

**ENVIRONMENTAL SCIENCE  
THE UNIVERSITY OF BURDWAN  
M. Sc. SYLLABUS 2007  
SEMESTER SYSTEM**

The course will be divided into four semesters each being of six months duration. Each semester contains six papers of total 300 marks all together twenty-four modules. 10% of the total theoretical marks (800) will be treated as internal assessment, i.e., 80.

***Duration of Theoretical Examination Time: 3 Hours***

***Duration of Practical Examination Time: Minimum 4 Hours & Maximum 5 Hours***

*Distribution of Marks: Total Theoretical Marks 45*

*Two long questions of 10 marks out of 4 questions*

*Three questions of 5 marks out of 8 questions*

*Five questions of 2 marks out of 8 questions*

**SEMESTER – I**

General Theoretical Papers	Marks: 180
General Practical	Marks: 100
Internal Assessment	Marks: 20

ENVIRON – 101: Basic Ideas on Environment	Marks: 45
ENVIRON – 102: Physical Environment	Marks: 45
ENVIRON – 103: Environmental Biology	Marks: 45
ENVIRON – 104: Environmental Microbiology	Marks: 45
ENVIRON – 105: General Practical	Marks: 50
ENVIRON – 106: General Practical	Marks: 50

**SEMESTER – II**

General Theoretical Papers	Marks: 180
General Practical	Marks: 100
Internal Assessment	Marks: 20

ENVIRON – 201: life Processes & Ecotoxicology	Marks: 45
ENVIRON – 202: Environmental Geoscience	Marks: 45
ENVIRON – 203: Soil Science, Energy Resource, & Environmental Statistics	Marks: 45
ENVIRON – 204: Environmental Pollution & Degradation	Marks: 45
ENVIRON – 205: General Practical	Marks: 50
ENVIRON – 206: General Practical	Marks: 50

### SEMESTER – III

General Theoretical Papers	Marks: 135
Special Theoretical Paper	Marks: 45
Special Practical	Marks: 50
General Practical	Marks: 50
Internal Assessment	Marks: 20
ENVIRON – 301: Environmental Impact Assessment & Environmental Laws	Marks: 45
ENVIRON –302: Environmental Economics & Environmental Management	Marks: 45
ENVIRON – 303: Emerging Environmental Problems, Health Hazards & Genetic Engineering	Marks: 45
ENVIRON – 304: Remote Sensing & GIS (Special Paper)	Marks: 45
ENVIRON – 305: General Practical Paper	Marks: 50
ENVIRON – 306: Special Practical Paper	Marks: 50

### SEMESTER – IV

General Theoretical Paper	Marks: 45
Special: Theoretical Paper	Marks: 90
General Practical	Marks: 50
Special Practical	Marks: 50
Seminar Presentation	Marks: 50
Internal Assessment	Marks: 15
ENVIRON – 401: Biodiversity Conservation & Sustainable Development	Marks: 45
ENVIRON – 402: Special Paper: Environmental Toxicology (Special paper)	Marks: 45
ENVIRON – 403: Special Paper: Environmental Biotechnology (Special paper)	Marks: 45
ENVIRON – 404: General Practical Paper	Marks: 50
ENVIRON – 405: Special Practical Paper	Marks: 50
ENVIRON – 406: Seminar Presentation Paper (Dissertation/ Term Paper 40+Viva-voce 10)	Marks: 50

NB. Internal Assessment will be made through class test/ class work performance, *etc.*

## FIRST SEMESTER

. ENVIRON – 101  
No. of Lectures: 40

Marks: 45  
Time of Examination: 3hrs

### BASIC IDEAS ON ENVIRONMENT

- I Environmental awareness:** Definition, principles scope , and objectives of environmental science; concept on environment; World Environment Day and National Earth Day and their relevance; environmental awareness and education. Environmental movements in India (Narmada Dam, Tehri Dam) [5]
- II Components of environment:** Lithosphere, hydrosphere, atmosphere and biosphere; physical and biological environments; [5]
- III Introduction to ecology:** Definition, principles, and scope of ecology, ecosystem ecology; concepts of Gaia Hypothesis; limiting factors, combined concept on limiting factors [5]
- IV Principles and concepts of ecosystem:** Concept of ecosystem; homeostasis of the ecosystem structure and functional aspects of ecosystem; ecological energetics; ecological interactions [5]
- V Life Processes and characteristics:** Basic ideas with respects to growth,metabolism and developmental processes [5]
- VI Biomes:** Meaning of biomes, biome type, tropical evergreen rainforest biome, Monsoon deciduous forest biome, Savana biome, Mediterranean biome, Temperate grassland biome, Tundra biome, Marine biome [5]
- VII Man, society and environment:** Human civilization processes (anthropological perspectives), society, class, gender; human settlements [5]

