

# **Department of Environmental Sciences**

## **Syllabus**

### **M.Sc Environmental Biotechnology**



**Maharshi Dayanand University**  
**Rohtak 124001**

## Choice Based Credit System

**Examination scheme of M.Sc. Environmental Biotechnology (Semester system) w.e.f. the academic session 2011-12**

### SEMESTER-1

S.No.	Course No.	Nomenclature of Paper	Type	L-T-P	Credits	Evaluation Scheme		
						Theory	IA	Total marks
1	ENB-201	Biochemistry	PC	4-0-0	4	80	20	100
2	ENB-202	Environmental Biology	PC	4-0-0	4	80	20	100
3	ENB-203	Analytical Techniques	PC	4-0-0	4	80	20	100
4	ENB-204	Cell and Molecular Biology	PC	4-0-0	4	80	20	100
5	ENV-201	Environmental Toxicology	PE	4-0-0	4	80	20	100
6	ENV-204	Environmental Pollution						
8	ENB-205	Lab Course-I	PC	0-0-20	10			150
9	ENB-206	Seminar-1	PC	0-0-0	1			50

Total Credits: 31

Total Marks: 700

### SEMESTER-2

S.No.	Course No.	Nomenclature of Paper	Type	L-T-P	Credits	Evaluation Scheme		
						Theory	IA	Total marks
1	ENB-207	Immunology	PC	4-0-0	4	80	20	100
2	ENB-208	Biodiversity	PC	4-0-0	4	80	20	100
3	ENB-209	Industrial microbiology & Enzyme Technology	PC	4-0-0	4	80	20	100
4	ENB-210	Biostatistics and Environment Modeling	PC	4-0-0	4	80	20	100
5	ENB-211	Genetic Engineering	PC	4-0-0	4	80	20	100
7	ENV-208 ENV-210 ENV-213	Natural Resources Resource Management Waste water treatment Technology	PE	4-0-0	4	80	20	100
8	ENB-212	Lab Course-II						

Total Credits: 34

Total Marks: 750

**SEMESTER-3**

S.No.	Course No.	Nomenclature of Paper	Type	L-T-P	Credits	Evaluation Scheme		
						Theory	IA	Total Marks
1	ENB-213	Environmental Chemistry	PC	4-0-0	4	80	20	100
2	ENB-214	Fermentation and Downstream Processing	PC	4-0-0	4	80	20	100
3	ENB-215	Tissue culture and Transgenics	PC	4-0-0	4	80	20	100
4	ENB-216	Remote Sensing and Geographical Information	PC	4-0-0	4	80	20	100
5	ENV-219	Elementary concept of Physical Environment	PE	4-0-0	4	80	20	100
6	ENV-220	Environment Impact Assessment						
8	ENB-217	Lab Course-III	PC	0-0-20	10			150
9	ENB-218	Self Study*	-	0-0-0	0			S/US
10	ENB-219	Summer Training Report	PC	0-0-0	1			50

\* Only Qualifying

Total Credits: 31

Total Marks: 700

**SEMESTER-4**

S.No.	Course No.	Nomenclature of Paper	Type	L-T-P	Credits	Evaluation Scheme		
						Theory	IA	Total Marks
1	ENB-220	Environmental Laws	OE	4-0-0	4	80	20	100
2	ENB-221	IPR and Biosafety	PC	4-0-0	4	80	20	100
3	ENB-222	Dissertation	PC	0-0-20	10			250

Total Credits: 18

Total Marks: 450

Grand Total Marks-2600

Grand Total Credits - 114

- The candidate shall be required to undergo Summer Training (4-5 weeks) at the end of II<sup>nd</sup> semester. He/She will be required to submit a comprehensive report before the commencement of the III<sup>rd</sup> next semester examination. The evaluation of the training report will be based on the Seminar/Presentation on the Training Report to be presented by each candidate in the department.
- In First semester, student has the option to take one Programme elective out of ENV-201/ ENV-204.
- In Second semester, student has the option to take one Programme elective out of ENV-208/ ENV-210/ ENV-213.
- In Third semester, student has the option to take one Programme elective out of ENV-219/ ENV-220.
- There is a paper named “Self Study” in third Semester, which will be graded as Satisfactory and Unsatisfactory (S/US).
- In Fourth semester, student has the option to take one Open elective.
- Dissertation will be undertaken by the students in groups under the supervision of Faculty members in the department during the IV<sup>th</sup> semester. Each group of students will make a presentation on their topic, its objectives, significance, methodology and review of literature, to be evaluated externally in terms of quality of written work, experimental work as well as performance in the viva-voce.

