

# **Patna University**

## **DEPARTMENT OF ZOOLOGY**

### **Courses of Studies**

**(Four Semester Course)**

**2015**

**M.Sc. Environmental Science and  
Management**

## Department of Zoology, Patna University, Patna

### M. Sc. (Environmental Science & Management) Course in Semester System

(As per the regulation of semester system, vide Patna University letter No. Acad-1563 dated 27.10.2009)

1. The duration of M.Sc. Environmental Science and Management course shall be of two academic sessions i.e. of two years, each divided into two semesters.

2. The first academic session called M.Sc. Part- I, shall consist of Semester I and

II while second academic session, called M.Sc. Part-II, shall consist of Semester III and IV,

3. There shall be a total of 16 papers in the entire course with 4 papers in each semester. It will consist of 12 core papers, 3 elective (optional) papers and 1 project work paper.

4. The performance of a student in each paper shall be assessed on the basis of a Continuous Internal Assessment (CIA) of 30 marks and End of Semester Examination (ESE) consisting 70 marks.

5. The components of CIA shall be

a. Two Mid-Semester Test of one hour duration

7.5 x 2 = 15 marks (third Repeat test for genuine absentees)

b. Seminar /Quiz/Viva- voce

5 marks

c. Home assignment/ Field Work/ Report writing

5 marks

d. Regularity and Behaviour

5 marks

**Total**

**30 marks**

## Department of Zoology, Patna University, Patna

### M.Sc. Environmental Science and Management

(Four Semester Course)

#### M.Sc. Part –I, Semester – I

Code	Subject	Credit	End Semester Exam (ESE)	Continuous Internal Assessment (CIA)	Total
ESM-M-101	Basics of Environmental Science	5	70	30	100
ESM-M-102	Environmental Geosciences	5	70	30	100
ESM-M-103	Statistical Methods & Computer Applications	5	70	30	100
ESM-M-104	Practical (Core)	5	70	30	100
	<b>Total</b>	<b>20</b>	<b>280</b>	<b>120</b>	<b>400</b>

#### M. Sc. Part-I, Semester – II

Code	Subject	Credit	End Semester Exam (ESE)	Continuous Internal Assessment (CIA)	Total
ESM-M-201	Environmental Chemistry	5	70	30	100
ESM-M-202	Environmental Biology	5	70	30	100
ESM-M-203	Environmental Biotechnology, Instrumentation & Scientific Communications	5	70	30	100
ESM-M-204	Practical (Core)	5	70	30	100
	<b>Total</b>	<b>20</b>	<b>280</b>	<b>120</b>	<b>400</b>

**M. Sc. Part-II, Semester - III**

<b>Code</b>	<b>Subject</b>	<b>Credit</b>	<b>End Semester Exam (ESE)</b>	<b>Continuous Internal Assessment (CIA)</b>	<b>Total</b>
ESM-M-301	Natural Resources, Environmental Monitoring, EIA	5	70	30	100
ESM-M-302	Environmental Management	5	70	30	100
ESM-M-303	Environment Planning, Policy and Legislation	5	70	30	100
ESM-M-304	Practical(Core)	5	70	30	100

**M.Sc. Part-II, Semester - IV**

<b>Code</b>	<b>Subject</b>	<b>Credit</b>	<b>End Semester Exam (ESE)</b>	<b>Continuous Internal Assessment CIA</b>	<b>Total</b>
ESM-M-401	Elective Paper-I A <sub>1</sub> /B <sub>1</sub> /C <sub>1</sub> /D <sub>1</sub>	5	70.	30	100
ESM-M-402	Elective Paper-II A <sub>2</sub> / B <sub>2</sub> /C <sub>2</sub> / D <sub>2</sub>	5	70	30	100
ESM-M-403	Practical (Elective)	5	70	30	100
ESM-M-404	Project/Dissertation & Viva-Voce	5	70	30	100
	<b>Total</b>	<b>20</b>	<b>280</b>	<b>120</b>	<b>400</b>

**Major Elective Papers: Twoto be selected**

<b>Code</b>	<b>Subject</b>	<b>Credit</b>	<b>End Semester Exam (Marks)</b>	<b>Internal Assessment (Marks)</b>	<b>Total Marks</b>
ESM-M-401(A <sub>1</sub> )	Natural Resources, Wildlife and Biodiversity	5	70	30	100
ESM-M-402 (A <sub>2</sub> )	Environmental Pollution	5	70	30	100
ESM- M-401(B <sub>1</sub> )	Disaster Management	5	70	30	100
ESM-M-402 (B <sub>2</sub> )	Environmental Health	5	70	30	100
ESM-M-401 (C <sub>1</sub> )	Hydrology and Water Resources	5	70	30	100
ESM-M-402 (C <sub>2</sub> )	Restoration ecology	5	70	30	100
ESM-M-401(D <sub>1</sub> )	Biodiversity and Conservation Biology	5	70	30	100
ESM-M-402 ( D <sub>2</sub> )	River and Wetland Ecosystem	5	70	30	100

# PATNA UNIVERSITY

## Course Structure: M.Sc. (Environmental Science and Management) M.Sc. Part —I First Semester: 4 Core Papers

<b>Theory</b>		<b>Marks</b>	<b>Total Marks</b>
ESM-M-101	Basics of Environmental Science	70	
ESM-M-101	Internal Assessment	30	100
ESM-M-102	Environmental Geosciences	70	
ESM-M-102	Internal Assessment	30	100
ESIVI-M-103	Statistical Methods & Computer Applications	70	
ESM-M-103	Internal Assessment	30	100
<b>Practical</b>			
ESM-M-104	Laboratory course	70	
ESM-M-104	Internal Assessment	30	100

## Second Semester: 4 Core Papers

<b>Theory</b>		<b>Marks</b>	<b>Total Marks</b>
ESM-M-201	Environmental Chemistry	70	
ESM-M-201	Internal Assessment	30	100
ESM-M-202	Environmental Biology	70	
ESM-M-202	Internal Assessment	30	100
ESM-M-203	Environmental Biotechnology, Instrumentation & Scientific Communications	70	
ESM-M-203	Internal Assessment	30	100
<b>Practical</b>			
ESM-M-204	Laboratory course	70	
ESM-M-204	Internal Assessment	30	100

**PATNA UNIVERSITY**

**Course Structure: M.Sc. (Environmental Science and Management)**

**M.Sc. Part —II**

**Third Semester: 4 Core Papers**

<b>Theory</b>		<b>Marks</b>	<b>Total Marks</b>
ESM-M-301	Natural Resources, Environmental Monitoring, EIA	70	
ESM-M-301	Internal Assessment	30	100
ESM-M-302	Environmental Management	70	
ESM-M-302	Internal Assessment	30	100
ESM-M-303	Environment Planning, Policy and Legislation	70	
ESM-M-303	Internal Assessment	30	100
<b>Practical</b>			
ESM-M-304	Laboratory course	70	
ESM-M-304	Internal Assessment	30	100

**Fourth Semester: 4 papers**

<b>Theory</b>		<b>Marks</b>	<b>Total Marks</b>
ESM-M-401	Elective Paper –I A <sub>1</sub> /B <sub>1</sub> /C <sub>1</sub> /D <sub>1</sub>	70	
ESM-M-401	Internal Assessment	30	100
ESM-M-402	Elective Paper- IIA <sub>2</sub> /B <sub>2</sub> /C <sub>2</sub> /D <sub>2</sub>	70	
ESM-M-402	Internal Assessment	30	100
ESM-M-403	<b>Practical</b> — Based on Elective Papers	70	
ESM-M-403	Internal Assessment	30	100
ESM-M-404	Project Work/ Dissertation	70	
ESM-M-404	Internal Assessment	30	100

# **M.Sc. (Environmental Science & Management): Part I**

## **Basics of Environmental science**

**ESM-M-101**

**(Semester – I)**

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x 4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x3 =30 Marks)

### **Unit 1: Introduction to Environmental Science**

1. Definition, scopes and importance of environmental science, interdisciplinary nature of environmental science.
2. Environmental education and awareness.
3. Segments of environment: Structure and composition of atmosphere, lithosphere, hydrosphere, biosphere and their interrelationship.

### **Unit 2: Ecosystem**

1. Ecosystem: Concept of ecosystem, structure and function- Abiotic and biotic factors, food chains, food webs, biomass, standing crop, trophic levels, ecological pyramids.
2. Concept of energy: Source and nature of its radiation; Laws of Thermodynamics, Lindemann's trophic dynamic concept, Energy flow models.

### **Unit 3: Nutrient Cycle and Ecological Productivity**

1. Biogeochemical cycles — carbon, nitrogen, phosphorus, sulphur.
2. Human impact on nutrient cycles, Nutrient budget.
3. Concept of ecological productivity - primary and secondary productivity, Measurement of primary productivity in aquatic and terrestrial ecosystem.

