

# **S.S.JAIN SUBODH P.G. (Autonomous) COLLEGE JAIPUR**

(Affiliated to University of Rajasthan)



## **SYLLABUS**

### **SCHEME OF EXAMINATION AND COURSES OF STUDY**

**FACULTY OF SCIENCE**

### **DEPARTMENT OF ENVIRONMENTAL SCIENCE**

- **M.Sc. Environmental Science ( I, II, III and IV Semester-2013-16)**
- **Foundation Environmental Studies for BA/B.Com./B.Sc. (Compulsory in Semester III and IV)**

# **Contents:**

## **1. OBJECTIVES**

## **2. ELIGIBILITY**

## **3. SCHEME OF EXAMINATION**

## **4. SEMESTER STRUCTURE**

### **Objectives:**

M.Sc. Environmental Science is an interdisciplinary program with an emphasis on environmental analyses, pollution control, climate changes, and impact assessment. The main objectives of the course are:

- To impart knowledge of environmental problems of regional and global scale;
- To train the students for scientific analysis of environmental components for critical understanding, efficient environmental decision-making and management.
- To prepare them for global competence for career options in education, research, industries, consultancy, environmental journalism etc.
- To train the students for Environmental Impact Assessment and for management systems
- To understand the impacts of climate change to develop mitigation strategies
- To prepare students for designing, conducting independent research in the area of their interest.
- To sensitize students towards developing the earth as a green planet for a clean habitat for all living forms.

### **Eligibility:**

A candidate who has secured more than 55% or CGPA of 3.5 in the UGC Seven Point scale [ 36% or Pass marks for SC/ST/Non-creamy layer OBC/SBC] or equivalent in the Bachelor degree in Science or Engineering or Technology or Medicine or Pharmaceutical Science shall be eligible for admission to First Semester of a Master of Environmental Science course. For candidates from outside state of Rajasthan 60% or CGPA of 4.0 in the UGC Seven Point Scale will be applicable irrespective of the category

## Scheme of Examination:

1. Each theory paper carries 100 marks. The internal assessment will be 30 marks and EoSE shall carry 70 marks. The EoSE will be of 3 hours duration. There will be a practical examination of 200 marks in allSemester
2. There will be two parts in EoSE theory paper. Part „A“ of theory paper shall contain 10 Short Answer Questions of 14 marks, based on knowledge, understanding and applications of the topics/texts covered in the syllabus. Candidate has to attempt seven questions out of 10 and each question will carry two marks for correctanswer.
3. Parts “B” of EoSE theory paper will consist ofing of four questions from each unit with internal choice of 14 mark each. The limit of answer will be fivepages.
4. Each Laboratory EoSE will be of four hour durations and involve laboratory experiments/exercises/ Seminar presentation / Synopsis presentation/Project work or field study / Industrial Training/ consultancy training and viva-voce examination consistofing of 200 Marks.
5. The aim of Project work or field study / Industrial Training/ consultancy training is to introduce students to research methodology in the subject and prepare them for pursuing research in theoretical or experimental or computational areas of the subject. The project work or Field Study is to be undertaken under guidance jointly by Head of the Department and a senior faculty or a Scientist or any other suitable person with proven research excellence in the concerned field of study. Project work or field study / Industrial Training/ consultancy training can also be taken up in an outside institution of repute Department. The guide will make continuous internal assessment of the Project work or field study / Industrial Training/ Consultancy training. EoSE for Project work or field study / Industrial Training/ consultancy training and seminar will be held at department of the college by a board of three examiners consist ofing of HoD, two senior faculty of the department or expert from interdisciplinary department of the institution.
6. Supplementary/ due paper/ special examinations will be resolute as per the institutions autonomous rules
7. Grade/CGPA/percentage/division will be decided as per the autonomous guidelines of the institution.

## M.Sc.I Semester

**Max.Marks (Theory): 400**

Nomenclature			External/ Theories	Internal / Theories	Total Max Marks	Total Mini. Marks
MES 101	Paper I	Ecology and Ecosystem	70	30	100	40
MES 102	Paper II	Biodiversity and Conservation	70	30	100	40
MES 103	Paper III	Environmental Pollution and Health	70	30	100	40
MES 104	Paper IV	Environmental Issues: Regional and Global	70	30	100	40
<b>MES 111 Practical: Based on Theory Paper Max Marks 200</b>						
Experimental work			80	60	200	80
Seminar				60		

## M.Sc. II Semester

Nomenclature			External/ Theories	Internal / Theories	Total Max. Marks	Total Mini. Marks
MES 201	Paper I	Waste Management	70	30	100	40
MES 202	Paper II	Environmental Policies, Legislation and Ethics	70	30	100	40
MES 203	Paper III	Environmental Chemistry	70	30	100	40
MES 204	Paper IV	Environmental Disasters and Management	70	30	100	40
<b>MES 211 Practical: Based on Theory Paper Max Marks 200</b>						
Experimental work			80	60	200	80
Seminar				60		

## M.Sc. III Semester

**Max. Marks Theory Papers: 400**

Nomenclature			External/ Theories	Internal / Theories	Total Max. Marks	Total Mini. Marks
MES 301	Paper I	Instrumentation for Environmental Monitoring and Analysis	70	30	100	40
MES 302	Paper II	Environmental Bioremediation Process and Technology	70	30	100	40
MES 303	Paper III	Pollution Control Technology	70	30	100	40
MES 304	Paper IV	Statistics, Environmental Modeling and Research Methodology	70	30	100	40
<b>MES 311 Practical: Based on Theory Paper Max Marks 200</b>						
Experimental work			80	60	200	80
Synopsis Preparation of Minor/ Major Research work				60		