**Syllabus**  
**M.Sc Environmental Biotechnology**

**Semester-I**

**ENB- 201 Biochemistry**

**M.M. : 80**  
**Time : 3 Hrs.**

**Note** 1. Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

**Unit - I**

Organisation of Biomolecules, Concept of pH, pK, acids, bases, buffers; Principle and biological application of diffusion osmosis, viscosity and Donnan membrane equilibrium.

Carbohydrates-Structure and classification of carbohydrates, Metabolism of carbohydrates.

**Unit – II**

Amino acids & Proteins: Structure and properties of aminoacids, Types of proteins and their classification. Different levels of structural organization of proteins. Amino acid metabolism, Urea cycle. Nitrogen cycle.

**Unit - III**

Lipids- Structure and functions, Classification of lipids and their biological significance. Essential fatty acids. Hydrolysis of fats, Saponification value, Rancidity of fats, Iodine number and Acid value.

Nucleic Acids- Structure and properties. Nucleosides and nucleotides. Biologically important nucleotides. Catabolism, *de novo*-biosynthesis of purine and pyrimidine nucleotides. Formation of deoxyribonucleotides.

**Unit – IV**

Photosynthesis: Light absorption and energy conversion; Calvin cycle; Hatch-Slack Pathway; Photorespiration. Mitochondrial oxidative phosphorylation: Mitochondrial electron transport chain.

**References :**

1. Biochemistry, 4th edition, by L. Stryer (1995). W.H. Freeman & Co. NY
2. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000)Maxmillan/ Worth publishers.
3. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999) , John Wiley & Sons, NY

## **ENB - 202 Environmental Biology**

Max. Marks : 80

Time : 3 Hours.

**Note:** 1. Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

### **UNIT - I**

Definition, principles and scope of ecology, human ecology and human settlements, evolution, origin of life and speciation, Ecosystem stability-cybernetics and ecosystem regulation, evolution of biosphere.

### **UNIT - II**

Ecosystem structure and functions, abiotic and biotic component, Energy flow, food chain, food web, Ecological Pyramids-types, biogeochemical cycles, ecological succession, Ecads and ecotypes.

### **UNIT - III**

Population ecology- density, natality, mortality, survivorship curves, age distribution, growth curves and models, r & k selection, population interactions- Mutualism, Parasitism, Predator- Prey relations, System Theory and Ecological Model.

### **UNIT - IV**

Earth's major ecosystem - terrestrial and aquatic ecosystem, soil microorganism and their functions, coastal management, criteria employed for disposal of pollutants in marine ecosystem, coastal water system and man-made reservoirs, biology and ecology of reservoirs.

### **References**

1. Basic ecology - E. P. Odum
2. Ecology and field biology - R.L. Smith
3. Ecology - P.D. Sharma
4. Fundamentals of ecology -E.P. Odum
5. Principles of ecology – Rickleff

## **ENB - 203 Analytical Techniques**

Max. Marks : 80

Time : 3 Hours.

**Note :** 1. Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

### **Unit - I**

Principles and application of Spectrophotometry (UV-Visible spectrophotometry), Titrimetry, Gravimetry, Colourimetry, NMR, ESR, Microscopy-phase, light and fluorescence microscopes, Scanning and Transmission electron microscopes.

### **Unit - 2**

Chromatographic techniques (Paper chromatography, thin layer chromatography, ion exchange chromatography, Column chromatography), Atomic absorption spectrophotometry, cytophotometry and flow cytometry, Fixation and staining, Principles and techniques of nucleic acid hybridization and Cot curves, Principle of biophysical method used for analysis of biopolymer structure, Hydrodynamics methods, Plasma emission spectroscopy.

### **Unit - 3**

Electrophoresis, solid and liquid scintillation, X-ray fluorescence, X-ray diffraction. Flame photometry, Gas-liquid chromatography, High pressure liquid chromatography – auto radiography, Ultracentrifugation.

### **Unit- 4**

Methods for measuring nucleic acid and protein interactions, DNA finger printing Molecular markers RFLP, AFLP, RAPD, Sequencing of proteins and nucleic acids, southern, northern, western blotting techniques, PCR polymerase chain reaction.

### **References :**

1. Principles of Biophysical chemistry - Uppadahay -Uppadahay- and Nath.
2. Analytical Techniques - S.K. Sahani

## **ENB–204 Cell and Molecular Biology**

**M.M. : 80**  
**Time : 3 Hrs.**

**Note:1.** Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

### **Unit I**

Cell: An introduction, classification of organisms by cell structure, Structure and functions of cellular organelles. Cell Division: Mitosis and Meiosis, Regulation of cell cycle.