### Suggested Readings

1. *Environmental Science* — S. C. Santra, New Central Book Agency.
2. *Environmental Science; Cunningham & Saigo WCB McGraw Hill*, 1999-5<sup>th</sup> Den.
3. *Environmental Science-Enger & Smith. 7<sup>th</sup> Den*, McGraw Hill .
4. *Fundamental of Ecology*, E.P. Odum, W.B. Sauders Company, USA.
5. *Concept of Ecology*, E. J. Kormondy, Prentice Hall of India Pvt. Ltd.
6. *Environmental Biology*, Biswarup Mukherjee, Tata McGraw Hill Co. Ltd., New Delhi.
7. *Ecology a bridge between science & society*, by E. P. Odum, Sinauer associates.

## FIRST SEMESTER

ENVIRON – 102  
No. of Lectures: 40

Marks: 45  
Time of Examination: 3hrs

### PHYSICAL ENVIRONMENT

- I Fundamentals of Earth processes:** Origin of Earth; Geological time scale; internal structure of earth; Geotectonics; Continental drift and mountain building with reference to plate tectonics;  
External geomorphic processes: weathering and erosion; Soil formation; Landforms developed due to water, wind and glacier; sediments and sedimentation [8]
- II Fundamentals of climatology:** Scale of meteorology; elements of climate -- pressure, temperature, precipitation, humidity, radiation and wind equation of motion for atmosphere; tropical motion systems  
Climate of India: Spatial and temporal patterns of climatic parameters in India, Indian monsoon, climatic regions of India [6]
- III Environmental chemistry:** Atoms, elements, compounds, chemical bonds and chemical reactions; geospheric element transformation and behaviour; organic compounds – hydrocarbons and polymer chemistry; biological chemistry – chemistry of carbohydrate, protein, fat, nucleic acids, pigments, phenol etc; green chemistry – concept, green catalyst; material life cycle and application of green chemistry [12]
- IV Principles of analytical methods:** Design of sampling techniques (air, soil, biological matters), Chromatography, gas chromatography, HPLC, GC-MS, Atomic absorption spectroscopy, Flame photometry; some microbial methods [8]

### Suggested Readings

1. *Environmental Geology*, Edward A. Keller, Prentice Hall, New Jersey.
2. *Physical Chemistry*, P.C. Rakshit, Sarat Book House, Calcutta.
3. *Environmental Chemistry*, A. K. De, New Age (p.) Ltd.
4. *Fundamentals of Environmental Chemistry*, Manban, S.E., Lewis Publishers.
5. *Elements of Bioinorganic Chemistry*, G. N. Mukherjee, Arabinda Das, U. N. Dhar & Sons Pvt. Ltd.
6. *Atmospheric Chemistry & Physics*, Sainfeld, John Wiley & Sons. Inc.
7. *Chemistry for Environmental Engineering*, Sway, MCarthy & Parkin; Tata Mc. Graw-Hill.

## FIRST SEMESTER

ENVIRON – 103  
No. of Lectures: 40

Marks: 45  
Time of Examination: 3hrs

### ENVIRONMENTAL BIOLOGY

- I Evolution:** Fundamentals of evolutionary processes; origin of life; role of natural selection, genetic drift, evolutionary divergence – races, species and isolating mechanism, patterns of speciation, population genetics, [7]
- II Biological diversity:** A brief accounts of microbes, plants and animals and microbes; principles of taxonomy – nomenclature, an outline of classification and identification (plants, animals) [8]
- III Population and environment:** Population characteristics; population dynamics; human population growth, natality, mortality, age structure, dispersal and distribution, immigration, emigration [6]
- IV Community ecology:** Biotic community concept and structure and classification; species diversity in communities, pattern in communities; ecological succession – causes, trends, of succession, basic types of succession, general process of succession, successional changes in community, model of succession, - relay floristic model, initial floristic composition model, tolerance and inhibition model; climax concept; structural and functional changes in hydrosere, xerosere [8]
- V Habitat ecology:** Freshwater ecology, marine ecology, estuarine ecology and terrestrial ecology [4]
- VI Forest and wildlife:** Classification and distribution of forests, ecological and economic value of forest, forest degradation and deforestation, impact of deforestation on the environment; current strategies of forest management, agroforestry, social forestry, farm forestry, green belt development, principles and strategies of protected area network, sanctuary, national park, biosphere reserve, wild life tourism [6]

