dynamics of Social Change, Role of NGOs in Development, World System and Development, Gender and Development

Recommended Books: (Latest editions where possible)

- Bernard, A. and T. Burgess (2004). Sociology, Cambridge University Press.
- DuBrin, A. J. (2007). Human Relations: Interpersonal Job Oriented Skills. New York, Prentice Hall.
- Maser, C. (1997). Sustainable Community Development: Principles and Concepts. Florida St. Lucie Press.
- Syed, S. H. (2003). The State of Migration and Multiculturalism in Pakistan: The Need for Policy and Strategy. Islamabad, UNESCO: 1-30.
- Weiss, A. M. (2001). Power and civil society in Pakistan, Oxford University press.

PSYCHOLOGY

2 (2+0)

Objectives:

Contents:

- What is Psychology?
- Nature, Scope and Application with Special Reference to Pakistan
- Different Schools of Psychology
- Methods of Psychology
- Learning
- Intelligence and Artificial Intelligence
- Personality and its Assessment
- Understanding Mal adjustive Behaviour
- Positive Emotional States and Processes
- Stress Management and Anger Management

Recommended Books: (Latest editions where possible)

- Atkinson R. C., & Smith E. E. (2000), Introduction to Psychology (13th ed.), Harcourt Brace College Publishers.

- Fernald, L. D., & Fernald, P. S. (2005), Introduction to Psychology, USA: WMC Brown Publishers.
- Hergenhahn, B. R. (2001). An Introduction to the History of Psychology, New York: Wadsworth.
- Goodwin, C. J, (2000) Research in Psychology: Methods and Design, (3rd ed.), New York: John Wiley & Sons.
- Synder, C. R., & Lopez, S. J. (2007) Positive Psychology, USA, Sage Publications.
- Allen, B. P. (1997), Personality Theories: Development, Growth and Diversity, (2nd Ed.), Boston: Allyn & Bacon.
- Cohen, R. J., & Swerdlik, M. E. (2005) Psychological Testing & Assessment (6th ed.), New York: McGraw-Hill.
- Corcini, R., (2000). Current Psychotherapies. London: Thompson & Co Publishers.
- Comer, R. J. (2004). Abnormal Psychology, USA: Freeman & Company.
- Schwartz, B., Wasserman, E., & Robbins, S. (2002), Psychology of Learning and Behaviour, 5th Ed. Norton and Company.

SUSTAINABLE URBAN PLANNING

2(2+0)

Objective:

To learn about urban planning objectives, principles, and practices and understand relationship of urban planning with environment.

Contents:

- 1. Introduction**
 - a. Terms and Definitions
 - b. Introduction to Sustainable Urban Planning
 - c. Scope of Urban Planning
- 2. The Distribution and Hierarchy of Settlements**
 - a. Provincial Capitals
 - b. Local Capitals
 - c. Fully-fledged Towns
 - d. Urban Villages or Major Rural Centers
 - e. Hamlets
 - f. Isolated Farmhouses
- 3. Sustainability and Compatibility of Land Use**
 - a. Roads
 - b. Town Center (Central Business District)
 - c. The Industrial Area
 - d. The Residential Neighborhood
 - e. Open Spaces and Parks
 - f. Neighbourhood Centre and Sub-Centers

- 4. Form and Pattern of Urban Spaces**
 - a. Linear City
 - b. Grid Iron Pattern
 - c. Ribbon Development and Growth
 - d. Radial City
- 5. Urbanization and Sustainable Development**
 - a. Spatial Growth Pattern
 - b. Urban Sprawl
 - c. Slums and squatter settlements
- 6. Development Plans in Pakistan**
 - a. Master Plans
 - b. Structure Plans
 - c. Guided Development Plans
 - d. Local Plan
 - e. Action Area Plan
 - f. Subject Plan
- 7. Urban Planning and Environment**
 - a. Urban Planning and Flooding
 - b. Impact of Urban Planning on Water Resources
 - c. Urban Heat Island
- 8. Strategies for Improvement of Urban Environment**
 - a. Urban Agriculture
 - b. Shifting of Land Uses

Recommended Books: (Latest editions where possible)

Textbook

City planning for civil engineers, environmental engineers, and surveyors (2009), Kurt W. Bauer

Reference Book

Town Planning in Third World

2. MANAGEMENT

ENVIRONMENTAL ECONOMICS

2 (2-0)

Objectives:

- To introduce the basic concepts of environmental economics
- To enhance the knowledge of economic analysis

Contents:

- Introduction to environmental economics.
- Natural resource accounting and valuation of environment; cost benefit analysis, discounting and present value of net benefit.
- Efficient and optimal use of natural resources.
- Economic benefits of non-renewable and renewable resources.
- Economic incentives for environmental protection
- Pollution control, targets and economic instruments.
- Economics of trans-boundary pollution problems
- Economics of natural resources exploitation
- Renewable resource economics
- Methods for valuing environmental costs and benefits
- The economics of sustainable development
- Environmental audits
- Case studies

Recommended Books: (Latest editions where possible)

- Hanley, N. J. F Shogren and B White, 2002, Environmental Economics in theory and practice, Palgrave Macmillan
- Moles, M. C. J, 1999. Ecology (Concepts and applications). 1st Ed WCB/McGraw-Hill New York, USA.
- Perman, R, Ma, Y, McGilvray, J. 1996. Environmental and Natural Resource Economics. Longman, London and New York.
- James R. K. 1998. The Economic Approach to Environmental and Natural Resources. Harcourt Brace College Publishers.

ECOLOGICAL MANAGEMENT

2 (2+0)

Objectives:

- To provide basic concepts of ecosystems
- To learn management techniques for sustainable development of ecosystem and environment

Contents:

- Basic concepts in ecology
- Structure of ecosystem,

- Energy and material flow within ecosystem. Succession: (only basic concepts). Ecosystem productivity , food webs and food chains
- Types of ecosystems and their management
- Biodiversity and ecological sustainability
- Nutrient cycles and Eutrophication
- Populations / communities and their dynamics and interaction.
- Species, and extinction,
- Impact of unsustainable development activities on man and ecosystem.

Recommended Books: (Latest editions where possible)

- A Guide to the Project Management Body of Knowledge, Third Edition (PMBOK Guides) by Project Management Institute
- Fundamentals of Technology Project Management by Colleen Garton
- The Art of Project Management (Theory in Practice (O'Reilly)) by Scott Berkun

PROJECT PLANNING AND MANAGEMENT

2 (2+0)

Objectives:

- To learn about the importance of planning and management of projects and its applications in environmental engineering.
- The course is designed to build and expand the basic knowledge needed by successful managers.

Contents:

- Introduction to project planning and management
- Understanding the importance and need for project planning and management,
- Defining project life cycle (process of initiating, planning, executing, controlling and closing the project)
- Types, time, cost and scope of the project, project approval processes in Pakistan,
- Introduction to contracting and tendering, relationship of development with environment
- Developing project team, defining role of team players, developing leadership skills,
- Responsibility, accountability, and effective communication skills, and managing conflicts.
- Managing the project scope, time, work flow (Gantt Charts, Network diagram, Pert Charts, CPM, etc.) , project resources, project quality, project human resource requirements,
- Estimating and managing project cost and budgets (budget plans), managing project communication (reports, meetings, correspondence, etc.), management of risk and changes in the project.

- Executing project, controlling project objectives, schedule, budget and changes, managing risk, conducting evaluation, project reporting, and project closing.
- Project monitoring guidelines, setting up monitoring and control process.
- Principles and use of Critical Path Method (CPM) in environmental projects, Gantt Charts, Pert charts, and use of computer software in project management and planning.

Recommended Books: (Latest editions where possible)

- A Guide to the Project Management Body of Knowledge, Third Edition (PMBOK Guides) by Project Management Institute
- Project Management: A Systems Approach to Planning, Scheduling, and Controlling by Harold, PhD. Kerzner
- Fundamentals of Technology Project Management by Colleen Garton
- The Art of Project Management (Theory in Practice (O'Reilly)) by Scott Berkun

NATURAL SCIENCES

LINEAR ALGEBRA & ORDINARY DIFFERENTIAL EQUATIONS

3 (3+0)

Objectives:

To make the students aware of the existence, classification, solutions and applications of different types of Differential Equations.