### **Unit 4: Basics of Life Sciences**

1. Classification of plants and animals up to class.
2. Brief account of phytogeography and zoogeography of India.

### **Unit 5: Pollution**

1. Pollution: Concept of Air, Noise, Water, and Soil Pollution.
2. Sources, effects, and control measures of Air, Noise, Water, and Soil Pollution.

### **Suggested Readings:**

1. Environmental Science Working with the Earth; **Miller, G.T. Jr**, Environmental Science Working with the Earth, Thomson Brooks/Cole Publ. (International Students Edition)
2. Environmental Science, **Miller, G.T.Jr&Spoolman, S.E.**Cenage Learning.
3. (2004) Fundamentals of Ecology: **Odum, E.P. & Gary, B.W.**, Cengage Learning, USA.
4. Readings in Ecology; **Dodson, S.I.** (1999),Oxford University Press.
5. Environmental Science-The Natural Environment and Human Impact: (1998) **A.R.W.Jackson&J.M.Jackson**, Longman
6. Energy and Environment; J.A Fay and T.S.Golond, Oxford University Press

# **M.Sc. (Environmental Science & Management): Part I**

## **Environmental Geosciences**

**ESM-M-102**

**(Semester – I)**

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x4 =20 marks)

Part C:5 Questions, 1from each unit, 3 to be answered (10 x3 =30 Marks)

### **Unit 1: Earth Processes and Geological Hazards**

1. Earth, Man and Environment; Basic idea of the origin, age and interior of the earth.
2. Earth Processes – Exogenic and Endogenic.
3. Geomorphic Processes - Catastrophic Natural Hazards, Study of Earthquake, Landslides, Avalanche, Floods, Volcano, Tsunami, and Mountain building.

### **Unit 2: Mineral Resources and Environment**

1. Rocks and their classification, Minerals & their classification.
2. Resource and reserve, ore forming processes, Environmental impact of exploitation, processing and smelting of minerals
3. Ocean as new areas for exploration and exploitation of minerals, Fossils fuels – coal and petroleum

### **Unit 3: Water resources**

1. Hydrological cycles, Types of water, Global water Balance; Ice sheet and fluctuation of sea level, ocean pollution by toxic wastes.
2. Human use of surface and ground water, ground water pollution – Arsenic, Fluoride.
3. Water crises – Conservation of water; Rain water harvesting- Traditional methods and modern approaches.

### **Unit 4: Environmental Geochemistry**

1. Concept of major, Trace and Rare Earth Elements (REE), Classification of trace elements, Mobility of trace elements
2. Geochemical cycles; Human use of trace elements; Possible effects of imbalance of some trace elements
3. Diseases induced by change in land use pattern.

### **Unit 5: Meteorology, Land use planning and Remote Sensing**

1. Fundamentals of Meteorology: Pressure, temperature, precipitation, Humidity and wind; Atmospheric stability, inversion and mixing heights, wind roses, Wind, Wind system- Microscale, Mesoscale, Macroscale.

2. Climate of India – Monsoon, EL-Nino, La-Lina drought, Tropical Cyclones, and western disturbances.
3. Types of soil, soil surveys in relation to Land use planning
4. Principle of Remote Sensing and its applications in Environmental sciences.
5. GIS and its application in Environmental Sciences.

### **Suggested Readings:**

1. General Meteorology: **H.R.Byers**; McGraw- Hill
2. Environmental Geology: **K.S. Valdiya**; Tata McGraw- Hill
3. General Climatology: **Critchfield H.J.**
4. Environmental Geosciences– Interaction between natural system and man:  
**A.N.Strahler&A.H.Strahler**: Santra Barbara, California, Hemilton publishing
5. Natural hazards-Local, National, Global. **G.F.White** (E.d. Oxford University Press)
6. An Introduction to GIS: **Haywood**; Pearson Education
7. An Introduction To The Environmental Physics of Soil, Water And Watersheds: **C. Rose**;  
Cambridge University Press
8. Handbook of applied hydrology: **V.T.Chow**; New York, McGraw- Hill.
9. Geological Hazards: Their Assessment, Avoidance and Mitigation:**F.G.E., &Spon, F.N**  
Books der ULB Darmstadt.Bell.
10. Introduction to Environmental Geology, **Keller, E.A. (2007)**, Prentice-Hall.
11. Environmental Geology: An Earth System Science Approach, **Merritts, D., De Wet, A.,  
&Menking, K.:**W.H.Freeman, San Francisco.
12. Environmental Hydrogeology, **LaMoreaux, P.E. et. al.**CRC Press.
13. Physical Climatology: **Sellers W.D**
14. Remote Sensing and Image interpretation, (2007):**Lillesand, T.,&Kefer, R.W.** John Wiley  
& Sons.
15. Environmental Geology 1987,**Valdiya, K.S.**
16. Introduction to Geochemistry: **Krauskoph K.B.**
17. Introduction to Weather and Climate: **Trewartha**
18. Introduction to Climatology for Tropics: **Ayoade J.O.**
19. Climatology: Fundamentals and Applications: **Mater J.R.**
20. Climatology, Selected applications: **Oliver J.E**
21. Groundwater Hydrology:**D.K.Tosdd**
22. Principles of remote sensing – **Lily &Kliffer**
23. Hydrology-Principles, Analysis and design(1996), **H.M.Raghunath**, New Age International  
Publishers.
24. Satellite Remote Sensing For Natural Hazards Preparedness and Emergency Response  
Planning(1989), **G. Morgan**, World Bank, Environmental Operation & Strategic Division,  
World Bank

# **M.Sc. (Environmental Science & Management): Part I**

## **Statistical Methods and Computer Applications**

**ESM-M-103**

**(Semester – I)**

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered ( 2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x 4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x 3 =30 Marks)

### **Unit 1: Introduction to Statistical Methods**

1. Definition, scopes and limitation of statistics, sources and classification of data, sample and sampling; Graphical representations of data.
2. Central tendency: Mean, median and mode. Measures of dispersion: range, quartile deviation, standard deviation, standard error

### **Unit 2: Moments and Basics of Correlation**

1. Moments.
2. Skewness, Kurtosis.
3. Correlation coefficient [Product Moment & Rank], Regression analysis.

### **Unit 3: Probability and Distribution**

1. Probability — Definition, Terms used in probability theory, addition and multiplication theorems (without proof).
2. Application of the binomial, Poisson and normal distributions along with the properties of normal curve.

### **Unit 4: Hypothesis Testing and Test of Significance**

1. Experimental design for different environmental issues and research methodology.
2. Test of significance; Hypothesis (Null and Alternative), Type- I and Type — II errors, Critical region and degree of freedom.
3. Testing of the mean of a population, difference in two means, applications based on chi- square and 't'- statistics; ANOVA- one way and two way classification.

### **Unit 5: Computer applications**

1. Basic concepts of computers, Classification of computers, Hardware and software, MS office and some packed languages, MS word, MS Excel, Power Point; Concept of Data Base Management System ( DBMS).

### **Suggesting Readings:**

1. Biometry (1995), **Sokal, R.R. & Rohlf, F.J.**; W.H. Freeman, San Francisco, CA, USA.
2. Biostatistical Analysis(1999), **Zar, J.H.**: Pearson Education Publication.( Indian Edition)
3. Statistical Ecology: A Primer on Methods & Computing (1988): **Ludwig, J.A. & Reynolds, J.F.**: John Wiley & Sons.
4. Statistics for Engineers and Scientists, **Walpole, R. and R. Myers** (1993). 5<sup>th</sup>edn. Mac Millan, N.Y.
5. Environmental Statistics and Data Analysis, **Wayne, R. Ott** (1995) CRC Press.
6. Statistics for Environmental Science and Management, (2001) **Manly, Chapman and Hall**, CRC Press.
7. Statistics for Environmental Biology and Toxicology, **W.E.Piegrosch and J.A.Bailer** (Chapman and Hall London, UK)
8. General Statistics **W. Chase and F. Bown** (J.Wiley, New York, USA)
9. Introduction to Statistics – **C. Leach** (J.Wiley, New York, USA)
10. Fundamentals of Mathematical Statistics: **S.C.Gupta and V.K.Kapoor.** S.Chand& Co.
11. Statistical Methods : An introductory test: **J.Medhi**, New Age International Ltd. Publishers

## **M.Sc. (Environmental Science & Management): Part I**

### **Practical (based on ESM-M-101,102 & 103)**

**ESM-M-104**

**(Semester- I)**

**Full marks:70**

**Time: 6 Hrs**

**5 Credits**

**Unit1: (Any one of the following)**

**15 marks**

1. Measurement of Transparency/Turbidity of aquatic body and light intensity using instrument.
2. Estimation of dissolved oxygen of water body; measurement of primary productivity in water body using light and dark bottle method

**Unit2: (Any one of the following)**

**15 marks**

1. Description and interpretation of geological maps, topo-sheet and remotely sensed data.
2. Identification of rocks and minerals.
3. Knowledge of the principles, working and related calculations of weather instruments- Thermometers, Wet and dry bulb thermometer, Barometer, Anemometer, Rain Gauge.
4. Graphical representation of climate data- Simple graph, Combine bar and line graph, Climatograph and Rainfall variability graph.
5. Study of climatic conditions obtained in open field and under the shade of trees for temperature, light intensity, wind velocity, Relative Humidity (RH).
6. GIS and GPS applications in environmental survey and monitoring.