### **Unit II**

Organization of bacterial genome. Structure of eucaryotic chromosomes, DNA/RNA as the genetic material, Mitochondria and chloroplast DNA, DNA reassociation kinetics(Cot curve analysis); Repetitive and unique sequences.

DNA Replication in prokaryotes and eukaryotes. DNA repair mechanisms, Recombination: Homologous and non-homologous; Site specific recombination, Transposons.

### **Unit III**

Prokaryotic Transcription: Mechanism of transcription, Promoters- Constitutive and Inducible, Operators; Regulatory elements.

Eucaryotic transcription: Mechanism of transcription. Post-transcriptional modifications of various RNA species. Transcription in mitochondria and chloroplast.

The Operon: Positive and negative control of transcription, repressor-inducer complex, catabolite repression and attenuation.

### **Unit IV**

Genetic Code, Properties of genetic code, Wobble hypothesis.

Protein Synthesis: Structure of prokaryotic and eukaryotic ribosomes and their role in protein synthesis. Regulation of translation in prokaryotes and eukaryotes. Post translational modifications of proteins.

## **References**

1. Cell Biology- Smith and Wood by Chapman and Hall.
2. Cell Biology: Organelle structure and function, Sadava, D E.(2004) Panima pub., New Delhi.
3. David Freifelder, Essentials of Molecular Biology, Narosa Publishing House.
4. George M. Malacinski, Essentials of Molecular Biology, Jones and Bartlett Publishers.
5. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris-A. Kaiser, Monty Krieger, Mathew P. Scott, S.Lawrence Zipursky, James Darnell, Molecular Cell Biology (Fifth addition), W.H.Freeman and company New York.
6. Genes VII, Lewin, Benjamin (2002) OUP, Oxford.
7. Genomes, 2<sup>nd</sup> ed, Brown, T. A.(2002) John Wiley and sons ,Oxford



**Program Elective**  
**ENV - 201 Environmental Toxicology**

Max. Marks : 80  
Time : 3 Hours.

**Note :** 1. Nine questions will be set in all.  
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight question will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

**Unit - I**

Toxic chemicals in the environment - air, water & their effects, Pesticides in water, Biochemicals aspects of arsenic, cadmium, lead mercury, carbon monoxide, ozone and PAN pesticide.

**Unit - 2**

Mode of entry of toxic substance, biotransformation of xenobiotics detoxification, Carcinogens in air, chemical carcinogenicity, mechanism of carcinogenicity, Environmental carcinogenicity testing.

**Unit - 3**

Insecticides, MIC effects. Concept of major, trace and Rare Earth Element (REE)- possible effects of imbalance of some trace elements

**Unit- 4**

Biogeochemical factors in environmental health,. Epidemiological issues goiter, fluorosis, arsenic poisoning.

**References :**

1. Environmental chemistry - Sodhi
2. Principals of Environmental chemistry - Manhan
3. Environmental hazards & human health R.B. Philip
4. Toxicology - principles & applications - Niesink & Jon devries
5. Parasitology - Chatterjee
6. Preventive & Social medicines – Perk

**Program Elective**  
**ENV - 204 Environmental Pollution**

Max. Marks : 80  
Time : 3 Hours.

**Note**

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

**UNIT - I**

Air pollution- natural and anthropogenic sources of pollution, primary and secondary pollutants, transport and diffusion of pollutants, gas laws governing the behaviour of pollutants in the atmosphere, Methods of monitoring and control of air pollution, SO<sub>2</sub>, NO<sub>x</sub>, CO, SPM.

**UNIT - II**

Water pollution - types sources and consequences of water pollution, physico-chemical and bacteriological sampling, Analysis of water quality, standards, sewage and wastewater treatment and recycling, water quality and standards.

**UNIT - III**

Soil pollution chemical and bacteriological sampling as analysis of soil quality, soil pollution control, industrial waste effluents and heavy metals and their interactions with soil components.

**UNIT - IV**

Noise pollution - sources of noise pollution, measurement and indices, Marine pollution, sources of marine pollution and its control, Effects of pollutants on human beings, plants, animals and climate, air quality standards and air pollution.

**References**

1. Air pollution and control - K.V.S.G. Murlikrishan
2. Industrial noise control - Bell & Bell
3. Environmental engineering -Peary
4. Introduction to environmental engineering and science- Gilbert Masters.

## Semester II

ENB – 207 Immunology

M.M. : 80

Time : 3 Hrs.

**Note:** 1. Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

### Unit I

#### **Immunology- fundamental concepts and anatomy of the immune system**

Innate and acquired immunity; Humoral and cell mediated Immune response; Haematopoiesis; Organs and cells of the immune system, Antigens – antigenic determinants (isotype, allotype and idiotype), immunogens, haptens; Major Histocompatibility Complex, HLA typing.