Contents:

- Introduction and Classification of Differential equation (DE):
- Linear Differential equations. , Classification of DE, Implicit, Explicit and Initial Value Problems.
- Existence of a Unique Solution:
- Analytical Methods to solve First Order DEs; Separable Equation.
- Linear Equations:
- Exact Equation; Methods to make a Non-exact as Exact DE
- Solution by Substitutions:
- Homogeneous DE, Bernoulli's DE, Reduction to Separation of Variable.
- Difference between linear and Non-linear Differential equations. Applications of First Order Linear Des.
- Miscellaneous Problems and Applications.
- Basic Theory of Higher order DEs; Linear DEs. Homogeneous Des.
- Homogeneous linear DEs with constant coefficients.
- Non-Homogeneous linear DEs with constant coefficients, and variable coefficients.

- Variation of Parameters.
- The Laplace Transform:
Basic Theory and its properties, Inverse Transforms.
- Transforms of Derivatives, Solving DEs,
- Partial Differential Equations (PDEs); Basic Theory, Method of Separation of Variables. Heat equation.
- Wave Equation and vibration problems. Laplace Equations.

Recommended Books: (Latest editions where possible)

Text-Books:

- Textbook: Differential Equations and Boundary Value Problems (6th Edition)
- Author: Dennis G. Zill, Micael R. Cullen
- Publisher: Brooks Cole, Thomson Learning, 2006
- Referred as: Zill

Reference Books: (Latest Editions where possible)

- Differential Equations and Boundary Value Problems (3rd Edition)
- Author: C. Henry Edwards, David E. Penny, 2007
- Publisher: Pearson Education
- Referred as: Penny

ENGINEERING CALCULUS

3 (3+0)

Objective:

To learn fundamentals of mathematics, calculus and analytical geometry.

Contents:

- Review of vectors, scalar and vector products, Definition of limit and continuity, techniques of finding limits.
- Complex Numbers: Basic Operations, Graphical Representations, Polar and Exponential Forms of Complex Numbers, De'Moivre's Theorem.
- Functions: Hyperbolic Functions, Hyperbolic and Trigonometric identities and their relationship, Exponential Functions.
- Differentiation: Differentiation and Successive Differentiation and its
- Application to Rate, Speed and Acceleration, Leibnitz's Theorem, Equations of Tangents and Normals, Curvature, Radius and Centre of Curvature, Centre of mass.
- Maxima and Minima of Function of One Variable and its Applications, Convexity and Concavity, Points of Inflexion.
- Concept of Infinite Series, Taylor's and Mclaurin's Series and Expansion of Functions.

- Partial Differentiation: Partial Differential Coefficient and Chain Rule, Partial Differentiation of an Implicit Function, Total Differential, Euler's Theorem, Statement of Taylor's Theorem of Two Independent Variable and its Applications.
- Integral Calculus: Standard Integrals, Integration by Substitution, by Partial Fractions and by Parts, Integration of Trigonometric Functions, Definite Integrals and their Properties.
- Co-ordinate Systems in Three Dimensions, Direction Cosines, Plane (Straight Line) and Sphere.

Text/ Recommended Books: (Latest editions where possible)

- Schaum's series, Calculus, Schum's Series
- Schaum's series, Complex, Schum's series
- Antom, H. Calculus and Analytic Geometry, John Wiley and Sons.
- Talpur, Calculus and Analytic Geometry, Ferozsons
- Yousuf, S. M. Mathematical Methods, Ilmi Kutab Khana
- G. B. Thomas Jr. & MR. L. Finney, Calculus & Analytical Geometry.
- E. W. Swokowski, M. Olinick, D. Pence, Calculus

PROBABILITY AND STATISTICS

3 (3+0)

Objectives:

- To learn the fundamentals of probability
- To introduce basic concepts and techniques of statistical analysis and their application in environmental engineering To introduce statistical packages/software

Contents:

- Introduction to statistics
- Descriptive Statistics
- Probability and probability distribution
- Random variables
- Sampling statistics
- Hypothesis testing
- Analysis of variance
- Linear regression
- Simulation and other statistical methods
- Statistical packages (e.g. SAS, S-PLUS, SPSS)

Recommended Books: (Latest editions where possible)

- Introduction to probability and statistics for engineers and scientists By Sheldon M. Ross, Elsevier Academic Press, 2009
- Schaum's outline of theory and problems of probability and statistics By Murray R. Spiegel, John J. Schiller, R. Alu Srinivasan, McGraw-Hill; 2nd Edition, 2000.

NUMERICAL ANALYSIS

3 (3+0)

Objective:

- To introduce and acquaint the various techniques for solving linear and non-linear equations using various numerical methods

Contents:

- Solution of Non-Linear Equations: Simple iteration, Bisection method, Newton's method, Secant method, Method of false position.
- Finite Differences: Difference operations and tables, differences of polynomials, Newton's and Gauss interpolating technique for equally spaced data, simple theorems on divided differences, Newton's formulation for unequal intervals, Lagrange's formulation of interpolation, numerical differentiation, curve fitting by the method of least squares.
- Numerical Integration: Review of integration concept and their physical significance for engineering, Trapezoidal and *Simson's* rule numerical integration techniques.
- Solution of Linear Simultaneous Equations: Jacobi's method, Gauss-Settle method, Sparse matrices, solution of differential equations, Euler and modified Euler methods, Runge Kutta and Kutta Merson methods.
- Eigen-values and Eigen-vectors: Interactive and transformation methods, Eigen-values of tri-diagonal matrix.
- Solution of Polynomial Equations: Polynomial equations, finding initial approximations and complete solution of polynomial regression analysis.

Recommended Books: (Latest editions where possible)

- Murray R. S., Schaum's Outline of Complex Variables, 2nd Edition, 2009
- Scheid F. J., Schaum's outline of theory and problems of numerical analysis, 2nd Edition, McGraw Hill, 1989
- Fundamentals of Engineering Numerical Analysis by Parviz Moin, Cambridge University Press, 2010

APPLIED PHYSICS

4 (3+1)

Objective:

- Teach the fundamentals of classical physics including the electrostatics, electrodynamics, solid-state physics, optics, and thermodynamics in relation to the cooling of electronics

Contents:

- Electrolytes; Electrolytic cells, Electrodes, Ionization, EMF
- Electrostatics: Coulomb's law, electric field and potential, capacitance, dielectrics.
- Electrodynamics: Magnetic field and force, sources of magnetic field, electromagnetic induction, inductance.
- Photovoltaics

- Solid-state physics: Crystal lattices, unit cells, energy bands, allowed and forbidden states, conductors, and insulators.
- Semiconductors: Composition, purity, n- and p-type materials, carrier properties, distribution and superconductivity.
- Carrier action: Diffusion, drift, generation, recombination. Conductivity, mobility, p-n junction diode, diode curve, forward-biased diode, reverse-biased diode, bipolar junction transistor and its biasing, MOSFET and its biasing, Hall effect.
- Optics: Optical absorption, photo-luminescence, photoconductivity, photoelectric effect, lasers.
- Heat and Thermodynamics in relation to cooling of electronics.

Lab Outline:

Electric fields, Gauss' law, electric potential, capacitance and dielectrics, current and resistance, magnetic fields, sources of magnetic field, Faraday's law, inductance, direct current circuits, alternating current circuits, diode characteristics, transistor characteristics nature of light, geometric optics, laws of geometric optics, interference of light waves, diffraction, polarization.

Recommended Books: (Latest editions where possible)

- David Halliday, Robert Resnick, and Jearl Walker, "Fundamentals of Physics," 7th Edition, 2005, John Wiley & Sons, ISBN: 0471465097.
- Arthur Beiser, "Schaum's Outline of Applied Physics," 4th Edition, 2004, McGraw-Hill, ISBN: 0071426116

ENVIRONMENTAL CHEMISTRY

4 (3+1)

Objective:

- To develop understanding of chemistry and its applications in environmental engineering.
- To enable students to deal with chemical principles operation in natural and altered environment.