## M.Sc. IV Semester

**Max. Marks Theory Papers: 400**

Nomenclature			External/ Theories	Internal /Theories	Total Max. Marks	Total Mini. Marks
MES 401	Paper I	Environmental Impact Assessment and Sustainable Development	70	30	100	40
MES 402	Paper II	Environmental Clearance and Environmental Audit	70	30	100	40
MES 403	Paper III	Remote sensing & GIS FOR Environmental Science	70	30	100	40
MES 404	Paper IV	Energy and Environment	70	30	100	40
<b>MES 411 Practical: Based on Theory Paper , Max Marks :200</b>						
Experimental work			80	60	200	80
Industrial Training / Minor Research work				60		

**Semester Structure:** The details of the courses with code, title assign are as given below.

## **M.Sc. Environmental Science**

**Duration:** 4 Semesters (2 Years)

■ **Semester–I**

MES101-Paper-I: Ecology and Ecosystem

MES102-Paper-II: Biodiversity and Conservation

MES103-Paper III: Environmental Pollution and Health

MES104-Paper IV: Environmental Issues: Regional and Global

**MES111-Practical: Based on Theory Papers**

■ **Semester–II**

MES201-Paper-I: Waste Management

MES202-Paper-II: Environmental Policies, Legislation and Ethics

MES203Paper III: Environmental Chemistry

MES204-Paper IV: Environmental Disasters and Management

**MES211-Practical: Based on Theory Papers**

■ **Semester–III**

MES301-Paper-I: Instrumentation for Environmental Monitoring and Analysis

MES302-Paper-II: Environmental Bioremediation Process and Technology

MES303-Paper III: Pollution Control Technology

MES304-Paper IV: Statistics, Environmental Modeling and Research Methodology

**MES311-Practical: Based on Theory Papers**

**Practical: Synopsis Preparation + Design of r Project work and Its Power point presentation**

■ **Semester–IV**

MES401-Paper-I: Environmental Impact Assessment and Sustainable Development

MES402-Paper-II: Environmental Clearance and Environmental Audit

MES403-Paper III: Remote sensing & GIS for Environmental Science

MES404Paper IV: Energy and Environment

MES411-Practical: Based on Theory Papers/ Based on Industrial Tanning/ Survey work/Lab work/ Minor Research Work/Project work

## **Abbreviations Used:**

### **Course**

**Category**CCC:

Compulsory Core Course

SEM: Seminar

PRJ: Project Work

### **Contact Hours**

L: Lecture

T: Tutorial

P: Practical or Other

S: Self Study<sup>12</sup>

### **Relative Weights**

CIA: Class Internal Assessment

( Test/Attendance/Classroom

Participation/Quiz/Home Assignment etc.)

EoSE: End of Semester Examination

## **COURSE DETAILS:**

### **Semester I**

#### **PAPER I(101): ECOLOGY AND ECOSYSTEM**

**Duration :3 hrs.**

**Max. Marks : 70**

**Note: There will be two parts in end semester theory paper.**

**Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.**

#### **UNIT -I**

**Ecosystem** – Concept of Ecosystem, Levels of Organization, Structure and functions of ecosystem - abiotic and biotic components, food chain, food web; The Energy flow in Ecosystems - Laws of thermodynamics, biogeochemical cycles of nitrogen, carbon, phosphorus, sulphur. Primary and secondary productivity. Ecological pyramids, Ecotypes, Ecospecies, Niche, Keystone species, invasive species, Ecotone, Edge effect.

#### **UNIT -II**

**Ecology and Ecological factors:** Ecology as an interdisciplinary subject, Types of ecology, Structure and Composition of atmosphere, hydrosphere, lithosphere and biosphere. Climatic and edaphic factors, Laws of limiting factors – Liebig's law of minimum, Shelford's law of tolerance.

#### **UNIT -III**

**Population and Community:** Population characteristics, population regulation– biotic potential and environmental resistances (r and k selections); Factors of population regulation – density dependent and density independent; and carrying capacity; genecology, Community Characteristics. Interactions- Co-evolution, Neutralism, symbiosis, commensalism, mutualism, antagonism, antibiosis, parasitism, predation; competition- inter and intra specific.

#### **UNIT -IV**

**Ecosystem Diversity:** Structure, types and characteristics of Terrestrial and aquatic ecosystem (Marine, freshwater, grassland, desert). Concept of Artificial or Man Made Ecosystem.

#### ***Reference Books***

1. Fundamental PROCESSES IN Ecology: An earth Systems Approach; David M. Wilkinson; OUP Oxford (13 Sept 2007)
2. Principles of Terrestrial Ecosystem Ecology; F. Stuart Chapin, III;et.al. Springer, 2012 edition (10 sept 2011)
3. Fundamentals of Ecology; Eugene Odum; Cengage 5 edn. (15 nov 2017)
4. Environment and Ecology: A Dynamic Approach, 3e By GKP: NeerajNachiketa
5. Ecology and Environment; PD Sharma: Rastogi Publications: 13 edn( 1jan 2017)

# Semester I

## PAPER II (102): BIODIVERSITY AND CONSERVATION

Duration :3 hrs.  
:70

Max. Marks

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.

### UNIT-I

**Forest:** Forest ecosystem goods and services, Global distribution of forests and forest types in India, Succession, Biogeographic regions of India, Forestry - Social forestry - farm forestry, urban forestry, community forestry, Commercial Forestry.

### UNIT-II

**Biodiversity:** Definition, Types of diversity and significance, criteria and measurement of biodiversity, factors affecting biodiversity, IUCN Criteria of endangerment, Red Data Books. Endemism.- Mega biodiversity nations, Hotspots of biodiversity.