**Unit 3: (Any one of the following) 15 marks**

1. Problems based on Standard deviation, Standard error, Chi-square test, Correlation, Regression, t-test of environmental data.
2. Graphical Representation of data.
3. Use of MS office for environmental data analysis.

**Unit 4:**

**5 marks**

Field work report based on

1. Visit to various natural ecosystem/ hazards affected area/ land use pattern
2. Visit to nearest meteorological station/ remote sensing centre & to understand its functioning.

**Unit 5:**

**20 marks**

1. Practical records /field collection/models/charts10 marks
2. Viva-voce10 marks

# M.Sc. (Environmental Science & Management): Part I

## Environmental Chemistry

ESM-M-201  
(Semester – II)

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x3 =30 Marks)

### Unit 1: Fundamentals of Environmental Chemistry

1. Concept and scope of environmental chemistry.
2. Stoichiometry: Mole concept and equivalent concept, Normality, Molarity, Molality, Mole fraction, Oxidation and Reduction.
3. Chemical equilibrium:  $K_c$ ,  $K_p$  and  $K_x$ , relation between  $K_c$ ,  $K_p$  and  $K_x$ . Le Chatelier's Principle.
4. Ionic equilibrium: Concept of acid and base, ionic product of water, pH, buffer solutions, solubility and solubility product, solubility of gas in water.
5. Thermodynamics: Laws of thermodynamics, enthalpy, Gibbs's free energy, entropy, spontaneity of physical and chemical process,  $C_p$  and  $C_v$ , Chemical potential.

### Unit 2: Atmospheric Chemistry

1. Chemical composition of the atmosphere, reaction in atmosphere, earth's radiation balance, particles, ions, radicals and particulate matters, formation of smog,
2. PAN, acid rain, chemistry of ozone layer, depletion of ozone layer, green house gases and global warming.
3. El-Nino phenomenon. Photochemical reactions in atmosphere, chemistry of air pollutants.

### Unit 3: Water Chemistry

1. Physical and chemical properties of water (fresh and marine).
2. DO, BOD and COD as test of water quality.
3. Sedimentation, coagulation, filtration, Redox potential.

### Unit 4: Soil Chemistry

1. Composition of soil, soil properties (physical and chemical), inorganic and organic components in soil.
2. Water holding capacity, pH, buffering capacity, humus, acidity, alkalinity, acid-base and ion-exchange reaction in soil.
3. Nitrogen pathway and NPK in soil.

## Unit 5: Toxic Chemicals in Environment

1. Biochemical effects of Arsenic, Cadmium, Lead, Mercury, Ozone.
2. Biochemical effects of Carbon monoxide, Aerosols, Photochemical smog, PAN, MIC.
3. Biochemical effects of Pesticides.

### Suggested Readings:

1. Environmental Chemistry: **Stanley E. Manahan**., CRC press.
2. Environmental Chemistry- A Global perspective : **G.W.Vanloon , S.J.Duffer** , , Univ. Press
3. Environmental Chemistry: **A.K.De**: New Age International publishers.
4. Environmental Analytical Chemistry: **F.W.Fifield and W.P.J.Hairens** , Black Well Science Ltd.
5. Basic Concept of Environmental Chemistry: **Connel, D.W.**; CRC Press
6. Environmental Chemistry; **Baird, C. & Cann, M.**; Freeman Publishers.
7. Introduction to Environmental Science and Engineering, **Masters, G.M. & Ela W.P.**; PHI Learning, New Delhi.
8. Aquatic Chemistry: Chemical Equilibria and rates in Natural waters,: **Stumm, W. & Morgan, J.J**; Wiley Publication
9. Environmental Chemistry: **J.W. Moore and E.A.Moore**
10. A text book of Environmental Chemistry And Pollution Control: **S.S Dara**
11. Environmental and Man: The Chemical Environment : **J. Lenihan**
12. Inorganic Chemistry of Earth : **Fergusson J.E.**
13. Environmental Chemistry: **Raiswell**
14. The Chemistry of our Environment: **R.A. Home**
15. Green Chemistry- **Paul Anastas and Tracy C. Williamson** – Oxford University Press

# **M.Sc. (Environmental Science & Management): Part I**

## **Environmental Biology**

**ESM-M-202**

**(Semester – II)**

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x 4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x3 =30 Marks)

### **Unit 1: Fundamental Ecology**

1. Ecology: - Definition, scopes & sub-divisions.
2. Ecological factors- Abiotic and biotic, climatic factors, topographic factors, edaphic factors.
3. Effect of climatic factors (light, temperature, precipitation) on biotic community.
4. Concept of Biological clocks, Liebig's Law of Minimum, Shelford's law of Tolerance, Concept of limiting factors.

### **Unit 2: Population Ecology**

1. Population ecology- Size and density, dispersion, age structure, natality, mortality and life table, population- growth curves, carrying capacity; Interaction between two species (competition, predation, parasitism, commensalism, antibiosis, co-operation and mutualism, Lotka-Volterra Model) and Niche theory.
2. Community- Concept of habitat, functional role, keystone species, dominant species, ecotone, edge effect, edge species, species diversity indices, measurement of diversity indices, invasive species and its environmental cost
3. Community dynamics- succession, type of succession, concept of climax and types of climax.

### **Unit 3: Ecosystems Diversity**

1. Major ecosystems of the world: fresh water: river and wetland, Grassland, desert and forests.
2. Aquatic biota- phytoplankton, zooplankton, benthos, periphyton, macrophytes, nekton, neuston and other organisms.

### **Unit 4: Microbiology**

1. History and scope of microbiology; General Classification of bacteria and virus, nutritional classification of bacteria; General idea of structure and reproduction of bacteria and virus.
2. Microbiological methods- isolation and pure culture of microbes (sterilization, media preparation, isolation technique, incubation and growth curve)
3. Aerobiology: Basic idea of Microflora of air; air sampling technique, identification of Aeroallergens and their impact as diseases causing agents, Air-borne diseases.

### **Unit 5: Immunology**

- I. Immunology- Basic Concept, Antigen, antibody,
2. Immunological response to diseases; Hypersensitivity (Allergy, allergens, autoimmunity)
3. Immunological methods: ELISA

### **Suggested Readings:**

1. Elements of Ecology, **Smith, T.M. & Smith, R.L.**; Elements of Ecology, Pearson, New Delhi.
2. Encyclopaedia of Environmental Biology, **Nierenberg, W.A.**; Three-Volume Set: 1-3, Academic Press.
3. Biological Diversity: The Coexistence of Species; **Huston, M.A.**: Cambridge University Press.
4. Ecology: From Individuals to Ecosystems; **Michael, B., Townsend R.C., & Harper, L.J.**: Wiley – Blackwell.
5. Ecology (2000), **Ricklefs, R.E. & Miller, G.**; W.H. Freeman
6. Elements of microbiology: **Pelzar, M.J. and Chan ECS**, 1981 McGraw Hill
7. General Microbiology: **Stainer, R.Y.; Adelberg, E.A. and Ingraham, J.L.** 1977, Macmillan Press
8. APHA, AWWA and WFF (2005): Standard Methods for the Examination of Water and Wastewater ( 20<sup>th</sup> ed. ) American Public Health Association.
9. Manual of environmental Microbiology (2001); **Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney**: ASM Press
10. Wastewater Microbiology, **Grbriel Bitton**, 2<sup>nd</sup> Edition, (1999) Wileu-Liss
11. Ecology, Individuals, Populations, and Communities. **Begon, M., J.L. Harper and C.R. Townsend**. Blackwell Science, Oxford, U.K
12. Ecological concepts, **Cherrett, J.M.**; Blackwell Science, Oxford, U.K
13. Population Biology, **Elseth, B.D. and K.M. Baumgartner**. Van Nostrand Co., New York
14. .Ecological Methodology. **Krebs**, Harper & Row, New York
15. Kuby Immunology – **Thomas J . Kindt, Richard A. Goldsby, Barbara A. Osborne**. W.H. Freeman & Co.
16. ‘The Green House effect, climate change, and ecosystem’ – **B. Warrick, D. Jager**-Wiley.

**M.Sc. (Environmental Science & Management): Part I**  
**Environmental Biotechnology, Instrumentation, and Scientific**  
**Communication**

**ESM-M-203**  
**(Semester – II)**

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5x 4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x3 =30 Marks)

**Unit 1: Basics of Biotechnology**

1. Concept of Genetic Engineering, Biological enzymes, vectors.
2. Role of genetic engineering in medicine and environmental protection.