#### Suggested readings

1. *Principles of Systematic Zoology*, E. Mayr and Peter D Ashlock, McGRAW-HILL, INC
2. *Principles of Animal Taxonomy*, G G Simpson, Columbia University Press

## FIRST SEMESTER

ENVIRON – 104  
No. of Lectures: 40

Marks: 45  
Time of Examination: 3hrs

### ENVIRONMENTAL MICROBIOLOGY

- I General microbiology:** Microbiology of air, water and soil; general idea about bacterial morphology -- shape, size; structure chemistry and function of capsule, pilus, membrane, cell wall, plasmid and chromose, replication of bacterial nucleus; fungal morphology [6]
- II Microbial culture techniques:** Isolation and characterization, microbial growth analysis; preservation of microorganisms [6]
- III Food Microbiology:** Contamination and microbial spoilage of fresh food and its preservation; food adulteration; fermented food; food poisoning; microbiology of milk, milk sources, types of microorganisms used, pasteurization [4]
- IV Microbes of different environment:** Thermophiles, psychrophiles, halophiles, acidophiles and alkaliphiles [6]
- V Microbial transformations of pesticides:** Fundamental reactions of pesticide metabolism, B-oxidation, oxidative dealkalation, thioether oxidation, decarboxylation, epoxidation, aromatic hydroxylation, aromatic heterocyclic and non-heterocyclic ring cleave; hydrolysis, halogen reactions, nitro reactions, miscellaneous reactions [6]
- VI Microbial transformations of heavy metals:** microbes in metal containing habitat, metal-microbes interactions, microbial immobilization and transformation of metals, microbial application of metal removal [6]
- VII Microbial properties:** Distinctive properties of virus, types of viral nucleic acids, replication of viral DNA and RNA, lysogeny, induction, lysogenic conversion significance of lysogeny, Viroids and prions. [6]

#### Suggested readings

1. *Microbiology*, Pelzer, M. J. Chan, E.C.S. and Kreig, N. R. McGraw-Hill Publishing Company.
2. *Wastewater Microbiology*, Bitton, G., John Wiley, NY.

## FIRST SEMESTER

ENVIRON – 105  
Time of Examination: 4hrs

Marks: 50

### GENERAL PRACTICAL PAPER

1. Measurement and preparation of Oxygen Profile in aquatic ecosystem
2. macroscopic and microscopic identification of igneous, sedimentary and metamorphic rocks, common minerals; Study of fossils with reference to paleoenvironment
3. Study of pond biota – phytoplankton, zooplankton and macrophytes
4. Physico-chemical analysis of water and and soil parameters
  - a) Meteorological parameters: Temperature, moisture, humidity, light
  - b) Soil parameters: pH, organic matter, N, P, K
  - c) Water parameters: DO, free and combined CO<sub>2</sub>, salinity, conductivity, turbidity (Secchi Disc method), sulfate, phosphate, nitrate-nitrogen, ammonical-nitrogen, residual chlorine, sodium and potassium
5. Laboratory Note book and *Viva-voce*:

15 marks

## FIRST SEMESTER

ENVIRON – 106  
Time of Examination: 4hrs

Marks: 50

### GENERAL PRACTICAL PAPER

1. Analysis of vegetation: Frequency, density, abundance, cover and basal area, dominance, Importance Value Index (IVI) and phytograph
2. Determination of species diversity by diversity indices in plant community
3. Lay out of experimental design (RBD; split-plot etc.); Sampling techniques and statistical analysis of experimental design
4. Study of bioenergetics – Plants and animal tissues by calorimetric methods
5. Estimation of biomass by crop growth analysis
6. Laboratory Note book and *Viva-voce*:

15 marks

## SECOND SEMESTER

ENVIRON – 201

No. of Lectures: 40

Marks: 45

Time of Examination: 3hrs

### LIFE PROCESSES & ECOTOXICOLOGY

- I Toxicology:** Principles of toxicology; elements and areas of toxicology; acute and chronic toxicology; dose-response relationship; statistical concept of LD<sub>50</sub> and LC<sub>50</sub>; chemical and biological factors and their influences, bioassay methods, routes of entry of toxicants; interaction of toxicants with organism  
Microbial toxins - algal, fungal and bacterial toxins [8]
- II Biochemical aspects of heavy metals:** Sources, distribution, mechanism of action, effects and remedial measures of some heavy metals like arsenic, cadmium, lead, mercury, aluminium, chromium [8]
- III Biochemical aspects of some specific industrial toxicants:** Sources, distribution, mechanism of action, effects and remedial measures of some specific toxicants like PAN, MIC [8]
- IV Immunology and immunotoxicity:** Properties of immune response; innate and acquired immunity; cells and organs of immune system; concepts of antigens; concept of antibodies with special reference to structure, function, classification; antigen antibody interaction, major histocompatibility complex; cell mediated and humoral immunity [8]
- V Stress Physiology:** Environmental stress -concept and stress agents-water, temperature, salinity, radiation, air pollutants and metals on plants and animal systems. [8]

