# UNIVERSITY OF MUMBAI

## Syllabus for the M.Sc. Part - II

## Program: M.Sc.
## Course: Life Sciences

## Specialisation:
## Environmental Biotechnology
## [Sem III and IV]

(Credit Based Semester and Grading System with effect from the academic year 2013-2014)

**M.Sc. Part – II Life Sciences Syllabus**
**Restructured for Credit Based and Grading System**
**To be implemented from the Academic year 2013-2014**

**SEMESTER III**

| Course Code | UNIT | TOPIC HEADINGS | Credits | L / Week |
|---|---|---|---|---|
| PSLSCEBTT301 | I | Biomathematics | 4 | |
| | II | Research Methodology | | |
| | III | Biostatistics | | |
| | IV | Population Biostatistics | | |
| PSLSCEBTT302 | I | Foundations of Environment and Ecology | 4 | |
| | II | Ecosystems | | |
| | III | Natural Resources | | |
| | IV | Current global environmental issues | | |
| PSLSCEBTT303 | I | Air pollution | 4 | |
| | II | Water pollution | | |
| | III | Land and Noise pollution | | |
| | IV | Radiation, Thermal pollution, Oil Pollution and Electronic waste | | |
| PSLSCEBTT304 | I | Environmental degradation | 4 | |
| | II | Environmental toxicology | | |
| | III | Environmental microbiology, diversity and systematic | | |
| | IV | Biotechnological methods to control pollution | | |
| PSLSCEBTP301 | Biomathematics and Biostatistics | | 2 | |
| PSLSCEBTP302 | Environment and Natural Resources | | 2 | |
| PSLSCEBTP303 | Environmental Pollution | | 2 | |
| PSLSCEBTP304 | Dissertation on Literature Review | | 2 | |

**SEMESTER IV**

| Course Code | UNIT | TOPIC HEADINGS | Credits | L / Week |
|---|---|---|---|---|
| PSLSCEBTT401 | I | Bioinformatics – I | 4 | |
| | II | Bioinformatics – II | | |
| | III | Intellectual Property Rights | | |
| | IV | Bioethics | | |
| PSLSCEBTT402 | I | Environmental Biotechnology | 4 | |
| | II | Fermentation in environmental biotechnology | | |
| | III | Environmental monitoring | | |
| | IV | Agricultural biotechnology | | |
| PSLSCEBTT403 | I | Biotechnology for industrial and municipal wastes | 4 | |
| | II | Liquid waste management | | |
| | III | Solid waste management | | |
| | IV | Biological Degradation Of Hazardous Wastes | | |
| PSLSCEBTT404 | I | Sustainable technology and biotechnology | 4 | |
| | II | Biofuels | | |
| | III | Natural resource recovery | | |
| | IV | Biotechnology of marine environment | | |

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| **PSLSCEBTP401** | Bioinformatics | **2** | |
| **PSLSCEBTP402** | Environmental Monitoring | **2** | |
| **PSLSCEBTP403** | Waste water analysis and isolation of industrially important microorganisms | **2** | |
| **PSLSCEBTP404** | Dissertation on Project | **2** | |

**M.Sc. Part – II Life Sciences Syllabus**
**Restructured for Credit Based and Grading System**
**To be implemented from the Academic year 2013-2014**

**SEMESTER III DETAILED SYLLABUS**

| Course Code | Title | Credits |
|---|---|---|
| **PSLSCEBTT301** | **Biomathematics / Research methodology / Biostatistics (60L)** | **4** |
| Unit I: **Biomathematics** **(15L)**<br>• Matrices, Rank of Matrices by Diagonalisation method<br>Limit and derivatives, Differentiation (including differentiability), Successive Differentiation and their application in biological research. Integration – Definite and Indefinite; Application of integration to find area and application in biological research.<br>• Differential equations --homogeneous and Linear ODE's and its simple applications to biological problems | | |
| Unit II: **Research Methodology** **(15L)**<br>• Meaning of Research, Objectives of research, motivation in research;<br>• Types of research - Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, Empirical and Other Types of Research;<br>• Research Approaches; Research Methods vs. Methodology;<br>• Research Process: Steps of research process; Criteria of Good Research; Sampling, Sample size determination, Plan for data collection, Methods of data collection, Plan for data processing and analysis;<br>• Ethical considerations during research | | |
| Unit : III **Biostatistics** **(15L)**<br>• **Basics:** Introduction, scope, applications and uses of statistics, census and sampling surveys,<br>• **Data, graphical presentation of data:** collection and tabulation and graphical representation of data, frequency distribution<br>• **Practice of statistical methods** in biological research, Measures of central tendency (grouped and ungrouped data), samples and populations; Central tendency measures: Arithmetic mean, median, dispersion and its measures: variance and standard deviation, coefficient of variation. Standard error. Skewness and kurtosis<br>• Population parameters and sample statistics, sampling techniques: simple random sampling; stratified random sampling, systematic sampling. Estimators of population mean & proportion (without proof), confidence intervals for population mean & proportion. Regression and correlation and its application in biology; types of correlation, correlation coefficient and | | |

