AC Item No: 1.2.4
June 29, 2024

SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

M.Sc (Environmental Science)

Sr. No.	Heading	Particulars
1	Title of the course	M.Sc (Environmental Science)
2	Eligibility for admission	A learner who has passed B.Sc. degree Examination of University of Mumbai or any other recognized university is eligible for the entrance examination. The learner must have secured minimum 50% marks (40% for the candidate belonging to reserved category) or equivalent grade at B.Sc examination in Chemistry, Botany, Zoology, Biotechnology, Microbiology, Life sciences, Biochemistry, Geology, Geography, Natural science, Agricultural Science or B.Sc degree with any other subject with Biological Science as one of the subject atF.Y./S.Y. level or B.E. degree of the university of Mumbai or any other University/institute recognised as equivalent or B.Sc in Vocational Course.
3	Passing Percentage	45% marks (40% for the candidate belonging to reserved category)
4	Semesters	Two semesters per year (Semester III)
5	Level	PG
6	Pattern	SEMESTER
7	To be implemented from	From Academic year 2024-25 in a progressive manner

Date: June, 29 2024

Signature:

Dr. Koel Roychoudhury
AC Chairperson

Dr.Jyoti G. Koliyar(Jatinder Das)
Head of the Department

SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

(Affiliated to University of Mumbai)

RE-ACCREDITED GRADE "A" BY NAAC (3rd CYCLE)

BOARD OF STUDIES

SYLLABUS FOR

M.Sc. Environmental Science

(WITH EFFECT FROM THE ACADEMIC YEAR 2024-2025)

PROGRAMME OBJECTIVES:

1. To specialize students in different areas like conservation, ecology, biology and environmental chemistry.
2. To prepare students with the latest knowledge about Impact Assessments.
3. To prepare students with the strong knowledge about Environmental Sciences so that they can be eligible for various positions in educational institution, Industry, governmental and non-governmental organizations.
4. To make the students ready for research and promote them for higher studies.

PROGRAMME OUTCOMES:

PO1: Relate and apply fundamental knowledge of environmental science to factual world problem.
PO2: Analyse, identify and formulate actual services/solutions/applications with environmental requirements.
PO3: Implement, and evaluate environmental – based solution applicable to public health, ecological safety, environmental management and sustainable development considerations.
PO4: Understand management and environmental principles run into need of environmental sectors.
PO5: Select and use existing techniques, skills and tools to solve environmental issues by analyzing the local and global impact on the environment.
PO6: Distinguish a problem; plan a solution for the needs of the society in health, safety and environment applying relevant environmental practice.
PO7: Use of demonstrating techniques to design experiments, by analyzing and interpreting data.
PO8: Recognize the need of constant expertized improvement through lifelong learning.

SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

M. Sc. Environmental Science Programme

(To be implemented from Academic Year- 2024-25)

No. of Courses	Course Code	Semester III	Credits
1	***Major***		
1	M24ES3MJ01	Industrial Hygiene and Health Safety	4
	M24ES3MJP01	Practical's in Industrial Hygiene and Health Safety	*2*
2	M24ES3MJ02	Environmental Biotechnology and Nanotechnology	4
	M24ES3MJP02	Practical's in Environmental Biotechnology and Nanotechnology	2
3	M24ES3MJ03	Instrumentation and Biostatistics	2
2	***Electives(E)(Optional Any One)***		
1	M24ES3E01	Environmental Toxicology	4
2	M24ES3E02	Intellectual Property Rights	4
3	***FP***		
1	M24ES3FP01	Field Project	4
		Total Credits	22

Industrial Hygiene and Health Safety

COURSE CODE : M24ES3MJ01 COURSE CREDIT: 04 (04 theory+02 practical)

1 credit - 15 lectures
1 lecture is 60 minutes

Course Objectives:

1. To understand the concept of Industrial Hygiene.
2. To identify methods of Monitoring of Work Environment.
3. To gain knowledge about Disaster Management Plan and Techniques of Hazard assessment.
4. To understand the concept of Industrial Safety.

Course Outcomes:

1. To discriminate the scope, significance and applications of industrial hygiene.
2. To predict about the monitoring and control measures of Work Environment.
3. To identify causes, impacts, management and control system of various disasters & hazards.
4. To evaluate various kinds of occupational diseases and personal protective equipment used for safety in industries.

Sr. No	Syllabus	No. of lectures
01	**Module-1 Industrial Hygiene** • Industrial Hygiene and Health :- ➢ Physiology of Work, Ergonomics, Occupational Health, Statutory Provisions, Indian Standards, Worked Examples • Occupational environmental stresses:- ➢ Noise: Generation, Perception, Nature & Types of Noise, Effects & Hazards of Noise, Measurement & Evaluation, Statutory Provisions, Indian Standards, Control Methods, Audiometry, Hearing Conservation Programmes, Worked Examples ➢ Vibration: Generation, Nature & types of Vibration, Effects of Vibration, Vibrating Equipment & Measurement, Control Methods, Indian Standards ➢ Illumination: Sight and Light, Purpose & Benefits of Good Lighting, Principles of Illumination, Recommended Standards of Illumination, Types of Light, Sources, Fittings	15

	and Installations, Design of Lighting Installation, Effects of Colour on Safety, Maintenance for Lighting and Colour. ➢ Ventilation and Heat Control: Purpose & Effects of Ventilation and Heat Control, Statutory Provisions, Indian Standards, Thermal Environment and its Measurements, Physiology of Heat Regulation, General Considerations for Ventilation, Types of Ventilation, Control of Heat Exposures, Testing and Maintenance of Ventilation Systems, Worked Examples • Chemical stresses: Toxic chemicals, hazardous chemicals. Flammable chemical, explosive chemicals. etc. Inhalation and ingestion risks. • Measurement of Airborne Contaminants: Dust or aerosols (respirable and non respirable, inhalable and total dust), gases, fumes, vapours, mist and smoke. • Concept of threshold limiting values(concentration), TLVs, time weighted averages (TWAs), short term exposure limits (STELs), minimal national standards(MINAS), International and national regulatory agencies like ACGIH, OSHA.	
02	**Module II- Industrial Work Environment** • Monitoring of Work Environment:- ➢ Identification of contaminants. Sampling strategies: monitoring methods / protocol on procedures. Sampling of airborne contaminants, viz dust, gases, fumes, vapours, mists etc in work place environment and analysis methods for quantification – Instrumental and manual methods. • Notifiable Diseases:- ➢ Pneumoconiosis, Silicosis, Asbestosis, Bagassosis, Byssiniosis. • Work environment control measures:- ➢ Working at Different Levels (Height, Confined Space, Underground, same level), Substitution, isolation, ventilation, local exhaust system and engineering control methods, Safety against Falling Bodies. • House Keeping and Maintenance:- ➢ Meaning of Housekeeping , Statutory provisions, Indian Standards, Housekeeping & Safety , Methods of Good Housekeeping, Management of Good Housekeeping, Japanese Concept of 'Five S', Inspection and Check-lists, Housekeeping of Specific Industries	**15**