### UNIT-III

Biodiversity conservation strategies: in-situ conservation through participatory conservation, Protected Area network - National Parks, sanctuaries, biosphere reserves, sacred groves; ex-situ conservation – Zoological Parks, Botanical Gardens, gene pools, Role of biotechnology, IN-vitro, Gene banks, cryopreservation and institutions(NBPGR). Wildlife of India Valuation of Biodiversity.

### UNIT-IV

**Biodiversity Conservation Efforts:** Intellectual Property Rights ,Bioprospecting, Biopiracy. Convention on Biological Diversity, Biosafety protocols,CITES, World Heritage sites, National Biodiversity strategy and Action Plan.

### *Reference Books*

1. Biodiversity Conservation and Phylogenetic Systematics: Roseli Pellens; Philippe Grandcolas: Springer 1 edn. 2016
2. An Advanced Textbook on Biodiversity: Principles and Practice: KV Krishnamurthy; Oxford and IBH Publishing Co Pvt Ltd. (30 March 2018)
3. Biodiversity: MN William;CBS (1 Jan. 2019)
4. Textbook of Biodiversity; KV Krishnamurthy; CRC Press; 1 edn. (10 Jan. 2003)

# Semester I

## PAPER III(103): ENVIRONMENTAL POLLUTION AND HEALTH

Duration :3 hrs.

Max. Marks :70

Note: There will be two parts in end semester theory paper.

Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

Part B of the paper will consist of four questions one question from each unit with internal choice.

Each question will carry 14 marks.

### UNIT-I

**Air Pollution:** Atmospheric composition and stratification. Sources of pollutants, classification – criteria and specific pollutants. Effects of air pollution on plants, human health, materials and ecosystems. Air quality Index and air quality standards, Air pollutant dispersion, Plume behavior, Temperature inversion, Lapse Rate and Stability, Wind Rose.

### UNIT-II

**Water Pollution:** Sources, species and water quality parameters, Organic and inorganic pollutants, Eutrophication, heavy metals, Bioaccumulation, Biomagnifications, Bio-indicators, Transport of pollutants in aquatic ecosystems. Characteristics of domestic, industrial and agricultural effluents, their effects, Waterborne diseases. Thermal Pollution: Sources, Effects of pollution on human and animals.

### UNIT-III

**Soil Pollution:** Sources of Soil pollution - industrial effluents, fertilizers, pesticides, heavy metals, waste disposal, Detrimental effects of soil pollutants on flora, fauna and ground water.

### UNIT-IV

**Noise and Radiation Pollution:** Sources, sound pressure level, noise-spectra-octave bands, noise-monitoring-sound level meter, frequency weighting net-works, equivalent continuous noise level and other noise indices, Effects of noise pollution on human and animals, Permissible standards, Radiation Pollution : Sources and Effects on human and animals.

### *Reference Books*

1. Environmental Chemistry; Air Pollution: O. Hutzinger; Springer; 1991 (3 OCT 2013)
2. Water Pollution: Concerns, Concepts and Analysis: Sheryl McMillan; Callisto Reference; (6 March 2015)
3. Soil Pollution: From Monitoring to Remediation; Armando C. Duarte et. al.; Academic Press, 1 edn. (18 oct 2017)
4. Noise Pollution and Its control: KJ Polak;CBS Publishers ; (24aug 2020)

# Semester I

## PAPER IV (104): ENVIRONMENTAL ISSUES: REGIONAL AND GLOBAL

Duration :3hrs.

Max. Marks :70

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice.

Each question will carry 14 marks.

### UNIT-I

**Global Issues** :Acid rain and its effects on ecosystems (flora, fauna and human beings). Ozone layer depletion, causes and consequences of Ozone depletion, CFCs. Heat Budget of the Earth, Green House Effect, global warming- causes and impact of global warming, Climate change, Carbon Sequestration.

### UNIT-II

**Population:** Population explosion, Malthusian theory, population un-sustainability, population growth, population pyramids, pattern of India population, scale of urbanization, migration trends- rural and urban, Population displacement due to developmental projects. International initiatives on population related issues.

### UNIT-II

**Environment and human health:** Hazardous chemicals, pesticides and their impact, polychlorinated biphenyls (PCBs), Lead, mercury, arsenic, cadmium, asbestos, dioxins. Environment and development, Social consequences of development and environmental changes.

### UNIT- IV

**Occupational Health and Industrial Hygiene:** Occupational hazards in industries and other sectors, Safety requirements and Measures, Industrial hygiene and Occupational health- Indian Scenario. Occupational diseases- Pneumoconiosis, Silicosis, Anthracosis, Byssinosis, Bagasosis, Asbestosis, Farmer's lung, Metal poisoning, Occupational cancer, Occupational dermatitis, Radiation Hazards.

### *Reference Books:*

1. Global Environment; Rosemary Charles; Syrawood Publishing House (30 may 2016)
2. Introduction to Population Biology; Dick Neal; Cambridge University Press; (29 nov 2018)
3. Environment and Human Health; Claudio Bini, JaumeBech; Springer; 1 edn. 2014.
4. Fundamentals of Industrial Hygiene; Barbara A. Plog; Natl Safety Council, 5 edn. (1 nov 2001)

**SEMESTER-I**  
**PRACTICAL**

Duration :4 hrs.