### Suggested Readings

1. *Toxicants in the aquatic ecosystem*, T. R. Crompton, John Wiley & Sons, NY.
2. *Casarett & Doull's Toxicology, The basic Science of poisons*, 2<sup>nd</sup> Den, Editors, J. Doull, C.D. Klaassen, M.O. Amdur, Macmillan Publishing Co. Inc., NY.
3. *Statistics for environmental Biology and Toxicology*, W. W. Piegorsh & A. J. Bailer.



## SECOND SEMESTER

ENVIRON –202

No. of Lectures: 40

Marks: 45

Time of Examination: 3hrs

### ENVIRONMENTAL GEOSCIENCE

- I. Land resources & management:** Land resources, land degradation cycle, land-use pattern, land reform, land use plan, soil surveys in relation to land use planning; methods of site selection and evaluation [6]
- II. Water resources management and its environment:** World water balance, hydrogeology and geochemistry of surface and groundwater; water quality, use of water, conservation of water resources, climate change impacts on water resource management [6]
- III. Mineral resources and environment:** Mineral resources in relation to plate tectonics and geology, geology of mineral resources, distribution of mineral resources in India, environmental impact of mineral development, recycling of mineral resources [8]
- IV. Geological hazards:** Earthquakes, Landslides, Cyclones and Floods Indian context [6]
- V. Environmental meteorology:** Atmospheric stability, adiabatic character; Turbulence and diffusion, Application of meteorology to air pollution study [6]
- VI. Environmental climatology:** Climatic change in of recent times; identification and characteristics of bio-climatic and agro-climatic regions of India; urban climatology; climate and human comfort [8]

### Suggested Readings

1. *Environmental Geology*, Edward A. Keller, Prentice Hall, New Jersey.
2. *Geology Environment Society*, K.S. Valdiya, University press
3. *Environmental meteorology*, B. Padmanabha Murthy, I.K. International
4. *Atmosphere, Weather and Climate*, Roger G. Barry Richard J. Charley, Routledge (Taylor & Francis group)
5. *Coping with natural hazards; Indian Context*, K.S. Valdiya, Orient Longman .
6. *Environmental Geology*, C.W. Montgomery, Mc. Graw Hill International.

## SECOND SEMESTER

ENVIRON – 203

No. of Lectures: 40

Marks: 45

Time of Examination: 3hrs

### SOIL SCIENCE, ENERGY RESOUCCE & ENVIRONMENTAL STATISTICS

- I Soil Science:** Origin, nature and classification of parent material for soil formation, soil profile, physical properties of soil, soil air, soil water, soil temperature, soil colloids, soil pH, mineral nutrition in plants; Soil erosion and conservation [8]
- II Energy:** Energy budget of the earth; earth's thermal environment and seasons; sun as a source of energy, solar radiation and its spectral characteristics. Conventional and non-conventional energy sources, fossil fuels; nuclear energy-fission and fusion; energy from biogas and biomass [6]
- III Energy and environment:** Principles of generation of Solar, hydropower wind, geothermal and ocean energy, energy use patterns in different parts of the world and India and its impact on the environment; [8]
- IV Energy management:** Energy consumption; energy conservation, increased efficiency, and cogeneration, energy policy, integrated energy management, management of nuclear energy wastes, some conservation factors, research and development on renewable energy [8]
- V Environmental statistics:** Basic elements and tools of statistical data analysis, bivariate and multivariate data; statistical measures --mean, median, standard error and deviation; testing of hypothesis: Null and alternative hypothesis, level of significance, degree of freedom, t-test [10]

### Suggested Readings

1. *Environmental Statistics and data analysis*, Ott, W. R., Lewis Publishers, New Jersey.
2. *Statistical Methods*, G. W. Snedecor & W. G. Cochran.
3. *Statistics for environmental Biology and Toxicology*, W. W. Piegorsh & A. J. Bailer.
4. *Soils – their properties & management*, Peter E. V. Charman, Oxford Univ. Press.
5. *Introductory Soil Science*, D.K.Das , Kalyani Publishers.