### Unit II

Immunoglobulins-basic structure, classes and subclasses of immunoglobulins. Organization and expression of immunoglobulin genes, generation of antibody diversity; class switching. Generation of B-Cell and T-Cell Responses : Major histocompatibility complex, Antigen processing and presentation.

Cell mediated immunity: T-cell receptor, T-cell maturation, activation and differentiation.

ADCC; Cytokines-properties, receptors and therapeutic uses;

### Unit III

#### **Antigen-antibody interactions**

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques - RIA, ELISA, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectron microscopy; CMI techniques- lymphoproliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis.

### Unit IV

#### **Immune System in Health and Disease**

Hypersensitive reactions. Auto immunity and immune response to infectious diseases. Tumor immunity. Immune response to transplants. Vaccines, Active and passive immunization, Hybridoma Technology, Monoclonal antibodies, Antibody engineering.

### References

1. William E. Paul, Fundamental Immunology, Wolters Kluwer/ Lippincott Williams & Wilkins.
2. Herman N. Eisen, MD, General Immunology. J.B. Lippincott Company. F.M. Burnet, Immunology. W.H. Freeman and company
3. Jack G. Chirikjian, Plant Biotechnology, Animal cell culture Immunobiotechnology. Jones and Bartlett Publishers.
4. Kuby's Immunology, 5th ed. Goldsby, R A., Kindt, T.J, Osborne, B.A.(2003) W. H. Freeman and company, New York.
5. Essential Immunology, 10th ed Roitt, Ivon; Delves, Peter(2001) Blackwell Scientific Publications Oxford.

## **ENB - 208 Biodiversity**

**Max. Marks : 80**

**Time : 3 Hours.**

**Note :** 1. Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

### **Unit - I**

Biodiversity - definition, hot spots of Biodiversity, strategies for Biodiversity Conservation, National Parks, Sanctuaries and Biosphere reserves, gene pool.

### **Unit - 2**

Aquatic common flora and fauna in India - phytoplankton, zooplankton and macrophytes, terrestrial common flora and fauna in India - forests, endangered and threatened species.

### **Unit - 3**

Strategies for Biodiversity Conservation, cryopreservation, gene banks, tissue culture and artificial seed technology, new seed development policy 1988, conservation of medicinal plants.

### **Unit- 4**

International conventions, treaties and protocols for Biodiversity Conservation, Biodiversity in the welfare of mankind, Species concept, Biological nomenclature theories of biological classification.

### **References :**

1. Global Biodiversity - W.R. L.IUCN
2. Ecology of natural resource - Ramade
3. Ecology - P.D. Sharma

## **ENB – 209 Industrial microbiology and Enzyme Technology**

**M.M. : 80**  
**Time : 3 Hrs.**

### **Note**

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

### **Unit I**

Morphology and cell structure of major groups of microorganisms e.g. bacteria, fungi, algae, protozoa and viruses. Microbial Taxonomy, Classification of Bacteria according to Bergey's manual; Molecular approaches. Current classification of bacteria.

### **Unit II**

Microbial Growth and Metabolism: Growth curve (normal and biphasic) and generation time. Measurement of growth; Nutritional categories of microorganisms; Media Formulation; Sterilization; Microbial growth: Batch, fed-batch, continuous kinetics. Microbial Reproduction, Bacterial recombination: transformation, transduction and conjugation.

### **Unit III**

Industrial Microbiology: Sources, isolation, screening, preservation and maintenance of industrially important microorganisms. Improvement of industrially important microorganisms; use of rDNA technology; selection of mutants.

Process technology for the Production of various Products: Primary metabolites (ethanol, acetone, butanol, citric acid, vinegar). Production of alcoholic beverages (wine and beer). Production of secondary metabolites: Antibiotics, Industrial enzymes. Biopesticides, Microbial proteins, Biofertilizers.

### **Unit IV**

Enzyme Technology- Nomenclature and Classification of enzymes; Enzyme kinetics- Michaelis Menten equations; Coenzymes, Mechanism of enzyme action, acid base catalysis, covalent catalysis proximity and orientation effects. Purification of enzymes. Immobilized enzymes. Application of enzymes in industry, analytical purposes and medical therapy. enzyme/cell electrodes.

### **References**

1. Michael J. Pelczar, Microbiology, Tata McGraw-Hill
2. L.E Casida, JR, Industrial Microbiology, New Age International , PJ Limited, Publisher.
3. Prescott and Dunn, Industrial Microbiology, C BS Publisher and Distributor
4. Process engineering in biotechnology. Jackson, A.T. (1991) Prentice Hall.
6. Manual of Industrial Microbiology and Biotechnology 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.