**Unit 2: Applications of Biotechnology**

1. Applications and products of biotechnology- Bio- fuels, Microbial leaching, Bio-fertilizers, Bio-pesticides, Vermiculture technology, Fermentation technology.
2. Genetically modified organisms (GMOs), Bt- cotton, Bt-brinjal, Pomato, GoldenRice.

**Unit 3: Instrumentation**

1. Principles and applications of colorimeter, spectrophotometer, flame photometer, and atomic absorption spectrophotometer.
2. Principles and application of chromatography: paper chromatography, column chromatography, GLC and HPLC.
3. Brief concept of Bio Sensors

**Unit 4: Scientific Communications**

1. Different types of scientific write-ups; technical reports, research papers, review papers and thesis /dissertation.
2. Scientific presentation — Oral presentation, poster presentation

## Unit 5: Environmental Ethics

1. Ethics, rights, and permissions regarding scientific communication.
2. Impact of GMOs on Human health and environment
3. Recent environmental issues related to use of animals in scientific experimentations.

### Suggested Readings:

1. Ethics & the Environment: An Introduction, (2008) **Jamieson, D.**, University Press.
2. Principles of instrumental analysis (2006): **Skoog, D.A., Holler, F.J., & Crouch, S.R.**: Brooks Cole.
3. Analytical Chemistry (1997): **Murphy, W.J.**, American chemical society, USA.
4. Environmental Biotechnology (2005): **Scragg, A.H.** Oxford University Press.
5. Environmental Biotechnology: Principles and Applications (2011): Rittmann, B.E & McCarty, P.L., McGraw Hill
6. Environmental Biotechnology: Theory and Applications (2003); **Evans, G.M. and Furlong, J.C.** John Wiley & Sons Publications.
7. Microbial Methods for Environmental Biotechnology: **Grainer, J.M. and Lynch, J.M.** 1984. Academic Press.
8. Microbial Methods for Environmental Scientists and Engineers: **Guady, A.F. and Guady, E.T.** 1980, McGraw Hill.
9. Global Environmental Biotechnology: **D.L. Wise**
10. Biotechnology and safety Assessment (2002): **Thomas, J.A & Fuchs, R.**, Academic Press
11. Genetically Modified Organisms in Agriculture: Economics & Politics; (2001) **Nelson, G.C**

**M.Sc. (Environmental Science & Management): Part I**

**Practical (based on ESM-M-201, 202 & 203)**

**ESM-M-204**

**(Semester- II)**

**Full marks:70**

**Time: 6 Hrs**

**5 Credits**

**Unit-1 (Any one of the following)**

**15 marks**

1. Preparation and standardization of reagents
2. Estimation of transparency, turbidity, total solid, suspended solid, dissolved and volatile solids in water samples
3. Estimation of total alkalinity, free CO<sub>2</sub>, hardness, chloride, calcium and magnesium in water and soil samples.
4. Estimation of Dissolved Oxygen in water sample.

**Unit-2: (Any one of the following)**

**15 marks**

1. Identification and comments upon planktons, neustons, nektons, benthos, and macrophytes.
2. Estimation of pH and conductivity of water and soil
3. Estimation of phosphate and nitrate in water samples
4. Estimation of Na and K by flame photometer.

**Unit-3 (Any one of the following)**

**15 marks**

1. Preparation of media for microbial culture, isolation and culturing of bacteria and fungi from air / water / soil samples.
2. Microbiological Analysis – isolation and characterisation of bacteria and fungi from soil and water.
3. Coliform count using MPN /CFU (Colony Forming Unit)/heterotrophic plate count methods.
4. Principle and applications of biological instruments –pH, Colorimeter, Spectrophotometer, flame photometer

**Unit-4:**

**5 marks**

Field work report based on

1. Visit to aquatic ecosystem and methods for collection of water and biota.
2. Visit to natural terrestrial ecosystem
3. Visit to well established tissue culture laboratory & study of its functioning

**Unit5:**

I. Practical records /field collection /models/charts

**10 marks**

2. Viva-voce

**10 marks**

**M.Sc. (Environmental Science & Management): Part II**  
**Natural Resources, Environmental Monitoring and EIA**

**ESM-M-301**

**(Semester – III)**

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x3 =30 Marks)

**Unit 1: Natural Resources**

1. Natural Resources and their conservation; Conservation and management of soil, land and water.
2. Wildlife — Meaning and its values, threats to wildlife
3. Wildlife conservation & preservation
4. Scope and functions of IUCN and other conservation agencies

**Unit 2: Environmental Monitoring**

1. Principles of environmental monitoring- (a) Water (b) Air and (c) Soil
2. Principles of site selection and sampling distribution-Water, Air and Soil
3. Concept of indicator Species and their ecological significance

**Unit 3: Environmental Impact Assessment**

1. Introduction to Environmental Impact Analysis. Environment Impact Statement, and Environment Management Plan, EIA guidelines 1994 and its recent amendments, if any , Notification of Government of India.
2. Generalised approach to impact analysis, Procedure for reviewing Environmental impact analysis and statement. Guidelines for Environmental audit.
3. Risk Management Programmes – Definition of risk, Management and analysis; Risk assessment application tools environmental management problems and industrial accidents and disasters

**Unit 4: Environmental Planning**

1. Introduction to environmental planning, Base line information and predictions (land, water, atmosphere, energy, etc); Restoration and rehabilitation technologies.
2. Land use policy for India, Urban planning for India, Rural planning and land use pattern.
3. Concept and strategies of sustainable development, Cost-Benefit analysis, Environmental priorities in India and sustainable development.

## **Unit 5: Ecotoxicology**

1. Definition of Toxicology, Toxic substances in environment; Acute toxicity, Chronic toxicity, Lethal concentration, Effective concentration, Bioconcentration, Biomagnifications.

2. Animal Toxicity tests, Concept of dose response relationship; Aquatic toxicity test, Statistical concept of LC<sub>50</sub>, Statistical concepts of LD<sub>50</sub>.

### **Suggested Readings:**

1. A new Century for Natural Resources Management: **Knight, R, L.,et.al (ed.)** (1995) Island Press
2. Principles of water Resources: History, Development Management, and Pollution: **Cech, T** (2002) Wiley, UK.
3. Mineral Resources Management & the Environment: **Aswathanarayana, U (2003)**: Taylor and Francis.
4. Environmental Impact Assessment Methodologies (2007): **Anjaneyulu, Y.:** B.S. Publication, Sultan bazaar, Hyderabad.
5. Introduction to Environmental Impact Assessment, (2012): **Glasson, J., Therivel, R. & Chadwick, A.:** Routledge, London.
6. Environmental Impact Assessment (1996): **Canter, L.W.:** McGraw Hill Publishers, New delhi.
7. Cumulative Environmental Impact Assessment (2006): **Ramachandra, T.V., Nova Science Publishers.**
8. Environmental Impact Assessment (2002): A methodological perspective : **Morgan, R.K:** Kulwer Academic Publishers, Dordrecht.
9. Land Degradation and Society – **P. Blaikie and H. Brookfield**, 1987, London, Methuen
10. Landuse in Central Boston – **W. Firey**, 1947, Cambridge, Harvard University Press.
11. Environmental Impact Assessment (2011): A guide to best professional practices: **Eccleston, C.H.:** CRC Press ,Boca Raton.
12. Environmental Risk Assessment : **Whyte, Anne, V. and Ian Burton** (eds) 2 ,John Wiley & sons, 1980
13. The theory of Environment Policy, **Baumol, W.J. and W.E. Oates**, Cambridge University Press, 1988.
14. Wildlife Biology – **C.H. Stevenson and Arwin**
15. India's Wildlife and Wildlife resources – B. Sterling Publishing Pvt. Ltd.
16. Methods of Environmental Impact Assessment; **Morris & Ayers**
17. Principles of Environmental toxicology: **I.C. Shaw & J. Chadwick**, Taylors & Francis Ltd.
18. Environmental Impact Analysis Handbook: **J.G. Rau & D.C. Wooten**, McGraw-Hill Book Co.
19. Environmental Impact Assessment: 2003; **A.K. Srivastav**, APH Publishing Corporation.

# **M.Sc. (Environmental Science & Management): Part II**

## **Environmental Management**

**ESM-M-302**

**(Semester – III)**

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x3 =30 Marks)

### **Unit 1: Sewage Treatment**

1. Concept of sewage, Estimation of Sewage quantity, flow variations
2. Sewage treatment processes: (a) Physical processes (b) Physico-chemical processes (c) Biological processes

### **Unit2: Unit Process**

1. Functions and operation of various units in sewage treatment plant  
(a) Screen chamber (b) Grit chamber (c) Primary settling tanks (d) Activated sludge process (e) USAB
2. Low Cost Treatment Technologies- Septic tank, Oxidation ponds, Aerobic lagoons.