(3 hrs perday)  
Max. Marks :200

**Part A**

- Determination of pH in water
- Determination of pH in soil
- Determination of conductivity of water
- Determination of conductivity of soil
- Determination of bulk density
- Estimation of TDS in the water sample
- Estimation of Acidity in the water sample
- Estimation of Alkalinity in the water sample
- Estimation of Chloride in the water sample
- Estimation of Chloride in the soil sample
- Estimation of Free CO<sub>2</sub> in the water sample
- Determination of turbidity of given water sample
- Measurement of noise in silence, industrial, residential and commercial zones.
- To Determine the Minimum Size of the Quadrat by Species Area Curve Method and to Calculate the Species Frequency, Density and Abundance.
- To calculate Importance value index (IVI) of species.
- Analysis of soil microflora by dilution plate method, study of rhizospheric and rhizoplane microbes.

**Part B**

Preparation of a Ecology File Comprising of the Following Topics

- Major biomes of the world
- Hotspots of Biodiversity in the World
- Important Environmental Organizations (National and International)
- National parks, Sanctuaries and Biosphere reserves of India
- Preparation of Green File
- Preparation of Seminar report on different topics

# Semester II

## PAPER I (201): WASTE MANAGEMENT

Duration:3 hrs.

Max. Marks: 70

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.

### UNIT-I

**Solid Wastes:** Types of wastes – Municipal and industrial wastes, domestic waste; agricultural waste. Solid waste characterization: Integrated Solid waste Management; Waste reduction at source, volume reduction, Collection techniques/Methods and Transport of solid waste. Recycling, treatment and disposal techniques. Landfill - landfilling methods and operation. composting, vermi-composting.

### UNIT-II

**Hazardous Waste:** Classification, nature and characteristics of hazardous waste, techniques of hazardous waste treatment, disposal of hazardous waste.

### UNIT-III

**Nuclear Waste** –Classification of nuclear waste. Concentration and Containment at Storage Site including at deep underground facilities , Delay for Decay of short lived radio nuclides, Dilution & Dispersion of residual waste;

### UNIT-IV

**Biomedical Wastes:** Types of solids, liquids, sharps, blood and blood tissue, nuclear medicinal wastes; segregation and designated storage of biomedical wastes. Transport of medical waste: Authorization and accidental spilling reporting; biomedical waste treatment and disposal methods: Incineration.

### *Reference Books*

1. Integrated Solid Waste Management: George Tchobanoglous et. al., Mac Graw Hill Education, (28 Apr. 2014)
2. Hazardous waste Management; JM Dewan, KN Sudarshan: Discovery Publishing Pvt. Ltd. (11 Aug 2008)
3. Nuclear Wastes : PC Sinha; South Asia Books( 1 oct 1998)
4. Biomedical waste Management: R. Radhakrishnan; Sumit Enterprises (1 jan 2007)

## Semester II

### PAPER II (202): ENVIRONMENTAL POLICIES, LEGISLATIONS AND ETHICS

Duration :3 hrs.

Max. Marks :70

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.

#### UNIT-I

**Environmental Policy:** National Environmental Policy, National Policy on EIA and Regulatory framework, Rajasthan State Environmental issues and policy framework. Constitutional Provisions (Article 21, 48A, 51A), Role of Ministry of Environment & Forests.

#### UNIT-II

**Acts, Rules and Regulations:** Acts, rules and amendments thereof - Wildlife (Protection) Act 1972, Water (Prevention and Control of Pollution) Act 1974, Central and State Pollution Control Boards; Forest Conservation Act 1980, Environment (Protection) Act 1986. Air (Prevention and Control of Pollution) Act 1981; Bio-Medical Waste (Management & Handling) Rules, 1998 and its amendments; Transboundary Movement Rules, 2008.

#### UNIT-III

**Environmental Treaties and Conventions:** Evolution and development of International Environmental laws with reference to Stockholm Conference on Human Environment, 1972, Montreal Protocol, 1987, Basel Convention (1989, 1992), Earth Summit at Rio de Janeiro, 1992, UNEP, GEF, UNFCCC, Kyoto Protocol, Copenhagen Summit 2009. UNCCD, Rio +10, Ramsar Convention.

#### UNIT-IV

**Environmental Ethics:** Value education, individual, community, corporate social responsibility. Movements related to Environment –Bishnoi tradition, Chipko movement, Tehri dam, Sardar Sarovar, Narmada dam, Almatti dam, Silent Valley. Role of NGOs. Environmentally Significant Days.

### *Reference Books*

1. Environmental economics and Policy: Lynne Lewis and Tom Titenberg: Routledge; 7 edn. (11 Dec 2019)
2. Environmental policy, Implementation and Enforcement: Neil Hawke; Routledge, 1 edn. (4 Nov 2019)
3. International Conventions on Protection of Humanity and Environment: Gunter Hoog: DE Gruyter ; Reprint 2020 edn ( 1 July 1993)
4. The Oxford Handbook of Environmental Ethics; Stephen M. Gardiner; Allen Thompson; Oxford University Press, (25 Oct 2016)

# Semester II

## PAPER III (203): ENVIRONMENTAL CHEMISTRY

Duration :3 hrs.

Max. Marks :70

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.

### UNIT-I

**Fundamentals of Environmental Chemistry:** Elements and organics and radio nuclides in nature, Stoichiometry, Gibbs' energy; chemical potential; chemical equilibria, chemical kinetics, oxidation-reduction potentials (ORP). Solubility of gases in water, carbonate system, Absorption, adsorption-isotherms, Vanderwaals forces, ion bonding.

### UNIT-II

**Atmospheric chemistry:** Major and Trace gases in the atmosphere; Natural and manmade sources. Chemical process of formation of inorganic and organic particulate matter Thermo-chemical and photochemical reactions in the atmosphere. Role of hydrocarbons, oxides of sulphur and nitrogen, halogens in the atmosphere; Chemical speciation.