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| scatter diagram. | |
| Unit : IV **Population Biostatistics** **(15L)**<br>• Concept of probability, Theories of Probability – addition and multiplication theorems.<br>Random variable and its distribution, Probability distributions – Binomial, Poisson and Normal;<br>• **Test of hypothesis:** Z-test, t-test, $X^2$ test and F test.<br>Difference between parametric and non-parametric statistics.<br>• **Analysis of variance (ANOVA**), one-way ANOVA, Tukey's post hoc test, two-way ANOVA<br>Basic introduction to Multivariate statistics.<br>Non parametric tests: Sign test and Run test. | |

**Practicals:**

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| **PSLSCEBTP301** | **<u>Biomathematics and Biostatistics</u> (60L)**<br>1. Solve sums on derivation and integration related biological data.<br>2. Formation of frequency distribution and calculation of descriptive measures – mean, median, mode, variance, standard deviation and standard error from a given data<br>3. Large and small sample tests for sample mean and proportion<br>4. Calculation of correlation coefficient and regression, coefficients and tests of significance<br>5. ANOVA – one way and two way classification; Estimation of genetic components and heritability from ANOVA data<br>6. Devise a research methodology for the project to be undertaken as the dissertation<br>7. Non Parametric tests: Sums on Sign test and Run test. | **2** | **04** |

| Course Code | Title | Credits |
|---|---|---|
| **PSLSCEBTT302** | **Environmental Sciences (60L)** | **4** |
| Unit I: **Foundations of Environment and Ecology (15L)**<br>• **Environment**: Definitions, Components and Inter-relationships, Parts of environment, Ecology and Ecosystems; Interconnections in nature examples.<br>• **Man Environment relationship and impact of technology**: Agriculture revolution and its impact on the environment; ecosystem imbalance; Impact of sciences and technology on the environment.<br>• **Ecology and ecosystem:** Structure and boundaries of ecosystem, evolution of an ecosystem, value of ecosystem and ecosystem services.<br>• **Food and energy:** First law of thermodynamics and second law of thermodynamics; Producers photosynthesis, consumers and decomposers, role played by decomposers; Food chains and food webs; Ecological pyramid, Pyramid of biomass and disruption of food chain | | |
| Unit II: **Ecosystems (15L)**<br>• **Classification of ecosystems** – different biomes in different region, distribution of biomes, tropical rain forests, temperate forests, coniferous forests, arctic tundra, grasslands and deserts<br>• **Aquatic ecosystems** – oceans, marine ecosystems and open sea, coastal zones, coral reefs and their importance, mangroves, estuaries and coastal wetlands, freshwater life zones<br>• **Evolution of an ecosystem** – habitat and ecological niche, ecosystem as sustainers of life, value of ecosystems and its services. Impact of human activity on the ecosystems<br>• **Biogeochemical cycles:** Cycling elements, water cycle, carbon cycle, nitrogen cycle, phosphorus cycle, sulphur cycle. Impact of human activity on the cycling elements | | |
| Unit : III **Natural resources (15L)**<br>• **Natural resources**: renewable and non-renewable natural resources, destruction and conservation of resources; Mineral resources Biodiversity in India, and Conservation of India's biodiversity. Endangered, Threatened and extinct species of the world<br>• **Water resources:** Availability of water resources, water needs, annual supply of water, water-shortage (reasons and its impact), Water scarcity and its management. Water use – irrigation, domestic, industrial, and miscellaneous; Methods of water conservation | | |