03	**MODULE III –Disaster Management and Risk Assessment** • Introduction, definitions, Natural Hazards, nature, causes impacts and occurrences. Earthquakes, volcanic activity, landslides, cyclones, floods, draughts, forest fires; their Mitigation. • Industrial and technological hazards; types and causes of industrial accidents: fire and explosion:- Fire Phenomena, Classification of Fire and Extinguishers, Statutory and other standards, Design for Fire Safety, Fire Prevention and Protection Systems, Explosion Phenomena, Inspection, Maintenance and Training for Fire Protection ,Worked Examples, toxic release and dispersion. • Disaster management:- ➢ Components of disaster management plan, On-site and Off-site emergency plans. • Technical hazards control system- ➢ Safety Appraisal, Analysis and Control Techniques, Plant safety Inspection, Accident Investigation, Analysis and Reporting, Reliability Engineering, Incident reduction, Incident Management. ➢ Techniques of hazards assessment: PHA, HAZOP,HAZAN, MCAA	
04	**MODULE IV- Safety** • Precautions in the processes and operations involving explosives, flammables, toxic substances, dusts, vapours, cloud formation and combating. • Safety precautions for transportation for hazardous chemicals. Handling and storage of hazardous chemicals. Safety in pipelines and colour coding, Safety in chemical industry, Safety in Textile Industry, Safety in Construction Industry, Accidents and unusual occurrences reporting . • Factories Act, Case Law and its amendments •Respiratory personal protective equipment (RPPE)& non respiratory personal protection equipment (NRPPE): - ➢ Need and Limitation, Statutory Provisions, Indian & Other standards, Selection and Classification, Non Respiratory Equipment, Respiratory Equipment, Training, Maintenance, Precaution and Care of PPE , Detection Equipment, PPE Testing Procedures & Standards head protection , ear protection , face and eye protection , hand protection, foot protection and body protection. Quality control of protective equipments.	**15**

Practicals

COURSE CODE	TITLE	CREDITS	HOURS
M24ES3MJP01	Industrial Hygiene and Health Safety	2	30

1. **A. Minor Experiments**
1. Preparation of Material Safety Data Sheet for some common chemicals.
2. To neutralize the given sample using NaOH / HCL/ CaCO3
3. Determination of CO2 from the atmosphere by volumetric method in a workplace Environment.
4. Estimate Noise Levels and Determine L10, L50, L90 by histogram method.
5. Prepare Safety Audit report of Chemical Industry/Textile Industry/Construction Industry.

B. Major Experiments
1. Air sampling of gases (sulphur dioxide, nitrogen dioxide, carbon disulphide, carbon monoxide etc.) and analysis by UV-Visible spectrophotometer.
2. Estimation of sulphur in coal and calculation of release of SO2 on combustion of per ton of coal.
3. Enlisting the characteristics, advantages and disadvantages of PPE and NRPPE of any industry.
4. Preparation of DMP for nuclear power plant, petrochemical industry, fertilizer plant, hydropower station, chemical industry, thermal power plant, textile mill, metallurgical industry

REFERENCES:

1.Fundamentals of Industrial Hygiene-KU Mistry
2. Industrial Hygiene & Chemical Safety - M.H.Fulekar: I. K.International Publishing House, New Delhi.
3. Industrial Hygiene Reference And Study Guide- Allan K. Fleeger, Dean Lillquist, AIHA, 01-May-2006
4. Personal Protective Equipment -Guide to Ports/Dock Workers - M.H.Fulekar : Government of India's Publication
5. Fundamentals of Industrial Hygiene-Barbara A. Plog, Patricia J. Quinlan, National Safety Council Press, 2002
6. Occupational safety management and engineering, Willie Hammer, Dennis Price, Prentice Hall, 2001
7. Industrial Safety and Health Management, C. Ray Asfahl, David W. Rieske, Prentice Hall, 31-Jul-2009
8. Fundamentals of Occupational Safety and Health, Mark A. Friend, James P. Kohn, Government Institutes, 16-Aug-2010
9. Handbook of occupational safety and health, Louis J. DiBerardinis, John Wiley, 1999
10. Occupational Hygiene. Blackwell Science, Harrington, J.M. & K. Gardiner. 1995, Oxford.
11. Industrial Hygiene Evaluation Methods. Micheal S. Bisesi. CRC Press, 28-Aug-2003

Environmental Biotechnology and Nanotechnology

COURSE CODE: M24ES3MJ02 **COURSE CREDIT: 04 (04 theory+02 practical)**

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objectives:

1.To understand the concept of DNA, RNA, rDNA, Phytoremediation and bioremediation.
2. To identify methods of Microbial degradation of various pollutants.
3. To assess methods of biopesticides and biofertilizers.
4. To recognize the concept of nanotechnology and its environmental applications.

Course Outcomes:

1. To identify the use of rDNA technology, Phytoremediation and Bioremediation in environmental pollution control.
2. To make use of Microbial degradation for Conservation of the Environment through pollutant degradation.
3. To identify and apply various biopesticides and biofertilizers for sustainable agriculture.
4. To identify applications of nanotechnology for environmental protection.

Sr. No	Syllabus	No. of lectures
01	**Module- I: Environmental Biotechnology** Basic Concept, Brief account of the structure and functions of DNA and RNA, Recombinant DNA Technology, Tools in rDNA Technology. • Transgenic Plants, Insect Tolerant and Herbicide Tolerant Plants, Environmental Impact of Transgenic Plants, Genetically Modified Organism (GMOs) Impact on the Environment, Molecular Probes in Environmental Monitoring. • Bioremediation Technology: Types, Factors influencing bioremediation, Land Treatment, Surface Soil Contaminant Remediation: Case Studies, Slurry Bioreactor, Bioremediation of Metals. • Phytoremediation- Approaches, Technical Considerations, Types of Phytoremediation, Factors influencing Phytoremediation, Uptake and Translocation, Enzymatic Transformation, Detoxification and Tolerance for Heavy Metals.	15

