

**REVISED CURRICULUM  
OF  
ENVIRONMENTAL ENGINEERING  
FOR  
M.E./M.Sc**

**Curriculum Development Project  
Sponsored by  
Ministry of Science & Technology  
Islamabad**



**HIGHER EDUCATION COMMISSION  
H-9, ISLAMABAD  
2003**

## CURRICULUM DIVISION, HEC

Prof. Dr. Altaf Ali G. Shaikh	Director General (Curriculum)
Mr. Muhammad Younus	Director Curriculum
Malik Ghulam Abbas	Deputy Director
Miss Ghayyur Fatima	Research Associate
Mr. M. Shabbir Baig	Curriculum Officer
Mr. M. Tahir Ali Shah	Assistant Director

*Composed by **Mr. Zulfiqar Ali**, HEC, Head Office, Islamabad*

## CONTENTS

1.	Introduction	6
2.	Scheme of Studies for M.E./M.Sc	8
3.	Detail of Courses for M.E./M.Sc	10
4.	Guidelines for the Award of Degree	18

## PREFACE

Curriculum of a subject is said to be the throbbing pulse of a nation. By looking at the curriculum of a subject, one can judge the state of intellectual development and the state of progress of a nation. The world has turned into a global village, new ideas and information are pouring in a constant stream. It is, therefore, imperative to update our curricula by introducing the recent developments in the relevant fields of knowledge.

In exercise of the powers conferred by Sub-section (1) of section 3 of the Federal Supervision of Curricula Textbooks and Maintenance of Standards of Education Act 1976, the Federal Government vide Notification No.D773/76-JEA (Cur.), dated December 4, 1976, appointed Higher Education Commission as the Competent Authority to look after the Curriculum Revision Work beyond Class XII at Bachelor level and onwards to all Degrees, Certificates and Diplomas awarded by Degree Colleges, Universities and other Institutions of higher education.

In pursuance of the above decisions and directives, the Commission is continually performing curriculum revision in collaboration with the Universities. According to the decision of the special meeting of Vice-Chancellors' Committee, curriculum of a subject must be reviewed after every 3 years. For the purpose, various Committees are constituted at the national level comprising senior teachers nominated by the Universities. Teachers from local degree colleges and experts from user organizations, where required, are also included in these Committees.

The National Curriculum Revision Committee on **Environmental Engineering** in its meeting held in July 2003 at the H.E.C. Regional Centre, Karachi finalized the draft curriculum after due consideration of the comments and suggestions received from the Universities and Colleges where the subject under consideration is taught.

The Final draft prepared by the Curriculum Revision Committee duly approved by competent authority is being circulated for implementation by the Universities.

**(PROF. DR. ALTAF ALI G. SHAIKH)**  
**D.G. (CURRICULUM)**

August 2003



## **INTRODUCTION**

The final meeting of National Curriculum Revision Committee on Environmental Engineering was held at Higher Education Commission, Regional office Karachi from 22 to 24<sup>th</sup> July 2003 to prepare the final draft curriculum for postgraduate Degree Program, The following experts from various Engineering universities of the country and other user organizations attended the meeting.

- |     |   |          |
|-----|---|----------|
| 01. | Prof. Shaukat Hayat<br>Institute of Environmental Engg. and Research,<br>University of Engineering & Technology Lahore.   | Convener |
| 02. | Prof. Saeed Ahmed Khan<br>Chairman,<br>Department of Environmental Engg., NED University<br>of Engg. & Tech. Karachi.   | Member   |
| 03. | Mr. Azhar Mashiatullah<br>Principal Scientific Officer,<br>Environmental Research Group, RAID Pakistan<br>Institute of Nuclear Science & Tech. P.O. Nilore,<br>Islamabad.                             | Member   |
| 04. | Prof. Dr. M.A.Q. Jehangir Durrani, Professor<br>Deptt. Of Civil & Environmental Engg. NWFP<br>University of Engg. & Tech. Peshawar  | Member   |
| 05. | Mr. Rahmatullah Jilani<br>Manager,<br>Space Science & Upper Atmosphere Research<br>Division, SUPARCO,<br>P.O. Box No. 8402, University Road, Karachi.   | Member   |
| 06. | Engr, S.Wajahat Hussain Kazmi<br>Deputy General Manager,<br>Pakistan Steel, Human Resource Dev. Deptt. Bin<br>Qasim, P.O. Box No. 5429, Karachi.  | Member   |
| 07. | Dr. Muhammad Anwar Baig<br>Principal,<br>Institute of Environmental Science & Engineering<br>(IESE), National University of Science & Technology<br>(NUST), Tamiz-u-Din Road, Rawalpindi, Cantonment. | Member   |