## **ENB - 210 Biostatistics and Environmental modeling**

**Max. Marks : 80**

**Time : 3 Hours.**

**Note:** 1. Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

### **UNIT - I**

Measurement of central tendency - mean (Geometric and Harmonic), median, mode, Measurement of dispersion moments, standard deviation, skewness and kurtosis, Correlation and linear regression of one independent variable, Basic laws and concepts of probability

### **UNIT - II**

Definition of random variable, density function, Basic concepts of binomial and normal distributions. Sampling measurement and distribution of attributes, moments, matrices and simultaneous linear equations, tests of hypothesis and significance.

### **UNIT - III**

Role of modelling in environmental sciences, Model classification deterministic models, stochastic models, steady state models, dynamic models, different stages involved in model building. Simple microbial growth kinetics monod equation, methods for formulation of dynamic balance equations mass balance procedures.

### **UNIT - IV**

Models of population growth and interactions Lotka Volterra model, Leslie's matrix model, Point source stream pollution, Box model, Gaussian plume model, Linear, simple and multiple regression models, validation and forecasting.

### **References**

1. Dynamics of Environmental Bioprocesses-Modelling and simulation-Snape and Dunn.
2. Environmental Modeling – Jorgensen

## **ENB – 211 Genetic Engineering**

**M.M. : 80**  
**Time : 3 Hrs.**

### **Note**

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

### **Unit I**

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization.

### **Unit II**

Cloning Vectors: Plasmids, Bacteriophages, Phagemids, Insertion and Replacement vectors, Cosmids, Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/baculo & retroviral vectors; Expression vectors, Plant based vectors, Ti and Ri as vectors.

### **Unit III**

Cloning Methodologies: Insertion of Foreign DNA into Host Cells, Introduction of DNA into mammalian cells, cDNA and genomic libraries, Yeast two hybrid systems, Phage display. PCR and types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products. PCR in molecular diagnostics: Viral and bacterial detection; PCR based mutagenesis, Mutation detection.

### **Unit IV**

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; siRNA technology; Principle and application of gene silencing, Gene knockouts and Gene Therapy Somatic and germ-line therapy- *in vivo* and *ex-vivo*; Suicide gene therapy.

### **References**

1. David P. Clark, Nanette J Pazdernik, Biotechnology Applying the Genetic Revolution, Elsevier.
2. Jack G. Chirikjian, Genetic Engineering Mutagenesis Separation Technology, Jones and Bartlett Publishers.
3. U. Satyanarayana, Biotechnology, Books and ALLIED (p) Limited.
4. Michael P. Tombs, Biotechnology and Genetic Engineering Reviews volume 10. Intercept.
5. Danniell L. Hart, Elizabeth W. Jones, essential Genetic (Second Edition) Jones and Bartlett Publishers.
6. E Johansen Nange, Arthur P Nange, Basic Human Genetics (Second Edition) Sinauer Association, Ins Publisher Sunderland, Massachusetts.

**Program Elective**  
**ENV - 208 Natural Resources**

Max. Marks : 80  
Time : 3 Hours.

**Note**

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

**UNIT - I**

Sun as a source of energy, solar radiations and its spectral characteristics fossil fuels classification, composition, physico- chemical characteristics and energy content of coal, petroleum and Natural gas.

**UNIT - II**

Principles of generation of hydroelectric power, tidal power, thermal energy conversion, wind, geo thermal energy, solar collectors, photovoltaic, solar ponds, oceans.

**UNIT - III**

Nuclear energy- fission and fusion, bio energy -energy from biomass and biogas, anaerobic digestion, energy use patterns in different parts of the world. Impacts of large scale exploitation of solar, wind, hydro and ocean energy.

**UNIT - IV**

Mineral resources and reserves, ocean ore and recycling of resources, Environmental impact of exploitation, processing and smelting of Mineral, oceans as need areas for exploitation of Mineral resources.

**References**

1. Living in the environmental - T.J. Miller.
2. Natural resource conservation - Owen & Chiras.
3. Encyclopedia Energy - I & II.



**Program Elective**  
**ENV - 210 Resource Management**

**M.M. : 80**  
**Time : 3 Hrs.**

**Note :** 1. Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

**Unit - I**

Resource management meaning & concept, management of rangelands & watersheds, management of Agricultural system.

**Unit - 2**

Management of waste resources, Management of forests, effects of deforestation. Management of fresh water ecosystem conservation strategies for non-renewable energy resources.