02	**Module-II: Biotechnology in Protection and Conservation of the Environment** Degradation of Xenobiotic compounds, Microbial degradation of surfactants, Biological Odorization, Bioleaching- Thiobacillus ferroxidant in leaching, • Metal recovery by Microbial Accumulation, Biosensors in Environmental Monitoring and Analysis, Biopolymers, Bioplastics • Biocomposting; Aerobic composting methods such as Windrow, Static pile and In-vessel methods for composting, Preparation of Biocompost, Particle size, Carbon to Nitrogen ratio, Temperature, Aeration, pH Control, Anaerobic Composting Fermentation/Digestion: Role of Hydrolyzing Microbes, Acetogens and Methanogens, Marketing of Biocompost • Vermicomposting: Introduction, Biology of Earthworm, Type/ Species of, Preparation of Worm Pit, Bedding Material, Addition of Worms, Sampling, Washing and Sieving Addition of Organic Waste, Harvesting the Final Product	15
03	**Module-III: Organic Farming** • Biopesticides: Introduction, Biological Insecticides, Properties of Bacillus thuringiensis, Microbial Pesticides, Entomopathogenic Fungi or Viruses, Entomopathogenic Nematodes Biochemical Pesticides Plant-Incorporated Protectants (PIPs) like GM plants etc, Insect Pheromones and other Semiochemicals, Applications of Biopesticides. • Biofertilizers: Classification, Nitrogen Fixation (Bacterial, with Blue Green Algae, VAM etc.), Symbiotic Nitrogen Fixers Rhizobium sp., Non-symbiotic, Free Living Nitrogen Fixers Azotobacter, Azospirillum etc. BGA Inoculants Azolla-Anabaena, Phosphate Solubilizing Microorganisms (PSM) Bacillus Pseudomonas, Penicillium Aspergillus etc. Mycorrhiza, Cellulolytic microorganisms and Organic fertilizers.	15
04	**Module-IV: Environmental Nanotechnology** •Nanotechnology: Definition, Introduction, Materials and Manufacture, Applications in Agriculture and Food Industry, Nanotechnology for Renewable Energy, • Nanotechnology in the Environment, Nanotechnology- Risks for Health and Environment, Benefits for the Environment. • Nanomaterials-Remediation, Nano Membranes, Nano Fibers, Nano Clays Adsorbents, Zeolites, Nano Catalysts, Carbon Nano tubes, • Environmental Nano Remediation Technology- Thermal, Physico-Chemical, and Biological Methods, Nano Filtration for the Treatment of Wastes, Removal of Organics, Inorganics and Pathogens, Nanotechnology for Water Purification..	15

COURSE CODE	TITLE	CREDITS	HOURS
M24ES3MJP02	Environmental Biotechnology and Nanotechnology	2	30

A. Minor Experiments

1. To isolate and study a pure culture of microorganisms from air, water and sewage.
2. Study the effect of pH on microbial growth.
3. Study the effect of heavy metals on the growth of bacteria.
4. Determination of MPN value of the drinking water and mineral water.
5. Estimation of DNA by spectrophotometer

B. Major Experiments

1. Development of Compost from Organic Waste
2. Phytoremediation of Heavy Metals by Green Plants in Aquatic/ Soil Environment.
3. Determination of molecular weight of DNA by electrophoresis.
4. Determination of coliforms by Membrane Filter Technique
5. Determination of *Streptococcus faecalis*.

REFERENCES:

1. M.H.Fulekar (2010) Bioremediation technology recent advances, springer
2. Environmental Biotechnology - Theory and Application – M.H.Fulekar: CRC Press and Science Publisher, USA
3. M.H.Fulekar (2005) Environmental Biotechnology Oxford IBH Publishing cooperation
4. Bioinformatics – Application in Life & Environmental Sciences - M.H.Fulekar: Springer Publisher
5. Environmental Biotechnology-Alan Scragg,Oxford University Press.
6. Environmental Biotechnology, A BiosystemsApproach,Author(s):Daniel A. Vallero, PhD, ISBN: 978-0-12-375089-1,Copyright © 2010 Elsevier
7. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
8. Environmental Biotechnology: Basic Concepts and Applications . 2006,InduShekhar Thakur, I. K. International Pvt Ltd.
9. N.P Cheremisinoff (1996) Biotechnology for Waste and Wastewater Treatment, William Andrew Publishing,New York
10. Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Environmental Microbiology, Academic Press, 2000.

Instrumentation and Biostatistics

COURSE CODE : M24ES3MJ03 COURSE CREDIT: 02 (Theory)

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objectives:

1. To discriminate the information on methods and advantages of Environmental Analysis
2. To gain information about Biostatistics

Course Outcomes:

1. To understand about the Instrumentation Methods of Environmental Analysis.
2. To obtain basic capability in skills and functional knowledge about Biostatistics.

Sr. No	Syllabus	No. of lectures
01	**MODULE 1- Instrumentation Methods of Environmental Analysis:** Conductometry, Potentiometry, Voltammetry :Theory, instrumentation and applications. • Colorimetry and spectrophotometry: Electromagnetic radiation spectrum. Interaction of radiation with matter. Beer- Lambert's law, Flame photometry. • Conventional microscopy and Scanningelectron microscopy. • Hyphenated techniques for analysis – GC-MS, HPTLC, GC-AES. Electrophoresis: Theory , classification instrumentation and applications Principle, instrumentation and environmental applications of Neutron Activation Analysis, X- Ray Fluorescence, X-Ray Diffraction Thermogravimetry. • Continuous monitoring analysis – fluorescent analyzer for SO2, chemiluminescentanalyzer for NOx, NDIR for CO Flow injection analyzer.	15
02	**MODULE-II- Biostatistics** Collection, classification and tabulation of data. Essentials of good tabular form. Preparation of one-way and two-way frequency tables. Diagrammatic and graphical representation of data (data bar, pie, picot and histograms, frequency polygons), frequency curves and cumulative curves. • Measures of central tendency and dispersion : mean. median, mode , range, standard and relative deviation, coefficient of variation, skewness, kurtosis confidence limits and confidence intervals and normal distribution curve, Analysis of variance one way and two way classification, probit analysis • Accuracy, precision and errors: Classification, Minimisation of errors, Rejection of data . Z, t, F, and chi-square tests • Correlation and Regression: Pearson's coefficient, Spearman's coefficient, regression lines and their use. Curve fitting. • Probability: Exclusive and independent events, addition and multiplication theorems, dependent events and conditional probability.	15

REFERENCES:

1. Fulekar, M. H. and BhawanaPathak "Bioinstrumentation" I K International Publication, New Delhi, 2013.
2. Willard. H., Merritt, L., Dean, D.A. and Settle F.A., 'Instrumental Methods of Analysis', 7th edition, Wordsworth, New York, 1998.
3. Galen. W. Ewing, 'Instrumental Methods of Chemical Analysis 5th edition, McGraw Hill, New York., 1995.
4. Roger Reeve,Introduction to Environmental Analysis, John Wiley & Sons Ltd,2002
5. Fundamentals of Analytical chemistry, D.A. Skoog, D.M. West and F.J.Holler, Harcourt Asia PTE. Ltd., 7th edition, New Delhi,2001.
6. APHA standard methods for Water and Wastewater Examination, 20th Edition, Washington,1998.

Elective 01: Environmental Toxicology

COURSE CODE: M24ES3E01 COURSE CREDIT: 04 (Theory)

1 credit - 15 lectures 1 lecture is 60 minutes.

Course Objective:

1. To understand the concept of Toxicology.
2. To identify the principles of Toxicology.
3. To gain knowledge about Toxicants in the Environment.
4. To understand the concept of assessment of Toxicity and Control Mechanism.