- |     |  |                       |
|-----|--|-----------------------|
| 08. | Mr. Umat Rasul<br>Engro Chemical Pakistan Ltd,<br>Karachi  | Member                |
| 09. | Mr. Nazim Hussain<br>Manager-Quality Assurance Dte<br>Pakistan Ordinance Factories (POFs),<br>Wah Cantt.   | Member                |
| 10  | Prof. Abdul Rashid Memon<br>Director<br>Institute of Environmental Engineering and<br>Management<br>Mehran University of Engg. & Tech. Jamshoro. | Member &<br>Secretary |

The Meeting started with the recitation from the Holy Quran. The meeting was inaugurated by Mr. Mohammad Younus, Director (Curriculum), Higher Education Commission Islamabad. Mr. Mohammad Younus on behalf of Chairman HEC welcomed the participants of the meeting and described the role of HEC in the curriculum development. Mr. Dholan Khiyani, Director HEC Karachi, assured his co-operation and facilitation to the honorable members of the committee and providing necessary services of typing and Photostat facility to make the whole practice of curriculum to be finalized in an appropriate manner. The committee unanimously recommended the names of Prof. Shaukat Hayat to convene the meeting and Prof. Abdul Rashid Memon to be the secretary of the meeting. . The committee discussed the first draft curriculum prepared during the preliminary meeting held on 17<sup>th</sup>- 19<sup>th</sup> December 2002. The members deliberated thoroughly on the comments and recommendations received from various universities, and made the necessary changes in the final draft. In conclusion, Mr. Muhammad Younus thanked the members for their full participation and praising their expertise.

**Secretary**

(Prof. Abdul Rashid Memon)

**Convener**

(Prof. Shaukat Hayat)

**SCHEME OF STUDIES FOR**  
**M.E./M.Sc**

**LIST OF COURSES**

<b><u>S. No.</u></b>	<b><u>NAME OF THE COURSE</u></b>	<b><u>CREDIT HOURS</u></b>
----------------------	----------------------------------	----------------------------

**LIST OF CORE COURSES**

1	ENVIRONMENTAL CHEMISTRY AND MICRO-BIOLOGY	3
2	ENVIRONMENTAL LABORATORY	2
3	SOLID WASTE MANAGEMENT	3
4	PHYSICO-CHEMICAL PROCESSES IN ENVIRONMENTAL STSTEMS	3
5	WASTEWATER TREATMENT AND DESIGN	3
6	AIR AND NOISE POLLUTION CONTROL	3
7	ENVIRONMENTAL MANAGEMENT AND IMPACT ASSESMENT	3
8	INDUSTRIAL AND HAZARDOUS WASTE MANAGEMENT	3
9.	ENVIRONMENTAL ENGINEERING SEMINAR	1

**LIST OF ELECTIVE COURSES**

1	WATER RESOURCES MANAGEMENT	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	SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING	3
12.	THESIS	6

## DETAIL OF COURSES FOR M.E./M.Sc

### CORE COURSES

#### 1. ENVIRONMENTAL CHEMISTRY AND MICRO BIOLOGY (3 CREDIT HOURS)

Physical and Chemical Properties of Water, Wastewater, Air and Soil. Acid-base Equilibrium, Chemical Kinetics, Oxidation-Reduction and Solubility Reactions. Mechanism of Coagulation, Adsorption, Precipitation, Absorption, Disinfections, Persistent Organic Pollutants (pop's). Nuclear Chemistry and Biochemistry.