**Unit - 3**

Wildlife Management & conservation efforts for threatened species, Water Management, Ganga Action Plan, Yamuna Action Plan, Environmental priorities in India.

**Unit- 4**

Reclamation & Management of waste lands, soil erosion, soil conservation, rural planning & land use pattern. Sustainable development, urban planning for India, Land use policy for India.

**References :**

1. Natural resources conservation -Oliver Ss. Owen.
2. Living of environment - T.J. Miller
3. Ecology of Natural resources - Ramade
4. Environmental Science- Cunningham Saigo
5. Restoration of degraded lands- J.S. Singh

**Program Elective**  
**ENV- 213 Waste Water Treatment Technology**

**M.M. : 80**  
**Time : 3 Hrs.**

**Note**

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

**Unit-I**

Overview of standards of water quality in relation to public health - Potable and nonpotable water; Methods of water sampling for pollution analysis. Principal forms of Water Pollutants and their sources; Pollution of stream, lakes and phenomenon of eutrophication; Ocean pollution – oil pollution; Ground water pollution and its control; Water pollution prevention.

**Unit II**

Methods of monitoring Pollution; Biological methods; Detection methods for DO, BOD, Pathogen monitoring by heterotrophic plate count; Multiple tube method; Membrane filtration methods; Other emerging techniques such as enzyme detection, hybridization, PCR, Gene probe technology etc.; Strategies for controlling pathogen transfer; Chemical methods- Detection methods for COD, pH, alkalinity, TSS, TDS, Total organic carbon, oil, grease etc.; Biosensors for pollution

**Unit III**

Sewage and waste water treatments systems, Primary, secondary and tertiary treatments, Biological treatments - aerobic versus anaerobic treatments; Environmental pollution control- Bioremediation, Bioaugmentation and Biostimulation; Biofilms in treatment of waste water; Bioreactors for waste water treatments.

**Unit IV**

Physicochemical characteristics and treatment strategies for effluent generated by Distillery and fermentation industry; Fertilizers and pesticide manufacturing industries; Dyes and textile industries; Paper and pulp industries; Tanneries; Pharmaceuticals; Thermal power plants; Food and dairy industries; Iron and steel industries; Organic solvents; Chlorinated minerals and inorganic chemical industries and petrochemicals.

**References**

1. Nicolas P Cherewsinott, Handbook of water and waste water Treatment Technology, Boston Oxford Auckland Johannesburg Melbourne ,N Delhi
2. Frederick W Pontinus, Water Quality and Treatment. American water works Association, MC Graw Hill Inc.
3. S K Agarwal, Water Pollution, APH Publishing Corporation.
4. Ronald L Dooste, Theory and Practical of water and waste water Treatment.
5. Bill T. Ray, Environmental Engineering, PWS Publishing company.

## Semester-III

### ENB - 213 Environmental Chemistry

Max. Marks : 80  
Time : 3 Hours.

#### Note

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

#### UNIT - I

Stoichiometry, Gibb's energy, Chemical potential, Chemical equilibria, acid-base reactions. Solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, Radio nuclides.

#### UNIT - II

Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermochemical and photochemical reactions in the atmosphere.

#### UNIT - III

First law of thermodynamics, enthalpy, adiabatic transformations, second law of thermodynamics, Carnot's cycle, entropy, Gibb's free energy, chemical potential, phase equilibria, Gibb's Donnan equilibrium, third law of thermodynamics, enzymes catalysis, Michaelis/ Menten equation.

#### UNIT - IV

Oxygen and ozone chemistry, Chemistry of air pollutants, Photochemical Smog, Chemistry of water, concept of D.O., B.O.D., and C.O.D, water treatment : Sedimentation, Coagulation, Filtration, tertiary and advanced treatment, redox potential. Inorganic and organic components of soil, nitrogen pathways and NPK in soils.

#### References

1. Environmental Chemistry - G.S. Sodhi
2. Environmental Chemistry - Mannhan
3. Fundamentals of soil science - Henry D. Futh
4. Textbook of limnology - G.A. Cole
5. Environmental Chemistry - Sharma and Kaur

## **ENB - 214 Fermentation and Down-stream Processing**

**M.M. : 80**  
**Time : 3 Hrs.**

**Note:** 1. Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

### **Unit-I**

**Fermentations:** Aerobic and anaerobic, Shake flask, batch and continuous operations. Solid state fermentations. Types of reactor: Batch, plug flow reactor (PFR), continuous stirred tank reactor (CSTR), Fluidized bed reactor, bubble column, air lift fermenter, Packed bed with immobilized enzymes or microbial cells, Trickling filter.