Course Outcomes:

1. To relate fundamental concepts of Eco-toxicology and pressure of ecological factors on the effect of toxicity.
2. To examine Toxic substances in the environment, their sources, entry routes and impact on environment.
3. To inspect dose response relationship and principles of toxicology.
4. To justify types of organ toxicity and injuries to the organ systems.

Sr. No	Syllabus	Lectures
	Module -I Introduction to Toxicology Definition and scope of environmental toxicology, Historical perspective, and key milestones, Sources of Toxic Compounds- Natural, Anthropogenic, Impact of toxicants on human health. Impact of toxic compounds on the environment. Types of Toxicity- Acute, Chronic, Systemic Toxicity: Neurotoxicity, Hepatotoxicity, Nephrotoxicity, Cardiotoxicity, Hematotoxicity, Immunotoxicity, Reproductive Toxicity, Developmental Toxicity.	15
CO 2	**Module II: Principles of Toxicology** Pathways of toxicity in the environment, Route of Exposure of toxic compounds- Inhalation, Ingestion, Absorption, Adsorption, Injection, Transplacental, Ocular Exposure, Concept of (ADME) absorption, distribution, metabolism, and excretion of toxic substances. Route of ADME in vertebrates. Biochemical basis toxicity, Receptor-mediated toxicity, Endocrine-disrupting toxicity,	15
CO 3	**Module III: Toxicants in the Environment** Target organs in Toxicity, Major Toxicants in the Environment. Bioaccumulation and biomagnification of toxic materials in the food chain. Biomonitoring of toxic compounds. Factors Affecting toxicity of a Substance, Bioindicators, Examples of toxic compounds and their toxicity effect: Pesticides, Environmental disasters: Chornobyl, Bhopal gas tragedy. Measurement of toxicity	15
CO 4	**Module IV: Assessment of Toxicity and Control Mechanism** Dose-response relationships, TLV, LC 50, LD 50, Concept of Dosimetry. Bioassay for toxicity testing. Regulatory Frameworks and Management Strategies for Environmental Toxicology, Ethical Considerations and Use of technology for Minimizing Impacts of toxicity on the Environment.	15

REFERENCES:

1. Principles of Environmental Toxicology: I. C. Shaw and J. Chadwick; Taylor&Francis ltd
2. Basic Environmental Health (2001): AnnaleeYassi, TordKjellstom, Theo de Kok, Tee Guidotti
3. Environmental Health : Monroe T. Morgan
4. Handbook of Environmental Health and Safety – principle and practices : H. Koren; Lewis Publishers
5. Moore, G.S., 2002, Living with the Earth: concepts in Environmental Health Science (2 nd Ed.), Lewis publishers, Michigan
6. Walker, C.H., Hopkin, S.P., Sibly, R.M., and Peakall, D.B. 2001. Principles of Ecotoxicology. 2 nd Ed. Taylor & Francis, London.
7. Environmental biology and Toxicology, by Sharma P.D. Rastogi and Lamporary., 1994.
8. Environmental pollution and Toxicology by MeeraAsthana and Astana D.K., Alka printers, 1990. 3. Toxicology, by A.Sood, Sarup and sons New Delhi, 1999
9. Text book of Preventive and Social Medicine, by Park J.E. and Park K., Banosidas Bharat Publishers, Jabalpur, 1985
10. Environmental Epidemiology, by AnisaBasheer, Rawat Publication Jaipur, New Delhi 1995.

Elective-02: Intellectual Property Rights

COURSE CODE : M24ES3E02 **COURSE CREDIT: 04 (Theory)**

1 credit - 15 lectures

1 lecture: 60 minutes

Course Objective:

1. To understand the concept of IPR
2. To understand the meaning of Trade Marks.
3. To gain knowledge about Patent Rights and Copy Rights.
4. To understand the current outline scenario of IPR with case studies.

Course Outcomes:

1. To discriminate the kinds of Intellectual Property Rights.
2. To understand the origin, meaning and Nature of Trade Marks.
3. To understand patent rights and copy rights.
4. To know the IPR current scenario with case studies.

Sr. No	Syllabus	No. of lectures
01	**Module I : Introduction to Intellectual Property Rights** Meaning of property, Origin, Nature, Meaning of Intellectual Property Rights. Kinds of Intellectual property rights—Copy Right, Patent, Trade Mark, Trade Secret and trade dress, Design, Layout Design, Geographical Indication, Plant Varieties and Traditional Knowledge.	15
02	**Module II: TRADE MARKS— Origin, Meaning & Nature of Trade Marks**: Types, Registration of Trade Marks, Infringement & Remedies, Offences relating to Trade Marks, Passing Off, Penalties DESIGN- Meaning, Definition, Object, Registration of Design, Cancellation of Registration, International convention on design, functions of Design. Semiconductor Integrated circuits and layout design Act-2000.	15
03	**Module III: PATENT RIGHTS AND COPY RIGHTS—** Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and licence , Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties. COPY RIGHT—Origin, Definition &Types of Copy Right, Registration procedure, Assignment & licence, Terms of Copy Right, Piracy, Infringement, Remedies, Copy rights with special reference to software.	15

04	**Unit IV: Current Outline** India`s New National IP Policy, 2016 – Govt. of India step towards promoting IPR – Govt. Schemes in IPR – Career Opportunities in IP - IPR in current scenario with case studies	15

REFERENCES:

1. Jyoti Rattan (2024). Intellectual Property Rights. Bharat Law House
2. Sumeet Malik (2013) Intellectual Property Rights Manual. 1st Ed. Eastern Book Company
3. Saurabh Bindal (2023). Intellectual Property Law: An Introduction. 2nd Ed. Eastern Book Company
4. Elizabeth Verkey and Jithin Saji Isaac. (2021). Intellectual Property. 2nd Ed. Eastern Book Company
5. Trade Marks Act, 1999 Bare Act. 19th Ed. 2024. Eastern Book Company
6. M.K. Bhandari (2023). Law Relating to Intellectual Property Rights. 6th Ed. Central Law Publication
7. Intellectual Property Rights and the Law, Gogia Law Agency, by Dr. G.B. Reddy
8. Law relating to Intellectual Property, Universal Law Publishing Co, by Dr. B.L.Wadehra
9. IPR by P. Narayanan 4. Law of Intellectual Property, Asian Law House, Dr.S.R. Myneni.

Field Project

M24ES3FP01 **Credit: 04**

Students are expected to spend a minimum **of 120 hours** during their **semester break** under the guidance of a competent professional/ scientist at a research institute or research centre with the aim of learning techniques and their applications Or internship in industry/ consultancy/ NGO.

The assessments should be based on supervisor's feedback, submission of a training report and an open presentation and Viva voce.