Contents:

- Introduction to environmental chemistry.
- Basic concepts of:
 1. general chemistry,
 2. physical chemistry,
 3. equilibrium chemistry,
 4. organic chemistry,
 5. biochemistry,
 6. photochemistry and
 7. colloidal chemistry
 8. nuclear chemistry
 9. nanoparticles

- Basic definitions and terms
- Acids and bases: pH diagrams, pH buffers
- Types of chemical reactions
- Carbonate chemistry: carbonate system
- Hardness and removal of hardness
- Precipitation and dissolution
- Solubility product, factors affecting solubility;
- Effect of temperature on chemical reactions
- Ion association and dissociation reactions
- Redox reactions
- Greenhouse gases
- Transfer and fate of pollutants in soil, air and water Soil chemistry and environmental contaminants: Pesticides and herbicides, PCBs, PAHs and dioxins, heavy metals and other chemical pollutants.
- Primary and secondary pollutants
- Introduction to organic chemistry with applications in environmental engineering
- Applications of chemistry in resolving environmental problems

Lab Content:

- Principles of titration, filtration, distillation, paper chromatography, spectroscopy, atomic absorption, determination of pH, DO, Eh, EC, water hardness, turbidity, BOD and COD.

Recommended Books: (Latest editions where possible)

- Clair N. Sawyer, Perry L. Mc Carly & Geve F Partern, Chemistry for Environmental Engineering. McGraw-Hill, Inc.
- Harrison R. M., De Mora S. J., Introductory Chemistry for the Environmental Sciences, Cambridge Environmental Series No. 17, Macmillan Press Ltd.
- Brimble combe, P., Jickells T. D., Liss, P. S., An Introduction to Environmental Chemistry.
- Stumm, W. and Morgan J., Aquatic Chemistry, Chemical Equilibria and Rates in Natural Waters, John Wiley and Sons, Inc., ISBN 0-471-51185-4.

INTRODUCTION TO MICROBIOLOGY

3 (3+0)

Objectives:

- To focus on bacterial structures which are involved in growth and reproduction;
- To examine the taxonomy and growth characteristics of the various organisms;
- To explore the mechanisms by which microorganisms persist in their environment, are transferred from species to species;

Contents:

- Introduction
- Microbiology and its scope
- Overview and history of microbiology (various theories).
- Microbes as a component of environment;
- Techniques of Microbiology [Microscopes and Microscopic Preparations, Preparation and study of cultures];
- Preparation and safety handling in environmental microbiology laboratory [Glassware and Equipments];
- Microbial Taxonomy;
- Microscopy of Bacteria
- Scientific naming and classification of microorganisms and major groups (Eucaryotes, Procaryotes);
- Organisms belonging to the animal and plant Kingdom;
- Morphology of Bacteria;
- Size and Shape [Cocci: Diplococci, Tetrads, Streptococci, Staphylococci, Sarcinare: Bacilli: Diplobacilli, Streptobacilli, Coccobacilli; Spirillae: Spirilla, Spirochetes];
- Reproduction and Heredity in Bacteria [The nucleus and its role in cell division and heredity];
- The basic structure and activities of microorganisms;
- Gross Morphology of Microorganisms [Bacteria; Fungi; Algae; Protozoa; Multicellular parasites; Viruses];
- Physiology of Bacteria [Basic Life Processes];
- Wet mount study
- Preparation of Media and Solutions;
- Staining Techniques [Simple; Differential; Negative; Spore; Cell Wall; Fluorescent];
- Hanging drop technique
- Biogeochemical Cycles;
- Influence of Environment on Growth;
- Grams staining
- Environmental Aspects of Microbiology [Applied Areas and Microbial World];
- Study of the algal population of waste stabilization ponds
- Groups of pathogenic microorganisms of public health importance in water;
- Basic techniques for the isolation, cultivation and characterization of environmental microorganisms.
- Methodology for Sample Collection [Sampling Program; Sampling Rules] Quality Assurance and Quality Control Microbiology Laboratory;

Recommended Books: (Latest editions where possible)

Text Book:

- Microbiology: An Introduction, by Tortora, Funke, and Case. Publisher: Benjamin/Cummings Publishing Company. (10th Edition). 2010.

Reference Books:

- Pelczar, J.; Michael, Chan, E. C. S.; Kerg, R. (1993). Microbiology concepts and applications. (Ed. International). McGraw-Hill. International.
- Microbiology, 6th Edition, by Prescott, Harley and Klein, McGraw-Hill, 2005.
- Atlas. M. Ronald. (1995). Principles of Microbiology. Mosby Year Book, Inc.
- Atlas. M. Ronald. (1995). Microorganisms in our world. Mosby-Year Book, Inc.

BIOLOGICAL PRINCIPLES OF ENVIRONMENTAL ENGINEERING

3 (3+0)

Objective:

- To introduce
 - Structure and function of biosphere and its evolution
 - Basic concepts in biology and their application in environmental engineering
 - Microbiology of water and wastewater; soil and food
 - Biodegradation/bioremediation and bioaccumulation

Content:

This course describes the ecological interaction with special reference to decline and extinction of species and their conservation efforts.

Basic biological concepts:

- Molecules of life
- Cell structure and function
- Cellular reproduction (prokaryotic & eukaryotic)
- Energy mechanism in microbial metabolism
- Organization of life
- Respiration
- Photosynthesis
- Ecological systems
- Interactions in ecological systems
- Biodiversity with special reference to decline and extinction of species
- Measuring biodiversity
- Consequences of losing biodiversity
- Theories of evolution of biosphere

Recommended Books: (Latest editions where possible)

- Gaston, K. J. and Spicer, J. I., Biodiversity: An Introduction, 2nd Ed. Blackwell Publishing, 2004

- Mitchell R. and Gu, J. D., Environmental Microbiology, John Wiley & Sons Inc., 2010
- Denyer S. P., Gorman S. P. and Sussman M., Microbial Biofilms: Formation and Control. Blackwell Scientific Publication, 1993

ENVIRONMENTAL MICROBIOLOGY

3 (2+1)

Objectives:

- To develop basic understanding of microbiology as related to water, wastewater, soil and food.
- To understand application of microbiology in reduction/elimination of environmental pollution.

Contents:

- Basics concepts in microbiology and their application in environmental engineering.
- Microbial classification, growth and nutrition. Influence of environment on growth including measurement of growth, DNA structure and replication, protein synthesis.
- Growth kinetics of bacteria
- Predator/prey relationship
- Food chain.
- Energy mechanism in microbial metabolism
- Cell structure and characterization; enzymes and enzyme activity;
- Examination and evaluation of the effects of microorganisms in water and wastewater;
- Pathogenic and non-pathogenic microorganisms
- Disinfection versus sterilization with special emphasis on *Giardia* *Lambia* and *Cryptosporidium*
- Study of microscopes, microbial staining and pure culture techniques, nutritional requirements cultivation and growth;
- Enumeration of microorganisms in water, standard plate count; indicator organisms,
- Control of microorganisms by physical and chemical agents; the structure and biological functions of microorganisms including bacteria, protozoa, algae, viruses; Micro biology of water, wastewater, soil, and food.
- Biodegradation and bioaccumulation.

Recommended Books: (Latest editions where possible)

- Prescott L. M., Harley G. P., Klei C. A. 1992. Microbiology (4th edition), McGraw-Hill Inc.
- Telezar M. A., Chan E. C. S. Microbiology: Concepts and Applications, McGraw-Hill Inc.
- Mitches R., Environmental Microbiology, McGraw-Hill Inc.
- Denyer S. P., Gorman S. P. Microbial Bioskills: Formation and Control, McGraw-Hill Inc.