## SECOND SEMESTER

ENVIRON – 204  
No. of Lectures: 40

Marks: 45  
Time of Examination: 3hrs

### ENVIRONMENTAL POLLUTION & DEGRADATION

- I Air Pollution:** Natural and anthropogenic sources of pollution; inorganic pollutants, ozone, SPM, photochemical smog, acid rain; organic pollutants, biopollutants; effects of air pollutants on human, plants, materials and climate; status of air pollution in Indian cities; different control measures and air quality standard
- II Water pollution:** Sources, types and consequences; inorganic and organic pollutants; concept of eutrophication, DO, BOD, COD; sewage and groundwater pollution; water quality, standard and health; physico-chemical analysis of water; effects of water pollution on biological system; status of water pollution in different water bodies with reference to Indian context; thermal pollution
- III Noise pollution:** Sources of noise, types of noise; noise and health; sonic boom; sound pressure and intensity level; decibels; noise exposure levels and standard; noise measurement; control of noise pollution; noise mapping
- IV Radiation pollution:** Radioactivity in the environment; biological effects of radiations; pollution from nuclear weapons' explosions; pollution from electric power generation plant and nuclear reactors,
- V Soil pollution:** Sources, effect of soil pollution on biota, surface water and groundwater regimes; fate and behavior of soil pollutants; impact of different pesticides (herbicides, insecticides, fungicides, nematocides, rodenticides etc.) on soil; different kinds of synthetic fertilizer (NP&K) and their interactions with different components of soil; management of agricultural pollution in India.
- VI Environmental degradation:** Wetlands, wastelands, and desertification; genesis of wasteland and wetland – problems and prospects; different conventions on wetland

#### Suggested Readings

1. *Environmental Noise Pollution and Its Control*, Chhatwal, Mehra Katyal, Satake Katyal, Nagahiro, Anmol Publications (Pvt.) Ltd., New Delhi.
2. *Environmental radiation and thermal pollution and their control*, G. R. Chhatwal *et al.*, Anmol Publications (Pvt.) Ltd., New Delhi.
3. *Elements of the nature & properties of soils*, Nyle C Bardy, Prentice Hall, New Jersey.
4. *Understanding environmental pollution*, Marquita K. Hill, Cambridge University Press, 1997.
5. *Air pollution and climate change*, Alan Wellburn-2<sup>nd</sup> Edn., Longman, 1998.

## SECOND SEMESTER

ENVIRON – 205  
Time of Examination: 4hrs

Marks: 50

### GENERAL PRACTICAL

1. Collection, isolation and population study of microorganism in air, water and soil
2. Handling of meteorological data recording equipment
3. Air pollution sampling, monitoring and analysis by High Volume Sampler
4. Measurement of noise level
5. Laboratory Note book and *Viva-voce*:

15 marks

## SECOND SEMESTER

ENVIRON –206  
Time of Examination: 4hrs

Marks: 50

### GENERAL PRACTICAL

1. Impact of agrochemicals on hydrophytes, xerophytes and mesophytes
2. Effect of pesticides on opening and closing of stomata of different crops
3. Effect of pesticides on total sugar content of different crops
4. Effect of pesticides and heavy metals on total protein content of different crops and aquatic vertebrates
6. Laboratory Note book and *Viva-voce*:

15 marks

## THIRD SEMESTER

[General Paper]

ENVIRON –301

No. of Lectures: 40

Marks: 45

Time of Examination: 3hrs

### ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL LAWS

- I Environmental Impact Assessment:** Concept and evolution/ origin of EIA; principle and characteristics of different EIA processes and their relationship; Environmental Impact Statement (EIS); environmental accounts, evaluation, audit and assessment; EIA and sustainable development; EIA guidelines 1994; Notification of GoI; Revised notification, Sept. 2006.
- II EIA techniques and methods:** Evaluation of methodologies, different methods -- Ad Hoc, Checklist, Overlay, Matrix, use of Computers & expert system; EIA and planning and management; global scale and transboundary IA; prediction and assessment of impacts on the air, surface water, soil, and noise environment; Strategic Environmental Impact Assessment System-an overview; Environmental Audit System.
- III Environmental modeling methods and future development of EIA Process**
- IV Environmental protection** – issues and problems; International and National efforts for Environment Protection; Provisions in constitution of India regarding Environment (Article 48A and 58A); Environmental Policy Resolution, Legislation and Public Policy Strategies in Pollution Control; Wildlife Protection Act, 1972 amended 1991; Forest Conservation Act, 1980, Indian Forest Act, (revised) 1982; Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and Control of Pollution) Act, 1974 as amended up to 1988; The Environment (Protection) Act, 1986 and Rules 1986; Scheme of labeling of environmental friendly products (Ecomark); Public Liability Insurance Act, 1991 and Rules 1991; Role of Supreme Court and Green Bench of High Court on environment protection in India; Role of NGOs in environmental protection in India; Acts and rules-CRZ & CMZ; 1991

#### Suggested readings

1. *Environmental and social impact assessment and introduction*, C. J. Barrow.
2. *Environment & Pollution Law Manual*, S. K. Mohanty, Universal Law Publisher Ltd. New Delhi.