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| • **Forest resources:** classification of forests, forest resources, destruction of forests – natural and manmade, International initiatives in forest conservation, State of forests in India, Local communities and forest conservation in India; Forest (Conservation) Act, 1980<br>• **Energy resources:** Source of our energy, Pattern of global energy use, non-renewable fossil fuels (coal reserves, natural gas, nuclear power), Concerns regarding depletion of oil resources, renewable sources (solar, wind, hydropower, biofuel, fuel cells), Conserving and using energy efficiently. | |
| Unit : IV **Current global environmental issues** **(15L)**<br>• Ozone layer depletion (Montreal protocol), El Nino, Acid rain - causes and effects, Green House Effect global climate change – GHG and green house effect, global warming – effect on oceans, coastline and marine ecosystem, impact of global warming on India. Response to global warming – Kyoto protocol and its outcome<br>• **Population and habitation:** Population explosion – Malthusian theory, distribution and growth of world population;<br>• Environmental implication of population growth and urbanisation in India. International initiatives on population related issues.<br>• **Environmental laws:** The Environment Protection Act, 1986;<br>The Wildlife Preservation Act, 1982; The Wildlife (Protection) Act, 1972;<br>The Biological Diversity Act, 2002;<br>The Biodiversity Rules, 2004; | |

**Practicals:**

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| **PSLSCEBTP302** | **<u>Environment and Natural Resources - I</u>** **(60L)**<br>1. Determination of total organic matter in soil.<br>2. Determination of pH value of different types of soil.<br>3. Determination of water holding capacity of soil.<br>4. To quantify hydrological cycle in different land use types in or around specified premises.<br>5. Case study – El Nino<br>6. Case study – acid rain<br>7. Case study – impact of agriculture on environment<br>8. Biodiversity study | **2** | **04** |

| Course Code | Title | Credits |
|---|---|---|
| **PSLSCEBTT303** | **Pollution (60L)** | **4** |
| Unit I: **Air pollution** **(15L)**<br>• Natural and anthropogenic sources of pollution, Primary and secondary pollutants transport and diffusion of pollutants, Effect of air pollution, control measures for air pollution;<br>• Methods of monitoring and control of air pollution - $SO_x$, $NO_x$, CO, SPM, PAN; Level of air pollution in India.<br>• Ambient air quality in India; The Air (Prevention and Control of Pollution) Act, 1981; Acid rains | | |
| Unit II: **Water pollution** **(15L)**<br>• **Types and sources of water pollution:** marine, fresh and ground water; consequences of water pollution;<br>• Analysis of water quality, sewage and waste water treatment, **Water quality and standards**<br>• **Marine pollution:** environmental effect of oil spills and oil leaks. Coastal pollution, international initiatives to control marine pollution<br>• Eutrophication and monitoring eutrophication; algal blooms The Water (Prevention and Control of Pollution) Act, 1974; | | |
| Unit : III **Land and Noise pollution** **(15L)**<br>• **Soil pollution:** Sources of pollution – water logging, soil salinity, desertification, mining, pollution by plastic, dumping of hazardous and toxic waste.<br>• Recycling solid waste and restoring soil condition<br>• Industrial waste effluents and heavy metal; managing of urban waste in India; Chemical and bacteriological analysis of soil sample, soil sampling methods and procedures<br>• **Noise pollution:** Basic properties of sound waves; loudness and intensity levels, decibel; Sources of Noise Pollution–Measurement and analysis of sound, Measures to control noise pollution. | | |
| Unit : IV **Radiation, Thermal pollution, Oil Pollution and Electronic waste (E-waste)** **(15L)**<br>• **Radiation pollution:** Radioactive decay; Interaction of radiation with matter; Biological impact and health hazards associated with radiation; Radioactive waste disposal.<br>• **Thermal pollution:** Definition and sources, Chemical and biological effects of thermal pollution; Effect on marine life, bacteria and water quality and other aquatic biota; Methods for minimization and control of thermal | | |

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| pollution<br>• **Oil Pollution:** Oil pollution and marine ecology, sources of oil pollution, factors effecting fate of oil after spillage movement, spreading, evaporation, emulsification, dispersion, remote sensing in water quality monitoring<br>• **Electronic waste (E-waste):** Sources and types and constituents of E-wastes and its environmental consequences. | |

