

University of Mumbai



No. AAMS_UGS/ICC/2024-25/134

CIRCULAR:-

Attention of all the Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head University Departments is invited to this office Circular No. AAMS_UGS/ICC/2023-24/23 dated 08th September, 2023 relating to the NEP UG & PG Syllabus.

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in Environment Science at its meeting held on 09th August, 2024 and subsequently passed by the Board of Deans at its meeting held on 03rd September, 2024 vide item No. 8.2 (N) has been accepted by the Hon'ble Vice Chancellor as per the power confirmed upon him under Section 12(7) of the Maharashtra Public Universities Act, 2016 and that in accordance therewith syllabus for **M.Sc. (Environment Science) Sem – III & IV** is introduced as per appendix (NEP 2020) with effect from the academic year 2024-25.

(The said circular is available on the University's website www.mu.ac.in).

MUMBAI – 400 032
21st September, 2024

(Dr. Prasad Karande)
REGISTRAR

To,

The Principals of the Affiliated Colleges, Directors of the Recognized Institutions and the Head, University Departments.

BOD 8.2(N)/03/09/2024

Copy forwarded with Compliments for information to:-

- 1) The Chairman, Board of Deans,
- 2) The Dean, Faculty of Interdisciplinary Studies,
- 3) The Chairman, **Ad-hoc Board of Studies in Environment Science**,
- 4) The Director, Board of Examinations and Evaluation,
- 5) The Director, Department of Students Development,
- 6) The Director, Department of Information & Communication Technology,
- 7) The Director, Centre for Distance and Online Education (CDOE), Vidyanagari.
- 8) The Deputy Registrar, Admissions, Enrolment, Eligibility & Migration Department (AEM).

Copy forwarded for information and necessary action to :-	
1	The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Dept)(AEM), dr@eligi.mu.ac.in
2	The Deputy Registrar, Result unit, Vidyanagari drresults@exam.mu.ac.in
3	The Deputy Registrar, Marks and Certificate Unit,. Vidyanagari dr.verification@mu.ac.in
4	The Deputy Registrar, Appointment Unit, Vidyanagari dr.appointment@exam.mu.ac.in
5	The Deputy Registrar, CAP Unit, Vidyanagari cap.exam@mu.ac.in
6	The Deputy Registrar, College Affiliations & Development Department (CAD), deputyregistrar.uni@gmail.com
7	The Deputy Registrar, PRO, Fort, (Publication Section), Pro@mu.ac.in
8	The Deputy Registrar, Executive Authorities Section (EA) eau120@fort.mu.ac.in He is requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to the above circular.
9	The Deputy Registrar, Research Administration & Promotion Cell (RAPC), rapc@mu.ac.in
10	The Deputy Registrar, Academic Appointments & Quality Assurance (AAQA) dy.registrar.tau.fort.mu.ac.in ar.tau@fort.mu.ac.in
11	The Deputy Registrar, College Teachers Approval Unit (CTA), concolsection@gmail.com
12	The Deputy Registrars, Finance & Accounts Section, fort draccounts@fort.mu.ac.in
13	The Deputy Registrar, Election Section, Fort drelection@election.mu.ac.in
14	The Assistant Registrar, Administrative Sub-Campus Thane, thanesubcampus@mu.ac.in
15	The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan, ar.seask@mu.ac.in
16	The Assistant Registrar, Ratnagiri Sub-centre, Ratnagiri, ratnagirisubcentre@gmail.com
17	The Director, Centre for Distance and Online Education (CDOE), Vidyanagari, director@idol.mu.ac.in
18	Director, Innovation, Incubation and Linkages, Dr. Sachin Laddha pinkumanno@gmail.com
19	Director, Department of Lifelong Learning and Extension (DLLE), Dlleuniversityofmumbai@gmail.com

Copy for information :-

1	P.A to Hon'ble Vice-Chancellor, vice-chancellor@mu.ac.in
2	P.A to Pro-Vice-Chancellor pvc@fort.mu.ac.in
3	P.A to Registrar, registrar@fort.mu.ac.in
4	P.A to all Deans of all Faculties
5	P.A to Finance & Account Officers, (F & A.O), camu@accounts.mu.ac.in

To,

1	The Chairman, Board of Deans pvc@fort.mu.ac.in
2	Faculty of Humanities, Dean 1. Prof.Anil Singh Dranilsingh129@gmail.com Associate Dean 2. Dr.Suchitra Naik Naiksuchitra27@gmail.com 3.Prof.Manisha Karne mkarne@economics.mu.ac.in
	Faculty of Commerce & Management, Dean 1. Dr.Kavita Laghate kavitalaghate@jbims.mu.ac.in Associate Dean 2. Dr.Ravikant Balkrishna Sangurde Ravikant.s.@somaiya.edu 3. Prin.Kishori Bhagat kishoribhagat@rediffmail.com

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3	Chairman, Board of Studies,
4	The Director, Board of Examinations and Evaluation, dboee@exam.mu.ac.in
5	The Director, Board of Students Development, dsd@mu.ac.in@gmail.com DSW directr@dsw.mu.ac.in
6	The Director, Department of Information & Communication Technology, director.dict@mu.ac.in

As Per NEP 2020

University of Mumbai



Title of the program

M.Sc. (Environmental Science)