## THIRD SEMESTER

[General Paper]

ENVIRON – 302

No. of Lectures: 40

Marks: 45

Time of Examination: 3hrs

### ENVIRONMENTAL ECONOMICS & ENVIRONMENTAL MANAGEMENT

- I. Environmental Economics:** Concept of ecological economics; environmental economics and principles; cost-benefits analysis; the economics of environmental quality; measuring environmental values; Polluter pays Principles; precautionary principle and compensation principle; trade and environment; externalities
- II. Resource Conservation and Management:** Concept of resources; resource taxonomy; exhaustive resources and renewable and recyclable resources; resource management and conservation principle and ways; conservation strategies
- III. Environmental Management System:** Environmental system principles, tools and management strategies; different Environmental management systems; perspectives of environmental management policy in India, ISO Systems & certification procedure
- IV. Natural disaster management:** IDNDR viewpoint; disaster studies – Indian scenario; role of information science and technology for natural disaster reduction; natural disaster mitigation *vis-à-vis* risk and vulnerability
- V. Waste management:** Types, sources and generation of wastes, their characterization, chemical composition; methods of disposal and management of wastes (Municipal, Bio-medical, and Hazardous e-waste); recycling of waste materials

#### Suggested readings

1. Uberoi, N K 1999 Environmental Management, New Delhi Publ. Excel Books
2. The Earthscan reader in Environmental economics, Markandya, A. 1992
3. Coping with Natural Hazards : Indian Content , K.S. Valdiya, Orient Longman.

## THIRD SEMESTER

[General Paper]

ENVIRON – 303  
No. of Lectures: 40

Marks: 45  
Time of Examination: 3hrs

### EMERGING ENVIRONMENTAL PROBLEMS, HEALTH HAZARDS & GENETIC ENGINEERING

**I Emerging Environmental Problems:** Environmental problems in developing countries – High-rise buildings, urban slum. sanitation problems  
Green house gases and global warming, carbon trading and sequestration; ozone depletion and its impact on global climate; temperature inversion; nuclear winter-concept and prediction.

**II Environmental health and health hazards:** Concept of health and disease; principles of epidemiology; epidemiology of communicable diseases *viz.*, Leprosy, Cancer, Malaria, Tuberculosis, AIDS etc; communication for health education; health planning and management

**III Principle of genetic engineering:** Concept, cell cycles, gene cloning; genetics responses of microorganisms with reference to pollutants; GMO and its merits and demerits; conservation of gene resources; recombinant DNA technology and its applications and limitations; Nif gene and biological nitrogen fixation; intellectual property rights and intellectual property protection

**IV Environmental mutagenic and genetic disorders;** Mutagenesis mechanism: UV-induced (cyclobutane type pyrimidine dimmers), single strand DNA breaks, chemical induced DNA alkylation, adduct formation, intra and inter-strand cross-linking; enzyme mediated photorepair and excision repair

#### Suggested Readings

1. **Global Environmental Governance** By James Gustave Speth and Peter M. Haas  
Washington, DC: Island Press, 2006. 179pp. ISBN: 1-59726-081-9, \$40
2. **The Environment in Asia Pacific Harbours** Eric Wolanski, ed. New York: Springer, 2007. 498 pp. ISBN: 978-1-4020-6566-8, \$99
3. **Human Genetic Engineering: A Guide for Activists, Skeptics, and the Very Perplexed**, by Shanks, Peter Nation Books, 06/2005, Paperback, \$16.95
4. **Genetic Engineering, Food and our Environment** Luke Anderson, Chelsea Green, 1999, \$7.95

## THIRD SEMESTER

[Special Paper]

ENVIRONS – 304  
No. of Lectures: 40

Marks: 45  
Time of Examination: 3hrs

### GIS & REMOTE SENSING

- I Concept of map, coordinate and projection:** Classification of map; map scale; spatial referencing system; map projections; commonly used map projections; grid systems
- II Basic principles of remote sensing-:** Electromagnetic remote sensing process; physics of radiant energy ; energy source sources and radiation principles; energy interactions in the atmosphere; energy interaction with earth surface materials; an ideal remote sensing system
- III Remote sensing platforms and sensors:** Satellite system parameters; resolutions; imaging sensor systems- active and passive; different types of satellite with special emphasis on Indian remote sensing satellites
- IV Digital image processing:** Basic character of digital image; image classification- supervised and unsupervised
- V Fundamentals of GPS and GIS and Integration of Remote Sensing and GIS**
- VI Environmental Application of Remote sensing and GIS:** Land use/land cover mapping; agricultural, water resource , disaster management and forestry application