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| **Practicals:PSLSCEBTP303** | **<u>Environment and Natural Resources - II</u>**<br>**(60L)**<br>1. Determination of mechanical composition of soil by Pipette method.<br>2. To study the soil profiles for their height, color, texture and electrical conductivity.<br>3. Determination of total nitrogen value of the soil by Kjeldahl's method<br>4. Determination of SAR value of soil. (Sodium Absorption Ratio)<br>5. Isolation of Microorganisms form polluted environment/Soil /Water resources /Air<br>6. Case study – Supersonic jets / Concorde<br>7. Case study – Bhopal Gas tragedy<br>8. Case study – APHA, AWWA | **2** | **04** |

| **Course Code** | **Title** | **Credits** |
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| **PSLSCEBTT304** | **Environmental degradation / toxicology and Biotechnological methods to control pollution**<br>**(60L)** | **4** |
| Unit I: **Environmental degradation** **(15L)**<br>• **Impact of anthropogenic activities of environment:** Land, Water, Air, Forest, Oceans and the coasts;<br>• Biodiversity destruction (flora and fauna); Disturbance of ecological balance United Nations Millennium ecosystem assessment<br>• **Exponential growth:** Four spikes and the reason for spikes, impact and significance of exponential growth,<br>Sustainability of exponential growth,<br>• Ecological balance and ecological footprint | | |
| Unit II: **Environmental toxicology** **(15L)**<br>• Toxic chemicals in the environment (air and water) – their effects and | | |

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| biochemical interactions;<br>• Biochemical aspects of arsenic, cadmium, lead, mercury, carbon monoxide, ozone and PAN pesticide; Mode of entry of toxic substance, its breakdown and detoxification; biotransformation of xenobiotics; Insecticides / Pesticides in environment, MIC effects<br>• Carcinogens in environment, chemical carcinogenicity, mechanism of carcinogenicity, environmental carcinogenicity testing.<br>• Epidemiological issues of toxic compounds and metal poisoning. | |
| Unit : III **Environmental microbiology, diversity and systematic (15L)**<br>• **Environmental microbiology**: Microorganisms in nature and their importance, sampling, culture and cultivation of microorganisms; Microorganisms involved and used in service of nature and humans; GMO and their uses in environmental management<br>• Environmental Problems and environmental monitoring through microorganisms; Microbiology of water, air and soil<br>• Influence of microorganisms on Earth's environment and its inhabitants; Rhizosphere, Phyllosphere, microbial interactions; ecological impacts of microbes; Role of microorganisms in natural and artificial ecosystems<br>• **Microbial diversity:** Classic and modern method Domain and Kingdom classification of microorganisms; Classification of bacteria according to Bergey's manual; Molecular methods of identification of microorganisms – DGGE, TGGE, ARDA, T-RFLP, 16S rDNA sequencing and Database project | |
| Unit : IV **Biotechnological methods to control pollution (15L)**<br>• Biofilters, Bioremediation, Biotransformation and Biodegradation: In situ and Ex situ bioremediation; Evaluating Bioremediation; Bioremediation of VOCs. Factors affecting process of biodegradation;<br>• Methods in determining biodegradability; Contaminant availability for biodegradation; Use of microbes (bacteria and fungi) and plants in biodegradation and Biotransformation;<br>• Phytoremediation: Waste water treatment using aquatic plants; Root zone treatment. | |

**Practicals:**

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| **PSLSCEBTP304** | **<u>Dissertation in Literature Review</u> (60L)**<br>1. Project dissertation of literature review | **2** | **04** |

**SEMESTER IV DETAILED SYLLABUS**

| Course Code | Title | Credits |
|---|---|---|
| **PSLSCT401** | **Bioinformatics and IPR and Bioethics (60L)** | **4** |

Unit I: **Bioinformatics – I** **(15L)**

- **Introduction to Bioinformatics:**
  Definition and History of Bioinformatics, Internet sources for Bioinformatics.
- **Biological databases:**
  (a) Nucleic acid databases **(**NCBI, DDBJ, and EMBL).
  (b) Protein databases (Primary, Composite, and Secondary)
  (c) Specialized Genome databases: (SGD, TIGR, and ACeDB)
  (d) Structure databases (CATH, SCOP, and PDBsum)
- **Alignment problem and solutions:**
  Alignment: Basics and techniques, Local alignment and Global alignment. Pairwise sequence alignment: NEEDLEMAN and Wunsch algorithm, Smith and Waterman algorithm, The Dot Plot, Dynamic Programming Algorithm. Multiple Sequence Alignment (MSA): Definition, Objective, Consensus.
- **Phylogenetic Analysis:**
  Phylogenetic-trees, Terminology of tree-reconstruction, rooted and un-rooted trees. Algorithms /methods of phylogenetic analysis: UPGMA, Neighbor-Joining Method.