SENIOR DESIGN PROJECT-I **3 (0+3)**

SENIOR DESIGN PROJECT-II **3 (0+3)**

ENTREPRENEURSHIP **2 (2+0)**

Objectives:

- To introduce the concept of entrepreneurship as a career and lifestyle choice
- To make student learn about opportunity identification, market assessment, financing and emerging firm, product innovation, technology commercialization, business plan development, strategy and entrepreneurship and managing a growing firm

Contents:

- Introduction to entrepreneurship
- Entrepreneurial process
- Business opportunity identification
- Market assessment
- Financing and emerging firm
- Product innovation
- Technology commercialization
- Business plan development
- Strategy and entrepreneurship
- Managing the growing firm

Recommended Books: (Latest editions where possible)

- Small Business and Entrepreneurship by Paul Burns and Jim Dew Hurt
- Entrepreneurial for economic Growth by P. N. Singh
- Entrepreneurship Success by John B. Miner

STRUCTURAL ANALYSIS **3 (3+0)**

Objective:

- To introduce students with the classical techniques of determinate structural analysis of a variety of structural members and fixed and moving loads

Contents:

- Introduction of structural analysis
- Types of structures; structural idealization; types of beams; supports and loads. Condition for generation of reactions at various types of supports
- Determinacy, indeterminacy and stability of structures

- Conditions of equilibrium for rigid bodies, determinate and indeterminate structures, stable and unstable structures. Degree of redundancy
- Analysis of determinate trusses
- Common types of coplanar trusses. Analysis by; method of joints, method of sections and by the combination of the two, methods of moments and shears. Graphical method Maxwell's diagram.
- Analysis of statically determinate rigid joined plane frames
- Determinacy and stability of plane frames, analysis of frames, shear force and bending moment diagrams.
- Rotations and deflections
- Deflection and elastic curves: rotations and deflections in beams and frames by moment area, unit load method, double integrin method and conjugate beam method. Energy method: application of principle of virtual work for trusses, beams and frames to compute.
- Three hinged arches
- Analysis of three hinged parabolic and circular arches with support at the same and different levels.
- Cables and suspension bridges
- Role of cables and suspension bridges. Simple applications and solution of numerical on cables and suspension bridges. Three hinged stiffening girder.
- Moving loads and influence line
- Definition of ILD, ILD's for reaction, SF and BM for simple and compound beams, standard loadings, evaluation of Max. reaction, SF and BM for a series of moving loads for simple beams, paneled girders, ILD's for axial forces in truss members.

Recommended Book: (Latest editions where possible)

- Theory of Indeterminate Structures by Syed Ali Rizwan

GROUND WATER POLLUTION CONTROL

3 (3+0)

Objectives:

- To learn about groundwater resources, its pollution and control strategies

Contents:

- Introduction: Scope, historical background
- Utilization of groundwater, Groundwater in the hydrologic cycle, Occurrence of groundwater
- Origin and age of groundwater, Rock properties affecting groundwater, Vertical distribution of groundwater, zone of aeration
- Geologic formations as aquifers, types of aquifers, storage coefficient, groundwater basins

- Provincial Groundwater Resources of Pakistan, groundwater quality in Punjab, Sindh, KPK, Baluchistan, groundwater movement
- Darcy's law, permeability, anisotropic aquifers, groundwater flow rates, groundwater flow directions
- Dispersion, groundwater tracers. general flow equations
- Groundwater levels and Environmental Influences, time variations of levels, stream flow and groundwater levels
- Fluctuations due to evapotranspiration, fluctuations due to meteorological phenomena, fluctuations due to tides, urbanization, earthquakes, external loads
- Land subsidence and groundwater, quality of groundwater
- Sources of Salinity, chemical analysis, physical analysis, biological analysis
- Groundwater samples, water quality criteria
- Changes in chemical composition, dissolved gases
- Temperature, saline groundwater
- Pollution of groundwater, pollution in relation to water use, sources and cases of pollution
- Attenuation of pollution, distribution of pollution underground
- Evaluation of pollution potential, monitoring groundwater quality
- Contamination by non-aqueous phase liquids (LNAPLS and DNAPLS)
- Saline water Intrusion in aquifers, pollution in relation to water use
- Sources and cases of pollution, Attenuation of pollution
- Distribution of pollution underground, evaluation of pollution potential
- Monitoring groundwater quality, control Strategies

Recommended Books: (Latest editions where possible)

- Groundwater Hydrology by David Keith Todd 2nd Ed.

ENVIRONMENTAL MODELING

3 (3+0)

Objectives:

- To introduce the basic concepts of water quality modeling in river, lakes and estuaries

Contents:

- Introduction
 - Understanding of surface water
 - Modeling of surface water
 - Hydrodynamics
- Water quality and eutrophication
 - Overview
 - Algae
 - Organic carbon
 - Phosphorus

- Nitrogen
- Dissolved oxygen
- Mathematical modeling and analysis
 - Mathematical models
 - Model selection
 - Spatial and temporal resolution
 - Statistical analysis
 - Model calibration and validation
- Water quality modeling of rivers
 - Characteristics of rivers
 - Hydrodynamics processes in river
 - Sediments and water quality processes in river
 - River modeling
- Water quality modeling of lakes and reservoirs
 - Characteristics of lakes
 - Hydrodynamics processes in lakes
 - Sediments and water quality processes in lakes
 - Lake modeling
- Water quality modeling of estuaries and coastal waters
 - Tidal processes
 - Hydrodynamics processes in estuaries
 - Sediments and water quality processes in estuaries
 - Estuarine and coastal modeling

Recommended Book: (Latest editions where possible)

- Hydrodynamics and Water Quality: Modeling River, Lakes, and Estuaries by Zhen-Gang Ji.

SCHEME OF STUDIES FOR ME/MS

SR. NO	NAME OF THE COURSE	CREDIT HOURS
LIST OF THE CORE COURSE (Minimum four core courses are required)		
1	ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY	3
2	ENVIRONMENTAL LABORATORY	3
3	SOLID AND HAZARDOUS WASTE MANAGEMENT	3
4	PHYSICO-CHEMICAL PROCESSES IN ENVIRONMENTAL SYSTEMS	3
5	WASTEWATER TRETMENT AND DESIGN	3
6	AIR AND NOISE POLLUTION CONTROL	3
7	ENVIRONMENTAL MANAGEMENT AND IMPACT ASSESMENT	3
8	WATER RESOURCES ENGINEERING	3
LIST OF ELECTIVE COURSES		
1	WATER RESOURCES AND IRRIGATION ENGINEERING	3
2	ECOLOGY AND RISK ASSESMENT	3
3	ENVIRONMENTAL HEALTH AND SAFETY	3
4	WATER SUPPLY AND WASTEWATER COLLECTION SYSTEMS	3
5	WATER QUALITY MODELING	3
6	MARINE POLLUTION AND CONTROL	3
7	MODELING OF ENVIRONMENTAL SYSTEMS	3
8	AGRICULTURAL POLLUTION AND CONTROL	3
9	REMOTE SENSING AND GIS	3
10	APPLIED MATHEMATICS FOR ENVIRONMENTAL ENGINEERS	3
11	STATISTICS FOR ENVIRONMENTAL ENGINEERING	3
12	OPERATIONS RESEARCH & QUANTITATIVE TECHNIQUES	3
13	CLIMATE CHANGE	3
14	OPEN CHANNEL HYDRAULICS	3
15	DISASTER RISK MANAGEMENT	3
16	ANAEROBIC WASTEWATER TREATMENT	3
17	BIOTECHNOLOGY FOR ENVIRONMENTAL ENGINEERING	3
18	DISASTER RISK MANAGEMENT	3
19	SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING	3
20	ELECTIVE PG COURSE OFFERED BY OTHER DEPARTMENTS AFTER FORMAL APPROVAL BY THE HEAD OF DEPARTMENT	3

21	INDUSTRIAL WASTE TREATMENT/MANAGEMENT	3
22	BIOLOGICAL PROCESS IN ENVIRONMENT ENGINEERING	3
23	THESIS	6

DETAIL OF COURSES FOR ME/MS

CORE COURSES

ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY

3 (1.5 +1.5)

Objectives:

- To impart advanced knowledge of environmental chemistry and its application to address environmental issues
- To develop understanding of microbiology and use of micro-organisms as a tool for biodegradation

Contents:

Modul-1: Chemistry

- Physical and Chemical Properties of Water, Wastewater, Air and Soil.
- Acid- base Equilibrium
- Chemical Kinetics
- Oxidation-Reduction and Solubility Reactions.
- Mechanisms of Coagulation, Adsorption, Precipitation, Absorption and Disinfections.
- Persistent Organic Pollutants (pop's).
- Nuclear Chemistry and Biochemistry.
- Hardness, Alkalinity, Buffer Solution
- pH-PC diagram,
- Endothermic and Exothermic reactions, Redox reactions.

Module-II: Microbiology

- Fundamental Concept of Biology
- Stoichiometric Chemistry of micro-organisms
- Classification, Nomenclature, Morphology,
- Physiology and Growth Mechanisms of Microbes;
- Energetic and Interaction among biological population
- Influence of environmental factors on growth and distribution of microbes;
- Concept of Bio-technology as applied to the pollution control and waste degradation.

Recommended Books: (Latest editions where possible)

- Chemistry for Environmental Engineers by C. D. Sawyar, McGraw-Hill (latest edition).
- Environmental Chemistry by S. E. Manahan (2000) Lewis Publisher London.
- Microbiology for Sanitary Engineering by R. E. Mc Kinmey McGraw-Hill (latest edition).
- Wastewater Microbiology by G. Britten (1994) Willy Inter-science New York.

