SYLLABI AND SCHEME OF EXAMINATION

For

M.Sc. (ENVIRONMENTAL BIOTECHNOLOGY)

(Based on Curriculum and Credit Framework for PG Programs under NEP)

MAHARSHI DAYANAND UNIVERSITY
ROHTAK (HARYANA)

Structure for 2 year Post Graduate Programme

	Semester	Discipline-Specific Courses (DSC)	Skill Enhancement Courses (SEC) / Vocational Courses (VOC)/ Internship	Research thesis/project	Total Credits
	First year of 2 Year PG program (NHEQF Level 6)				
	I	DSC 1 Environmental Biology @ 4 credits DSC 2 Analytical Techniques@ 4 credits DSC 3 Environmental Pollution @ 4 credits DSC 4 Biochemistry @ 4 credits DSC 5 Cell and Molecular Biology @ 4 credits	SEC1 Techniques in Environmental Biotechnology- I @ 4 credits	---	24
	II	DSC 6 Natural Resources@ 4 credits DSC 7 Immunology @ 4 credits DSC 8 Biostatistics & Environmental Modelling @ 4 credits DSC 9 Industrial Microbiology & Enzyme technology @ 4 credits DSC 10 Waste Water Treatment Technology @ 4 credits	SEC2Techniques in Environmental Biotechnology-II @ 4 credits	---	24
Students who exit after first year on completion of 48 credits will be awarded PG Diploma in concerned discipline					
Second year of two year PG program (NHEQF Level 6.5) (STUDENT SHOULD SELECT ANY ONE OPTION FOR THE SECOND YEAR OF 2 YEAR PG PROGRAM)					
Only Course Work					
Option 1	III	DSC 11 Environmental Chemistry@ 4 credits DSC 12 Fermentation and Downstream processing@ 4 credits DSC 13 Environmental Impact Assessment @ 4 credits DSC 14 Tissue Culture techniques @ 4 credits DSC 15 Environmental Microbiology @ 4 credits	SEC 3Techniques in Environmental Biotechnology –III @4 credits		24
	IV	DSC 16 Environmental Laws@ 4 credits DSC 17 IPR& Biosafety @ 4 credits	SEC 4 Environmental data handling and statistics/ Internship* @ 4 credits	---	24

		DSC18 Genetic Engineering@ 4 credits			
		DSC19 Academic Writing@ 4 credits			
		DSC20 Climate Change and Sustainability @ 4 credits			
Course work and Research (Only for students securing ≥75% in first year)					
Option 2	III	DSC 11 Environmental Chemistry@ 4 credits	SEC 3Techniques in Environmental Biotechnology –III @4 credits	---	24
		DSC 12 Fermentation and Downstream processing@ 4 credits			
		DSC 13 Environmental Impact Assessment @ 4 credits			
		DSC 14 Tissue Culture techniques @ 4 credits			
		DSC 15 Environmental Microbiology @ 4 credits			
	IV	--	SEC 4 Environmental data handling and statistics/ Internship* @ 4 credits	Research thesis/project @20 credits	24

Only Research (only for the students who have completed 3 Years Bachelor's Program)

	Semester	Discipline-Specific Courses (DSC)	Skill Enhancement Courses (SEC) / Vocational Courses (VOC)/ Internship	Research thesis/project	Total Credits
Option 3**	III	--	SEC3/Internship* 3 @ 4 credits	20 credits*	24
	IV	--	SEC4/Internship* 4 @ 4 credits	20 credits**	24

Note:

*The students are required to submit a comprehensive report highlighting their learning and takeaways during the internship period duly signed by Internship supervisor from UTD and mentor from internship providing organization. The evaluation of the internship report and viva-voce will be jointly conducted by the Internship supervisor and mentor from internship providing organization. There will be assessment of 30 marks by the mentor, internship report of 40 marks and Viva voce of 30 marks comprising a total of 100 marks.

** The students who opted Option 3 should submit a project report/synopsis comprising of Literature survey, identification of Research Problem, Plan of work, methodology as well as practical work (if any) at the end of 3rd semester and the same will be evaluated by internal and external examiners.

**The students should continue the research work in 4th semester based on the project work/synopsis submitted at the end of 3rd semester. The final thesis/project report will be evaluated by the internal and external examiners.

Structure for 1 year Post Graduate Programme (2nd year of 2 Year PG Program)

	Semester	Discipline-Specific Courses (DSC)	Skill Enhancement Courses (SEC) / Vocational Courses (VOC)/Internship	Dissertation/ Project work	Total Credits
(STUDENT SHOULD SELECT ANY ONE OPTION)					
Only Course Work					
Option 1	I (Semester III of 2 year PG Program)	DSC 11 Environmental Chemistry@ 4 credits DSC 12 Fermentation and Downstream processing@ 4 credits DSC 13 Environmental Impact Assessment @ 4 credits DSC 14 Tissue Culture techniques @ 4 credits DSC 15 Environmental Microbiology @ 4 credits	SEC 3Techniques in Environmental Biotechnology –III @4 credits	---	24
	II (Semester IV of 2 year PG Program)	DSC 16 Environmental Laws@ 4 credits DSC 17 IPR& Biosafety @ 4 credits DSC18 Genetic Engineering@ 4 credits DSC19 Academic Writing@ 4 credits DSC20 Climate Change and Sustainability @ 4 credits	SEC 4 Environmental data handling and statistics/ Internship* @ 4 credits	---	24
Course work and Research					
Option 2	I (Semester III of 2 year PG Program)	DSC 11 Environmental Chemistry@ 4 credits DSC 12 Fermentation and Downstream processing@ 4 credits DSC 13 Environmental Impact Assessment @ 4 credits DSC 14 Tissue Culture techniques @ 4 credits DSC 15 Environmental Microbiology @ 4 credits	SEC 3Techniques in Environmental Biotechnology –III @4 credits	---	24
	II (Semester IV of 2 year PG Program)	--	SEC 4 Environmental data handling and statistics/ Internship* @ 4 credits	Dissertation/ Project work @ 20 credits	24