### **Unit 3: Characterization of Wastes**

2. Types and sources of solid wastes, municipal solid wastes, bio-medical wastes, industrial solid wastes and hazardous wastes.
3. Recycling of waste materials, Waste minimization technologies.

### **Unit 4: Disposal of Wastes**

1. Properties of solid waste: Physical and chemical composition of municipal solid wastes. Fundamentals of solid waste management: Source, Segregation, Collection, Transportation and disposal.
2. Disposal Technologies- (a) Composting- Aerobic, Anaerobic and Mechanical and their limitations (b) Incineration (c) Sanitary land –fill.

3. Hazardous Waste Management: Definition and classification of hazardous wastes, Treatment Technologies, Hazardous Waste-Management, and Handling Rules-1991, Biomedical wastes and their management, Disaster Management and Risk analysis.

#### **.Unit 5: Environmental Audit and reputation**

1. Environmental Audit- Concept, Audit process, Pre- and Post- audit activities & Format of Audit Documents, Benefits of Environmental Audit.

2. Regulatory requirements of Pollution control in industries.

#### **Suggested Readings:**

1. Environmental Engineering (2007); Kiely, G. Tata McGraw-Hill, New Delhi.
2. Environment Pollution Control Engineering(2011); **Rao, C.S.**, New Age International Publishers, New Delhi.
3. Introduction to Environmental Engineering and Science (1991); **Gilbert M. Masters**,; Prentice Hall.
4. Comparative Analysis of Alternative Policy Instruments' Chap.10 In Handbook Of Natural Resources and Energy Economics, **Bohm, P and Russell, C.**, Vol. I Ed. A.V. Kneese and J.L.Sweeney, 1985.
5. Manual on Sewerage & Sewage treatment, Ministry of works & Housing, New Delhi.
6. Waste water Engineering : Treatment and Use, **Met Calf & Eddy**: INC, Tata McGraw Hill
7. Physico – chemical: Process for water quality control, **W.J.Webber**, Wiley inter-science
8. Disposal of Municipal waste, House report no. 2012, Report by subcommittee on Govt. Operation, House of representative, March 24, 1965, UK
9. Water Supply & Sanitary Engineering, **Birdie G.S.**, Dhanpat Rai & Sons, New Delhi
10. Handbook of Environmental Management and Technology: **Gwendolyn Holmes, Ben Ramnarine Singh, and Louis Theodore.**
11. Environment Management – **N.K. Oberoi**
12. 'Waste water Engineering – Treatment, disposal & reuse', **Met Calf & Eddy**: INC, Tata McGraw Hill
13. Environmental Audit by **A.K.Mhaskar**. Dot Publication Pune
14. Environmental Auditing By **CPCB**, Delhi
15. Biological Process design for waste water treatment, **L.D.Bemefield and C.W. Randall**, Parentice Hall
16. Environmental Engineering, Howard, **Peavy, D. Rowe H.S. Peavy**, Mac Graw Hill

**M.Sc. (Environmental Science & Management): Part II**  
**Environmental Planning, Policy and Legislation**  
**ESM-M-303**  
**(Semester – III)**

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x 4 = 20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x 3 = 30 Marks)

**Unit 1: Environment Management System**

1. EMS, Model, its ingredients and benefits.
2. Development of Environmental Standards.
3. ISO, ISO 9000 & series, ISO 14000 & series.
4. Legislation and standards.
5. EIA

**Unit 2: Environmental Legislation in India**

1. Salient features of Constitutional Provisions: The complementary relationships amongst 48 A and 51(A) (g) and Article 14 (Equality), 19(1)(g)-Business and 21 (life)
2. Statutory Provisions for Environmental control and prevention: Wildlife Protection Act, 1972, Amended 1991, Forest Conservation Act 1980, Indian Forests Act (Revised) 1982, Air (Prevention and control of Pollution) Act, 1981 as amended by Amendment Act 1987 and Rules 1982, Motor Vehicle Act, 1988; The water (Prevention and control of pollution) Act, 1974 as amended up to 1988 and Rules 1975, The Environment (Protection) Act, 1986 & Rules 1986. (Preamble of the Acts)

**Unit 3: Doctrines governing judicial review of Environmental Legislation**

1. Public Trust doctrine.
2. Polluters Pay Principle.
3. Sustainable Development

**Unit 4: Environment Planning and Policy in India**

1. (i) Environmental Policy- Introduction (ii) Environment- Economy Linkages (iii) Major Environmental Concerns (iv) Underlying Causes of Environmental degradation (v) Policy Response and Current Policy Trust
2. Environmental Planning (i) Elements of Environmental Planning (ii) Different environmental Issues in India and proper planning for them.

## **Unit 5: Current Environmental issues and International Conventions/ Treaties**

1(i) Climate Change (ii) Wasteland and their reclamation (iii) Desertification and its control (iv) Fly ash utilization (v) Environmental effects of dams and barrages (vi) Narmada Dam, Tehri Dam, Almati Dam.

2. Ramsar Convention, Stockholm Summit; Montreal and Kyoto Protocol, WCED (Brundtland Commission), Earth Summit, CITES, CMS, CBD, WTO and Environment; salient features of Biodiversity Act, 2002.

### **Suggested Readings:**

1. Human Ecology – Basic Concepts for sustainable Development: **Marten, G.** (2001) Earthscan Publications, UK.
2. Ecological diversity in Sustainable Development: **Chris, M.** (1999), Lewis Publisher.
3. Environmental Law and policy in India, New delhi: **Divan, S. & Rosencranz, A** (2008), Oxford University Press.
4. Environmental Law in India (2008): **Leelakrishnan, P. & Wadhwa, B.** New Delhi.
5. Environmental Laws in India. **Pares Distn.**
6. The ISO 14000 Handbook: **Joseph Cascio**
7. ISO 14004 – Environmental Management Systems: General guidelines on principles, systems and supporting techniques (ISO 14004:1996 (E)).
8. ISO 14001: Environmental Management Systems: Specification with guidance for use (ISO 14001: 1996 b (E)). (International organization for standardization – Switzerland).
9. Restoration Ecology and Sustainable Development – **K.M. Urbanska** (eds)
10. Environmental Management: **G.N. Pandey**, Vikash Publishing House
11. Environmental Management: **H.M. Saxena**, Rawat Publications
12. Environmental Management in India: Vol I & II, **R.K. Sapru**, Ashish Publishing House
13. “Prospect of Sustainable energy: A critical assessment” – **E.S. Cassidy** – Cambridge University Press.

**M.Sc. (Environmental Science & Management): Part II**

**Practical(Based on ESM-M-301, 302 & 303)**

**ESM-M-304**

**(Semester- III)**

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

**Unit-1: (Any one of the following)15 marks**

1. Collection of plankton / benthos
2. Qualitative and Quantitative analysis of plankton of anaquatic body.
3. Estimation of diversity of Plankton.
4. Study of prepared histopathological slides to describe the toxicological effects of environmental agents.
5. Survey of vehicular traffic at two important traffic intersections.
6. Noise Monitoring at two contrast sites.

**Unit-2: (Any one of the following)15 marks**

1. Quantification and characterization of municipal solid wastes.
2. Principle and applications of Pollution measuring instruments.

**Unit-3: Minor Project based on paper ESM-M-40415marks**

(A) Introduction (B) Hypothesis (C) Literature survey (D) Methodology (E) Scope of the work

**Unit-4:**

**5 marks**

Field work report based on

1. Visit to a sewage treatment plant and assess the impact of treatment on sewage quality and prepare flow diagram of the treatment process.
2. Visit to nearest industries / Ramsar sites / Dam / Barrage

**Unit 5:**

**20 marks**

1. Practical records/models/charts 10 marks
2. Viva-voce 10 marks

**M.Sc. (Environmental Science & Management): Part II**  
**Natural Resources, Wildlife, and Biodiversity**  
**Elective Paper ESM-M-401 (A<sub>1</sub>)**  
**(Semester IV)**

**Full marks: 70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 = 20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x 4 = 20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x 3 = 30 Marks)

**Unit 1: Natural Resources: Living & Non-living**

1. Natural resources and associated problems, Concept and strategies of sustainable development.
2. Forest resources: Use and over-exploitation, deforestation.
3. Water resources: Use and over-utilization of surface and ground water, conflicts over water, Environmental effects of dams & barrage.
4. Mineral resources: Environmental effects of extracting and using mineral resources.
5. Soil resources: Soil as a resource, soil degradation, soil erosion and desertification.