Unit II: **Bioinformatics – II** **(15L)**

- **Protein structure analysis and prediction**:
  Identification/assignment of secondary structural elements from the knowledge of 3-D structure of macromolecule using DSSP and STRIDE methods.
  Prediction of secondary structure: PHD and PSI-PRED methods.
  Tertiary (3-D) Structure prediction: Fundamentals of the methods for 3D structure prediction. Homology Modeling, fold recognition, threading approaches, and ab-initio structure prediction methods.
- **Genomics**:
  Basic concepts on identification of disease genes, role of bioinformatics-OMIM database, identification of SNPs, SNP database (DbSNP), SNP arrays.
- **Drug discovery and Development** :
  Introduction to Drug Design and Development, Drug targets, Lead Identification and Modification, Computer-Aided Drug Design, Drug Delivery, Pre-clinical and Clinical Testing
- **Applications Of Bioinformatics**:

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| Pharmaceutical industries, immunology, agriculture, forestry; Biosensing | |
| Unit : III **Intellectual Property Rights** **(15L)**<br>• Introduction to IPR; Types of Intellectual property – Patents, Trademarks, Copyrights and related rights; Traditional vs. Novelty;<br>Importance of intellectual property rights in biology and environmental sciences;<br>• GATT and WTO and IPR provisions under TRIPS;<br>Madrid agreement; Hague agreement; WIPO treaties; Budapest treaty; Indian Patent Act (1970)<br>• **Patents:** Definition, patentable and non-patentable inventions; types of patent application – Ordinary, Conventional, PCT, Divisional, and Patent of addition;<br>• Concept of Prior Art; Precautions while patenting - disclosure / non-disclosure; Time frame and cost;<br>• Patent databases, Patent infringement – meaning, scope, litigation, case studies; Patenting rules in different countries | |
| Unit : IV **Bioethics** **(15L)**<br>• Bioethics: Definition – moral, values, ethics and ethics in biology; Role and importance of ethics in biology;<br>Basic Approaches to Ethics; Posthumanism and Anti-Posthumanism;<br>• Bioethics in healthcare, agriculture, modern biology, biotechnology, animal welfare & right / animals in research, wildlife conservation and management, commercialism in scientific research<br>• Bioethics and cross-cultural bioethics – Autonomy, Rights, Beneficience, Do No Harm, Justice, Confidentiality, Animal Rights, Environmental ethics, Mixed Perception of Benefit & Risk,<br>• Reasoning behind Acceptance or Rejection of Genetic Manipulation, Concerns about Consuming products of GMOs.<br>Past and Present 'Bioethical Conflicts' in Biotechnology- Interference with Nature , Fear of Unknown, Regulatory Concerns, Human Misuse | |

**Practicals:**

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| **PSLSCEBTP401** | **Bioinformatics (60L)**<br>1. Biological Databases with Reference to Expasy and NCBI<br>2. Queries based on Biological databases<br>3. Sequence similarity searching using BLAST<br>4. Pairwise sequence alignment<br>5. Multiple Sequence and Phylogenetic Analysis<br>6. Gene Prediction<br>7. Secondary Structure prediction<br>8. Tertiary Structure Prediction<br>9. Homology Modeling Using Modeller<br>10. Case study – Various Applications of Bioinformatics<br>11. Case study – Bioethics for GMO<br>12. Case study – IPR and India | **2** | **04** |

| **Course Code** | **Title** | **Credits** |
|---|---|---|
| **PSLSCEBTT402** | **Biotechnology in Environmental Science (60L)** | **4** |
| Unit I: **Environmental Biotechnology (15L)**<br>• Role of environmental biotechnology; Scope for use, Market for environmental biotechnology, modalities and local influences,<br>• Integrated approach in environmental biotechnology;<br>• Immobilisation, Degradation or Monitoring of Pollutants from a Biological Origin,<br>• Metabolic Pathways of Particular Relevance to Environmental Biotechnology, | | |
| Unit II: **Fermentation in environmental biotechnology (15L)**<br>• Importance of fermentation in environmental biotechnology Types of bioreactor, design of bioreactor;<br>• Microbial growth kinetics and yield constants; Monod kinetics;<br>• Types of fermentation: Batch, Continuous and Fed-batch system; Continuous culture – types, multistage systems, feedback systems; Comparison of batch and continuous culture – biomass productivity, metabolite productivity, continuous culture and biomass productivity, Fed-batch culture – types and applications<br>• Strain improvement: Methods of strain improvement in fermentation. | | |