SCHEME OF EXAMINATION FOR POST GRADUATE PROGRAM IN ENVIRONMENTAL BIOTECHNOLOGY

Type of Course	Nomenclature of Course	Course Code	Credits Distribution			Total Credits	Workload			Total Workload	Marks			
			L	T	P		L	T	P		Theory		Practical	Total Marks
											Internal	External		
Semester I														
DSC 1 @ 4 credits	Environmental Biology	24EVB201DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC 2 @ 4 credits	Analytical Techniques	24EVB201DS02	4	0	0	4	4	0	0	4	30	70	-	100
DSC 3 @ 4 credits	Environmental Pollution	24EVB201DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC 4 @ 4 credits	Biochemistry	24EVB201DS04	4	0	0	4	4	0	0	4	30	70	-	100
DSC 5 @ 4 credits	Cell and molecular biology	24EVB201DS05	4	0	0	4	4	0	0	4	30	70	-	100
SEC1 @ 4 credits	Techniques in Environmental Biotechnology –I	24EVB201SE01	0	0	4	4	0	0	8	8	-	-	100	100
Semester II														
DSC 6 @ 4 credits	Natural Resources	24EVB202DS01	4	0	0	4	4	0	0	4	30	70	-	100
DSC 7 @ 4 credits	Immunology	24EVB202DS02	4	0	0	4	4	0	0	4	30	70	-	100
DSC 8 @ 4 credits	Biostatistics & Environmental Modelling	24EVB202DS03	4	0	0	4	4	0	0	4	30	70	-	100
DSC 9 @ 4 credits	Industrial Microbiology & Enzyme technology	24EVB202DS04	4	0	0	4	4	0	0	4	30	70	-	100
DSC 10 @ 4 credits	Waste Water Treatment Technology	24EVB202DS05	4	0	0	4	4	0	0	4	30	70	-	100
SEC2 @ 4 credits	Techniques in Environmental Biotechnology-II	24EVB202SE01	0	0	4	4	0	0	8	8	-	-	100	100

Type of Course	Nomenclature of Course	Course Code	Credits Distribution			Total Credits	Workload			Total Workload	Marks			Total Marks
			L	T	P		L	T	P		Theory		Practical	
											Internal	External		
Semester III														
SC 11 @ 4 credits	Environmental Chemistry	25EVB203DS01	4	0	0	4	4	0	0	4	30	70	-	100
SC 12 @ 4 credits	Fermentation and Downstream processing	25EVB203DS02	4	0	0	4	4	0	0	4	30	70	-	100
SC 13 @ 4 credits	Environmental Impact Assessment	25EVB203DS03	4	0	0	4	4	0	0	4	30	70	-	100
SC 14 @ 4 credits	Tissue Culture techniques	25EVB203DS04	4	0	0	4	4	0	0	4	30	70	-	100
SC 15 @ 4 credits	Environmental Microbiology	25EVB203DS05	4	0	0	4	4	0	0	0	30	70	-	100
EC 3 @ 4 credits	Techniques in Environmental Biotechnology –III	25EVB203SE01	0	0	4	4	0	0	8	8	-	-	100	100
Semester IV OPTION 1														
SC 16 @ 4 credits	Environmental Laws	25EVB204DS01	4	0	0	4	4	0	0	4	30	70	-	100
SC 17 @ 4 credits	IPR& Biosafety	25EVB204DS02	4	0	0	4	4	0	0	4	30	70	-	100
SC18 @ 4 credits	Genetic Engineering	25EVB204DS03	4	0	0	4	4	0	0	4	30	70	-	100
SC19 @ 4 credits	Academic Writing	25EVB204DS04	4	0	0	4	4	0	0	4	30	70	-	100
SC20 @ 4 credits	Climate change and Sustainability	25EVB204DS05	4	0	0	4	4	0	0	4	30	70	-	100
SEC4/Internship 4 @ 4 credits	Environmental data handling and statistics /Internship	25EVB204SE01 25EVB204IN01	0	0	4	4	0	0	8	8	-	-	100	100
Semester IV OPTION 2														
SEC4/Internship 4 @ 4 credits	Environmental data handling and statistics /Internship	25EVB204SE01 25EVB204IN01	0	0	4	4	-	-	8	8	-	-	100	100
Research thesis/ project @20 credits	Dissertation/Project work	25EVB204PD01	0	0	20	20	-	-	40	40	-	-	500	500

Semester III OPTION 3														
SEC3/ Internship 4 @ 4 credits	Techniques in Environmental Biotechnology –III /Internship	25EVB203SE01 25EVB203IN01	0	0	4	4	-	-	8	8	-	-	100	100
Research thesis/ project @20 credits	Dissertation/Project work	25EVB203PD01	0	0	20	20	-	-	40	40	-	-	500	500
Semester IV OPTION 3														
SEC4/ Internship 4 @ 4 credits	Environmental data handling and statistics /Internship	25EVB204SE01 25EVB204IN01	0	0	4	4	-	-	8	8	-	-	100	100
Research thesis/ project @20 credits	Dissertation/Project work	25EVB204PD01	0	0	20	20	-	-	40	40	-	-	500	500

L: Lecture; T: Tutorial; P: Practical

Syllabi for Post Graduate Program in Environmental Biotechnology

Semester - I

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Environmental Biology	Course Code	24EVB201DS01
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Students would be able to understand the vital connections between plants, animals and the world around them.
CLO 2: Students would learn principle, scope of ecology and ecosystem stability along with its regulation.
CLO 3: Students would be able to analyse the roles of organisms as part of interconnected food webs,populations, communities and ecosystems.
CLO 4:Students would get sufficient knowledge and understand the significance of competition, Predation, dispersal, mortality and survival strategies for changes and fluctuations in population sizes.

Unit 1: Definition, principles and scope of ecology, human ecology and human settlements, evolution, origin of life and speciation, Ecosystem stability-cybernatics and ecosystem regulation, evolution of biosphere.

Unit 2: 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 3: 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 4: Earths 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.

Suggested readings:

1. Odum, E.P. (1983). Basic ecology, Holt-Saunders (Japan)
2. Smith R.L. (1966). Ecology and field biology, Harper & Row
3. Sharma, P.D. (2000). Ecology &Environment, 7th Edition, Rastogi Publications, Meerut.
4. Odum, E.P. (2005). Fundamentals of Ecology, 5th Edition, Cengage Learning Publication.
5. Rickleff (2008). Principles of ecology, W.H. Freeman and Company.
6. J.S. Singh, S.P. Singh and S.R. Gupta. (2008). Ecology, Environment & Resource Conservation. Anamaya Publications.
7. Begon, M., Townsend, C.R. and Herper, J.L. (2005). Ecology: From Individuals to Ecosystems, 4th Edition, John Wiley & Sons
8. Cunningham, W. P. and Cunningham, M. A. (2004). Principles of Environment Science. Enquiry and Applications. 2nd Edition. Tata McGraw Hill, New Delhi
9. Smith, T.M. and Smith, R.L. (2015). Elements of Ecology. 9th Edition, Pearson Benjamin Cummings, USA

Name of Program	**M.Sc. Environmental Biotechnology**	**Program Code**	**ENB2**
Name of the Course	**Analytical Techniques**	**Course Code**	**24EVB201DS02**
Hours per Week	**4**	**Credits**	**4**
Maximum Marks	**70**	**Time of Examination**	**3 hours**

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Understand the design, operational principles and practical applications of modern instrumental methods employed in chemical analysis of environmental samples.