ENVIRONMENTAL LABORATORY

(0-3)

Objectives:

- To provide comprehensive knowledge of analytical techniques and use of modern analytical instruments
- Assessment and meaningful interpretation of analytical results

Contents:

- Principles of physical, chemical and microbiological analysis of environmental pollutants.
- Instrumental techniques.
- Sampling procedures for the examination of water, wastewater, air and solid waste.
- Laboratory techniques and field monitoring of parameters of importance causing environmental pollution.
- Instrumental techniques using atomic absorption, spectrophotometry,
- Gas chromatography
- Assessment and interpretation of results using statistical tools.

Recommended Books: (Latest editions where possible)

- Standard Methods for the Examination of Water and Wastewater by AWWA, WPCF Washington DC, (latest edition)
- Environmental Engineering Laboratory by Dr. Khurshid Ahmed A-one Publishers, Lahore. (latest edition).
- Principles of Environmental Sampling by Keith (latest edition)

SOLID AND HAZARDOUS WASTE MANAGEMENT

3 (3+0)

Objectives:

- To create an understanding of solid waste generation and management
- To adopt to best practices in waste minimization, and 3Rs

Contents:

- Sources, classifications, characteristics, generations,
- Onsite handling and storage, collection and transfer

- Recycling and disposal and waste techniques of municipal solid waste (MSW),
- Landfilling and landfill design
- Types and impacts of hazardous waste
- Concepts of waste to energy,
- Incinerator design concepts and hazard management
- Composting.
- Concepts of integrated solid waste management.
- Existing solid waste management practices and their hazards.
- Economic evaluation of the on-going solid waste collection and disposal systems.
- Hospital waste management.
- Case studies

Recommended Books: (Latest editions where possible)

- Integrated Solid Waste Management By G. Tehobanoglous (1993) McGraw-Hill.
- Solid waste Management, by Prof. Shaukat Hayat and Prof. Dr. Sajjad Hayder, A-One Publishers Lahore.

PHYSICO-CHEMICAL PROCESSES IN WATER TREATMENT

3 (3+0)

Objectives:

- To understand the fundamental principles of water treatment
- To learn to design a full scale water treatment plant for potable supplies

Contents:

- Water related diseases,
- Population Estimates, demand Calculation,
- Stoichiometry, Chemical Equilibriae and Kinetics,
- Reactions, Reactors and Reactor Theory,
- Selecting source and appropriate treatment techniques
- Coagulation Flocculation,
- Sedimentation,
- Filtration
- Disinfection,
- Adsorption
- Ion Exchange,
- Membrane Processes.
- Sludge Management.
- Removal of Inorganics e.g. NO_3 , As, F, Se etc.
- Organic removal.

Recommended Books: (Latest editions where possible)

- Water treatment: unit processes by D. W. Hendricks. (2008)
- Unit operations and process in Environmental Engineering, by Jon D. Reynolds.
- Water Treatment Principle and Design by James M. Montgomery Consulting Engineers Wiley Inter-science New York (latest edition).

WASTEWATER TREATMENT AND DESIGN**3 (3+0)****Objectives:**

- To understand the fundamental design principles of wastewater treatment
- To learn to treat wastewater for secondary and tertiary reuse.

Contents:

- Municipal and commercial sources of wastewater ,
- Flow Estimations.
- Physical, chemical and biological characteristics of wastewater
- Basic concepts in aerobic and anaerobic waste water treatment
- Biochemical reaction and reactor design
- Design of unit operations.
- Principles of biological and natural treatment processes and design,
- Sludge treatment methods and disposal.
- Plant hydraulics.
- Wastewater treatment for reuse.

Recommended Book: (Latest editions where possible)

- Wastewater Engineering by Metcalf & Eddy (2004) McGraw-Hill.

AIR AND NOISE POLLUTION CONTROL**3 (3+0)****Objectives:**

- To identify the major sources of air and noise pollution and their impacts on environment
- To create an understanding of climate change on natural ecosystem

Contents:

- Introduction
- Meteorology, climatology
- Sources, Classification and Effects of air pollutants;
- Sampling and Monitoring Techniques
- Indoor & Out door (Industrial and Vehicular Emissions) air quality assessment;

- Plume Dispersion Model
- Air pollution control techniques.
- Chemistry of climate change and its impacts on to the ecosystem
- EM radiations and their impacts onto the environment
- National and global sources and impacts of climate change on economy.
- Air and noise pollution laws and regulations.
- Noise Pollution-sources and types
- Fundamentals of acoustics
- Characteristics, impacts and control measures.

Recommended Books: (Latest editions where possible)

- Air Pollution Control Engineering by N. D. Nevers (1995) McGraw-Hill
- Air Pollution by H. C. Perkins McGraw-Hill (latest edition)
- Noise Pollution by Tripathy, Debipras (latest edition)

ENVIRONMENTAL MANAGEMENT AND IMPACT ASSESSMENT

3 (3+0)

Objectives:

- To understand the processes involved in environmental management
- To learn the basic concepts of environmental audit, risk management and EMS

Contents:

- Environment and Environmental Issues,
- Country Profile
- Concepts of Sustainable Development.
- Basic Environmental Economics.
- Environmental Organizations,
- Environmental Legislations NEQs, Pollution Charges.
- Cleaner Production,
- Components for Environmental Assessment;
- Screening, Scoping, Baseline Study,
- Mitigation, Monitoring,
- Environmental Impact Methodology.
- Environmental Management Plan
- Environmental Impact Statements.
- Life Cycle Assessment (LCA)
- Environmental Auditing.
- Risk Analysis.
- EMS and ISO-14001

Recommended Books: (Latest editions where possible)

- Environmental Impact Assessments by Canter McGraw-Hill (latest edition)
- PEPA Guidelines by PEPA M. O. E. Government of Pakistan (latest edition).
- Environmental Management in Practice Vol. I, II, III by Nathe Etal. 1998 Roulledge Publisher, London
- Environmental Sciences: Towards a Sustainable Future, Wright Boorse, 2011, 11th Ed. Pearson Education Inc. USA

WATER RESOURCES MANAGEMENT

3 (3+0)

Objectives:

- To develop the basic understanding about hydrological processes and their impacts
- To learn to assess and conserve the water resources

Contents:

- Hydrological Processes,
- Watershed and watershed management
- Types and distribution of precipitation,
- Glacier and ice caps-conservation strategy
- Limnology of wetland, lakes, estuaries, deltas and reservoirs
- Water losses and remedial measures
- Flood forecasting and flash floods
- Flow in stream, river, estuaries, wetlands, lakes and reservoirs.
- Ground water flow and water exploration techniques.
- Flood and drought management,
- Water conservation and rainwater harvesting,
- Water quality and water shed management,
- Water flow measurements & hydraulics;
- Sustainable development.

Recommended Books: (Latest editions where possible)

- Water Resource Engineering by Linsley McGraw-Hill.
- Hydrology and Flood plain analysis, by Philip B. Bedent (4th Edition)
- Hydrology and Management of Watersheds (3rd Edition) by Brooks

ELECTIVE COURSES

INDUSTRIAL AND HAZARDOUS WASTE MANAGEMENT

3 (3+0)

Objectives:

- To make students understand issues related to industrial waste and learn methods of waste minimization and treatment

Contents:

- Course introduction and need for the course, Ecology
- National Legislation, SMART, NEQs and International MEAs
- Industrial profile in Pakistan-Province wise Types and number of industries in Pakistan
- Industrial waste types and characteristics
 - a. Liquid waste-Physical, Chemical and biological characteristics
 - b. Solid Waste-Physical, Chemical and biological characteristics
 - c. Air Emissions-Physical, Chemical and biological characteristics
- Industrial Waste Minimization and Management, Waste Audits
- Hazardous waste-Characteristics and Treatment
- General industrial waste treatment techniques
 - d. Preliminary techniques for SMEs
 - e. Standard Techniques for large industries
- Solid Waste management
 - f. Waste types
 - g. General removal protocol
- Noise management
- Air pollution control
- Industry Specific Waste Management technology
- Pollution control in Chemical processing companies
- Pollution control in food processing companies
- Pollution control in textile and fiber industries
- Pollution control in hospitals and clinics
- Hazardous waste management

Recommended Books: (Latest editions where possible)

Industrial Water Pollution Control by W. Wesley Eckenfelder, Jr. and
INDUSTRIAL WASTEWATER MANAGEMENT, TREATMENT AND DISPOSAL, WEF,
2008

Reference Books:

- Handbook of Industrial Pollution and Control by S. C. Bhatia
- Hazardous Waste Management by Michael D. LaGrega, Phillip L. Buckingham and Jeffery C. Evans
- Water Quality- Characteristics, Modeling and Modification by George Tchobanoglous and Edward D. Schroeder

ECOLOGY AND RISK ASSESSMENT

3 (3+0)

Objective:

To understand the nature of environmental influences on individual organisms, their population and communities and concept of sustainability.