### UNIT-III

**Chemistry of Aquatic Environment:** Physical and chemical properties of water and their environmental significance, concept of oxygen demand -DO, BOD, COD; TDS, pH, conductivity. Colloids.Salinity.Chemical speciation in aquatic environment.

### UNIT-IV

**Soil Chemistry:** Physico-chemical characteristics of Soil, soil clays, organic carbon, soil humus and mineralization, cation exchange capacity, soil water solution, Nitrogen pathways, C/N ratio, NPK in soil, soil acidity, soil salinity.

### *Reference Books*

1. Chemistry for Environmental Engineering and Science: Clair N. Sawyer et. al., MC. Graw Hill Education; ( 1 July 2017)
2. Environmental Chemistry: Stanley Manahan: CRC Press, 10 edn, (27 march 2017)
3. Chemistry of Atmosphere; Richard P. Wayne; OUP Oxford; 3 edn.( 2 march 2000)
4. Soil Chemistry: Daniel G. Strawn et.al. , Wiley-Blackwell; 5 edn. (30 Jan 2020)

# Semester II

## PAPER IV (204): ENVIRONMENTAL DISASTERS AND MANAGEMENT

Duration :3 hrs.

Max. Marks :70

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.

### UNIT- I

**Disaster-** Concept, definition, and classification of disasters, Rapid onset and slow onset disasters, Hydrology. Changes in Coastal zone, coastal erosion, beach protection. Coastal erosion due to natural and manmade structures.

### UNIT- II

**Floods and Cyclones:** Trends in climatology and meteorology, causes, nature and frequency of flooding, Hazards associated with flooding. Flood forecasting. Flood management, Integrated Flood Management and Information System (IFMIS), Flood control. Types of wind forces, Coriolis Effect, Structure and nature of tropical cyclone. Droughts: Causes, impacts and mitigation.

### UNIT- III

**Earthquakes:** Nature and responses to geo-hazards, Causes and characteristics of ground-motion, Seismic activities , earthquake scales, magnitude and intensity, earthquake hazards and risks, Tsunamis – causes and physical characteristics. Volcanic land forms, eruptions, early warning from satellites, risk mitigation and training, Landslides and avalanches.

### UNIT- IV

**Mitigation efforts:** UN draft resolution on Strengthening of Coordination of Humanitarian Emergency Assistance, International Decade for Natural Disaster Reduction (IDNDR), Policy for disaster reduction, problems of financing and insurance.

### ***Reference Books:***

1. Environmental Disasters, Natural Recovery and Human Responses; Roger del Moral et.al., Cambridge University Press; (29 March 2007)
2. Environmental Disasters (Let's Explore Science); Shirley Duke; Rourke Educational media (30 Nov 2018)
3. Earthquakes: Seymour Simon: Harper Collis; (23 may 2006)
4. Improving Disaster Resilience and Mitigation- IT Means and Tools; Horia- Nicolai Teodorescu et. al., Springer; 2014 edn. (22 sept 2014)

## **Semester II PRACTICAL**

**Duration :4 hrs.**

**(3 hrs per day)**

**Max. Marks :200**

### **Part A**

- To study principle, components and working operation of Fine Dust Sampler for sampling & assessment of TSPM level in the ambient air.
- Sampling and Analysis of SO<sub>2</sub>,NO<sub>2</sub>
- Plot Wind Rose diagram to summarize meteorological condition.
- Study of plume behavior in relation with wind velocity in your surrounding area.
- Estimation of Total Hardness in the water sample
- Estimation of Calcium, Magnesium Hardness in the water sample
- Determination of Dissolve Oxygen & Biological Oxygen Demand (BOD) – (3 Day 280C or 5 day200C)
- Determination of Chemical Oxygen Demand(COD)
- To determine moisture content, pH and conductivity of solid wastes sample.
- Determination of water holding capacity of soil
- Study of soil texture.
- To determine the ash content and organic carbon content of given material.
- Determination of Dust Retaining Capacity of plants (APT index)

### **Part B**

- Data on the various methods of handling and transport of hospital wastes in the city.
- A visit to normal and secured landfill site, biological composting/vermin-composting
- Preparation of Green File
- Preparation of Seminar report on different topics

## Semester III

### PAPER I (301) : INSTRUMENTATION FOR ENVIRONMENTAL MONITORING AND ANALYSIS

Duration :3 hrs.

Max. Marks :70

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice.

Each question will carry 14 marks.

#### UNIT-I

**Sampling Methods:** Sampling methodologies for Air, Water, Soil Noise. Sampling protocols- Selection of sites, Time and frequency for sampling. Preservation, Storage and Handling of samples.

#### UNIT-II

**Analytical Instruments:** Principles, working and applications of High volume sampler, Respirable Sampler, Cyclones, Particle Size Analyser, Gas Analysers, Spectrophotometer (UV-Visible), Flame Photometer, Atomic Absorption spectrophotometer (AAS).

#### UNIT-III

**Chromatographs:** Principles, working and applications of Gas Chromatograph (GC), HPLC, Ion chromatograph and Size – exclusion Chromatography

#### UNIT-IV

**Radiation Detectors and Monitors:** Principles and working of radiation detectors- gas filled, scintillation(inorganic and organic) and semiconductor. Principles and working of Alpha Counter, Beta Counter, Gamma-ray Spectrometer, Liquid scintillation Counter, Beta-Gamma survey meters, Alpha, Beta and Gamma contamination Monitors.