CLO 2: Explain the concept of spectrometry and optical techniques.

CLO 3: Elucidate the working of chromatography, elemental analyser and electrophoresis.

CLO 4: Explain the techniques used for analysis based on DNA and proteins biomolecules.

Unit 1: Principles and application of Spectrophotometry (UV-Visible spectrophotometry), Titrimetry, Gravimetry, Colorimetry, NMR, ESR, Microscopy-phase, light andfluorescence microscopes, Scanning and Transmission electron microscopes.

Unit 2: Chromatographic techniques (Paper chromatography, thin layer chromatography, ion-exchange chromatography, Column chromatography), Atomic absorption spectrophotometry, cyto-photometry and flow cytometry, Fixation and staining, Principles and techniques of nucleic acid hybridization and Cot curves, Plasma emission spectroscopy.

Unit 3: Electrophoresis, solid and liquid scintillation, X-ray florescence, X-ray diffraction. Flame-photometry, Gas-liquid chromatography, High pressure liquid chromatography – autoradiography, 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.

Suggested readings:

1. AvinashUpadhyay, KakoliUpadhyay, NirmalenduNath (2009) Biophysical chemistry: Principles and techniques, Himalaya Publication House.
2. David Freifelder (1976) Physical Biochemistry: Applications to Biochemistry and Molecular Biology, W. H. Freeman and Company, San Francisco.
3. Sambrook and Russell (2007) Molecular cloning A Laboratory Manual 3rd edition Vol. 1, 2, 3, Cold Spring Harbor Laboratory Press.
4. Keith Wilson and John Walker (Eds.) (2010) Principals and Techniques of Biochemistry and Molecular Biology, Edited by, 7th Edition, Cambridge UniversityPress.
5. RajanKatoch (2011) Analytical Techniques in Biochemistry and Molecular Biology, Springer-Verlag New York.

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Environmental Pollution	Course Code	24EVB201DS03
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Students would come to know the air pollution, their sources and behaviour of pollutants in the atmosphere and methods for monitoring air pollution.

CLO2: Students would study about the water pollution including sources and its consequences. They will learn about how to analyse the water quality and the treatment of wastewater.

CLO3: Students would know about soil pollution, analysis of soil quality control of soil pollution and the interaction of these pollutants with soil components.

CLO4: Students would get the sufficient knowledge regarding noise pollution and marine pollution, theirsources and control.

Unit 1: Air pollution- natural and anthropogenic sources of pollution, primary and, transport and diffusion of pollutants, gas laws governing the behaviour of pollutants in the atmosphere, Methods of monitoring and control of air pollution, SO_2, NOx, CO, SPM.

Unit 2: Water pollution - types sources and consequences of water pollution, physic-o-chemicaland bacteriological sampling, Analysis of water quality, standards, sewage and wastewater treatment and recycling, water quality and standards.

Unit 3: 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 4: 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.

Suggested readings:

1. Krishan, K.V.S.G.M. (2015) Air pollution and control. University Science Press.
2. Bell, L.H. and Bell, D.H. (1993) Industrial Noise Control. CRC Press
3. Rao, C.S. (2006) Environmental Pollution Control Engineering. New Age International.
4. Rao, M. and Rao, H.V.N. (2017) Air Pollution. McGraw Hill Education.
5. Gilbert, M. M. and Ela, W.P. (2007) Introduction to Environmental Engineering and Science. Pearson.

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Biochemistry	Course Code	24EVB201DS04
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Explain the various concept of biochemistry and structure and metabolism of carbohydrate
CLO2: Understand the structural organization, metabolism of amino acid and protein.
CLO3: Understand the structure and biological function of lipids and nucleic acid
CLO4: Explain the *de novo*-biosynthesis of nucleotide
CLO5: Knowledge about the concept of photosynthesis and various mitochondrial mechanisms

Unit 1: 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 2: Amino acids & Proteins: Structure and properties of amino acids, Types of proteins and their classification. Different levels of structural organization of proteins. Amino acid metabolism, Urea cycle.Nitrogen cycle.

Unit 3: 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 de-oxyribo-nucleotides.

Unit 4: Photosynthesis: Light absorption and energy conversion; Calvin cycle; Hatch-Slack Pathway; Photorespiration. Mitochondrial oxidative phosphorylation: Mitochondrial electron transport chain.

Suggested readings:

1. Stryer,L.(1995). Biochemistry, 4th edition,W.H. Freeman & Co. New York.
2. Nelson,D.L., and Cox,M. M.(2013).Lehninger Principles of Biochemistry, 6th edition,Maxmillan/ Worth publishers
3. Voet, D., Voet, J.G., and Pratt,C.W.(2016). Fundamentals of Biochemistry, John Wiley &Sons, NY
4. Vasudevan ,D.M.,Sreekumari,S. and Vaidyananthan K.(2016).Textbook of Biochemistry for medical students,8th edition,Jaypee brothers medical publishers(P) Ltd.
5. Satyanarayana,U.(2017). Biochemistry.5th edition,Elsevier India

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Cell and molecular Biology	Course Code	24EVB201DS05
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: By completion of course the student is able to understand life processes at the cellular, sub-cellular and molecular level that occur in and between the cells.
CLO2: Analyze the overall architecture of eukaryotic and prokaryotic genomes along withStructure and function of genes.
CLO3: Correlate the structure of cell, cellular organelles and bio molecules with their functions in plants and animals, thereby enabling their survival.
CLO4: Elucidate the molecular mechanisms by which DNA controls growth, development and morphological traits of organisms.

Unit 1: 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 2: Organization of bacterial genome. Structure of eucaryotic chromosomes, DNA/RNA as the genetic material, Mitochondria and chloroplast DNA, DNA reassociationkinetics(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 3: 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 4: 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.

Suggested readings:

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

Name of Program	**M.Sc. Environmental Biotechnology**	**Program Code**	**ENB2**
Name of the Course	**Techniques in Environmental Biotechnology –I**	**Course Code**	**24EVB201SE01**
Hours per Week	**8**	**Credits**	**4**
Maximum Marks	**100**		

Note: The practical exam of Techniques in Environmental Biotechnology –I will be conducted at the end of semester. The question paper of practical will be prepared by external examiner, total marks of exam will be100.