### **Unit-II**

**Unconventional bioreactors:** Gas liquid reactors, hollow fiber reactor, membrane reactor and perfusion reactor for animal and plant cell culture. High Performance Bio Reactors, Reactors for Solid state fermentation.

### **Unit-III**

**Down-stream Processing:** Scope of downstream processing in biotechnology, problems, requirement of purification. Overview of a bioprocess including upstream and downstream processing. Characteristics of biotechnology products, classes of byproducts, physicochemical basis of bioseparation.

### **Unit-IV**

Separation of particulate by filtration, centrifugation, settling, sedimentation, decanting and micro filtration. Primary isolation methods including solvent extraction, sorption. precipitation, ultra filtration, reverse osmosis, super critical fluid extraction, evaporation, super liquid extraction and foam based separation.

**Purification methods:** Fractional precipitation, electrophoresis, electro dialysis and various kinds of chromatography.

### **References:**

1. Principles of fermentation technology, Stanbury, P. F. and Whitaker, A. (1984), Pergamon press.
2. Separation Process Principles, Seader, J.D. & Henley, E.J. (1998) John Wiley & Sons, Oxford.
3. Bioseparation: Downstream Processing for Biotechnology. Belter, P. A.; Cussler E. L. and Hu W. S. (2003) John Wiley & Sons. OXFORD.
4. Multiphase Bioreactor Design. Edited by: Joaquim M.S. Cabral, Manuel Mota, Johannes Tramper (2001) CRC Press.
5. Bioreactor & Ex Situ Biological Treatment Technologies – 5. Allerman Bruce, Allerman Bruce C, Leeson Andrea, (1999). Battelle publisher.

## ENB – 215 Tissue Culture and Transgenics

M.M. : 80  
Time : 3 Hrs.

**Note:** 1. Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

### Unit- I

**Plant Tissue Culture:** Totipotency; Tissue culture media; Direct and indirect organogenesis; Direct and indirect embryogenesis; Cell suspension culture; Micropropagation – shoot tip culture, somatic embryos, artificial seeds; Applications of tissue culture; Embryo culture; Anther culture and dihaploids, Protoplast isolation and fusion, somatic hybridization, Somaclonal variations.

### Unit- II

**Animal Tissue Culture:** Basic techniques of animal cell culture & their applications. Balanced salt solutions and simple growth media. Serum quality and cell culture.

**Preservation and maintenance of animal cell lines:** Cryopreservation and transport of animal germplasm (i.e. semen, ovum and embryos).

### Unit- III

**Transgenic animals Methodology:** Retroviral vector method, DNA microinjection method and engineered embryonic stem cell method. Cloning by nuclear transfer. Yeast artificial chromosome transgenesis. *In Vitro* fertilization and embryo transfer technology.

### Unit- IV

**Gene transfer in plants:** Direct transformation of protoplasts; Transformation by particle bombardment; *Agrobacterium* mediated transformations, Ti and Ri plasmids, T-DNA genes, mechanism of T-DNA transfer; Transgene silencing.

**Transgenics in crop improvement:** Resistance to stresses- disease resistance, herbicide resistance. Oxidative stress, salt stress and fruit ripening. Transgenics for : improved quality, longer life, flower color and shapes, for male sterility, for terminator seed. Transgenic plants as bioreactors. Commercial transgenic crops.

### References:

1. R.H.Smith, Plant Tissue Culture: Techniques and Experiments, Academic Press, San Diego. 1992.
2. M. J. Chrispeels and D.F. Sadava (eds), Plants, Genes and Crop Biotechnology, 2nd Edition, Jones and Barlett Press, 2003
3. J.H. Hammond, P. Mcgarvey, and V. Yusibov (eds), Plant Biotechnology, Springer Verlag, Heidelberg. 2000
4. R. I. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005.

## **ENB - 216 Remote sensing and Geographical Information**

**M.M. : 80**  
**Time : 3 Hrs.**

**Note :** 1. Nine questions will be set in all.

2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

### **Unit - I**

Definition, Introduction and scope of remote sensing. Electromagnetic radiation, atmosphere window, Platforms, Sensors and type of scanning systems. Basic characteristics of sensors; salient features of sensors used in LANDSAT, SPOT and Indian remote sensing satellites.

### **Unit - 2**

Aerial photography- vantage point, cameras, Filters and types of films. Elements of visual image interpretation. Multispectral Remote sensing, Microwave Remote sensing, Photogrammetry - Introduction, Stereo- scopic vision, Projection types.

### **Unit - 3**

Digital image and image structure, Image restoration and image and image enhancement. Image classification. Remote sensing application in Forestry, Ecology and environment, Landuse, Agriculture, soils and geology, Disaster management.