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| Chemical and molecular methods of strain improvement, Random and site direct methods of mutagenesis; use of molecular biology for the development of strain to be utilised for fermentation examples with respect to environmental biotechnology | |
| Unit : III **Environmental monitoring** **(15L)**<br>• Definition and environmental monitoring process;<br>Sampling – land (site) sampling, water sampling, air sampling,<br>• Analysis – physical, chemical and biological analysis methods and process<br>Use of microbial population for environmental monitoring – recombinant DNA technology and proteomics<br>• Monitoring pollution; Bioindicators;<br>Biomarkers – biochemical indicators, immunochemistry, genetic indicators;<br>Toxicity testing using biological material<br>Biosensors – mechanism, principle and working<br>• Environment Impact Assessment: EIA complete process, Importance of EIA | |
| Unit : IV **Agricultural biotechnology** **(15L)**<br>• Application of biotechnology in agriculture – Detection and diagnostics, Micropropagation;<br>• Somatic cell genetics – production of callus and suspension cultures, production of protoplasts, somaclonal variation, protoplast fusion, haploid production<br>• Transgenic plants: Production of transgenic plants – complete process, vectors used, transformation methods used; Types of GM Plants and Products obtained from GM Plants, Biopharming, Safety of transgenic crops<br>• Transgenic animals: Production – process, disease control, germplasm and biodiversity | |

**Practicals:**

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| **PSLSCP402** | **Environmental Monitoring** **(60L)**<br>1. Estimation of total solids<br>2. Estimation of volatile solids<br>3. Estimation of cellulose<br>4. Estimation of starch<br>5. Estimation of hemicelluloses<br>6. Estimation of organic carbon – Walkely and Black's method<br>7. Estimation of Potassium<br>8. Estimation of phosphate<br>9. Carry out fermentation using *Saccharomyces spp.* to produce ethanol<br>10. Case study on EIA | **2** | **04** |

| Course Code | Title | Credits |
|---|---|---|
| **PSLSCEBTT403** | **Biotechnology in Waste management (60L)** | **4** |
| Unit I: **Biotechnology for industrial and municipal wastes (15L)**<br>• Waste classification and characterisation, Waste material suitable for Biological treatment,<br>• Wastewater Treatment, BOD Removal, Types of Biological Processes,<br>• Activated Sludge Process, Sludge, Tapered Aeration, Step Feed Aeration, Contact Stabilization, Complete Mix, Extended Aeration, Oxidation Ditch, Anaerobic Digestion<br>• **Sludges,** Desulfurization, Nitrification/Denitrification, Nitrification, Suspended Growth Systems, Attached Growth Systems, Aquatics | | |
| Unit II: **Liquid waste management (15L)**<br>• Waste-treatment system, Sewage-treatment methods;<br>• Design of bioreactors for liquid waste management – activated sludge process, trickling filters, rotating biological contactors, anaerobic treatment of waste water;<br>• Modification of existing processes, removal of nitrogen and phosphorus, sludge removal and disposal, agricultural waste treatment | | |
| Unit : III **Solid waste management organisms (15L)**<br>• Solid waste management – Introduction, Treatment processes for solid wastes, thermal conversion process, biological conversion process,<br>• Landfill and landfill bioreactor for solid waste treatment<br>• Bioremediation: Process of bioremediation; Bioremediation of synthetic compounds, petrochemicals, inorganic wastes;<br>Bioremediation strategies, Phytoremediation and Phyto-technology | | |