Course Learning Outcomes (CLO):

CLO1: Students would able to monitor the air pollution.
CLO2: Students would able to measure the organic water pollution. They will learn about how to analyze the water quality.
CLO3: Students would able to estimate soil pollution.
CLO4: Students would get the sufficient knowledge to measure nutrients in water samples.

Experiments

1. To study soil profile of a given area.
2. To determine the organic carbon in the soil sample.
3. To determine the calcium and magnesium in the soil samples.
4. To determine moisture content, water holding capacity, pH and conductivity of the soil samples.
5. To determine the distribution pattern of a plant community.
6. To determine the basal area and dominance of different species in a particular vegetation area.
7. To determine Important Value Index of a given vegetation area.
8. To verify Beer- Lambert's Law of absorption of light.
9. To study absorption spectrum of bromophenol blue as indicator dye at different pH range.
10. To perform paper chromatography of amino acids and calculation of Rf value.
11. Isolation of plant pigments by column chromatography and study their absorption spectrum.
12. To perform agarose gel electrophoresis for separation of nucleic acids.
13. Estimation of carbohydrate by anthrone reagent method.
14. Determination of acid and saponification value of oil/fat.
15. Estimation of amino acid L-proline in the given sample.
16. To measure the length and breadth of the cell by using micro meter.
17. To study Mitosis and the Cell Cycle in Onion Root-Tip Cells.
18. Identification of different stages of meiosis in onion buds
19. To determine the membrane stability index of plant cells.
20. Cell Counting and viability testing of the microbial culture.
21. To perform Gram staining for bacteria.
22. To perform Capsule staining of bacteria.
23. Genomic DNA isolation from the cultured/bacterial cells/plant tissueand its estimation.
24. Isolation and purification of plasmid DNA from bacteria.
25. Isolation of casein protein from milk and its estimation using Folin-Lowry's method.

Semester –II

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Natural Resources	Course Code	24EVB202DS01
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: Students would gain an understanding of the need for using non-renewable sources of energy.
CLO2: Students would get sufficient exposure of solar energy and fossil fuels classification, composition and their characteristics.
CLO3: Students would learn about various renewable energy sources and carbon credits.
CLO4: Students would understand the global energy pattern and impacts of exploitation of renewable energy sources.

Unit 1: 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 2: Principles of generation of hydroelectric power, tidal power, thermal energy conversion, wind, geo thermal energy, solar collectors, photovoltaic, solar ponds, oceans, Soil microorganisms and their functions, Carbon credits

Unit 3: 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 largescale exploitation of solar, wind, hydro and ocean energy.

Unit 4: Mineral resources and reserves, ocean ores and recycling of resources, Environmental impact of exploitation, processing and smelting of Mineral, oceans as need areas for exploitation of Mineral resources.

Suggested readings:

1. T.J. Miller. (2003) Living in the environmental, 5th edition, Brooks/Cole
2. Owen &Chiras (1990), Natural resource conservation, 5th edition, Macmillan USA
3. Encyclopedia of Energy - I & II. (2008), First Edition, Elsevier
4. Craig, J.R., Vaughan, D.J. Skinner, B.J. (1996). Resources of the Earth: Origin, Use, And Environmental Impact, (2nd Ed). Prentice Hall, New Jersey
5. Owen, O.S, Chiras, D.D. &Reganold, J.P. (1998). Natural Resource Conservation – Management For Sustainable Future, (7thEdn.), Prentice Hall.
6. Twidell, I.J. and Tony, W. (2007). Renewable Energy Resources. Taylor and Francis Group.
7. Vaughn Nelson. (2011). Introduction to Renewable Energy. CRC Press

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Immunology	Course Code	24EVB202DS02
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1: To understand the Cells, organs and molecules of immune system
CLO2: To describe Structure and function of antibodies.
CLO3: To understand the experimental aptitude to analyses the antigen antibody interaction
CLO4: To explain the kinetics of antigen and antibody interaction Immunity to infectious agents
CLO5: To knowledge about the various diseases caused by immune system and their importance toward health.

Unit 1: Immunology- fundamental concepts and anatomy of the immune system, Innate and acquired immunity; Humoral and cell mediated Immune response; Haematopoesis; Organs and cells of the immune system, Antigens – antigenic determinants (isotype, allotypeanidiotype), immunogens, haptens; Major Histocompatibility Complex , HLA typing.

Unit 2: 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-CellResponses : 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 3: 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, Apoptotosis.

Unit 4: Immune System in Health and Disease, Hypersensitive reactions.Auto immunity and immune response to infectious diseases.Tumorimmunity.Immune response to transplants. Vaccines, Active and passive immunization, Hybridoma Technology, Monoclonal antibodies, Antibody engineering.

Suggested readings:

1. Goldsby, R. A,,Kindt, T.J., Osborne, B.A. and Kuby,J. I.(2000) Kuby Immunology,4th edition, W H Freeman & Co (Sd).
2. Roitt,I. M. and Delves,P.J(2001).Roitt's essential immunology,10thedition,Blackwell Scientific Publications Oxford.
3. Abbas,A.K.,Lichtman A.H., and Pillai,S.(2014). Cellular and Molecular Immunology,8thedition,Elsevier Health Science
4. Levinson ,W.,Chin-Hong,P.,Joyce,E.A.,Nussbaum,J., and Shwartz,B.(2020).Review of Medical Microbiology and immunology AGuide to clinical infectious diseases.16thedition,McGrew Hill education.
5. Kenneth,M. and Weaver,C.(2017). Janeway'sImmunobiology,9th edition, Garland scienceTaylor and Francis roup,LLC

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Biostatistics and Environmental modelling	Course Code	24EVB202DS03
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Familiarity with the basic knowledge of Biostatistics.
CLO 2: Selection of right choice of sampling method for research purpose.
CLO 3: Acquire skills for formulating research problems and hypotheses.
CLO 4: Identification of appropriate model for research conditions.
CLO 5: Applying right test to a problem to reach a conclusion.

Unit 1: 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 2: Definition of random variable, density function, Basic concepts of binomial and normal distributions. Sampling measurement and distribution of attributes, moments, matricsandsimultaneous linear equations, tests of hypothesis and significance.

Unit 3: 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 4: Models of population growth and interactions LotkaVolterra model, Leslies matrixmodel, Point source stream pollution, Box model, Gaussian plume model, Linear, simple and multiple regression models, validation and forecasting.