### *Reference Books*

1. Environmental Instrumentation and Analysis Handbook ardcover – Illustrated, by Randy D. Down, Jay H. Lehr, Wiley-Interscience; 1st edition, 2004
2. Atwal,G.R.,and Anand,S.K. Instrumental Methods of Chemical Analysis. Himalaya Publishing House, Delhi. 2007.
3. De, A.K. Environmental Chemistry, New Age International, New Delhi. 2000.
4. Introduction to the environmental monitoring instruments, Jian-Feng Wang, Jian-Feng Tian, Xian-Qun Zeng, Res. Astron. Astrophys, 2020
5. Environmental Impact Assessment: Theory and Practice, M. Anji Reddy, BS Publications/BSP Books, 2019

# Semester III

## PAPER II (302) : ENVIRONMENTAL BIOREMEDIATION PROCESS AND TECHNOLOGY

Duration :3 hrs.

Max. Marks :70

**Note: There will be two parts in end semester theory paper.**

**Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.**

### UNIT-I

Basic Concept of bacteria, fungi, algae, Protozoa and viruses. Use of microorganisms in bioremediation of soil and oil spills. Bio - fertilizers, Rhizobium, Azotobacter, Nitrogen fixation, vermin-technology and vermin-composting. Xeno-biotics, biodegradation of harmful (toxic) organic pollutants-pesticides, chloroaromatic compounds and benzene.

### UNIT-II

PCB and its degradation, Integrated treatment system for biodegradation of Polychlorinated biphenyls (PCBs) Enzymes contributing to industrial sustainable development. Starch processing, detergents, textile, leather, pulp and paper manufacture, Industrial ecology

### UNIT – III

Biodegradation of halogenated hydrocarbons; polycyclic aromatic hydrogen; Pesticides and Detergents. Applications of microbes in removal of heavy metals and other contaminants from water and soil.

### UNIT-IV

**Biotechnology for Management of Resources:** Role of environmental biotechnology in management of resources; Reclamation of wasteland; Biomass production; Biogas and biofuel production, Microorganisms in mineral and energy recovery, Nanotechnology for control of pollution.

### *Reference Books*

1. Environmental Bioremediation Technologies, S.N. Singh, R. D. Tripathi Springer Science & Business Media, 2007.
2. Applied Bioremediation and Phytoremediation, Ajay Singh, Owen P. Ward, Springer Science & Business Media, 15-Jun-2004
3. Environmental Biotechnology: Concepts and Applications, Hans-Joachim Jördening, Josef Winter, Wiley pub., 06-Mar-2006
4. Pepper, I.L. and Gerba, C.P. Environmental Microbiology - Laboratory Manual. Elsevier, USA. 2005. Ratledge, C. and Kristiansen, B. Basic Biotechnology. 2nd ed. Cambridge University Press, Cambridge, UK. 2002.

## Semester III

### PAPER III (303): POLLUTION CONTROL TECHNOLOGY

Duration : 3 hrs.

Max. Marks :70

**Note:** There will be two parts in end semester theory paper.

**Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.**

#### UNIT-I

**Air Pollution Control:** Air quality. Stack emission monitoring. Air Quality Monitoring Programme. Preliminary information required for planning an air quality survey; Control of air pollutants: General methods of control of Gaseous pollutants- scrubbers, condensers, control equipment for particulate matter- gravity settling chambers, cyclone, fabric filters, electrostatic precipitators, Hybrid Filter (Combination of ESP and Bag House).

#### UNIT-II

**Control Technology for Drinking Water:** Water quality standards. Treatment for Clean Water: Water Treatment Plant Procedures- Pre-treatment, Primary- flocculation, settling, filtration, reverse sand filter, cleaning, secondary biological methods of treatment Trickling filters, rotatory biological contactors, oxidation ponds

#### UNIT-III

**Physico-Chemical Treatment:** Tertiary treatment methods; chlorination, chemical oxidation, Membrane filtration processes (RO, Microfiltration, Ultrafiltration, nanofiltration) and adsorption using various materials, UV treatment. Sludge treatment and process

#### UNIT-IV

**Soil Treatment Technologies:** Methodologies for soil conservation, conservation of arable land, techniques of reclamation and restoration of soil, wasteland reclamation, soil salinity management, Biochar for soil remediation.

#### *Reference Books*

1. Bhargava, S. K. Practical Methods for Water and Air Pollution Monitoring, New Age International Pub., New Delhi. 2008.
2. Bhatia, S.C. Textbook of Air Pollution and Its Control. Atlantic Pub., New Delhi. 2007.
3. Clarke, Andrew G. Industrial Air Pollution Monitoring, Gaseous and Particulate Emissions, Springer. 2008.
4. Kumar, R and Singh, R.N. Municipal Water and Wastewater Treatment. Capitol Pub. Co., New Delhi. 2006.

## Semester III

### PAPER IV(304): STATISTICS, ENVIRONMENTAL MODELING AND RESEARCH METHODOLOGY

Duration :3 hrs.

Max. Marks :70

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.

#### UNIT-I

**Statistical Analysis:** Sampling, Data collection and recording. Central tendency – concept; arithmetic mean, mode, median for ungrouped and grouped data. Measures of dispersion: absolute and relative measures; range, standard deviation (grouped and ungrouped data), variance, quartile deviation, coefficient of variability. Skewness, Kurtosis;

#### UNIT-II

**Probability and Tests of Significance:** Probability - normal, poisson and binomial, Statistical Methods: Hypothesis testing, significance and correlation. Correlation. Linear models and regressions. Pearson and other correlation coefficients. Distribution- Normal, t and chi square test.

#### UNIT-III

**Environmental Model Approaches:** Approaches to development of models; linear simple and multiple regression models; models of population growth and interactions: Lotka-Volterra model, Leslie matrix model, Point source stream pollution model, Box model, Gaussian plume model.