#### ***Suggested Reading:***

1. *Remote sensing of urban environment*, B. S. Sokhi, S. M. Rashid, Manak Publication (pvt.) Ltd.
2. *Remote sensing and image interpretation*, Lilles and Kiefer, 3<sup>rd</sup> Edition, John Wiley & Son Inc., NY.
3. *Text book of Remote Sensing and Geographical Information System* , M. Anji Reddy , BS publications
4. *Remote Sensing principles and Applications*, Dr. B. C. Panda. Viva Books pvt. Ltd.



### **THIRD SEMESTER**

ENVIRON – 305  
Time of Examination: 4hrs

Marks: 50

#### **[GENERAL PRACTICAL]**

- I Analysis of environmental data and their computer handling
- II Characterization of wastes and waste water: MLSS;MLVSS
- III Identification(with characters) of some parasitic and other pathogenic diseases.
- IV Preparation of report (case studies on EIA)
- V Bacterial transformation experiments
- VI Study of chromosome-Allium and Drosophila

### **THIRD SEMESTER**

ENVIRON – 306  
Time of Examination: 4hrs

Marks: 50

#### **[SPECIAL PRACTICAL]**

- I. Digital image processing: Raw image data reading; image enhancement technique; histogram equalization technique ;FCC and spectral signature of earth features
- II. Georeferencing and mosaicking of image
- III. Image subset and export
- IV. Classification of image- supervised and unsupervised
- V. Digitization and different types of vector layer generation
- VI. Cartographic representation

## FOURTH SEMESTER

[General Paper]

ENVIRON – 401

No. of Lectures: 40

Marks: 45

Time of Examination: 3hrs

### BIODIVERSITY CONSERVATION & SUSTAINABLE DEVELOPMENT

- I Biodiversity:**  $\alpha$   $\beta$ ,  $\forall$  biodiversity; genetic species and ecosystem diversity; Biological diversity and biogeography; biological productivity – succession and restoration; ‘Hotspots’ of biodiversity; strategies for biodiversity conservation and Agenda-21; ex-situ and in-situ conservation; Biodiversity acts of India; National biodiversity authority; Indian board on Wildlife; convention on biodiversity; value of biodiversity; Phytogeographical and Zoogeographical regions of India.; IPR and IPP in biodiversity.
- II Sustainable development :** overview, sustainable management practices in agriculture, forestry, aquaculture, industrial development, urban development
- III Bioremediation:** Concept. Practices and applications; microbial process of bioremediation; phytoremediation factors influencing bioremediation; ex- situ bioremediation of contaminated soil; microbial removal of nitrogen and phosphorus; The water hyacinth pond; The algae fish pond, The duckweed pond and the reed beds.

#### Suggested readings

1. *Bioremediation*, Baker, H., and Herson, D. S., McGraw-Hill Publishing Company.
2. *Bioremediation principles*, Eweis, J. B. Ergas, S. J., Chang, D. P.Y. and Schroeder, E. D., McGraw-Hill Publishing Company.

**FOURTH SEMESTER**  
[Special Paper]

ENVIRON – 402  
No. of Lectures: 40

Marks: 45  
Time of Examination: 3hrs

**ENVIRONMENTAL TOXICOLOGY**

- I. Toxic responses:** General toxic responses of cell, organs, nervous system, gastrointestinal tract, liver, kidney, blood, and reproductive system; mechanism of cellular injury; bioaccumulation and biomagnifications of toxicants in ecosystem; toxic responses to different types of plant systems
- II. Toxic agents:** Phytotoxins; animal toxins; Microbial toxin and xenobiotic and their impact.
- III Genetic toxicology:** Types, classes, mode of action, metabolism of chemical carcinogens; mutagenicity, genetic diseases; teratogenicity
- IV Impacts of industrial effluents:** General impacts of some effluents discharged from paper and pulp industry, sugar, distillery, tannery, mining, sponge-iron on ecosystem with special reference to occurrence, environmental sources, biochemical effects, and remedial measures
- V Bioactive substances:** Bioactive substances and their significance in the ecosystem; food additives; synthetic dyes etc
- VI Applied toxicology:** Forensic toxicology, clinical toxicology ; occupational toxicology

**Suggested Readings**

1. *Toxicants in the aquatic ecosystem*, T. R. Crompton, John Wiley & Sons, NY.
- 2.. *Casarett & Doull's Toxicology, The basic Science of poisons*, 2<sup>nd</sup> Den, Editors, J. Doull, C.D. Klaassen, M.O. Amdur, Macmillan Publishing Co. Inc., NY.
3. *Statistics for environmental Biology and Toxicology*, W. W. Piegorsh & A. J. Bailer.