SCHEME OF EXAMINATION

The scheme of examination shall be divided into two parts:

- **Internal assessment 40% i.e. 40 marks**
- **Semester end examination 60% i.e. 60 marks**

(A) Internal Assessment 40 marks

Description	Marks
Internal tests of 20 marks each Q.1 Multiple choice Questions/True or False - 10 Marks Q.2. Attempt 2 questions out of 3 questions (5 marks each)- 10 Marks	20
One Project and Viva voce/Presentation/Case studies/Assignments	15
Attendance and Class behavior	5
Total	40

(B) External Examination

M.Sc ENVIRONMENTAL SCIENCE

Maximum Marks: 60

Duration: $2^{1/2}$hr

Question 1: Unit I

Question 2: Unit II

Question 3: Unit III

Question 4: Unit IV

Question 5: Unit I to Unit IV (Mixed questions)

Instructions: i. All Questions are compulsory
ii. All questions carry equal marks
iii. Draw neat and labeled diagrams wherever necessary

Q.1. Answer any two questions from the following (Based on Unit I) 12 Marks
a. 06
b. 06
c. 06

Q.2. Answer any two questions from the following (Based on Unit II) 12 Marks
a. 06
b. 06
c. 06

Q.3. Answer any two questions from the following (Based on Unit III) 12 Marks
a. 06
b. 06
c. 06

Q.4. Answer any two questions from the following (Based on Unit IV) 12 Marks
a. 06
b. 06
c. 06

Q.5. Answer any three questions from the following (Mixed Questions) 12 Marks

a. 03
b. 03
c. 03
d. 03
e. 03
f. 03
g. 03

(C) PRACTICAL EXAMINATION

Paper Pattern

1. **Major Experiment**: 25 Marks
2. **Minor Experiment: 15** Marks
3. **Journal:** 05 Marks
4. **Viva Voce:** 05 Marks

NOTE:

NOTE:- Students should undertake field work and survey. The Students should visit different places to collect data to make survey and analyze. At least four places may be visited.

The Places of visit could be: Lakes, rivers, estuary and marine, nature parks, water/ sewage/ Industrial effluent treatment plant, Solid waste dump, meteorological centre, mangrove vegetation, industries – food, pharmaceutical, petrochemical, fertilizer, paper, sugar, distillery etc. The students should also be encouraged to participate in the public lectures/ seminars/ workshops etc. on environment related issues.

Reports on each of visit/ activity undertaken must be included in the journal.

D) Scheme of Examination for 2 Credits shall be divided into two parts:-

- **Internal Assessment: 20 Marks**

Description	Marks
Internal tests of 10 marks each Q.1 Multiple choice Questions/True or False - 05 Marks Q.2. Attempt 2 questions out of 3 questions (5 marks each)- 05 Marks	10
One Project and Viva voce/Presentation/Case studies/Assignments	05
Attendance and Class behavior	05
Total	20

- **External Assessment: 30 Marks**

Paper Pattern

Total Marks: 30

Q.1 Answer any 2 two questions from the following…(Based on Unit I) (10Marks)

a. 05
b. 05
c. 05

Q.2 Answer any 2 two questions from the following… (Based on Unit II) (10Marks)

a. 05
b. 05
c. 05

Q.2 Answer any five questions from the following…(Mixed Questions) (10Marks)

a. 02
b. 02
c. 02
d. 02
e. 02
f. 02
g. 02
h. 02

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AC Item No: 1.2.4
Date: June 29, 2024

SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

M.Sc (Environmental Science)
(AC Item No: 1.2.4)

Sr. No.	Heading	Particulars
1	Title of the course	M.Sc (Environmental Science)
2	Eligibility for admission	A learner who has passed B.Sc. degree Examination of University of Mumbai or any other recognized university is eligible for the entrance examination. The learner must have secured minimum 45% marks (40% for the candidate belonging to reserved category) or equivalent grade at B.Sc examination in Chemistry, Botany, Zoology, Biotechnology, Microbiology, Life sciences, Biochemistry, Geology, Geography, Natural science, Agricultural Science or B.Sc degree with any other subject with Biological Science as one of the subject atF.Y./S.Y. level or B.E. degree of the university of Mumbai or any other University/institute recognised as equivalent or B.Sc in Vocational Course.
3	Passing Percentage	45% marks (40% for the candidate belonging to reserved category)
4	Semesters	Two semesters per year (Semester IV)
5	Level	PG
6	Pattern	SEMESTER
7	To be implemented from	From Academic year 2024-25 in a progressive manner

Date: June 29, 2024

Signature:

Dr. Koel Roychoudhury
AC Chairperson

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SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

(Affiliated to University of Mumbai)

RE-ACCREDITED GRADE "A" BY NAAC (3rd CYCLE)

BOARD OF STUDIES

SYLLABUS FOR

M.Sc. Environmental Science (Semester IV)

(WITH EFFECT FROM THE ACADEMIC YEAR 2024-2025)

PROGRAMME OBJECTIVES:

1. To specialize students in different areas like conservation, ecology, biology and environmental chemistry.
2. To prepare students with the latest knowledge about Impact Assessments.
3. To prepare students with the strong knowledge about Environmental Sciences so that they can be eligible for various positions in educational institution, Industry, governmental and non-governmental organizations.
4. To make the students ready for research and promote them for higher studies.

PROGRAMME OUTCOMES:

PO1: Relate and apply fundamental knowledge of environmental science to factual world problem.
PO2: Analyse, identify and formulate actual services/solutions/applications with environmental requirements.
PO3: Implement, and evaluate environmental – based solution applicable to public health, ecological safety, environmental management and sustainable development considerations.
PO4: Understand management and environmental principles run into need of environmental sectors.
PO5: Select and use existing techniques, skills and tools to solve environmental issues by analyzing the local and global impact on the environment.
PO6: Distinguish a problem; plan a solution for the needs of the society in health, safety and environment applying relevant environmental practice.
PO7: Use of demonstrating techniques to design experiments, by analyzing and interpreting data.
PO8: Recognize the need of constant expertized improvement through lifelong learning.

SIES (Nerul) College of Arts, Science and Commerce (Autonomous)

M. Sc. Environmental Science Programme

(To be implemented from Academic Year- 2024-25)

No. of Courses	Course Code	Semester IV	Credits
1	*Major*		
1	M24ES4MJ01	Environmental Management	4
	M24ES4MJP01	Practical's in Environmental Management	*2*
2	M24ES4MJ02	Ecotechnology	4
	M24ES4MJP02	Practical's in Ecotechnology	2
3	M24ES4MJ03	Remote Sensing and GIS	2
2	*Electives(E)* (Any One Optional)		
1	M24ES4E01	Sustainable Management	4
2	M24ES4E02	Management of Resources	4
3	*OJT*		
1	M24ES4RP01	Research Project	6
		Total Credits	**22**

Environmental Management

COURSE CODE : M24ES4MJ01 COURSE CREDIT: 04 (04 theory+02 practical)

1 credit - 15 lectures
1 lecture is 60 minutes
Course Objective:

1. To understand the principle of Environment Management.
2. To learn about Environmental Management Systems and Life Cycle Assessment.
3. To gain knowledge about Environmental Audit and Environmental Economics.
4. To understand the concept of Environmental Design and Modelling.