Suggested readings:

1. Kothari C.R. (2004). Research Methodology: Methods and Techniques (2nded). New Age International Publishers
2. Rastogi V. B. (2015). Biostatistics (3rded). MEDTECH
3. S.P. Gupta (1978) Elementary Statistical Methods, S. Chand Publications, New Delhi.
4. Spiegel, M.R., Stephens L.J. (2014). Statistics, (5thed) Schaum's outlines, McGraw-Hill Education.
5. Masters, G. M&Ela, W. P (2015). Introduction to Environmental Engineering and Science (3rded). Pearson

Name of Program	**M.Sc. Environmental Biotechnology**	**Program Code**	**ENB2**
Name of the Course	**Industrial Microbiology and Enzyme Technology**	**Course Code**	**24EVB202DS04**
Hours per Week	**4**	**Credits**	**4**
Maximum Marks	**70**	**Time of Examination**	**3 hours**

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO): Students would be able to

CLO 1: Isolate, screen, preserve and maintain microorganisms.
CLO 2: Classify the microorganisms of economic importance.
CLO 3: Optimize the growth conditions of microorganisms depending upon the mode of operation.
CLO 4: Operate and optimize process parameters in a fermenter for producing industrial products.
CLO 5: Purify enzymes from their natural resources and their application in industry, analytical purposes and medical therapy.

Unit 1: 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 2: 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 3: 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 4: Enzyme Technology- Nomenclature and Classification of enzymes; Enzyme kinetics- MichaelisMenten equations; Coenzymes, Mechanism of enzyme action, acid base catalysis, covalent catalysis proximity and orientation effects.Purification of enzymes.Immobilizedenzymes.Application of enzymes in industry, analytical purposes and medical therapy.enzyme/cell electrodes.

Suggested readings:

1. Chan, E.C.S., Pelczar, M. J., Krieg, N.R.(1998) Microbiology 5th Edition, Tata McGraw-Hill Education Pvt. Ltd.
2. L.E Casida, JR, (2019) Industrial Microbiology, New Age International Private Limited..
3. Reed (2004) Prescott and Dunns Industrial Microbiology 4th Edition, CBS Publisher.
4. Jackson, A.T. (1991) Process engineering in biotechnology. Prentice Hall.
5. Baltz, R.H., Arnold L. & Davies, J.E. (Eds.) (2010) Manual of Industrial Microbiology and Biotechnology 2nd Edition, American Society for Microbiology.

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Waste water treatment Technology	Course Code	24EVB202DS05
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO 1: Students would understand the water quality in relation to public health, principal forms of water pollution.

CLO2 Students gain knowledge about Pollution of stream, lakes, Ocean and Ground water pollution and how prevention will be attained.

CLO3 Students get exposure to various techniques used for monitoring pollution along with strategies for controlling pathogen transfer

CLO4 Students gain insight knowledge about primary, secondary and tertiary methods used for treatment of sewage and waste water along with biological methods concerning pollution control.Studentswould be able toassess the waste water.

Unit-1: 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 2: 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 3: 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 4: 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.

Suggested Readings:

1. Handbook of water and wastewater analysis (2007), KanwaljitKaur, Atlantic publishers and distributors (P) Ltd.
2.APHA(2023)StandardMethods FortheExaminationofWater andWastewater, 24thEdition
3. Nicolas P Cherewsinott, Handbook of water and waste water Treatment Technology, Boston Oxford Auckland Johannesburg Melbourne, New Delhi
4. Frederick W Pontinus, Water Quality and Treatment. American water works Association, MC Graw Hill Inc

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Techniques in Environmental Biotechnology-II	Course Code	24EVB202SE01
Hours per Week	8	Credits	4
Maximum Marks	100		

Note: The practical exam of Techniques in Environmental Biotechnology –II will be conducted at the end of semester. The question paper of practical will be prepared by external examiner, total marks of exam will be100.

Course Learning Outcomes (CLO):

CLO 1: Studentswould be able tounderstand the immunological interactions in the human body.
CLO 2: Studentswould be abletomeasurethe antigenic response of the body during infections.
CLO 3: Studentswould be able to understand the processes of fermentation industry.
CLO 4: Studentswouldgetsufficientknowledgeto isolate and purify microbial enzymes.

Experiments

1. To determine the blood group and Rh factor of humans.
2. To determine the titre value of antibodies present in test serum due to the infection of *Salmonella* genus causing entire or typhoid fever by using quantitative tube agglutination test.
3. To study the reaction pattern of an antigen with a set of antibodies by Ouchterlony double diffusion method.
4. To separate lymphocytes from human blood using density gradient media.
5. To term the technique of latex agglutination
6. To determine the antigen concentration in blood serum by sandwich ELISA method.
7. To plot growth curve of bacterial culture and calculate the generation time.
8. Isolation of antibiotic producing microorganisms by crowded plate technique.
9. Isolation of amylase producing microorganisms from soil by serial plate dilution.
10. Batch fermentation for production of alcohol by *Saccharomyces cerevisae*.
11. Citric acid production by *Aspergillusniger*and recovery from fermented broth.
12. Production of extracellular enzyme amylase, its purification and estimation of enzyme activity.
13. To study design of different types of reactors used in the industry.
14. Production of biofertilizers using solid state/submerged fermentation.
15. To locate major renewable energy resources in the map of India.
16. To locate major non- renewable energy resources in the map of India.
17. To identify and locate major renewable and non- renewable resources in the world map.
18. To determine pH, Electrical Conductivity, turbidity, total solids, total suspended solids (TSS) and total dissolved solids (TDS) in given sample of water.
19. Measurement of sodium and potassium using flame photometer in a given water sample.
20. To determine the amount of oil and grease content present in the given water sample.
21. To determine phosphate content in a given sample of water.
22. To determine sulphate content in a given sample of water.
23. Measurement of Nitrate in given water sample using phenol disuphonic method.
24. Measurement of Ammonia in given water sample using nessler's reagent.
25. Measurement of fluoride in the given water sample using ion-selective fluoride meter.
26. To determine the total chlorine (residual) by Iodometric method.
27. To determine the minimum dose of a coagulant required to coagulate a given sample.
28. To study heavy metals present in given waste water sample by Atomic absorption spectrophotometer.
29. To determine Biochemical Oxygen Demand (BOD) of given industrial waste water sample.
30. To determine Chemical Oxygen Demand (COD) of given waste water sample

Semester –III

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Environmental Chemistry	Course Code	25EVB203DS01
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1 Students would understand the basic concept of stoichiometry with reference to chemical equillibria in carbonate system, hydrocarbons and radionuclides.