#### UNIT-IV

**Research Methodology:** Basic principles of research design, execution and reporting; Concept of research articles, research papers, reviews, scientific popular articles, Preparation of synopsis and research report writing, Concept of Research Ethics and its Basic Principles.

#### *Reference Books*

1. Kulkarni, A.P. Basics of Biostatistics, 2nd Edition 2019, CBS Publishers
2. Introduction To Biostatistics And Research Methods 5Th Edition by Rao, P.S.S.S. PHI Learning Pvt. Ltd.; 5th edition (1 January 2012)
3. Introduction to Environmental Modeling, William G. Gray, Genetha A. Gray, Cambridge University Press
4. Research Methodology: Methods and Techniques, C R Kothari, NEW AGE Publication

## Semester III

### PRACTICAL

Duration :4 hrs.

(3 hrs per day)

Max. Marks :200

#### Part A

- Determination of Sulphate content in the water sample by Spectrophotometric method.
- Estimation of Nitrate in water sample by Spectrophotometric method.
- Estimation of Phosphorus in water sample by Spectrophotometric method.
- Determination of cations (Na, K, Ca and Mg) in a given water sample by using a Flame photometer.
- Determination of cations (Na, K, Ca and Mg) in a given soil sample by using a Flame photometer.
- Determination of Cation Exchange Capacity of soil.
- Determination of Total Kjeldahl Nitrogen (TKN) in soil samples.
- Determination of Total Organic Carbon of a soil samples.
- Determination of Heavy metals in soil samples.
- Calculation of mean, mode, median, standard error, standard deviation.
- Regression analysis and application of statistical tests in environmental problems.
- Use of Chi-square, F-test and t-test.
- Calculation of Coefficient of Correlation.

#### Part B

- Preparation of Synopsis on different project/dissertation work
- Visit to a national park/any-natural habitat/sanctuary and report preparation for the same.
- Study of rainwater harvesting structure.
- Survey of market for environmental sound products(eco-labeling)
- Visit to a Cement Industry to know about CDM it has followed.

# Semester IV

## PAPER I(401): ENVIRONMENTAL IMPACT ASSESSMENT

Duration :3 hrs.

Max. Marks :70

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.

### UNIT-I

**Overview of EIA;** Objectives and development of EIA.Benefits of EIA, Indian directions of EIA.Rapid and comprehensive EIA perspectives.Sources and collection of data for EIA.

### UNIT-II

**EIA Methodology:** Outline of EIA process, Screening, Scoping, Purpose of scoping, impact implications, Baseline studies and superimposition of projected plant emission impacts, EIA methodology : checklist, matrices, Overlays and Geographical Information System, Impact analysis and Predictions, Environmental Impact Statement [EIS], cost benefits analysis (CBA), Public hearing as part of EIA.

### UNIT-III

**Environmental Management and ISO Certification:** Environmental Management Systems (EMS), ISO 14000 (EMS). Components of Environmental Management System-Objectives, Policies, Implementation and Review. Life Cycle Analysis –LCA Defining goal and scope, preparation of life cycle inventory.

### UNIT-IV

**Public Participation:** Social impact assessment (SIA), Strategic Environmental Assessment (SEA), Public involvement, Public Hearing compulsion, restoration and rehabilitation methodologies, Mitigation criteria, Project modification, Post project analysis, Overview of CSR, ISO 26000

### *Reference Books*

1. Environmental Impact Assessment Methodologies 3Rd Edition by Anjaneyulu Ceramal Valli Manickam, BS Publications
2. Methods Of Environmental And Social Impact Assessment 4Th Edition by Riki Therivel and Graham Wood , Taylor & Francis
3. Environmental Management,Ajith Sankar, Oxford University Press; Illustrated edition (29 June 2015)
4. ISO 14001: 2015 – Environmental Management System (EMS) ‘Beginners Guide’, Mohamed Nazeer Ali,Notion Press; 1st edition (25 March 2021)

# Semester IV

## PAPER II (402): ENVIRONMENTAL CLEARANCE AND ENVIRONMENTAL AUDIT

Duration : 3 hrs.

Max. Marks: 70

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.

### UNIT-I

**EIA Notification:** EIA in Indian context, EIA Notification 2006, Prior environmental clearance requirements, EIA authority - State and Central government, Committees for Environmental Clearance, Application for EC, Form 1- contents. Categorization of projects, list of projects, activity, financial overlays, conditions and specifications.

### UNIT-II

**Project types:** General idea, categorization criteria important considerations/features developmental projects – river valley project, mining, cement industry, thermal power, pulp and paper industry, Road /highway construction.

### UNIT-III

**Reports for Environmental Clearance:** Generic structure of environmental impact assessment document – Executive summary of Project, Introduction, Project description, Project benefits, Policy legal and administrative framework, Description of Environment, prediction of environmental impacts, evaluation of impacts, Impact evaluation, Environmental Management Plan(EMP),

### UNIT-IV

**Environmental audit-** objectives, frequency and criteria audit team, Environmental appraisal, accounting and environmental audit. Environmental guidelines for siting of industry, Green Marketing, Global Reporting Initiative Guideline G-3, Green Accounting, Environmental GRI reports

### *Reference Books*

1. Environmental Impact Assessment, R.R. Barthwal, New Age International Private Limited; 2nd edition (1 January 2012)
2. Environmental Impact Assessment, A. K. Shrivastava, APH (1 December 2003)
3. Environmental Auditing, Neil Humphrey, Mark HadleyEMIS Professional Publishing, 2000
4. Environmental Impact Assessment: Practical Solutions to Recurrent Problems, David P. Lawrence, John Wiley & Sons, Inc.