Course Outcome:

1. To discriminate about resources, wealth and concept of environmental management practices.
2. To predict the importance of ISO 14000 and also to gain information about the procedure of Life Cycle Assessment.
3. To evaluate the concept of environmental audit and environmental economics.
4. To plan for environmental design consideration in product life stages and also synthesizes the need of water and air quality model.

Sr. No	Syllabus	No. of lectures
01	**Module-I: Principles of Environment Management** • Definition and Scope, Goals of Environmental Management, significance of environmental management, scope of environmental management, Need for Sustainable Development and environmental linkages, Environmental concerns in India, Actions For Environmental Protection Indian initiatives, National committee on Environmental Planning and Coordination, The Tiwari committee, Department of Environment etc, MOEFCC, Changes in Environmental Management Practices, Environmental Management Tools	15
02	**Module-II: Environment Management Systems and Life Cycle Assessment** • International Organization for Standardization (ISO), Plan -Do-Check-Act Cycle, EMS Certification ,ISO 14000 series, ISO 14001, Difference between ISO 14000 and ISO 14001 Environmental Policy, Planning, Implementation and Operation, Checking, Management Review, Benefits of ISO 14001 certification. • Evolution of Life Cycle Assessment (LCA), Cradle to grave approach. Different applications of LCA (Private and Government), Procedure for LCA: Defining goal and scope, preparation of life cycle inventory, assessment of environmental impact, Areas for Improvement and Interpretation, Methods to assess impact using	15

	methods like ecoindicator-95, Eco-Innovation, Circular Economy, 4R, 5R case study, Case Study of Substitutes for PVC, Case Study of Steel Sector in India.	
03	**Module-III: Environmental Audit and Environmental Economics** • Introduction to environmental audit, Objectives and Scope, Types of environmental audits, General audit methodology, Elements of Audit process: Introduction, the basic steps of an environmental audit program. Element of audit process, Waste audits and pollution prevention assessments, Waste Minimization audit examples, Environmental Audit in Industrial Projects, Liability audit and Site Assessments, Auditing of Environmental Management System. • Economics and the Environment, Introduction to environmental economics, Environmental Taxes, Environmental Accounting, Environmental Valuation, Valuation of environment impacts: Types of economic values, approach, valuation techniques, valuing environmental amenities. Environmental Costs and benefits analysis, examples of cost benefit analysis of technology or process, Economics of Natural Resources (Fisheries, Forestry, Water Use, Agriculture), Environment and Regional Economics, Ecological Economics, Introduction to Market based instruments and command control instrument for pollution control.	
04	**MODULE IV- Environmental Design(ED) and Modeling** • Principles of Environmental Design (ED). Benefits of environmental design, Motivation for Environmental Design, Environmental Design and other Environmental Design Practices, ED of manufactured products, ED considerations in products life stages-Design for Environment concepts, Tools for ED of products, Examples of Environmental Design, Concept of Ecolabelling, • Environmental Design for Buildings, Green Buildings, Principles of Green Building, ED strategies for Building Construction, ED for Developmental Planning frame work with Indian Examples. Cleaner Production Programmes, Leadership in Energy and Environmental Design certification Programmes. • Introduction to Environmental Monitoring and Modeling, Definition of model, Need of modeling, water quality models-surface and ground water, Air Quality Models-Dispersion and receptor models	**15**

Practicals

COURSE CODE	TITLE	CREDITS	HOURS
M24ES4MJP01	Environmental Management	2	30

A. Minor Experiments

1. Prepare an Environmental Policy for an Organization
2. To study the PDCA cycle of any one Company.
3. Prepare a brief report on environmental objectives from any two policies.
4. Draft a Case study on Circular Economy
5. To perform Water/Energy audit in the house/college building /society/laboratory
6. To study sustainability report of major business groups/environment compliance report for a company.
7. Report on Visit to NGO/Biomedical waste management site/hazardous waste Management/Pollution control facility of any industry.
8. Report on Seminar/Conference attended.

B. Major Experiments

1. Prepare a report on Environmental Design of any one Product.
2. Prepare a report on Environmental Audit of any one Organization.
4. Prepare a Life Cycle Assessment report on any one Product
5. Report on study tour to the following places

•Lakes/rivers/estuary/marine ecosystem.
• National Park/Sanctuary
• Mangrove Ecosystem/Open Cast Mining/Agricultural field.
• Pollution Control Board/Research Institute/Meterology Department.

References:

1. Vijay Kulkarni and T.V.Ramachandra, 2006. Environment Management,
2. Common wealth of Learning, Canada, Centre for Ecological Sciences, Indian Institute of Science, Karnataka Environment ResearchFoundation.TERI press.
2. Environmental Economics for Non-Economist, John Asafu-Adjaye,World scientific publishing Co Pvt Ltd, 1999
3. Camborne D F, Environmental Life Cycle Analysis, Lewis Publishers, 1997.
4. Cattanach,R.E., Hodrieth J.M., Reinke D.P., Sibik L.K., Environmentally Conscious Manufacturing from Design to Production to Labelling and Recycling, National Centre for Manufacturing Sciences (NCMS), Irwin Publications,1995.
5. Fundamental concepts of Environmental chemistry,2009, G.S. Sodhi, Narosa Publishers.

Ecotechnology

COURSE CODE : M24ES4MJ02 COURSE CREDIT: 04(Theory)+ 02 Practical

1 credit - 15 lectures

1 lecture is 60 minutes

Course Objective:

1. To understand the concept of Ecotechnology.
2. To know about Pytosanitation and Green Inhibitors.
3. To gain knowledge about Climate Change Mitigation And Carbon Sequestration.
4. To understand the concept of Restoration Ecology and Remediation Technology.

Course Outcomes:

1. To discriminate the principles, concept, application of ecotechnology and also appropriate technologies for rural technology
2. To predict the concept, application of SPS and also to gain information about environmental green inhibitors
3. To apply the concept of Clean Development Mechanism (CDM) to combat CC, Development of C-sequestration projects their modalities & procedures- reducing emissions.
4. To justify the principles, concept, strategies of restoration ecology and remediation technology.