CLO2 Students would study about chemical processes occurring in atmosphere concerning with the formation of particles.

CLO3 Students would be able to develop experimental aptitude to analyse water quality parameters and treatment methods.

CLO4 Students would learn the chemistry of ozone, air, water quality treatment techniques and sewage and waste water treatment systems.

UNIT - I

Stochiometry, 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, enthalphy, adiabatic transformations, second law ofthermodynamics, Carnot's cycle, entropy, Gibb's free energy, phaseequilibria, 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.

Suggested readings:

1. Fundamental Concepts of Environmental Chemistry - G.S. Sodhi
2. Environmental Chemistry, Ninth Edition- Manahan, Stanley
3. Fundamentals of soil science - Henry D. Futh
4. Textbook of limnology - G.A. Cole
5. Environmental Chemistry - Sharma and Kaur

Name of Program	**M.Sc. Environmental Biotechnology**	**Program Code**	**ENB2**
Name of the Course	**Fermentation and Downstream Processing**	**Course Code**	**25EVB203DS02**
Hours per Week	**4**	**Credits**	**4**
Maximum Marks	**70**	**Time of Examination**	**3 hours**

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1 Students would learn about the conventional and unconventional reactors used in the industry.
CLO2 Students would develop understanding about the process of fermentation in the industries.
CLO3 Students would gain knowledge about the process of biotechnological product synthesis.
CLO4 Students would learn the various separation and purification methods.

Unit 1: Fermentations: Aerobic and anaerobic, Shake flask, batch and continuous operations. Solid state fermentations. Types of reactor: Batch, plug flow reactor.

Unit 2: 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 3: 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 bio-separation.

Unit 4: 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 variouskinds of chromatography.

Suggested readings:

1. Principles of fermentation technology, Stanbury, P. F. and Whitaker, A.
2. Separation Process Principles, Seader, J.D. & Henley, E.J.
3. Bioseparation: Downstream Processing for Biotechnology. Belter, P. A.; Cussler E. L. and Hu W. S.
4. Multiphase Bioreactor Design. Edited by: Joaquim M.S. Cabral, Manuel Mota, Johannes Tramper
5. Bioreactor & Ex Situ Biological Treatment Technologies – 5. Allerman Bruce, Allerman Bruce C, Leeson Andrea.

Name of Program	**M.Sc. Environmental Biotechnology**	**Program Code**	**ENB2**
Name of the Course	**Environmental Impact Assessment**	**Course Code**	**25EVB203DS03**
Hours per Week	**4**	**Credits**	**4**
Maximum Marks	**70**	**Time of Examination**	**3 hours**

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1 Students will able to analyse and document the Environmental impact by understanding the Environmental guidelines in India.

CLO2 Students will able to describe the generalised approach to impact assessment and monitor environmental impact assessment methodologies with reference to case studies.

CLO3 Students will able to learn the baseline information, environmental auditing and land use policy in India.

CLO4 Students will able to examine environmental risk by its assessment and management by understanding the steps involved.

UNIT – I

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

UNIT – II

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

UNIT - III

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

UNIT - IV

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.

Suggested readings:

1. Introduction To Environmental Impact Assessment, 5th edition - John Glasson and RikiTherivel
2. Methods of Environmental Impact Assessment - Morris and the rivel- Peter Morris and RikiTherivel
3. Environmental Imapct Assessment - L. W. Canter.
4. Chemical principles of Environmental pollution - Lalloway and Ayers.
5. Industrial Environment Assessment and Strategy- ShyamKishorAgarwal.

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Tissue culture Techniques	Course Code	25EVB203DS04
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1 Students would be able to explain the role of medium and other condition in plant tissue culture along with different culture types and their application

CLO2 Students would be able to describe the animal tissue culture, preservation and their maintenance.

CLO3 Student would develop the methodologies used in insertion of foreign DNA into animal and discuss on in vitro fertilization and embryo transfer technology

CLO4 Students will be able to explain the various mechanism for making transgenic plants and importance of transgenic plants in crop improvement.

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

Suggested readings:

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, 2ndEdition, 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.

Name of Program	**M.Sc. Environmental Biotechnology**	**Program Code**	**ENB2**
Name of the Course	**Environmental Microbiology**	**Course Code**	**25EVS203DS05**
Hours per Week	**4**	**Credits**	**4**
Maximum Marks	**70**	**Time of Examination**	**3 hours**

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes (CLO):

CLO1 Students would understand microbiology, microbial reactors, and biogas technology.

CLO2 Students would learn about basic concepts of environmental planning and about land use planning and its methods

CLO3 Students would be able to understand the principle and working of Batch culture, continuous culture, and various technologies of biogas production.

CL4 Students would know about the biotransformation, bioconversion, bioremediation and various environmental monitoring techniques through microorganisms.

Unit 1: Microbiology- organisms in nature & their importance, sampling, culture & cultivation of microorganisms, microbes in service of nature & mankind, Batch culture & continuous culture of microbes for commercial use.

Unit 2: Microbial Reactors, genetically modified microbes & their uses in Environmental management recycling & up gradation technologies, Production of products, energy form waste.

Unit 3: Biogas technology, plant design, construction, operation, biogas form organic wastes, water weeds, landfills, microbiology of anaerobic fermentation.

Unit 4: Biotransformation, bioconversion, bioremediation, phytoremediation technology, fermentation technology, development of stress tolerant plants, Environmental problems & Environmental monitoring through microorganism, microbiology of water, air and soil, microbes as pathological agent in plant, animal and man.

Suggested readings:

1. Principles of microbiology - Pelzar
2. Microbial Biotechnology: Fundamentals of Applied Microbiology 2nd Edition-
3. by Alexander N. Glazer and Hiroshi Nikaido
4. Microbial Ecology: Fundamentals and Applications- Ronald M. Atlas and Richard Bartha
5. Molecular biology second edition - H.D. Kumar
6. Environmental Biotechnology for Waste Treatment: Gary S. Sayler, Robert Fox and James Blackburn

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Techniques in Environmental Biotechnology –III	Course Code	25EVS203SE01
Hours per Week	8	Credits	4
Maximum Marks	100		

Note: The practical exam of Techniques in Environmental Biotechnology –III will be conducted at the end of semester. The question paper of practical will be prepared by external examiner, total marks of exam will be100.

Course Learning Outcomes (CLO):

CLO1 Students will understand the applicability of stoichiometry in real world.
CLO2 Students will able to develop experimental aptitude to analyse water quality parameters.
CLO3 Students would be able to visually interpret landset imagery of various geographic regions.
CLO4 Students would learn geo-referencing from toposheet in ERDAS domain.