Basics, 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 Conversion.

#### RECOMMENDED BOOKS:

1. Environmental Chemistry by S.E. Manahan (2000) Lewis Publisher London
2. Wastewater Microbiology by G. Britten (1994) Wiley Inter-science New York
3. Chemistry for Environmental Engineers by C.D. Sawyer McGraw Hill (latest edition)
4. Microbiology for Sanitary Engineering by R.E. McKinney McGraw Hill (latest edition)

#### 2. ENVIRONMENTAL LABORATORY (2 CREDIT HOURS)

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 for Parameters of Importance Causing Environmental Pollution. Instrumental Techniques using Atomic Absorption, Spectrophotometry, Gas Chromatography, to Analyzer etc. Assessment and Interpretation of Results using Statistical Tools.

#### RECOMMENDED BOOKS:

1. Standard Methods for the Examination of Water and Wastewater by Awwa, WPCF Washington DC, (latest edition)
2. Environmental Engineering Laboratory by Dr. Khurshid Ahmed A. one Publishers Lahore. (latest edition)
3. Principles of Environmental Sampling by Keith (latest edition)
4. Microbiology by Nester, Roberts Holt, Rine Hast Winston Seattle Washington DC (latest edition)

5. Environmental Pollution Analysis by S.M. Khopar, New Age International CP Ltd. Publishers, New Delhi- London- Bang Kong, 1995

**3. SOLIDWASTE MANAGEMENT (3 CREDIT HOURS)**

Sources, Classifications, Characteristics, Generations, Onsite Handling and Storage, Collection, Transfer Recycling and Disposal Techniques of Municipal Solid Waste (MSW), Landfilling, Thermal Conversion, Composting. Concepts of Integrated Solid Waste Management. Existing Practices and their Hazards. Economic Evaluation of the Systems. Hospital Waste Management.

**RECOMMENDED BOOKS:**

1. Integrated Solid Waste Management By G.Tehobanoglous (1993) Mcgraw Hill

**4. PHYSICO-CHEMICAL PROCESSES IN ENVIRONMENTAL STSTEM (3 CREDIT HOURS)**

Stoichiometry, Chemical Equilibriae and Kinetics, Reactors and Reactor Theory, Principles and Design of Physico-Chemical Treatment Processes; Sedimentation, Coagulation Flocculation, Filtration and Disinfection, Membrane Processes. Water Softening, Distillation, Ion Exchange, Adsorption, Corrosion. Sludge Management.

**RECOMMENDED BOOKS:**

1. Water Treatment Principle and Design by I.M. Montgomery Consulting Engineers Wiley Inter-science New York (latest edition)
2. Integrated Design of Water Treatment Facilities by S. Kawamura (1990) Wiley Inter-science, New York.
3. Physio-chemical Processes for Water Quality Control by W.J. Weber Jr. (1992), John Wiley & Sons
4. Wastewater Engineering by Metcalf & Eddy (1994) Mcgraw Hill

**5. WASTEWATER TREATMENT AND DESIGN (3 CREDIT HOURS)**

Sources, Flow Estimations, Characteristics, Design of Unit Operations. Principles of Biological and Natural Treatment Processes and Design, Biochemical Reactors, Sludge Treatment and Disposal. Plant Hydraulics . Wastewater Reuse.

**RECOMMENDED BOOKS:**

1. Wastewater Engineering by Metcalf & Eddy (1994) Mc Graw Hill

**6. AIR AND NOISE POLLUTION CONTROL (3 CREDIT HOURS)**

Introduction, Sources, Classification and Effects of Air Pollutants; Sampling and Monitoring Techniques, Indoor & Out door (Industrial and Vehicular Emissions) Air Quality Assessment ; Dispersion Model; Air Pollution Control Techniques. Air Pollution Laws and Regulations.

Noise Pollution, Characteristics. Sources, their Effects and Control Measures.