Sr. No	Syllabus	No. of lectures
01	**Module 1:Ecotechnology** • Definition, Principles and Concept of Eco technology, Why Eco technology and Applications of Eco technology. Eco designing Eco technology for social welfare and sustainable development. • Appropriate technology for rural environment: Gandhian philosophy: swadeshi movement, concept & definition characteristic features of appropriate technologies, An account of various technologies developed for rural people- Biogas schemes for rural development, solar cells, solar cooker, solar heaters smokeless chulas, Biogas stoves, community Biogas plant Bioenergy, Agro chemicals, Biological Control measures Ecoplantation	15

02	**Module 2: Sanitation –Phytosanitation And Green Inhibitors** • Meaning, concept and importance of SPS, in reference to WTO-SRS Agreement, important phytosanitation technologies-HBPST,TDC,SPS committee-Who and What they do, the ten commandments of SPS agreement of WTO. • Green inhibitors: Factors pertaining to metal samples, Inhibitors in use, Cooling systems, Processing with acid solutions, Corrosion ,Problems in oil industry, Corrosion inhibition in the mining industry, Atmospheric corrosion inhibition mechanisms, Standardized Environmental testing, Hybrid coating & Corrosion Inhibitors, Environmental green inhibitors, Industrial application of corrosion inhibition.	
02	**MODULE-III- Climate Change Mitigation And Carbon Sequestration** • Carbon related definitions C-pool, C-stock, C-Flux, C-sink, C-source, sequestration/uptake. • A brief understanding of the Clean Development Mechanism (CDM) to combat CC, Developing C market for combating CC, how India can benefit from CDM projects. • Development of C-sequestration projects their modalities & procedures- reducing emissions from degradation and deforestation (REDD and REDD+),International efforts in combating global warming & CC.A brief understanding of UNFCCC(Kyotoprotocol)NATCOM,IPCC, CBD, UNCCD, World heritage conventions, UN forum on forests etc.	**15**
	Module IV Restoration Ecology and Remediation Technology Definitions, aims and objectives, principles, concept & strategies (long tern vs short term), physical chemical & biological restoration, role of ecological principles in restoration, holistic approach in restoration. • Greenness improvement & planting technologies, bamboo forest maintenance, biotopes, recycled water technology, soil & ground water contamination survey & cleaning technologies.	15

COURSE CODE	TITLE	CREDITS	HOURS
M24ES4MJ02	Eco Technology	2	30

A. Minor Experiments

1. Study on ecological restoration by field visit
2. Determination of carbon sequestration by plant
3. Determination of Translocation factor by phytoremediation.
4. Case study on Tehri project, Silent Valley Project, Narmada Dam Project, Biopiracy, Ecodisaster of deforestation

B. Major Experiments

1. Tracing of watershed and their morphological features from toposheets.
2. Interpretation of Aerial photographs/satellite imageries/GIS data.
3. Water Audit of an Institution.
4. Designing structures for water conservation and harvesting based on field visits.

TEXTS/REFERENCES

1. Cunningham. Principles of Environmental Science.
2. Faegri, K.vanderpifl (1976). The principles of pollination ecology.3rd Edition pergamon press
3. Green Corrosion Inhibitors by V.S.Sastri
4. Joanne E. Norris, Alexia Stokes, Slobodan B. Mickovski, Erik Cammeraat, Rens van Beek, Bruce C. Nicoll, Alexis Achim, (2008). Slope Stability and Erosion Control: Ecotechnological Solutions.
5. Mitsch, William & Jørgensen, S.E. (1989). Ecological Engineering: An Introduction to Ecotechnology.
6. William J. Mitsch (2004). Ecological Engineering and Ecosystem Restoration.

Remote Sensing and GIS

COURSE CODE : M24ES4MJ03 COURSE CREDIT: 02 (02 theory)

1 credit - 15 lectures
1 lecture is 60 minutes

Course Objective:

1. To understand the concept of Remote sensing and its applications in Environmental Monitoring.
2. To gain knowledge about Geographical Information System (GIS).

Course Outcome:

1. To apply the principle, basic concepts and applications of remote sensing in Environmental Monitoring.
2. To evaluate the basic principles, techniques and application of Geographical Information System in Environmental Sciences.

Sr. No	Syllabus	No. of lectures
01	**Module- I : Remote sensing and its applications in Environmental Monitoring:** Principles and Basic concepts of Remote sensing; EMR & its interaction with matter; Aerial Photography and image recognition; Sensors & platforms; IRS satellites & their sensors; Application of remote sensing in environmental studies: land use mapping, forest survey, habitat analysis, water management, drought monitoring and flood studies, wetland survey ; rainfall estimation, pollution studies, soil conservation, watershed management and vegetation mapping.	15
02	**Module- II: Geographical Information System (GIS):** Basic principles, Techniques Application in Environmental Sciences. Types of Geographical Data; Data Structure; Vector and Raster data: their Advantages and Disadvantages; Input, verification, storage and out put of geographical data; Importance of Geographical 15 Information System in environmental studies. Global Positioning System (GPS): basic principles, Applications to environmental studies -Point source pollution, hazard monitoring and assessment.	15

1. J. Weston (1997) Planning and EIA in Practice, Longman.
2. Jos Arts and Angus Morrison-Saunders (2004) Assessing Impact - Handbook of EIA and SEA follow-up, Earthscan, London.
3. website of MoEF, GOI, New Delhi 8. Srivastava, D. C. (2005)
4. Readings in Environmental Ethics: Multidisciplinary perspectives, Rawat Publications,Jaipur.

Elective 01- Sustainable Management

COURSE CODE: M24ES4E01 **COURSE CREDIT: 04**

1 credit - 15 lectures 1 lecture is 60 minutes.

Course Objective:

CO 1: Students will be able to understand the concept of sustainable development

CO 2: Students will assess the effectiveness, feasibility, and ethical implications of different approaches to sustainability in diverse socio-economic and environmental contexts.

CO 3: Students will be proficient in synthesizing and evaluating business strategies integrating sustainability principles

CO4: Students will evaluate the effectiveness of regulatory mechanisms in achieving sustainable goals by policy and framework.

Course Outcome:

1. Students will demonstrate a comprehensive understanding of the concept of sustainable development, including its principles, goals, and significance

2. Students will develop the ability to critically analyze and compare different strategies, considering their impact on society, the economy, and the environment, thus contributing to informed decision-making and sustainable development practices

3. Students will adeptly synthesize and evaluate business strategies that integrate sustainability principles, fostering a balanced approach to economic growth and environmental stewardship within organizational contexts.

4. Students will skillfully assess the efficacy of regulatory mechanisms in attaining sustainable goals through policy and framework in businesses.

Sr. No	Syllabus	Lectures
	Module -I Introduction to Sustainable Development Definition and Evolution of Sustainable Development, Principles, and Pillars of Sustainability: Ecological, Social, and Economic, Sustainable Development Goals (SDGs) 2020, Environmental Challenges and Natural Resources and Biodiversity Loss, Pollution Control and Waste Management, Economic Growth and Sustainable Development.	15

CO 2	**Module II: Strategies for Sustainable Development** Environmental related insecurity in Society, Sustainable Urban Planning, Green infrastructure, and public transportation, Concept of Smart and Sustainable City. Sustainable energy efficient technologies., Sustainable Agriculture and Food Security, Understanding Environmental Regulations and Standards, Strategies for Compliance, Role of Businesses in Shaping Sustainability Policy, climate change , socio economic status in our country.	15
CO 3	**Module III: Business Strategies and Sustainability** Corporate Social Responsibility (CSR), CSR Frameworks and Standards (e.g., ISO 26000, GRI), Integrating CSR into Business Strategy, Green Supply Chain Management, Sustainable Sourcing and Procurement, Life Cycle Assessment (LCA) in Supply Chains, Reducing Supply Chain Carbon Footprint, Concept of Circular Economy, Strategies for Enhancing Energy Efficiency in Operations Strategies for Waste Minimization and Resource Efficiency, Principles of Sustainable Marketing	15
CO 4	**Module IV: Policy and Regulation Compliance for Sustainability.** Historical Perspectives, OECD guidelines, NPG Guidelines, SEBI, Introduction to Environmental, Social, and Governance, ESG Reporting and Standards Framework for Sustainability Reporting, Integrating GRI and SASB, Implementing ESG in Business Strategy, ESG Matrix and ESG Business Responsibility & Sustainability Reporting (BRSR), Integrating ESG and BRSR into Business Strategy, SEBI guideline for BRSR in India and its application with case study	15