Experiments

1. To disrupt microbial cells by sonication at different time intervals and to measure the amount of protein released.
2. To study the effect of Increasing speeds and centrifugal times of centrifugation on the settling of the yeast cell particles.
3. To find % protein recovery from precipitation of proteins from the given solution by adding Ammonium sulphate.
4. To produce ethanol by submerged fermentation using Brewer's yeast and its estimation.
5. To isolate the given protein by aqueous two phase extraction and to find the partition Coefficient.
6. Preparation of Murashige and Skoog media for plant tissue culture.
7. Induction of shoot regeneration from chickpea/mungbean cotyledons culture.
8. Induction of roots in vitro regenerated shoots.
9. Transplantation of in vitro regenerated plant in soil and their acclimatization.
10. Preparation of synthetic seed by encapsulation of somatic embryos.
11. To find λmax value of K2Cr2O7 and KMnO4 solution using spectrophotometer.
12. To plot standard curve for Cr(VI) using K2Cr2O7 and to find concentration of Cr(VI) in unknown sample.
13. To determine the concentrations of heavy metals present in the water/soil samples.
14. Environment impact assessment case studies of
    a) Hyrdoelectric Power Project.
    b) Thermal Power Project.
    c) Coal Mining Project.
    d) Oil Refinery.
    e) Ports and Harbours.
    f) Natural Gas Power Plant.
    g) Fertilizer Plant
    h) Nuclear Power Project
    i) Roads and Highways
    j) Railway Project.
15. Isolation and enumeration of microbes from soil sample by serial dilution agar plating method or by viable plate count method.
16. Bacteriological tests for potability of water
    a. MPN, Confirmed and Completed test.
    b. Membrane filter technique

Semester- IV

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Environmental Laws	Course Code	25EVB204DS01
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes:

CLO1 Students would learn eco-friendly techniques i.e. eco-marks and provisions given in the constitution of India regarding environment.

CLO2 Students would be able to describe of environmental policy resolution, legislation and public policy strategies in pollution control with reference to wildlife protection act 1972 and its amendment in 2002, forest conservation act 1980 and India forest act 1927.

CLO3 Students would learn to analyse the environmental issues and problems with national and international efforts for environment protection with special reference to the water (prevention and control of pollution) Act 1974, its amendment 1978 and rules 1975.

CLO4 Students would understand the efforts done at national and international level for environmental protection issues and problems.

UNIT - I

Scheme of lebelling of environmentally friendly products (ecomark). Public liability Insurance Act. 1991. Provision of constitution of India regarding environment [article 48 A &51A(g)].

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.

Suggested readings:

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

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	IPR and Biosafety	Course Code	25EVS204DS02
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes:

CLO1 The students would learn about the different types of Intellectual property and will be motivated for outcome based research.

CLO2 They would become familiar with the international agreements administered by WIPO. They will also understand the impact of signing GATT & TRIPS on the present economic status of the country.

CLO3 The students would learn patent procedures, Patent licensing and agreement system.

CLO4 The students would understand about the safety levels that will help them during their laboratory work while working with microorganisms and hazardous chemicals

CLO5 They would also become familiar with the issues related to environmental release of GMOs.

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.

Suggested readings:

1. Intellectual Property Laws, Eastern Law House - P. Narayanan,
2. Intellectual Property Laws, Allahabad Law Agency 6th edition - Meenu Paul,
3. Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Genetic Engineering	Course Code	25EVS204DS03
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes:

CLO1 Students would be able to explain the role of enzymes and hybridization techniques used in genetic engineering

CLO2 Students would able to elucidate the structure and importance of various types of cloning vector

CLO3 Development of methodologies used in insertion of foreign DNA into host cell and explain the mechanism and function of various types of PCR in molecular diagnostic

CLO4 Students would able to identify the importance of gene Sequencing, gene silencing and gene therapy to human welfare.

Unit-I

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNApolymerase, 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/bacculo& retroviral vectors; Expression vectors, Plant based vectors, Ti and Rias 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.

Suggested readings:

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. Danniel L. Hart, Elizabeth W. Jones, essential Genetic (Second Edition) Jones and Batlett Publishers.
6. E Johansen Nange, Arthur P Nange, Basic Human Genetics (Second Edition) SinauerAssociation, Ins Publisher Sunderland, Massachusetts.

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Academic Writing	Course Code	25EVB204DS04
Hours per Week	4	Credits	4
Maximum Marks	70	Time of Examination	3 hours

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes:

CLO 1: Students will learn about academic writing.
CLO 2: Students will have ideas to identify and avoid plagiarism.
CLO 3: Students will learn writing skills for research papers, reviews, and thesis writing.
CLO4: Scientifically acknowledge different sources of information in their writings

Unit 1: Introduction to Academic writing: Basic rules of academic writing; Importance of report writing in academics and research; Characteristics of educational and research reports/presentations.
Forms of Academic Writing: Abstract writing; summarization; review of literature; scientific poster presentations; reflective, analytic and descriptive reports; book review; film review; tables and graphs in academic papers.

Unit 2: Research paper writing: Types of research papers, Structure of research papers, Research paper formats (Abstract writing, Methodology, Results and discussions), Ways of communicating a research paper.
Writing research proposals: Writing project proposals, Progress/utilization reports, Scientific reports, etc.
Thesis writing: Structure of a thesis, introduction, Literature review, Experimental/computational details, Results and Discussions, Figures and Tables preparation, Conclusions, and future works, Bibliography, Appendices; Usage of line, bar-graphs, charts to describe the results.

Unit 3: Presentation of research : title of the study, aims and objectives; format of research; pagination; grammar, punctuation and the conventions of academic writing: organization of materials; in-text citations; list of works cited; footnotes and endnotes; research findings; Different formats for referencing, bibliography; using standard style.

Unit 4: Plagiarism: Introduction; Tools for the detection of plagiarism; Avoiding plagiarism;
Ethics in Research (Research fraud, competing interest, authorship); Publication ethics: definition, introduction, and importance; Conflicts of interest; Copyright and Ethical issues in paper writing
Databases and research metrics: Databases: Indexing databases, Citation databases (Web of Science, Scopus, etc); Research Metrics (Impact Factor of the journal as per Journal Citation Report, SNIP, SIR, Cite Score & Metrics (h-index, g index, i10 index)

Suggested readings:

1. Chindhade, S. and A. Thorat (2009), An Introduction to Research, Mumbai: Cambridge University Press.
2. Abdul Rahim, F. (2005), Thesis Writing: A Manual for Researchers, New Delhi: New Age International.
3. MLA Handbook for Writers of Research Papers (7th edn. 2009), New York: MLA Association.