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| • Metals bioremediation, Gaseous bioremediation, Biochemical pathways of bioremediation | |
| Unit : IV **Biological Degradation Of Hazardous Wastes (15L)**<br>• Introduction;<br>Abiotic Treatment Techniques: Wastewater Treatment, Liquids-Solids Separation, Chemical Treatment, Physical Methods, Incineration, Wet Air Oxidation, Solidification Techniques,<br>• Biological Control Methods: Land Treatment, Composting, Liquids/Solids Treatment Systems (LSTS) , Soil Biofilters, Wastewater Treatment, Activated Sludge Process, Trickling Over Process, Stabilization,<br>• Degradability: Basis for Biodegradation, Genetics, Testing for Recalcitrance, Aerobic Tiered Testing, Anaerobic Tiered Testing; Testing for Recalcitrance;<br>• Biochemical pathways of hazardous waste remediation: PCB Biodegradation, Landfill Leachate; TCE Degradation, Any Example of biodegradation (Aromatic Hydrocarbon, Chlorinated Wastes, p-Nitrophenol Degradation, Dioxin, Selenium) | |

**Practicals:**

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| **PSLSCEBTP403** | **PRACTICAL VII: Genetics Practicals (60L)**<br>1. Waste water analysis - pH, COD, BOD, Hardness, halides, Total solids, alkalinity and chloride<br>2. Assessment of point of use water purifiers (Zero B) for removal of bacteria and the Bacteriological examination of Water<br>3. Detection and isolation of industrially important microorganisms – lipase producers, oil degraders, antibiotic producers<br>4. Removal of oil spills form soil<br>5. Microbial degradation of textile dyes/pesticides/hydrocarbons and oils<br>6. ETP: Primary, chemical and biological treatment<br>7. Case study – biotransformation<br>8. Case study – bioremediation<br>9. Case study – phytoremediation | **2** | **04** |

| Course Code | Title | Credits |
|---|---|---|
| **PSLSCEBTT404** | **Industrial Environmental Biotechnology (60L)** | **4** |
| Unit I: **Sustainable technology and biotechnology (15L)**<br>• Introduction; Provision of bulk and fine chemicals – plants as a source, microbial production of chemicals, their production process (any example: | | |

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| acetic acid, citric acid, ethanol, glycerol, isopropanol, lactic acid, acrylamide)<br>• Microbial polymers and plastics – process, production and organisms involved;<br>• Industrial process and clean technology: extraction and supply of raw materials; processing of raw material (eg. Enzymes, extremophiles), use and disposal of product | |
| Unit II: **Biofuels** **(15L)**<br>• Finite supply of fossil fuels, emissions from fossil fuels, Greenhouse gases – $CO_2$, Ozone, Sulphur dioxide, their interactions with environment; remediation of the emissions from fossil fuels<br>• Alternative energy sources; Biological energy sources,<br>• Biofuels – generations of biofuels; Combustion of biomass, Biogas, Biodiesel, Ethanol, hydrogen<br>• Biofuels from waste: Methods and processes for utilization of waste for production of fuels, economical and social aspects of waste treatment, Community biogas plant, biogas scheme – scope of rural development, | |
| Unit : III **Natural resource recovery** **(15L)**<br>• Introduction to natural resource recovery<br>• **Oil recovery:** Introduction, Enhanced oil recovery (EOR),<br>• Microbially enhanced oil recovery (MEOR), Microbial biopolymers used in recovery<br>• **Recovery of metals:** Bioleaching – direct and indirect, bioleaching microorganisms, recovery of metals from mining waste; Extraction of – Copper, uranium, gold, etc; Recent developments in natural resource recovery | |
| Unit : IV **Biotechnology of marine environment** **(15L)**<br>• Introduction, Extreme environmental conditions, Marine life forms Role of microorganisms in ocean processes; Biomimetic materials<br>Marine pollution and its control – Biosensors, oil spills and remediation<br>Biofouling and bio-deterioration,<br>• Compounds obtained from marine environment – industrial products and processes, sea and land based cultivation of these pharmaceutical products, Molecular biology products eg. *Thermus aquaticus*, Polymers – eg Polysaccharides, emulsans, polyhydroxyalkanoates, adhesives and melanins;<br>Microalgae – products obtained from microalgae;<br>Marine Genomics and Proteomics | |

**Practicals:**

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| **PSLSCEBTP404** | **Dissertation of Research Project** **(60L)**<br>1. Project studies: presentation and preparation of report of observations and results | **2** | **04** |

## REFERENCES


**PSLSCEBTT301**

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2. Das, S.K., 1986, an Introduction to Research, Kolkata, Mukherjee and Company Pvt. Ltd.
3. Misra R.P., 1989, Research Methodology: A Handbook, New Delhi, Concept Publishing Company
4. Kumar, R., 2005, Research Methodology-A Step-by-Step Guide for for Beginners, (2nd.ed.), Singapore, Pearson Education.
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**PSLSCEBTT401**