**RECOMMENDED BOOKS:**

1. Air Pollution Control Engineering by N.D. Nevers (1995) MC Graw Hill
2. Air Pollution by H.C. Perkins MC Graw Hill (latest edition)
3. Noise Pollution by Tripathy, Debipras (latest edition)

**7. ENVIRONMENTAL MANAGEMENT AND IMPACT ASSESSMENT (3 CREDIT HOURS)**

Environment and Environmental Issues, Country Profile, Basic Environmental Economics. Environmental Organizations, Legislations, Standards; Iso-14000 and Neqs, Pollution Charges. Components for Environmental Assessment; Screening, Scoping, Baseline Study, Mitigation, Monitoring, Prediction and Auditing. Environmental Impact Methodology. Environmental Impact Statements. Concepts of Sustainable Development. Risk Analysis.

**RECOMMENDED BOOKS:**

1. Environmental Impact Assessments by Canter MC Graw Hill (latest edition)
2. Epa Guidelines by Epa M.O.E. Government of Pakistan (latest edition)
3. Environmental Management in Practice Vol.I, II, III by Nathe- Etal. 1998 Roulledge Publisher, London

**8. INDUSTRIAL AND HAZARDOUS WASTE MANAGEMENT (3 CREDIT HOURS)**

Origin, Characteristics and Classification of Industrial and Hazardous Waste. Hazards of Industrial Waste, Waste Audit Process, Waste Minimization and Elimination Techniques, Engineering Principles and Processes for Pollution Prevention, Treatment, Recovery. Transportation and Disposal Including Landfilling, Conversion, Safe Engineered Storage. Case Studies of Various Industries. Clinical Waste Management.

**RECOMMENDED BOOKS:**

1. Environmental Engineering & Sanitation by Saluate (1992) Wiley Inter-Science
2. Environmental Health Engineering by S. Caernerross (1993) Wiley Inter-Science
3. Industrial Water Pollution Control, 2<sup>nd</sup> edition, W.W. Ecken Felder, 1989, MC. Graw Hill
4. Hazardous Management , M.D. Lagrega, P.B. Buckingham and I.C. Evans, 1994, MC. Graw Hill

**ELECTIVE COURSES**

**1. WATER RESOURCES MANAGEMENT (3 CREDIT HOURS)**

Hydrological Processes, Watershed, Types and Distribution of Precipitation, Water Losses, Flow in Stream, River, Estuaries, Lakes and Reservoirs. Ground Water Flow and Water Exploration Techniques. Flood and Drought Management, Water Conservation and Harvesting, Water Quality and Water Shed Management, Water Flow Measurements & Hydraulics; Sustainable Development.

**RECOMMENDED BOOKS:**

1. Water Resource Engineering by Linsley MC Graw Hill
2. Hydrology for Engineers by Serrano & Environmental Professionals

**2. ECOLOGY AND RISK ASSESSMENT (3 CREDIT HOURS)**

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:**

1. Fundamentals of Ecology by Odhum (latest edition)

2. Ecological Engineering by Mitch / Iorgemaker (latest edition)

**3. ENVIRONMENTAL HEALTH AND SAFETY (3 CREDIT HOURS)**

Principles of Public Health; Communicable Diseases, Water Borne, Food Borne, Air Borne and Sanitation Related Diseases and Control Measures. Industrial Hygiene and Safety, Accident Prevention and Elimination Plans, Fire Protection Techniques, Safety Equipments.

**RECOMMENDED BOOKS:**

1. Environmental Engg. & Sanitation by Salvata (1992) Wiley Interscience
2. Environmental Health Engg. by S. Caeneross (1993) Wiley Interscience
3. Safety for Industry by Creber , F.L, Rospa (1967)
4. Economics by K.F.H. Murrell, Chapman & Hall International (latest edition)

**4. WATER SUPPLY AND WASTEWATER COLLECTION SYSTEMS (3 CREDIT HOURS)**

Water Supply Storage Systems, Water Supply Distribution Systems Analysis and Design, Pipes and Appurtenances.