**Unit 2: Energy Resources**

1. Sun as source of energy; solar radiation and its spectral characteristics: Fossil fuels-classification, composition, physico-chemical characteristics and energy content of coal, petroleum and natural gas.
2. Principles of generation of hydroelectric power, tidal, Ocean Thermal Energy, Conversion, wind, geothermal energy.
3. Solar collectors, photovoltaics, solar ponds: nuclear energy-fission and fusion; magnetohydrodynamic power;
4. Bio-energy, energy from biomass and biogas, anaerobic digestion; energy use pattern in different parts of the world.
5. Environmental implication of energy use; CO<sub>2</sub> emissions, global warming; air and thermal pollution; radioactive waste and radioactivity from nuclear reactors; impacts of large-scale exploitation of Solar, Wind, Hydro and Ocean energy

**Unit 3: Biodiversity**

1. Concept of biodiversity; genetic, species and ecosystem diversity; categorisation of species in the context of biodiversity.
2. Values of biodiversity- consumptive use, productive use, social; ethical and aesthetic value etc.
3. Biodiversity at global, national and regional levels.

4. India as a mega-diversity nation.

#### **Unit 4: Conservation of biodiversity**

1. Hot-spots of biodiversity, Strategies for bio-diversity conservation.
2. Various threats to biodiversity and its conservation:
3. Conservation of biodiversity: endangered and endemic species of India, Traditional knowledge, sacred groves. *In-situ* and *Ex-situ* conservation of biodiversity, Gene pool, Biodiversity conservation and Agenda 21.
4. Salient features of CBD & Biodiversity Bill; Bioprospecting, Biopiracy, Biosafety and Patent.

#### **Unit 5: Wildlife and its management**

1. Concept of wildlife, wildlife diversity.
2. Important wildlife of India; Values of wildlife: consumptive, productive, social, aesthetic and ecological.
3. Wildlife conservation in India; Steps taken for the conservation of vulture, tiger, Gangetic dolphin in India and Tibetan Antelope etc.

#### **Suggested Readings:**

1. Non-conventional Sources of Energy-A text book for Engineering Students: **Rai, G.D** (2010), Khanna Publisher, Delhi.
2. Renewable Energy Sources and their Environmental Impact: **Abbasi.T&Abbasi, S.A** (2006), PHI Learning Pvt. Ltd.
3. Energy & the Environment: **Fay, J.A & Golomb, D.S** (2011), Oxford university press.
4. Global Biodiversity Strategy: WRI, IUCN & UNEP
5. Biodiversity Profile of India. [Ces.iisc.ernet.in/hpg/cesmg/indiabio.html](http://Ces.iisc.ernet.in/hpg/cesmg/indiabio.html)
6. Biodiversity : An introduction, **Gaston, K.J. and J.I.Spicer, 1998**, Blackwell Science, London, U.K
7. IUCN 2004. Red list of Threatened species. A global species assessment. IUCN, Gland,
8. Biodiversity and ecosystem functioning: Synthesis and Perspectives: **Loreau, M., and P. Inchausti**, 2002, Oxford Univ. Press, Oxford, UK.
9. The Conservation Handbook, **Sutherland, W.** John Wiley
10. Essentials of Conservation Biology, **Primark, R.B.**, 2002 3<sup>rd</sup> ed. Sinauer Associates, Sunderland, Ma. USA.
11. Diversity of Life, **Wilson, Edward O.(1993)** Harvard University Press, Cambridge, MA.
12. Measuring biological diversity, **Magurran, A.E.**, 2003. (Paperback edition). Wiley-Blackwell.

## **M.Sc. (Environmental Science & Management): Part II**

### **Environmental Pollution**

**Elective paper - ESM-M-402( A<sub>2</sub>)**

**(Semester IV)**

**Full marks: 70**

**Time: 3 Hrs 5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x3 =30 Marks)

#### **Unit-I: Basics of Pollution**

1. Pollution: Definition and Different types of pollution- Air, Water and Soil Pollution, Local, Regional and Global issues related to environment
2. Environmental pollutants- Definition and Classification of pollutants, Heavy metals and pesticides, Causes of pollution.

#### **Unit-2: Air and Thermal Pollution**

1. Air pollution- Definition, Air Pollutants, Causes of air pollution, Biological indicators, Ecological effects of Air pollution, Control of air pollution, Air Quality Standards.
2. Thermal pollution- Definition, Sources, Source of thermal pollution , Ecological effects and control of thermal pollution.

#### **Unit- 3: Water and Land Pollution**

1. Water pollution- Types, sources and consequences of water pollution, Ground water pollution including Arsenic, Fluoride and Nitrate pollution, Water Quality Standards.
2. Land pollution: Definition, Land pollutants, Causes of Land pollution, Soil Quality Standards.

#### **Unit-4: Radioactive and Noise Pollution**

1. Radioactive Pollution - Definition, fallout, radioactive elements, radiation, source of Radiation, Natural radiation, man-made radiations, types of atom bomb, internal or external emitter, biological effects of radiations, control of radioactive pollution.
2. Noise Pollution- Definition, Causes of Noise pollution, Ecological effects of Noise Pollution, Noise Quality Indices.

## **Unit-5: Pesticide Pollution**

1. Pesticide: Classification, Sources, Impact of pesticides.
2. Biological Magnification of toxic materials and pesticides, Antidotal procedures in toxicology.
3. Bio-monitoring of toxic chemicals, Bio assay and its application in toxicology.
4. Bio-remediation of pesticide pollution.

### **Suggested Readings:**

1. Environmental Pollution control engineering, (2011) **Rao, C.S.:** New Age International Publishers, New Delhi.
2. Water Pollution, Palmer, E. (2010), Apple Academics, Canada.
3. Water Pollution Biology, Able, P.D.(2010) Water Pollution Biology, Taylor and Francis, London.
4. Environmental Radioactivity – **M.Eisenbud**, Academic press
5. Essentials of nuclear chemistry – II, **T. Arnikar, Wiley easter**
6. ‘Handbook of industrial pollution and control ‘- Vol. I & II, **Bhatia** – CBS
7. Indian Standard for Drinking Water, BSI, New Delhi
8. Handbook of Environmental Health & Safety- Principles & Practices, Vol. II, **H. Koren**, Lewis Publishers
9. Air Pollution – Threat & Response: **D.A.Lynn**
10. Handbook of Industrial Pollution & Control- **S.C.Bhatia**, Vol – I, CBS Pub.

## **M.Sc. (Environmental Science & Management): Part II**

### **Practical**

**ESM-M-403**

**(Based on elective papers ESM-M-401 A<sub>1</sub> & 402 A<sub>2</sub>)**

**(Semester- IV)**

**Full marks:70**

**Time: 6 Hrs 4 Credits**

**Unit-1: (Any one of the following) 15 marks**

1. Estimation of diversity indices, richness, evenness, dominance.
2. Study of Conservation projects in India.
3. Characterization & categorization of threatened species data

**Unit-2: (Any one of the following) 15 marks**

1. Determination of the minimum size of a quadrat for a grassland / forest by species-area curve method.
2. Determination of frequency, density, abundance, and Importance Value Index of grassland/forest area with the help of Quadrat method
3. Vegetation studies by line, quadrates and belt transect methods and their analysis.

**Unit-3: (Any one of the following) 15 marks**

1. Estimation of DO, BOD, COD of water sample
2. Soil quality analysis – soil colour, soil moisture, water holding capacity pH, N, P, K and organic carbon.
3. Dust fall, SPM, CO<sub>2</sub>, CO, O<sub>2</sub>, NO<sub>2</sub>, and SO<sub>2</sub> monitoring
4. Measure of Noise in relatively silent, industrial, residential, and commercial zones

**Unit-4: 5 marks**

Field work report based on

1. Visit to various Biodiversity rich centres / National Parks / Wildlife Sanctuary / Bird Sanctuary/ Biological Parks
2. Visit to nearest Thermal Power / Hydel Power generation stations / Solar Power Parks and others

**Unit-5: 20 marks**

1. Practical records/models/chart 10 marks
2. Viva-voce 10 marks

## **M.Sc. (Environmental Science & Management): Part II**

### **Disaster Management**

#### **Elective Paper-ESM-M-401 (B<sub>1</sub>)**

(Semester IV)

**Full marks:70**

**Time: 3 Hrs5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10=20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x4 =20 marks)

Part C: 5 Questions, 1from each unit, 3 to be answered (10 x3 =30 Marks)

#### **Unit — 1: Meaning and concept of Disaster**

1. Natural disasters; nature, causes and effects; cyclone, tornadoes, tsunami, floods, earthquakes, avalanches, landslides, drought, diseases and fire.
2. Forecasting and warning systems for disasters.