Contents:

- Introduction;
- Principles and Concepts of Eco-system,
- Energy in Eco-system,
- Biogeochemical Cycles;
- Principles Pertaining to Limiting Factors;
- Principles and Concepts at the Community and Population Levels;
- Species in Eco-system;
- Devolution and Evolution of Eco system;
- Models in Ecology;
 - Fresh Water Ecology;
 - Marine Ecology;
 - Estuarine Ecology;
 - Terrestrial Ecology;
- Concepts and Principles in Sustainable Development and Biodiversity;
- Habitat,
- Damage Assessment;
- End Point Definition;
- Quantification of Uncertainty;
- Predictive Risk Assessment;
- Exposure, Organism- level Effects;
- Case Studies.

Recommended Books: (Latest editions where possible)

- Fundamentals of Ecology by Odhum (latest edition)
- Ecological Engineering by Mitch/lorgemaker (latest edition)

ENVIRONMENTAL HEALTH AND SAFETY

3 (3+0)

Objectives:

To learn to develop safe healthy environment, friendly working/occupational environment, preventing operational hazards, accidents risk and their possible consequences. Also targeting zero accidents in industries life spans.

Contents:

- Principles of Public Health
- EHS Movement and National regulations
- Communicable Diseases

- Water Borne and Food Borne disease
- Air Borne and Sanitation Related Diseases
- Noise and vibration related sicknesses
- Factors that Modify an Individual's Response to Occupational and Environmental Hazards
- EHS Manager and Team requirements
- Industrial Hygiene and Safety
- Health implications of Indoor air quality
- Accident, sources and factors and their impact on Industry
- Accident Prevention and Elimination Plans
- Fire: Sources, Types, Protection equipment and techniques,
- Safety Equipment at work
- Industrial Health Hazards
- Heat and temperature hazard
- Pressure hazards
- Toxic substances and explosives hazards
- Emergency Preparedness
- Promoting Safety
- Health and safety training
- Ergonomics and Safety
- TQM and Safety Management
- Risk and Risk Management
- EHS Audit EHS Audit Case Studies
- Components of ISO 14000
- ISO 14000 Audit Case Study

Recommended Books: (Latest editions where possible)

- Environmental Engg. & Sanitation by Salvata (1992) Wiley Interscience
- Environmental Health Engg. by S. Caeneross (1993) Wiley Interscience
- Safety for Industry by Creber , F. L, Rospa (1967)
- Economics by K. F. H. Murrell, Chapman & Hall International (latest edition)
- Occupational Safety and Health by David L. Goetsch, 1993, Second Edition
- Handbook of Environmental Health by Herman Koren & Michael Bisesi 2002
- Environmental Health and Safety Auditing Handbook by Lee Harrison, 1994

WATER SUPPLY AND WASTEWATER COLLECTION SYSTEMS ENGINEERING

3 (3+0)

Objectives:

To enable student to understand and design water supply and WWT collection system.

Contents:

- Water Supply Storage Systems, Water Supply Distribution Systems Analysis and Design, Pipes and Appurtenances.
- Wastewater Collection and Disposal Works.
- Estimation of Sanitary Sewage and Storm Water Runoff.
- Formulation of Rainfall Intensity Duration and Frequency Relationships.
- Layout and Hydraulic Design of Sanitary Sewers.
- Flow in Sewers Transitions, Side Weirs and Drainage Systems.
- Design of Sewage Pumping Stations.
- Agricultural Runoff and Drainage System Design.
- Flush flooding and Control measures

Recommended Books: (Latest editions where possible)

- Wastewater Engineering, Collection and Metcalf and McGraw-Hill Book Co. Pumping of Wastewater Eddy Inc. (1981) The text does not make any sense. The latest edition of this book was published in 2003. It seems that who wrote the text was not even aware of the latest edition of the main textbook to be taught in the course.
- Waste Supply and Sewerage 6th Edition T. J. Mcghee McGraw-Hill Book Co. (1991)
- Water and Wastewater Engineering Fair, Gayer McGraw-Hill Book Co. and Okan (latest edition)

WATER QUALITY MODELING

3 (3+0)

Objective:

To learn and develop different water quality models related to Environment Engineering.

Contents:

- Basic Concept of Modeling.
- Hydrological Considerations in Water Quality Modeling.
- Low Flow Frequency Analysis.
- Sources of Pollution and Types of Wastes;
- Point and Non-point Sources.
- General Mathematical Formulation of Water Quality Models for Streams and Rivers; BOD, DO, COD, Bacterial Decay,
- Nitrification and Eutrophication Stream Surveys for Model Calibration

and Verification;

- Application of river models for water quality management.
- Streeter Philips Model
- Application of estuarine water quality models.
- Steady state lake models.
- Ocean outfalls and mathematical models of wastewater dispersion in oceans.

Recommended Books: (Latest editions where possible)

- Principles of Surface Water Quality Modeling and Control by E. V. Thomson (1987) Hipper and Row Publishers New York.
- Water Quality Modeling by M. D. Palmer the World Bank Washington DC. (latest edition)

MARINE POLLUTION AND CONTROL

3 (3+0)

Objectives:

- To learn about Marine pollution.
- To learn methods for its prevention and control.

Contents:

- Effects of pollutant discharges
- Oil spills
- Coastal zone management
- Beach erosion
- Channel dredging and changing sea-level on marine environment and control measures
- Modeling for pollution dispersion.
- Study of marine biology (organism, fisheries and mangroves),
- Coastal geology and estuarine ecology.
- Marine resources management. Sea water intrusion.

Recommended Books: (Latest editions where possible)

- Introduction to Earth Systems Science and Global Environmental Change, Fred Mackenzie, Printice-Hall 1998
- Case Studies in Oceanography and Marine Affairs George Brows and Engela Open University, UK 1991
- Ocean Chemistry and Deep Sea Sediments, Open University, UK, 1995
- Sea Water its Composition Properties and Behavior, Evelyn Brown, Engela Collings, 1995

MODELING OF ENVIRONMENTAL SYSTEMS

3 (3+0)

Objectives:

- To learn basic modeling concepts and techniques.
- To apply modeling for solving Environment problems/issues.

Contents:

- Basic concepts and definitions,
- Environmental systems,
- Modeling objectives and choices,
- Sensitivity analysis and sources of error,
- Introduction to numerical methods,
- Reaction type and orders of reactions conservation of mass,
- Energy and momentum,
- River/stream quality.
- Development of models;
- Water quality models of rivers, lakes, reservoirs, estuaries;
- Contaminants transport models for groundwater and soil,
- Air pollution dispersion models;
- Noise pollution models in urban centers;
- Environmental planning models.

Recommended Books: (Latest editions where possible)

- Process Dynamics in Environmental System by W. J. Weber and F. Digiamo 1995, Wiley Intisene
- Principals of Surface Water Quality Modeling and Control by R. V. Thomann & J. A. Mullama 1987, Hamper and Row.
- Environmental Cheno dynamics Movement of Chemicals in Air, Water & Soil by Louis J. Thibodeaun (latest edition)

AGRICULTURAL POLLUTION AND CONTROL

3 (3+0)

Objective:

- To learn about agricultural pollution, its prevention and remedies.

Contents:

- Environmental issues in agriculture,
- Types of farming systems,
- Agro meteorology,
- Water and nutrients requirement,
- Types of fertilizers,
- Pesticides and other agrochemicals,
- Soil and water conservation practices,
- Water logging and salinity; causes and effects.
- Wastewater reuse in agriculture,
- Management and control of agricultural waste;
- Recycling and reuse.