## FOURTH SEMESTER

[Special Paper]

ENVIRON – 403

No. of Lectures: 40

Marks: 45

Time of Examination: 3hrs

### ENVIRONMENTAL BIOTECHNOLOGY

- I Microbes in relation to environment:** virus, bacteria, fungi, algae, lichen, protozoa microbial groups
- II Practical utility of viruses-**Bioinsecticides, phase topping
- III Bacteriology of water and sewage,** Methods for differentiating faecal from Sewage organisms and their characters.
- IV Biotechnological methods:** Pollution detection and abatement
- V Molecular biology in Environmental monitoring** –an overview.
- VI Biosensor in environmental analysis :** Enzyme electrode, immobilized cell biosensor, optical biosensor, ISFET based devices, H<sub>2</sub>O<sub>2</sub> biosensor, microbial biosensor, gas phase biosensor, nanobiosensor, amphoteric biosensor,, environmental application of biosensor
- VII Agricultural biotechnology :** Biofertilizer-types and application in agriculture; biopesticides; biocomposting; integrated pest management-concept, technology involved in agriculture and forestry

#### Suggested readings:

1. Environmental Biotechnology, Eastern book Corporation, Hemant Rawat.2008
2. Environmental Biotechnology, Indian Book.Co.in S.K. Agarwal, 1998
3. Environmental Biotechnology : Principles and Application Springer ( India0 Pvt. Ltd., A. M. Chakraborty, M. Moo-Young and W. A. Anderson ( Ed) 2007.
4. Environmental Biotechnology ( 2<sup>nd</sup> edition ) A. K. Chatterjee, Prentice Hall Of India Pvt. Ltd. New Delhi-110001
5. Environmental Microbiology Biotechnology by New Age International Publishers, 2004 D. P. Singh & S. K. Dwivedi
6. Text Book of Environmental Biotechnology . I. K. International Publishing House Pvt. Ltd. Pradipta Kumar Mahapatra.2006.

## **FOURTH SEMESTER**

ENVIRON – 404  
Time of Examination: 4hrs

Marks: 50

### **[GENERAL PRACTICAL]**

1. Studies on specific physicochemical characteristics of wetlands, wasteland, crop land of your locality
2. Changes in bacterial population in effluents coming from industry
3. Studies on bioassay of wastewater by using lemna
4. Studies on relative water content of leaves under mesophytic, xerophytic and hydrophytic conditions
5. Excursion (Educational tour –Submission of Field Report and field samples)

## **FOURTH SEMESTER**

ENVIRON – 405  
Time of Examination: 4hrs

Marks: 50

### **[SPECIAL PRACTICAL]**

1. Identification of microbes and higher plants involved in Environmental Biotechnology
2. Collection and Identification of floral diversity from crop field
3. Isolation and characterization of nitrogen fixing bacteria from crop field
4. Isolation of root nodules and Quantification of leg- hemoglobin
5. Quantitative estimation of indole acetic acid from plant material.
6. Measurement of ascorbic acid , chlorophyll and phenol in plants
7. Isolation and measurement of DNA and RNA.
8. Assay of toxicity by algal specimens
9. Microbial assessment of water quality
10. Studies on heavy metal toxicity by seed germination and seedling growth test
11. Screening of resistant varieties of crop under drought stress .

## FOURTH SEMESTER

ENVIRON – 405  
Time of Examination: 4hrs

Marks: 50

### [SPECIAL PRACTICAL]

- 1.Measurement of LC<sub>50</sub>/LD<sub>50</sub> and safe concentration of toxicants
- 2.Quantifiative estimation of residual heavy metals in the tissue of aquatic vertebrates with special reference to fish by Atomic Absorbtion Spectrophotometer
- 3.Study on chronic toxicity
- 4.Study on toxicological lesions viz. sistopathological,histochemical
- 5.Study on toxicological response through biochemical tests viz.amylase activity,protease activity etc.
- 6.Study on histochemical localization of heavy metals

## FOURTH SEMESTER

ENVIRON – 406

Marks: 50

### SEMINAR PRESENTATION PAPER

[**Dissertation**/ Term Paper]

Submission of Dissertation paper	40
<i>Viva-Voce:</i>	10

**ENVIRONMENTAL SCIENCE  
THE UNIVERSITY OF BURDWAN**

**M. Sc. SYLLABUS  
SEMESTER SYSTEM**

*Prepared by:-*  
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