### **Unit- 4**

GIS technology and its uses in environmental science, Hardware and software requirement for GIS. Conceptual model of spatial information, Conceptual model of non spatial information. GPS.

### **References :**

1. Introduction to Environmental remote sensing - Curtis
2. Principles of Remote sensing - Lily and kliffer.
3. Remote sensing of the Environment – Jenson

**Program Elective**  
**ENV - 219 Elementary Concept of Physical Environment**

Max. Marks : 80  
Time : 3 Hours.

**Note**

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

**UNIT - I**

Definition, Principles and scope of Environmental Science. Earth, Man and Environment, Ecosystem, Pathways in Ecosystems, Physico- chemical and biological factors in the Environment.

**UNIT - II**

Geographical classification and zones. Structure and composition of Biosphere. General relationship between landscapes, biomes and climates.

**UNIT - III**

Primary differentiation and formation of core, mantle and crust. Igneous, sedimentary and metamorphic rocks, weathering, erosion, transportation and deposition of earth's material by running water, wind and glaciers.

**UNIT - IV**

Mass and energy transfer across the various interphases, Material Balance, Heat Transfer processes, scales of Meteorology, various kinds of lapse rates, vertical stability of atmosphere, cloud classification & formation.

**References**

1. Ecology - P.D. Sharma
2. Concepts of physical environment- Savinder Singh
3. The Atmosphere- an Introduction- F.K. Lutagens
4. Atmospheric weather and climate - Navarra.

**Program Elective**  
**ENV - 220 Environmental Impact Assessment**

**M.M. : 80**  
**Time : 3 Hrs.**

**Note :** 1. Nine questions will be set in all.  
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question 1 and four by selecting one from each section.

**Unit - I**

Introduction to environment impact analysis, Environmental impact statement and Environmental management plan, ISO14000, EIA guidelines 1994, Notification of Govt. of India.

**Unit - 2**

Impact assessment methodologies, Generalized approach to impact analysis. Case study: EIA of some dam, procedure for reviewing Environmental impact analysis and statement.

**Unit - 3**

Guidelines for Environmental Audit, Baseline information and prediction (land, water, atmosphere, energy), Restoration and rehabilitation technologies.

**Unit- 4**

Risk analysis - definition of risk, Environmental risk analysis, risk assessment and risk management, Basic steps in risk assessment - hazard identification, dose- response assessment, exposure assessment, Risk characterization.

**References :**

1. Environmental Impact Assessment- John Glasson.
2. Methods of Environmental Impact Assessment - Morris and the rivell.
3. Environmental Impact Assessment - L. W. Canter.
4. Chemical principles of Environmental pollution - Lalloway and Ayers.
5. Industrial Environment - Assessment and strategy - S.K. Aggarwal



## **Semester IV**

### **ENB - 220 Environmental Laws**

**Max. Marks : 80**

**Time : 3 Hours.**

#### **Note**

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

#### **UNIT - I**

Scheme of labelling of environmentally friendly products (ecomark). Public liability Insurance Act. 1991. Provision of constitution of India regarding environment (article 48 A & 58A).

#### **UNIT – II**

Environmental policy resolution, legislation, public policy strategies in pollution control. Wild life protection act, 1972 amended 2002. Forest conservation act, 1980. Indian forest act 1927.

#### **UNIT - III**

Air (prevention & control of pollution) Act 1981 as amended by amendment 1987 & rule 1982. Motor vehicle act, 1988, The environment (protection) Act, 1986, rules 1986.

#### **UNIT – IV**

The water (prevention & control of pollution) Act, 1974 as amended by amendment 1978 & rules 1975. Environment protection issues & problems, international & national efforts for environment protection.

.

#### **References**

1. Environmental administration & law - Paras Diwaa.
2. Environmental planning, policies & programs in India - K.D. Saxena.

## **ENB – 221 IPR and Biosafety**

**M.M. : 80**  
**Time : 3 Hrs.**

### **Note**

1. Nine questions will be set in all.
2. Question No. 1 will be objective covering the entire syllabus & compulsory. The remaining eight questions will be set with two questions from each unit. The candidate will be required to attempt five in total, Question I and four by selecting one from each section.

### **Unit I**

**Introduction to Intellectual Property** Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs.

### **Unit II**

**Agreements and Treaties:** GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

### **Unit III**

#### **Patent filing procedures**

National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting, Patent licensing and agreement, Patent infringement.

### **Unit IV**

#### **Biosafety**

Introduction to Biological Safety Cabinets; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Environmental release of GMOs; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

### **References**

1. P. Narayanan, Intellectual Property Laws, Eastern Law House.
2. Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.
3. Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.