Recommended Book: (Latest editions where possible)

- Agriculture and non-point source pollution control: Good Management practices by Rita Cesttic, Srivastava, Jung (World Bank) 2003

REMOTE SENSING AND GIS**3 (3+0)****Objective:**

To enable the students to learn remote sensing and GIS and its application in environmental engineering.

Contents:

- Fundamentals of remote sensing. Satellite imageries, image processing, interpretation. Fundamental of GIS. Data analysis and output. GIS applications in environmental problems.

Recommended Books: (Latest editions where possible)

- Environmental Remote Sensing from Regional to Global Scales by Foody and Curran, 1994, John Wiley & Sons.
- Remote Sensing and Image Interpretation by Lillesand and Kiefer, John Wiley and Sons.
- Geographic Information Systems by Taylor, 1991, Pergamon Press
- GIS Fundamentals: A First text on Geographic Information Systems by Paul Bolstad.

APPLIED MATHEMATICS FOR ENVIRONMENTAL ENGINEERS**3 (3+0)****Objective:**

To learn statistics and probability and its application in Environmental Engineering.

Contents:

- Laws of probability, conditional probability, events.
- Review of measures of central tendency and measures of dispersion.
- Continuous random variable and its probability density function.,
- Functions and their approximation to poisson distribution.
- Sampling and estimation,
- Statistical tests.
- Regression analysis,
- Analysis, of variants,
- Design of experiments

Recommended Book: (Latest editions where possible)

- Statistics for Environmental Engineers, by Brown & Berthouex

Contents:

- Concept of Statistical Application in Environmental
 - Review of Concepts
 - Refreshing of Stat graphics Skills: Foundation Course statistical material reviewed through coordinated set of exercises on Stat graphics
- Environmental Measurements
 - Laboratory Measurements
 - Measurement Concepts: Measurement errors and uncertainty
 - Measurement Variability: Repeatability and reproducibility; inter-laboratory variability
 - Assay Calibration
 - Reported Values: Range and accuracy; reporting limits (measurement sensitivity, LOD/LOQ, Non-detects)
 - Field Measurements
 - Types of Environmental Field Measurements
 - Sampling Units, Plot Shapes and other practical collection issues
- Robust Statistics for Environmental Data
 - Robust Statistics Concepts: Exploratory data analysis; robust summary statistics and non-parametrics; re-sampling techniques (Bootstrap & Jackknife); non-normality and outlier detection; working with quantiles
 - Comparing Two Groups
 - Comparing Three or More Groups
 - Correlation
 - Regression, Trends and Seasonality
- Non-detects and Data Analysis-Handling Left-Censored Environmental Data
 - Statistical Understanding of the Reporting Limit Problem
 - Three Approaches: Substitution, MLE, Non-parametrics
 - Plotting Data with Non-detects
 - Computing Summary Statistics
 - Computing Interval Estimates
 - Robust Statistical Analysis for Comparisons and Relationships
 - All Data Below Reporting Limit-What to do now?
- Environmental Assessment: Sampling Design and Analysis
 - Goals and Objectives for Environmental Sampling Design
 - Basic Sampling: Concepts and Simple Designs
 - Equal Probability Sampling: Simple Random Sampling
 - Estimation of Population Values and Site-Wide Measures: Mean, Site Total, Proportions, Quantiles, and Ratios

- Sample Size and Precision of Estimates
 - Unequal Probability Sampling
 - Estimating Site-Wide Population Values: Classical Sampling Designs
 - Stratified Sampling
 - Cluster Sampling
 - Systematic Sampling
 - Composite Sampling
 - Multistage Sampling
 - Double Sampling
 - Others: Network Sampling, Ranked Set Sampling
 - Detectability Sampling: Elusive Populations, Location of Hot Spots, Common Source vs Point Source Contamination and Pollution
 - Basics of Detectability: Concepts, Measures and Simple Sampling
 - Grid Sampling
 - Line Transects and Variable Circular Plots
 - Line Intercept Sampling
 - Capture-Recapture Sampling (special topic for clients with interest in animal presence/abundance estimation)
 - Adaptive Sampling
 - Basic Concepts
 - Adaptive Cluster Sampling
 - Systematic and Strip Adaptive Cluster Sampling
 - Stratified Cluster Sampling
 - Spatial Sampling
 - Spatial Design and Spatial Prediction
 - Statistics for Spatial Data: General Concepts
 - Geostatistics
 - Lattice Data
 - Point Patterns
- Environmental Monitoring: Sampling Design and Analysis
 - Variability over Time
 - Detection of Change
 - Control Charts and Tolerance Charts
 - Detecting and Estimating Trends
 - Modeling and Prediction of Temporal Data: Trends, Seasonality, Cycles (Regression Modeling and ARIMA Methods)
- Ecological Statistics
 - Ecological Concepts and Measures: Species diversity; species abundance relationships; species affinity relationships; and others
 - Environmental and Ecological Indices
 - Multivariate Analysis of Ecological Data: Ordination and Classification
- Special Topics in Environmental Application Fields (OPTIONAL)

(in context to statistical data and its importance in assessing and managing the environmental issue /problem)

- Contamination and Pollution Monitoring
- Polluted Site Cleanup
- Water Resources: Quality and Quantity
- Air Quality
- Soil Quality, Fertility and Agriculture
- Common Waste Management

Recommended Books: (Latest editions where possible)

OPERATIONS RESEARCH AND QUANTITATIVE TECHNIQUES

3 (3+0)

Objective:

To learn different modeling in operation research, programming computer simulation and applying it in Environment Engineering and Management.

Contents:

- Modeling in operations research,
- Linear programming (graphical method, Simplex method, duality, sensitivity analysis, use of computer optimization software such as LINDO),
- Nonlinear programming,
- Dynamic programming,
- Stochastic modeling,
- Computer simulation,
- Time series analysis,
- Network analysis and design,
- Transportation models,
- Queuing models,
- Application of OR concepts and techniques in environmental engineering and management.

Recommended Book: (Latest editions where possible)

- Operations Research: An Introduction (8th Edition) by Hamdy A. Taha.

CLIMATE CHANGE

(3(3+0))

Objective:

To study climate change its impacts on environment. Also study the dermatology of Pakistan.

Contents:

- Composition of Air,
- Sources of air pollution,
- Impacts of air pollutants on environment (Electromagnetic Radiations)

- Climate change and its implications,
- Indicators of Climate Change,
- Adoption to climate change with reference to Pakistan,
- Case studies.

Recommended Books: (Latest editions where possible)

OPEN CHANNEL HYDRAULICS

3 (3+0)

Objectives:

- To understand different types of flow, its characteristics.
- To learn River Engineering with environmental safety aspects.
- Observe and understand types and characteristics of flow in open channels (natural and constructed)
- Develop ability to use one-dimensional, conservation laws (mass, energy, momentum) to analyze steady and unsteady, gradually and rapidly varied flows in rigid boundary channels
- Understand and use design methods for rigid and moveable, boundary channels
- Develop and apply discharge relations to flow measurement structures
- Introduce methods to control channel geometry and sediment movement in natural channels

Contents:

- Energy and momentum relations for steady flow (specific energy, specific force, critical depth)
- Measurement devices and methods for depth, velocity and flow
- Velocity and shear distributions, discharge relations Manning's equation, and channel design (non-erodible, erodible, grassed) in steady, uniform flow
- Computation of water surface profiles (energy and mass conservation equations), effects of channel geometry (width, alignment, junctions) and structures, and channel resistance and sediment movement in steady, gradually varied flow
- Depth and velocity changes (mass and momentum conservation relations) with application to hydraulic jumps, channel transitions and waves in steady, rapidly varied flow
- Unsteady flow computation for gradually varied conditions (flood routing methods) and for rapidly varied conditions (surge and dam break methods)
- River engineering problems and approaches for channel control, sediment control, and effects of structures
- Learning through analytical tools used for steady and unsteady, one-dimensional, uniform, gradually varied, and rapidly varied flows in rigid boundary, open channels (natural and constructed); the specific tools are basis for assessing environmental impacts of proposed channel alterations

- Knowledge of design methods used to select the geometry of non-erodible, erodible, and grass channels to meet economic and environmental considerations
- Types, characteristics and selection of flow measurement structures are presented and used with consideration of environmental and safety effects
- Methods of river engineering with environmental and safety aspects are introduced.