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## OVERALL EXAMINATION AND MARKS DISTRIBUTION PATTERN

**Semester III**

| Course | PSLSCEBTT301 | | | PSLSCEBTT302 | | | PSLSCEBTT303 | | | PSLSCEBTT304 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Internal | External | Total | Internal | External | Total | Internal | External | Total | Internal | External | Total | |
| **Theory** | 40 | 60 | 100 | 40 | 60 | 100 | 40 | 60 | 100 | 40 | 60 | 100 | **400** |
| | **PSLSCEBTP301** | | | **PSLSCEBTP302** | | | **PSLSCEBTP303** | | | **PSLSCEBTP304** | | | |
| **Practicals** | - | 50 | 50 | - | 50 | 50 | - | 50 | 50 | - | 50 | 50 | **200** |

**Semester IV**

| Course | PSLSCEBTT401 | | | PSLSCEBTT402 | | | PSLSCEBTT403 | | | PSLSCEBTT404 | | | Grand Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Internal | External | Total | Internal | External | Total | Internal | External | Total | Internal | External | Total | |
| **Theory** | 40 | 60 | 100 | 40 | 60 | 100 | 40 | 60 | 100 | 40 | 60 | 100 | **400** |
| | **PSLSCEBTP401** | | | **PSLSCEBTP402** | | | **PSLSCEBTP403** | | | **PSLSCEBTP404** | | | |
| **Practicals** | - | 50 | 50 | - | 50 | 50 | - | 50 | 50 | - | 50 | 50 | **200** |

## MODALITY OF ASSESSMENT:

**THEORY EXAMINATION PATTERN:**

**A] Internal Examination for Theory: 40 marks**

| No. | Particulars | Marks |
|---|---|---|
| 1. | Active participation in routine Class instructional deliveries | 05 |
| 2. | Overall conduct as a responsible learner, Communication & leadership qualities in organizing related academic activities. | 05 |
| 3. | One seminar based on curriculum to be assessed by the teacher of the institution teaching P.G. learners/ publication of a research paper/presentation of a research paper in seminar or conference | 30 |
| | (a) Selection of the topic, Introduction, write up, references (15) | |
| | (b) Presentation with the use of ICT (15) | |

**B] External Examination - 60 % [Semester End Theory Assessment]: 60 marks**

1. Duration - These examinations shall be of two and half hours duration.
2. Theory question paper pattern:-
   (a) There shall be **five** questions each of **12** marks. On each unit there will be one question & fifth one will be based on all the four units .
   (b) All questions shall be compulsory with internal choice within the questions. Each question will be of **24** marks with options.
   (c) Questions may be sub divided into sub questions **a, b, c & d only, each carrying six marks OR a, b, c, d, e & f only** each carrying **four** marks and the allocation of marks depends on the weightage of the topic.

**PRACTICAL EXAMINATION PATTERN**

**A] Internal Examination:**

There will not be any internal examination/ evaluation for Practicals.

**B] External (Semester end practical examination) per course:**

| No. | Particulars | Marks |
|---|---|---|
| 1. | Laboratory work | 40 |
| 2. | Journal | 05 |
| 3. | Viva | 05 |

**SEMESTER III:**

Practical examination will be held at the college / institution at the end of the Semester.

The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the department, failing which the student will not be allowed to appear for the practical examination.

**Research proposal (Dissertation based on Literature Review):** Candidates are required to present duly certified research proposal (as per the BCUD format) with relevant references (minimum 25) and make the power point presentation of the same for the evaluation by the examiner (the research proposal must be included with literature survey of the selected research topic).

**SEMESTER IV:**

Practical examination will be held at the college / institution at the end of the semester. The students are required to present a duly certified journal for appearing at the practical examination, failing which they will not be allowed to appear for the examination.

In case of loss of Journal and/ or Report, a Lost Certificate should be obtained from Head of the Department/ Co-ordinator of the Department, failing which the student will not be allowed to appear for the practical examination.

**Research Project work (Dissertation based on Research):** Candidates are required t present duly certified dissertation report based on the topic of research along with the laboratory notebook containing raw data and make the poster presentation of the research work for evaluation by the examiner.