#### **Unit — 2: Measurement of Disaster**

1. Measurements of responses of disasters, community reaction to disaster, coping mechanism, classes of victims.
2. Disaster management, pre-disaster phase, actual disaster phase, post-disaster phase

#### **Unit 3: Disaster Education and Assistance**

1. Disaster assistance, technological assistance, relief camps, organization, camp layout, fire fighting camping and tent pitching, rope, knots and their use, rescue, emergency rescue.
2. Disaster education; Alternatives and new directions, conceptualizing disaster recovery,

#### **Unit — 4: Disaster Mitigation**

1. Mitigation and preparedness, programme planning and management
2. Case studies of disasters.

#### **Unit — 5: Disaster Awareness**

1. Environmental needs and social justice, cultural significance of natural protection, Participatory management of biological resources, role of traditional knowledge.
2. Human rights in relation to environment; Role of Non-Government Organizations (NGOs) in environmental protection.

### **Suggested Readings:**

1. Disaster Management(2000) (Ed), **Singh R. B**, Rawat Publication, New Delhi.
2. Disaster Management (2003)(Ed), **Gupta H.K**, University Press, India
3. Disaster Management in Hills (2003), **Dr. Satender**, Concept Publishing Co., New Delhi.
4. An overview on Natural and Man-made Disaster and their Reduction, **R.K.Bhandani**, CSIR, New Delhi
5. Manuals on Natural Disaster Management in India, M.C.Gupta, National Centre for Disaster Management, IIPA, New Delhi, 2001
6. Action plan for Earthquake, Disaster and Mitigation Arya A.S (1994) V.K.Sharma (Ed); Disaster Management IIPA Publication, New Delhi
7. Natural hazards- Local, National, Global. **G.F.White** (E.d. Oxford University Press)
8. Natural Hazard in Human Ecological Perspective: Hypothesis and Models – **R.W.Kates**, 1970, Natural Hazards research working paper no. 124, Cambridge, USA
9. Geological Hazards: Their Assessment, Avoidance and Mitigation:**F.G.E., &Spon, F.N**Books der ULB Darmstadt.Bell.

## **M.Sc. (Environmental Science & Management): Part II**

### **Environmental Health** **Elective paper- ESM-M-402(B<sub>2</sub>)** **(Semester IV)**

**Full marks:70**

**Time: 3 Hrs**

**5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x 4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x 3=30 Marks)

#### **Unit — 1: Concepts of Environmental Health**

1. Basic principles of Environmental Health
2. Impact of environmental stress on human physiology.
3. Environmental Health Management in India; occupational safety and Health Administration.

#### **Unit - 2: Impact of Air and Noise Pollutants**

1. Air pollution and human health; Causes of air pollution and Air- borne diseases
2. Accounts of occupational diseases like silicosis, lung diseases.
3. Noise pollution and human health hazards

#### **Unit -3: Water and Nuclear Pollutants and their impact**

1. Water pollution; Sources and effects on human health; Water borne diseases; risk assessment and preventive measures.
2. Indoor pollution and human health.
3. Nuclear pollution & human health.

#### **Unit - 4: Soil and Land Pollutants and their impact**

1. Soil pollution; Sources and effects on human health.
2. Hospital wastes and human health.
3. Agrochemicals and human health

#### **Unit-5: Regulations and Human Health**

1. Hazardous waste management and human health.
2. WHO standards of working conditions.
3. Organizations on human health: ICMR, Red Cross Society, WHO and UNICEF

### **Suggested Readings:**

1. Basic Environmental Health (2001): **Annalee Yassi, Tord, Kjellström, Theo de Kok, Tee Guidotti**
2. Environmental Health: **Monroe T. Morgan**
3. Handbook of Environmental Health & Safety- Principles & Practices, Vol. II, **H. Koren,** Lewis Publishers
4. Textbook of Medical Physiology: **Arthur C. Guyton, M.D. & John E Hall** W B Saunders Company

## **M.Sc. (Environmental Science & Management): Part II**

### **Practical**

**ESM-M-403**

**(Based on elective papers ESM-M-401 ( B<sub>1</sub>)& 402 ( B<sub>2</sub>)**

**(Semester- IV)**

**Full marks:70**

**Time: 6 Hrs5 Credits**

**Unit-1:Any one of the following15 marks**

1. GIS laboratory work- Computer based model on earthquake, tsunami and other disasters.
2. Brief idea of seismograph and seismogram

**Unit-2:Any one of the following15 marks**

1. Characterization, separation and quantification of wastes affecting health.

**Unit-3:Any one of the following15 marks**

1. Study of different types of hospital wastes, laboratory wastes etc.
2. Documentation of diseases caused by environmental pollutants.

**Unit-4:5 marks**

**Field work report based on**

1. Visit to disaster affected sites
2. Visit to hospitals and nursing homes.

**Unit —5:20 marks**

1. Practical records /Model/Chart10 marks
2. Viva-voce10 marks

## **M.Sc. (Environmental Science & Management): Part II**

### **Hydrology and Water Resources**

**Elective paper - ESM- M-401(C<sub>1</sub>)  
(Semester IV)**

**Full Marks: 70**

**Time-3hrs5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x 10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x3 =30 Marks)

#### **Unit-1**

1. Water Resources: Surface water, ground water,
2. Oceans, ice caps, glaciers, lakes, streams, rivers.

#### **Unit-2**

1. Hydrological cycle: Precipitation, Infiltration, Evaporation, Evapotranspiration, Run-off
2. Water budget.

#### **Unit-3**

1. Hydrography and human influences, factors influencing the surface water ,
2. Characteristics of stream flow, seasonal variations in stream flow, lake and wetland hydrology.

#### **Unit-4**

1. Groundwater: Characteristics of ground water .Fundamental Equations of ground water flow: Generalization of Darcy's law, Equations of continuity, Elementary problems of confined, semi-confined and unconfined aquifer,
2. Fluctuations due to meteorological phenomena, urbanization, external loads, land subsidence, factors affecting groundwater quality with special reference to Fluoride, Arsenic, Nitrite, and Iron.

#### **Unit-5**

1. Impact of climate change on water resources.
2. Planning for water resource development: Level phases, objectives, data requirements.
3. Project formulation, environmental considerations, multi-purpose project, National Water Policy.

## **Suggested Readings**

1. Elementary Engineering Hydrology (1980):**Deodhar, M.J.**: Pearsons Education Pub.
2. A Text Book of Hydrology (2005): **Reddy,P.J.R.**:Laxmi Publications.
3. Applied Hydrology (2013) :**Chow, v., Maidment, D & Mays, L.**: McGraw-Hill Professional.

## **M.Sc. (Environmental Science & Management): Part II**

### **Restoration Ecology**

**Elective paper - ESM- M-402(C<sub>2</sub>)**

**(Semester IV)**

**Full Marks: 70**

**Time-3hrs5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x3 =30 Marks)

#### **Unit-1.**

1. Causes of Ecological Degradation: Pollution and waste disposal, excess nutrient loading in aquatic ecosystems.
2. Mining, deforestation, overgrazing, salinization and exotic species.

#### **Unit-2.**

1. Principles for the Ecological Restoration; Conservation biology and restoration ecology,
2. Disturbance, succession, fragmentation, and ecosystem function.

#### **Unit-3.**

1. Reference Ecosystem, Rehabilitation, Reclamation, Mitigation and Restoration: Methods, techniques and approaches.
2. Biomanipulation and lake restoration.

#### **Unit-4.**

1. Ecological trajectory during restoration.
2. Attributes of restored ecosystems, Ecological engineering

#### **Unit-5.**

1. Bioremediation and constructed wetlands;
2. Natural versus Restored Ecosystems – limitations of restored ecosystems; Case studies.

### **Suggested Readings:**

1. Foundation of restoration ecology: the science and practice of ecological restoration (2006)  
**:Falk, D.A., et al.:** society for Ecological Restoration International, Tucson, Az., USA. .
2. Restoration ecology (1987) **: Jordan, W.R., et al.:** Cambridge University Press.
3. Restoration ecology (Eds) (2012) **:Andel, J. &Aronsons:**The New Frontier; Wiley Blackwell.

## **M.Sc. (Environmental Science & Management): Part II**

### **Practical**

**ESM-M-403**

**(Based on elective papers ESM-M-401( C<sub>1</sub>)&402 ( C<sub>2</sub>)**

**(Semester- IV)**

**Full marks:70**

**Time: 6 Hrs5 Credits**

**Unit-1: Any one of the following15 marks**

Collection and estimation of physicochemical characteristics of Groundwater and surface water.

**Unit-2: Any one of the following15 marks**

Collectionand estimation of physicochemical characteristics of wetland water and soil.