REFERENCES:

1. Our Common Future, Chapter 2: Towards Sustainable Development: Report of the World Commission on Environment and Development.
2. Edwards, Andres R., The Sustainability Revolution: Portrait of a Paradigm Shift. New Society Publishers, 2005.
3. Report of the Department for Policy Coordination and Sustainable Development (DPCSD), United Nations Division for Sustainable Development.
4. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF,2011.
5. World Resources Institute (1995) "Environmental Indicators: A Systematic Approach to Measuring & Reporting on Environmental Policy Performance in the Context of Sustainable Development", World Resources Institute, Washington, DC.
6. Adger, W.N., Brown, K., Fairbrass, J., Jordan, A., Paavola, J., Rosendo, S., Seyfang, G. (2003) Governance for sustainability: towards a 'thick' analysis of environmental decisionmaking. Environment and Planning A 35, 1095 –1110.
7. Connelly, J. and Smith, G. (2003). Politics and the Environment: from theory to practice. Routledge, London.
8. Carter, N. (2001) The politics of the environment. Cambridge University Press: Cambridge
9. Leach, M., Scoones, I., Wynne, B. (2005) Science and Citizens: Globalization and the Challenge of Engagement.Zed books, London.
10. Pearce, D.W., Barbier, E. (2000) Blueprint for a sustainable economy. Earthscan, London.

Elective-02: Management of Resources

COURSE CODE : M24ES4E02 **COURSE CREDIT: 04 (Theory)**

1 credit - 15 lectures

1 lecture: 60 minutes

Course Objective:

1. To understand the concept of Resource management.
2. To learn about Management of Waste Resources.
3. To gain knowledge about Wild life Management.
4. To understand the concept of Reclamation & Management of waste lands.

Course Outcomes:

1. To discriminate the concept of Resource Management.
2. To predict conservation strategies for non-renewable energy resources.
3. To identify methods of control and management of Wildlife, Threatened Species and Water.
4. To plan for reclamation and management of waste lands.

Sr. No	Syllabus	No. of lectures
01	**Module-I-** Resource management its meaning & concept, management of rangelands & watersheds, management of Agricultural methods.	15
02	**Module – 2-** Management of waste resources, Management of forests, effects of deforestation. Management of fresh water ecosystem conservation strategies for non-renewable energy resources.	15
03	**Module-3** -Wildlife Management & conservation efforts for threatened species, Water Management, Ganga Action Plan, Yamuna Action Plan, Environmental priorities in India.	15
04	**Module-4-** Reclamation & Management of waste lands, soil erosion, soil conservation, rural planning & land use pattern. Sustainable development, urban planning for India, Land use policy for India.	15

References:

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

Research Project

M24ES4RP01 **Credit: 06**

Students are expected to spend a minimum **of 180 hours** during their **semester break** under the guidance of a competent professional/ scientist at a research institute or research centre with the aim of learning techniques and their applications Or internship in industry/ consultancy/ NGO.

The assessments should be based on supervisor's feedback, submission of a training report and an open presentation and Viva voce.

SCHEME OF EXAMINATION

The scheme of examination shall be divided into two parts:

- **Internal assessment 40% i.e. 40 marks**
- **Semester end examination 60% i.e. 60 marks**

(A) Internal Assessment 40 marks

Description	Marks
Internal tests of 20 marks each Q.1 Multiple choice Questions/True or False - 10 Marks Q.2. Attempt 2 questions out of 3 questions (5 marks each)- 10 Marks	20
One Project and Viva voce/Presentation/Case studies/Assignments	15
Attendance and Class behavior	5
Total	40

(B) External Examination

M.Sc in ENVIRONMENTAL SCIENCES

Maximum Marks: 60
Duration: $2^{1/2hr}$
Question 1: Unit I
Question 2: Unit II
Question 3: Unit III
Question 4: Unit IV
Question 5: Unit I to Unit IV (Mixed questions)

Instructions: i. All Questions are compulsory
ii. All questions carry equal marks
iii. Draw neat and labeled diagrams wherever necessary

Q.1. Answer any two questions from the following (Based on Unit I)
a. 06
b. 06
c. 06

Q.2. Answer any two questions from the following (Based on Unit II)
a. 06
b. 06
c. 06

Q.3. Answer any two questions from the following (Based on Unit III)
a. 06
b. 06
c. 06

Q.4. Answer any two questions from the following (Based on Unit IV)
a. 06
b. 06
c. 06

Q.5. Answer any two questions from the following (Mixed Questions)

a. 03

b. 03

c. 03

d. 03

e. 03

f. 03

(C) PRACTICAL EXAMINATION

Paper Pattern

1. **Major Experiment**: 25 Marks
2. **Minor Experiment: 15** Marks
3. **Journal:** 05 Marks
4. **Viva Voce:** 05 Marks

NOTE:

NOTE:- Students should undertake field work and survey. The Students should visit different places to collect data to make survey and analyze. At least four places may be visited.

The Places of visit could be: Lakes, rivers, estuary and marine, nature parks, water/ sewage/ Industrial effluent treatment plant, Solid waste dump, meteorological centre, mangrove vegetation, industries – food, pharmaceutical, petrochemical, fertilizer, paper, sugar, distillery etc. The students should also be encouraged to participate in the public lectures/ seminars/ workshops etc. on environment related issues.

Reports on each of visit/ activity undertaken must be included in the journal.

D) Scheme of Examination for 2 Credits shall be divided into two parts:-

- **Internal Assessment: 20 Marks**

Description	Marks
Internal tests of 10 marks each Q.1 Multiple choice Questions/True or False - 05 Marks Q.2. Attempt 2 questions out of 3 questions (5 marks each)- 05 Marks	10
One Project and Viva voce/Presentation/Case studies/Assignments	05
Attendance and Class behavior	05
Total	20

- **External Assessment: 30 Marks**

Paper Pattern

Total Marks: 30

Q.1 Answer any 2 two questions from the following…(Based on Unit I) (10Marks)

a. 05
b. 05
c. 05

Q.2 Answer any 2 two questions from the following… (Based on Unit II) (10Marks)

a. 05
b. 05
c. 05

Q.2 Answer any five questions from the following…(Mixed Questions) (10Marks)

a. 02
b. 02
c. 02
d. 02
e. 02
f. 02
g. 02
h. 02

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