Name of Program	**M.Sc. Environmental Biotechnology**	**Program Code**	**ENB2**
Name of the Course	**Climate change and Sustainability**	**Course Code**	**25EVB204DS05**
Hours per Week	**4**	**Credits**	**4**
Maximum Marks	**70**	**Time of Examination**	**3 hours**

Note: Examiner will set nine questions and the candidates will be required to attempt five questions in all. Question number one will be compulsory containing short answer type questions from all units. Further, examiner will set two questions from each unit and the candidates will be required to attempt one question from each Unit. All questions will carry equal marks.

Course Learning Outcomes:

CLO 1: Identify, list environmental, social, and economic impacts of anthropogenic activities and required sustainability framework for mitigation.

CLO 2: Discuss the anthropogenic and natural drivers of climate change and future development aspects for sustainability.

CLO 3: Analyze the impacts of climate change and compare with the future goals of sustainability.

CLO 4: Compare different policies and agreements regarding climate change and developmental goals.

Unit 1: Climatic Systems and Variations: Global Climate System, Causes for Modern Climate & Climate Change Consequences and Challenges: Impacts on Life, Vegetation, Fauna, Glaciers and Ice Sheets Melting, Sea Level Changes, Economics of Climate Change, Climate Change adaptation and Mitigation measures.

Unit 2: Confronting Climate Change: Policies and Efforts

International Response: UNFCCC and Conference of the Parties, Special Reports by IPCC, Kyoto Protocol, Bali Road Map and Agreements, Copenhagen Conference.

National Response: National Action Plan on Climate Change (NAPCC) and 8 National Missions on Climate Change, State Action Plan on Climate Change (SAPCC), National Adaptation Fund on Climate Change (NAFCC), India's Post-2020 Climate Goals, Climate Change Action Programme (CCAP), National Carbonaceous Aerosols Programme (NCAP), LiFE Mission, Global Alliances.

Unit 3: Origins of Sustainable Development: Definition, Evolution and Principles, Brundtland Report, Strategies for Sustainable Development, Sustainability and Human Development, Cultural Elements in Sustainable Development Frameworks, Sustainable Development Goals (SDGs) and Issues, Public Engagement in Sustainable Development.

Unit 4: Environmental Society Governance (ESG) and Sustainability, Corporate Social Responsibility (CSR) Urbanization and Sustainable Cities.

Appropriate Technology and Sustainability Science, Corporate Sustainability, Sustainability Metrics and Indices, Ecological and Carbon Footprint for Sustainability Measurement, Sustainability Measurement and Reporting Tools.

Suggested readings:

1. D. T. Allen and D. R. Shonnard, Sustainability Engineering: Concepts, Design and Case Studies, 1st Edition, Prentice Hall, 2001.
2. H.S. Sharma S. Padmaja and Ganesh Sharma, Climate Change Biodiversity and Green Economy, Concept Publishing Company Pvt. Ltd. (2013).
3. A. S. Bradley, A. O. Adebayo, and P. Maria, Engineering Applications in Sustainable Design and Development, 1st Edition, Cengage Learning, 2015.
4. K. M. Mackenthun, Basic Concepts in Environmental Management, 1st Edition, Lewis Publishers, 1998.
5. Bureau of Energy Efficiency, Energy Conservation Building Code (ECBC), 1st Edition, Bureau of Energy Efficiency, New Delhi, 2007.
6. N. B. Chang, Systems Analysis for Sustainable Engineering: Theory and Applications, 1st Edition, McGraw-Hill Professional, 2011.
7. J. W. Twidell and A. D. Weir, Renewable Energy Resources, 2nd Edition, Taylor & Francis, 2006.

Name of Program	M.Sc. Environmental Biotechnology	Program Code	ENB2
Name of the Course	Environmental Data Handling and Statistics	Course Code	25EVB204SE01
Hours per Week	8	Credits	4
Maximum Marks	100		

Note: The practical exam of Environmental Data handling and Statistics will be conducted at the end of semester. The question paper of practical will be prepared by external examiner, total marks of exam will be100.

Course Learning Outcomes (CLO):

CLO1 Students will learn to handle the data generated in real world.
CLO2 Students will able to apply statistical tools to analyse the experimental data.
CLO3 Students would be able to interpret the results and generate valid conclusions.
CLO4 Students would learn the calculation of various environmental indices used for data reporting

Experiments

1. To measure and analyze noise levels in different environments using sound meter.
2. To measure the concentration of particulate matter (PM10 and PM2.5) in ambient air using air sampler.
3. To analyze and classify solid waste into different categories based on its physical, chemical, and biological characteristics for effective management and disposal.
4. To measure the concentration of sulphur dioxide (SO_2) in ambient air using standard sampling and analysis methods.
5. To measure the concentration of nitrogen oxides (NOx) in ambient air using standard sampling and analysis methods.
6. To perform one-way ANOVA to compare the water quality parameters of different locations.
7. To perform a chi-square test for analyzing the relationship between waste segregation practices.
8. To apply Pearson's correlation on water quality paramters.
9. To assess difference in noise level across various location or time using ANOVA.
10. To measure the concentration of Total Suspended Particles (TSP) in ambient air using standard sampling and analysis method.
11. To measure the concentration of inorganic ions such as sulfates (SO_4^{2-}), nitrates (NO_3^-), and ammonium (NH_4^+) using High Volume Air Sampler.
12. Analyzing biodiversity in a specific area by conducting a field survey to map species distribution with the help of GIS.
13. To analyze how changes in land use (e.g., urbanization, deforestation) affect environmental quality indicators such as air quality, water quality, or biodiversity.
14. To assess how soil quality parameters (e.g., pH, organic matter content, nutrient levels) affect crop yield.
15. To determine the sensitivity of certain environmental parameters (e.g., vegetation growth, water availability) to changes in climate conditions.
16. To apply statistical quality control techniques (e.g., control charts, process capability analysis) to environmental data to monitor consistency and identify outliers.
17. To evaluate vegetation diversity in a given area using the quadrat sampling method and calculate the species richness index.
18. To monitor the heat island effect by recording temperature variations in urban and rural areas using a portable temperature logger.
19. To assess water quality using the Water Quality Index (WQI) by analyzing parameters such as pH, dissolved oxygen, turbidity, and nitrate levels.
20. To perform soil texture analysis using the hydrometer method and classify soils based on the USDA soil texture triangle.