Wastewater Collection and Disposal Works. Estimation of Sanitary Wewage 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 Run off and Drainage System Design

**RECOMMENDED BOOKS:**

1. Wastewater Engineering, Collection and Metcalf and Mcgraw Hill Book Co. Pumping of Wastewater Eddy Inc. (1981)
2. Waste Supply and Sewerage 6<sup>th</sup> edition T.J. Mcghee Mcgraw Hill Book Co. (1991)
3. Water and Wastewater Engineering Fair, Gayer Mcgraw Hill Book Co. and Okan (latest edition)

## **5. WATER QUALITY MODELING (3 CREDIT HOURS)**

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, Bacterial Decay, and Nitrification. Stream Surveys for Model Calibration and Verification; Application of river models for water quality management.

Development of estuarine water quality models. Steady state lake models. Ocean outfalls and mathematical models of wastewater dispersion in oceans.

### **RECOMMENDED BOOKS:**

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

## **6. MARINE POLLUTION AND CONTROL (3 CREDIT HOURS)**

Effects of pollution discharges, oil spills, coastal development, 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:**

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

**7. MODELING OF ENVIRONMENTAL SYSTEMS (3 CREDIT HOURS)**

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:**

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

**8. AGRICULTURAL POLLUTION AND CONTROL (3 CREDIT HOURS)**

Environmental issues in agriculture, types of farming systems, agrometeorology, 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 BOOKS:**

**9 REMOTE SENSING AND GIS ( 3 CREDIT HOURS)**

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

**RECOMMENDED BOOKS:**

1. Environmental Remote Sensing fro Regional to Global Scales by Foody and Curran, 1994, John Wiley & Sons

2. Remote Sensing and Image Interpretation by Lillesand and Kiefer, John Wiley and Sons
3. Geographic Information Systems by Taylor, 1991, Pergamon Press

**10 APPLIED MATHEMATICS FOR ENVIRONMENTAL ENGINEERS  
(3 CREDIT HOURS)**

Error analysis and computer arithmetic, linear systems of algebraic equations, solution of large system of linear algebraic equations. Nonlinear algebraic equations, finite difference, numerical differentiation and integration. 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

**11 SPECIAL TOPICS IN ENVIRONMENTAL ENGINEERING ( 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

**GUIDELINES FOR THE AWARD OF DEGREE**

Name of the degree: The degree will be called M.Sc. in Environmental Engineering / M. Engineering (Environment)

Degree Requirements: Student has to pass a minimum of 24 credit hours course work and six credit hours of his research work in form of thesis.

- List of Core Courses: In total there are eight core courses. Out of these minimum five courses are to be taken by the students.
- Elective Courses: Ten elective courses have been formed keeping in view the needs in the field of Environmental Engineering in the country. However the universities are at liberty to add more courses as per need of the field in future. This has been taken care in the last topic as special topics. Out of these a student has to pass requisite number of courses to complete his total 24 credit hours of coursework.
- Eligibility: The Engineering students holding B.Sc. or B.E. degree registered with Pakistan Engineering Council will be eligible. Of course they have to fulfill the requirement of pre-requisite as required by the University where they are getting admission.
- NOTE:** However NUST representative demanded to include other disciplines with equivalent qualification recognized by HEC and accepted by the concerned University.
- Thesis: A research with a weight age of 6 credit hours needs to be completed by the students.
- NOTE:** However, NED university representative disagreed for including thesis work in M. Engg. ( part time).Thesis is included in their M. Engg. (By research) Program
- Seminar: To improve the student communication skills, a Seminar may be included in the course work at the end of third and fourth term / semester, which will be a non- credit course.
- Time Limit: (1) The minimum time limit for award of degree will be 1½ years and maximum 4 years for full time students.  
(2) The minimum time limit for award of degree will be 2 years & maximum 6 years for part time students.

**NOTE:**

The courses “Industrial and Hazardous waste management” and “Environmental Management and Impact Assessment” are included in the list of core subjects

for the award of degree on the request of representatives of the Industries & EPA with consensus of the Committee members.

**Secretary**

(Prof. Abdul Rashid Memon)

**Convener**

(Prof. Shaukat Hayat)