Recommended Books: (Latest editions where possible)

DISASTER RISK MANAGEMENT

3 (3+0)

Objectives:

To enable student to prepare and prevent natural disasters reduce suffering from natural disasters, avoid human/economic losses and accelerate recovery.

Contents:

Introduction to Hazards and Disasters (Concepts & Definitions), Hazard Dimensions, Distributions, Patterns, Associated Processes & History of Hazards Research, Social & Economic Aspects of Natural and man-made Hazards, Individual and Community Adjustments: Perceptions, Attitudes and Behavior, Hazard and Disaster Investigation Hazard Vulnerability Assessment & Mapping, Element at risk mapping Risk Management, Disaster Management Cycle, Pre-Disaster Phase (Prevention, Mitigation & Preparedness), Disaster Phase (Response), Post-Disaster Phase (Rehabilitation, Development), Damage assessment, loss analysis, Risk management in development planning. Disaster management policies and infrastructure at local and national level. Case Studies.

Recommended Books: (Latest editions where possible)

- Timothy Beatley, Philip Berke, David J. Brower 1999 Natural Hazard Mitigation: Recasting Disaster Policy and Planning, Island Press ISBN: 1559636025
- Charlotte Benson, Edward J. Clay (2004) Understanding the Economic and Financial Impacts of Natural Disasters, World Bank Publications ISBN: 0821356852

Objectives:

To familiarize students with bio-chemical anaerobic reactions and their control for Waste Water Treatment.

Contents:

- Mathematical tools
- Computing Skills
- Introduction to O & M of WWTPs using SCADA (Supervisory Control and Data Acquisition) System
 1. Basic Activated Sludge Process Theory
 - a. Activated Sludge Configurations
 - b. Conventional including tapered aeration, step feed, and other loading/aeration adaptations
 - c. High rate including contact stabilization
 - d. Extended aeration including package plants
 - e. Fixed film + suspended growth hybrid systems (RBC, FAST, MBBR)
 2. Biological Nutrient Removal (BNR)
 - a. Nitrification & denitrification
 - b. Anaerobic phosphorus removal
 3. Membrane Bioreactors (MBR)
 - a. General Design and Process Theory
 - b. External separation systems
 - c. Submerged (internal) systems
 - d. BNR adaptations
 4. Sludge Processing
 - a. Sources and Characteristics of Sludge
 - b. Grit and screenings
 - c. Primary sludge
 - d. Scum
 - e. Secondary sludge
 - f. Volume Reduction and Stabilization
 - g. Aerobic digestion including auto thermal aerobic digestion
 - h. Anaerobic digestion
 5. Sludge Thickening Technologies
 - a. Gravity thickeners
 - b. Gravity belt thickeners
 - c. Dewatering Technologies
 - d. Centrifuges & decanters
 - e. Horizontal belt filters
 - f. Pressure filters
 - g. Sand beds
 - h. Sludge (“Biosolids”) Disposal Techniques
 6. Composting

Laboratory Topics & Activated Sludge Process Control

1. Biochemical gas measurements
 - a. Oxygen Demand Tests
 - b. Biochemical Oxygen Demand (BOD) including carbonaceous (CBOD) & soluble (dissolved) BOD fractions
 - c. Chemical Oxygen Demand (COD)
 - d. Specific Oxygen Uptake Rate (SOUR)
2. Solids Tests
 - a. Settleometer/Imhoff's Cone tests
 - b. Total and Volatile Suspended Solids (TSS & TVSS)
 - c. Mixed Liquor Suspended and Volatile Solids (MLSS and MLVSS)
 - d. Process control calculations
 - e. Food/Microorganism Ratio (F/M)
 - f. Sludge Age
 - g. Mean Cell Residence Time (MCRT)
 - h. Sludge inventory control-waste activated sludge rates
3. Microbiology
 - a. Fecal Coliform Bacteria
4. Activated sludge microbiology including filament identification and troubleshooting

Recommended Books: (Latest editions where possible)

BIOTECHNOLOGY FOR ENVIRONMENTAL ENGINEERING

3 (3+0)

Objectives:

Develop understanding about various techniques in biotechnology and their applications to environmental problems. Students are expected to have good understanding of biotechnology techniques and be able apply in their research if required.

Contents:

Biotechnology: definition, principal and process, Recombinant DNA. technology: genetics of bacteria, Methods of gene transplanted in bacteria: development and use for pollution monitoring, Bio absorption and bioaccumulation of heavy metals, Biodegradation of toxic chemicals, genetics of biodegradation, Phytoremediation, Bioreactor: types and construction, Immobilization and biofilm formation. GEMS: construction and use.

Recommended Books: (Latest editions where possible)

- Ratledge C., et al, 2001, Basic Biotechnology, Cambridge University Press.
- McEldowney S, Hardman D. J., Waite S, 1993, Pollution: Ecology and Bio treatment, Longman Scientific & Technical.

SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING

(3 CREDIT HOURS)

- 1. ANY ELECTIVE POSTGRADUATE COURSE OFFERED BY OTHER DEPARTMENTS AFTER FORMAL APPROVAL OF HEAD OF DEPARTMENT (3 CREDIT HOURS)**

RECOMMENDED LIST OF JOURNALS:

1. Journal of Environmental Engineering (ASCE)
2. Environmental Science and Technology (ACS)
3. Water Environment Research + Water Environment and Technology (WEF)
4. Journal of Air and Waste Management Association (AWMA)
5. Atmospheric Environment
6. Water Resources Research (AGU)
7. Journal of Applied and Environmental Microbiology
8. Environmental Manager
9. *Water Research*, International Water Association (IWA)
10. *Journal - American Water Works Association*, American Water Works Association (AWWA)

Recommendations/Suggestions

To cater for the current/future needs of the academics and research in Environmental Engineering, the National Curriculum Revision Committee (NCRC) of the Higher Education Commission on Environmental Engineering put forward the following recommendations:

1. It is proposed that the above recommended schemes of studies for the graduate/undergraduate courses in Environmental Engineering programme may be incorporated to broaden the domain of specialization in the discipline of Environmental Engineering.
2. Students should be encouraged to take basic courses in Environmental Engineering to promote Sustainable Development.
3. Institutions should be well equipped with adequate labs and mobile lab units to acquire quality in teaching and to promote and support research culture.
4. The information on current trends in research in the area of Environmental Engineering should be disseminated to the public/private sector universities to create better understanding of environmental issues.
5. Public awareness/outreach programmes through electronic media, NGO collaboration, print media and by holding seminars in interaction with industry on various environmental issues will promote environmental awareness.
6. Higher education: tertiary and secondary level teachers should be trained and refresher training courses should be arranged in leading environmental institutions / organizations on periodic basis.
7. The revised curricula offer flexibility to universities / degree awarding institutions in terms of diversity, depth and level (knowledge content and extent). The committee recommended that universities should offer some courses from the list of electives to prepare graduates in a manner they are ready to take up advanced specialization at next higher academic level.
8. Fundamental courses in Environmental Engineering should be introduced at Second and Third year of engineering programme.
9. The academia should promote the computer based learning wherever applicable in the engineering subjects of the discipline so as to abreast the students with the practical knowledge of professional tools.

10. Increased interaction/collaboration between universities and relevant research & development (R&D) organizations at national and international levels should be established to promote academic research.
11. National and international experts should be approached to share their technical expertise in joining collaborative studies/projects/theses research and academics, such as part-time and split study programs.
12. The committee also recommends the consideration of extending the existing MS/MSc Environmental Engineering program into “MS Leading to PhD” as it will improve the existing undergraduate and postgraduate programmes in terms of faculty (human resource) and infrastructure (research).
13. The committee proposes to establish a society by the name of “**Pakistan Environmental Society (PES)**”, and request HEC to patronize the publication of a scientific & engineering Journal in Environment and Environmental Engineering.

Further, the Committee made the following recommendations:

- Internship in 3rd Year of course work is mandatory
- In order to improve their communication skills the students should make a presentation at the end of each engineering course
- Although three courses have been recommended by the committee in English and Computers in view of HEC guidelines, it is felt that two courses each will suffice the requirements in both cases.
- Minimum credit hours required per semester may be adjusted as per revised curriculum.
- The laboratories may be upgraded as per revised courses recommended.
- Capacity of the teaching and laboratories staff may also be enhanced through refresher courses as needed.
- Where possible, each course should be supplemented with a field visit
- Guest speaker from consultancies and government departments be invited to reinforce students’ knowledge with field experiences.