**Unit-3: Any one of the following15 marks**

Collection and estimation of physicochemical characteristicsof lake/ pond water

**Unit-4:5 marks**

**Field work report based on**

1. Visit to Wetland.
2. Visit to any lake.

**Unit —5:20 marks**

1. Practical records /Model/Chart**10 marks**
2. Viva-voce**10 marks**

## **M.Sc. (Environmental Science & Management): Part II**

### **Biodiversity and Conservation Biology**

#### **Elective paper - ESM- M-401 (D<sub>1</sub>) (Semester IV)**

**Full Marks: 70**

**Time-3hrs5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x3 =30 Marks)

#### **Unit 1: Introduction to Biodiversity**

1. General concepts of biodiversity, Levels of diversity – Functional diversity, Phylogenetic diversity.
2. Regional and global patterns of diversity (latitudinal, altitudinal, insular, Species-Area relationships)
3. Ecological and evolutionary factors affecting biodiversity.
4. Valuing biodiversity – Ecological economics, Ecosystem services, Direct and indirect benefits

#### **Unit 2: Types of Biodiversity**

1. Species diversity – Measurement (Indices of diversity and equability). Global and Indian biodiversity data.
2. Ecosystem diversity – biomes, mangroves, coral reef, wetlands.
3. Genetic diversity – varieties, populations.

#### **Unit 3: Causes of Loss of Biodiversity**

1. Threats to biodiversity: Extinctions – natural and anthropogenic; Habitat destruction, fragmentation, degradation, climate change; Overexploitation; Invasive species and diseases.
2. Bio-prospecting

#### **Unit 4: Conservation of biodiversity**

1. History of conservation movement-International and National .
2. Island biogeography and theory of Conservation.
3. Methods of conservation: *in situ* and *ex situ*; Biosphere reserves, National parks, Sanctuaries, Biodiversity hotspots, Zoological Parks, Botanical gardens and Biodiversity parks.
4. IUCN categories-endangered, threatened, vulnerable.

## Unit 5: Sustaining Biodiversity

1. Designing and managing protected area.
2. Conservation and Sustainable Development.
3. Stake holders in Conservation.
4. Conservation Ethics.
5. Ecologically relevant parameters (minimum viable population, minimum dynamic area, effective population size, metapopulations).

### Suggested Readings

1. Biodiversity Profile of India. [Ces.iisc.ernet.in/hpg/cesmg/indiabio.html](http://ces.iisc.ernet.in/hpg/cesmg/indiabio.html)
2. Nature's Services: Societal Dependence on Natural Ecosystems,(e.d) (1997):**Daily, G.C.**;Island Press, Washinton, D.C.
3. Biodiversity: An Introduction,(1998):**Gaston, K.J. & Spicer, J.I.**; Blackwell Science, London, U.K.
4. Global Biodiversity: Earth's Living Resources in the 21<sup>st</sup> Century,(2000):**Grombridge, B. & Jenkis, M.**; World Conservation Press, Cambridge, U.K.
5. **IUCN 2004**. Red list of threatened species. A global species assessment. IUCN, Gland, Switzerland
6. Biodiversity and ecosystem functioning: Synthesis and Perspectives,(2002):**Loreau, M. & Inchausti, P.**; Oxford University Press, Oxford, UK.
7. Climate change and Biodiversity (eds) (2006): **Lovejoy, T.E. & Hannah, L.**: Yale University Press
8. Measuring biological diversity, (2003): **Magurram, A.E.**; Wiley-Blackwell.
9. The Conservation Handbook, (2000): **Sutherland, W.**; JohnWiely.
10. Principles of conservation Biology (2005): **Meffe, G.K. & Carroll, C.R.**; Sinauer Associates
11. Essentials of Conservation Biology (2002): **Primack, R.B.**; Sinauer Associates, Sunderland, Ma. USA
12. Diversity of life, (1993): **Wilson, E.O.**; Harvard University Press, Cambridge, MA.

## **M.Sc. (Environmental Science & Management): Part II**

### **River and Wetland ecosystem**

#### **Elective paper - ESM- M-402(D<sub>2</sub>) (Semester IV)**

**Full Marks: 70**

**Time-3hrs5 Credits**

Part A: 10 Questions (multiple choice), 2 from each unit, all to be answered (2 x10 =20 marks)

Part B: 5 Questions, 1 from each unit, 4 to be answered (5 x4 =20 marks)

Part C: 5 Questions, 1 from each unit, 3 to be answered (10 x 3 =30 Marks)

#### **Unit 1: Freshwater Ecosystem**

1. Freshwater ecosystems: Introduction, Characteristics of lotic and lentic habitats, threats to freshwater ecosystems.
2. Autotrophs – periphyton, macrophytes, phytoplankton. Primary production in Tropical streams and rivers and associated floodplains wetlands, Lotic Communities, Trophic relationships: lotic biodiversity and food web, Lotic Communities.
3. Primary production and factors affecting it in floodplains. Heterotrophic energy sources: decomposition of coarse particulate organic matter, fine particulate organic matter, dissolved organic matter.

#### **Unit 2: River ecosystem**

1. River evolution, River channel units and mesohabitats; River classification, River hydraulics & structural analysis, River Flow and its Dynamics.
2. River water chemistry: Dissolved gases, major dissolved components of river water, dissolved gases, influence of chemical factors on the biota.
3. River/stream riparian interactions/connectivity: Structure and composition, vegetation types and distribution.
4. Physical factors of importance to the biota of rivers: current, substrate, temperature.

#### **Unit 3: River and Flood**

1. River continuum concept, Flood Pulse Concept
2. River regulation: Physical and biological effects of dams and impoundments, biological effects of water diversion; impact of flood control measures and regulation of flow on river ecosystem, invasive species, effects of climate change on rivers.
3. River Conservation – drivers of conservation issues, major conservation issues, Recovery and restoration of rivers, National River Conservation Programmes, Water quality and monitoring.
4. Socio-economics of riverine ecosystem: livelihood & socioeconomics, water supply (quantity and quality).

#### **Unit 4: Dynamics of Aquatic Body**

1. Hydrology, sedimentation and geomorphology; hydrologic flow paths and hydrodynamic exchange processes; aquatic-terrestrial connectivity; structure and function of stream-beds; water current measurement; discharge calculations; river morphology; grain size analysis.
2. Nutrient dynamics: basic principles of nutrient cycling, nutrient concentrations in running waters, transport and transformation of nutrients.

#### **Unit 5: Wetland Ecosystem**

1. Wetlands: Definition, Characterization, classification, Functions, and Values,
2. Hydrology, biogeochemistry, biological adaptations to the wetland Environment, wetland food web and waterfowl.
3. Inland wetland ecosystem: freshwater marshes, peatland, freshwater swamps, Riparian wetlands, constructed wetlands.
4. Human impacts and management of wetlands, Ramsar Convention, Wetlands of India and their Conservation

#### **Suggested Readings:**

1. Wetlands, (2007); **William Mitsch, J. & James Gosselink. G.**, Jhon Wiley & Sons, Inc.
2. Ecology of fresh waters: Man and Medium, Past to future, **Moss, B.** (2008) Blackwell Science.
3. Wetland Ecology, **Keddy, P.A.** (2000), Cambridge University Press.
4. Ecosystem services and river basin technology; **Chichago, Luis, Muller, Felix, Fohrer, Nicola**

## **M.Sc. (Environmental Science & Management): Part II**

### **Practical**

**ESM-M-403**

**(Based on elective papers ESM-M-401 I (D<sub>1</sub>) & 402 II (D<sub>2</sub>)**

**(Semester- IV)**

**Full marks:70**

**Time: 6 Hrs 5 Credits**

#### **Unit-1: Any one of the following 15 marks**

1. A visit to lotic ecosystem and wetlands for water, sediment, plankton and benthos collection
2. Plankton and zoobenthos identification and quantification collected from river/wetland.

#### **Unit-2: Any one of the following 15 marks**

Comparative study of physicochemical characteristics viz. pH, transparency, turbidity, total solids, suspended solids, dissolved solids, total alkalinity, free CO<sub>2</sub>, hardness, chloride, calcium and magnesium of river water and wetland water.

#### **Unit-3: Any one of the following 15 marks**

Preparation of media for microbial culture, isolation and culturing of bacteria and fungi from air / water / soil samples.

#### **Unit- 4. Field work report based on 5 marks**

1. Visit to lotic ecosystem
2. Visit to Wetland
3. Visit to National park/ Wildlife Sanctuary.

#### **Unit-5 20 marks**

1. Practical records / Model/Chart 10 marks
2. Viva-voce 10 marks

## **M.Sc. (Environmental Science & Management): Part II**

### **Project Work- One month**

**(Semester IV)**

**ESM-M-404 Full marks:70**

**5 Credits**

**Detailed study and preparation of dissertation on any one topic subject of Environmental Sciences**

#### **Unit-1:**

1. Natural Resource Management
2. Study of Forest and Wildlife
3. Ecosystem function
4. Surface / Ground water monitoring
5. Bio- monitoring of aquatic ecosystem
6. Ambient air quality monitoring
7. Vehicular emission monitoring
8. Study of the impact of air pollution on plants/animals
9. Environmental monitoring of industries, power plants etc.
10. Monitoring of sewage treatment plant
11. Bioremediation
12. Toxicological studies
13. Eco-tourism
14. Environmental Law
15. Other issues related to environment