## Semester IV

### **PAPER III (403): REMOTE SENSING AND GIS FOR ENVIRONMENTAL SCIENCE**

**Duration:3 hrs.**

**Max. Marks:70**

**Note: There will be two parts in end semester theory paper.**

**Part A of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.**

**Part B of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.**

#### **UNIT-I**

**Fundamentals of Remote Sensing:** Principles of remote sensing (Optical/Microwave) - principles of Aerial photography, Imaging systems, satellites, sensors, data generation. History of remote sensing.Hyper spectral remote sensing.

#### **UNIT-II**

**Image Interpretation:** Principles of image interpretation, visual image interpretation. Digital image processing- Image enhancement, image rectification, image classification techniques and Accuracy assessment.

#### **UNIT-III**

**Applications of Remote Sensing:** Remote sensing based land use/land cover mapping, remote sensing of vegetation-spectral characters of vegetation, remote sensing of biodiversity applications, remote sensing for climate change studies, remote sensing for flood mapping,

#### **UNIT – IV**

**GIS System:** GIS concepts. Basic concepts of cartography. Data structures - vector and raster data. Data inputting, Data storage, Data editing.

### ***Reference Books***

1. Remote Sensing and GIS, Basudeb Bhatta, OUP India; 3rd edition (27 January 2021)
2. Basics Of Remote Sensing And GIS, S. Kumar, Laxmi Publications; First edition (1 January 2016)
3. Remote Sensing and GIS for Ecologists, Martin Wegmann, Benjamin Leutner, Stefan Dech, Pelagic Publishing Ltd
4. Textbook of Remote Sensing and Geographical Information Systems, Kali Charan Sahu Atlantic Publishers & Dist, 2007

# Semester IV

## PAPER IV (404): ENERGY AND ENVIRONMENT

Duration: 3 hrs.

Max. Marks :70

**Note:** There will be two parts in end semester theory paper.

**Part A** of the paper shall contain seven short answer questions of 14 marks. Each question will carry two marks for correct answer.

**Part B** of the paper will consist of four questions one question from each unit with internal choice. Each question will carry 14 marks.

### UNIT-I

**Non-renewable Sources of Energy:** Fossil fuels-classification, composition, physico-chemical characteristic and energy content of coal, petroleum and natural gas. Gross-calorific value and Net- calorific value. Mining and uses of coal, oil and natural gas. Environmental impact of extraction, processing and smelting of minerals, recycling and recovery of resources.

### UNIT-II

**Renewable Sources of Energy:** Solar energy- Sun as a source of energy; solar radiation and its spectral characteristics, Harnessing of solar energy, Solar collectors, solar heaters, dryers, photovoltaic, solar ponds: Wind energy- harnessing of wind energy, wind mill; Generation of hydropower, tidal energy, ocean thermal energy conversion; Geothermal energy, Magneto-hydrodynamic power;

### UNIT-III

**Alternate Energy Resources:** Fission and fusion, Nuclear fuels – mining and processing of Uranium, concentration, Nuclear reactors, Bioaccumulation, Impact on environment. Bio-energy- energy from biomass and biogas, anaerobic digestion. Hydrogen as fuel.

### UNIT-IV

**Environmental implications:** Environmental implications of energy use; energy use pattern in India and the world, Renewable energy potential in India, emissions of CO<sub>2</sub> in developed and developing countries including India, Impact of large scale exploitation of solar, wind, hydro and other renewable energy sources.

### *Reference Books*

1. Energy and Environment, V K Ahluwalia The Energy and Resources Institute (TERI)
2. Energy, the Environment, and Sustainability, Efstathios E. Michaelides, CRC Press
3. Sustainable Energy and Environment: An Earth System Approach, Sandeep Narayan Kundu, Muhammad Nawaz, CRC Press
4. Renewable Energy: Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 1996

## **Semester IV PRACTICAL**

**Duration :4 hrs.**

**(3 hrs per day)  
Max. Marks :200**

### **Part A**

- To estimate carbohydrate content in given plant sample.
- To estimate protein content in the given sample.
- Study of morphological changes in plants to detect effect of pollution.
- Estimation of total coliform bacteria in water sample.
- Estimation of heavy metals and Dyes in wastewater sample.
- Estimation of phytoplankton species in given water sample.
- Determination of Total Kjeldahl Nitrogen (TKN) in plant samples.
- Study of biochemical & morphological parameters during pre, peak & post stages of plants.

### **Part B**

- Report writing Cost – benefit analysis.
- Environment auditing procedures and report writing.
- EIA of: dam / Industry / Mining exploration/ Housing/ Thermal Power plant/Bridge/ railway tract/ urban city (Visits for EIA preparation) categorized by MOEF and VivaVoce.
- A Project work / Dissertation topic may be allotted by the department

### **Dissertation Report Submission Guidelines:**

The dissertation report should contain the followings:

1. Dissertation report will contain a cover page, certificate signed by student and supervisor, table of contents, introduction, Objective, Literature review, methodology, results and discussions conclusion, and references.
  - The paper size to be used should be A-4 size.
  - The font size should be 12 with Times New Roman.
  - The text of the dissertation may be typed in 1.5 (one and a half) space.
  - The print out of the dissertation shall be done on both sides of the paper (instead of single side printing)
  - The total no. of written pages in dissertation report should be 40 to 60.
2. The candidate shall be required to submit three hard bound copies of dissertation along with a soft copy emailed to the department as per the date announced.
3. The candidate will defend her/his dissertation/project work through presentation before the External examiner at the end of semester and will be awarded marks.