Syllabus for Semester – Sem III & IV

Ref: GR dated 16th May, 2023 for Credit Structure of PG

(With effect from the academic year 2024-25)

University of Mumbai



(As per NEP 2020)

Sr.No.	Heading	Particulars
1	Title of program O: _____ B	M.Sc. (Environmental Science)
2	Scheme of Examination R: _____	NEP 50% Internal 50% External, Semester End Examination Individual Passing in Internal and External Examination
3	Standards of Passing R: _____	40%
4	Credit Structure R. <u>IMP-30B</u>	Attached herewith
5	Semesters	Sem. III
6	Program Academic Level	6.5
7	Pattern	Semester
8	Status	New
9	To be implemented from Academic Year	2024-25

Sign of the BOS

Chairman

Name of the Chairman
BOS in

Sign of the

Associate Dean

Name of the Associate
Dean
Faculty of

Offg.

Sign of the

Offg. Associate Dean

Name of the Associate
Dean
Faculty of

Sign of the

Offg. Dean

Name of the Dean
Faculty of

Preamble

1) Introduction

The University of Mumbai offers a unique opportunity to pursue a job-oriented M.Sc. Environmental Science program. This program provides a focused learning environment for those passionate about creating a sustainable future.

The program emphasizes a proactive approach to environmental challenges. Students will gain the knowledge and skills to solve problems at their source, fostering preventative solutions rather than relying solely on reactive measures. This approach equips graduates for success in various sectors, including research, academia, industry, NGOs, and the service sector.

Furthermore, the program directly addresses the growing demand for skilled environmental professionals in both public and private sectors.

2) Aims and Objectives

The M.Sc. Environmental Science program has the following key aims and objectives:

Aim: To cultivate a generation of environmental professionals equipped with the knowledge and skills to address sustainability challenges across various sectors.

Objectives:

- Equip students with the ability to identify and address environmental issues at their root cause, promoting preventative solutions over reactive measures.
- Provide a comprehensive understanding of sustainable practices applicable to research, academia, industry, NGOs, and the service sector.
- Prepare graduates to meet the growing demand for skilled environmental managers and sustainability professionals in both public and private sectors.
- Integrate knowledge from diverse disciplines to cultivate well-rounded environmental professionals capable of tackling complex challenges.

3) Learning Outcomes

- a. Acquire in-depth knowledge and integrate with existing knowledge to sensitize the people about global and local environmental issues.
- b. Develop an ability to identify, critically analyze, formulate and solve environmental problems using basic principles of nature conservation. Get acquainted with environmental and social impacts of any developmental activity.
- c. An ability to design a system and process to meet desired needs of society within realistic limitations such as health, safety, security and environmental considerations.
- d. An ability to design and conduct experiments, interpret data, and provide well informed conclusions.

- e. Communicate effectively socio-economic problems related to environment by appropriate documentations and presentations.
- f. Environments and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

4) Programme Outcomes (POs):

- Demonstrate advanced knowledge and critical thinking skills in environmental science.
- Apply scientific and technological solutions to address complex environmental challenges.
- Manage environmental projects effectively, ensuring ethical considerations and social responsibility.
- Communicate environmental information to diverse stakeholders using appropriate methods.
- Advocate for and implement sustainable practices in various sectors.
- Adapt to emerging environmental issues and technologies.
- Pursue lifelong learning and contribute to advancements in environmental science.

5) Programme Specific Outcomes (PSO):

- Students will gain knowledge about innovative and eco-friendly technologies for pollution mitigation and resource conservation.
- Students will learn to use geospatial tools for environmental mapping, monitoring, and resource management.
- Students will develop practical skills in applying eco-technologies and geospatial tools to real-world environmental problems.
- Students will gain in-depth knowledge about advanced wastewater treatment technologies and their applications.
- Students will explore the use of biotechnology and nanotechnology for environmental remediation and resource recovery.
- Students will gain knowledge about the impacts of pollutants on ecosystems and human health.
- Students will gain knowledge about occupational health hazards, safety protocols, and industrial waste management.
- Students will develop skills in applying sustainability principles to business practices and resource management.
- Students will gain practical experience in implementing industrial hygiene practices and sustainable management strategies.
- Students will further refine their research skills by conducting a more comprehensive research project, culminating in a thesis presentation.
- Students will gain knowledge about intellectual property rights related to environmental technologies and innovations.
- Students will develop skills in environmental management systems, environmental impact

assessment, and environmental auditing.

6) Any other point (if any) –Nil

7) Baskets of Electives- 08 Electives given (Each Semester two)

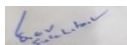
Sem I	Sem II	Sem III	Sem IV
Environmental Economics	Environmental Audit	Environmental Biotechnology & Nanotechnology	Intellectual Property Rights
Wildlife Conservation and Management	Sustainable Tourism	Environmental Toxicology	Sustainable Management

8) Credit Structure of the Program (Table as per परिशिष्ट १ with sign of HOD and Dean)

Credit Structure M.Sc. Part II (Sem III & IV) Environmental Science Ratnagiri Sub-Campus University of Mumbai

R. IMP-30B

Year (2Yr PG)	Level	Sem. (2 Yr)	Major		RM	OJT /FP	RP	Cum. Cr.	Degree
			Mandatory*	Electives Any one (Credits 4)					
II	6.5	Sem III	Eco Technology(Credits 4) PSEVS 301	Environmental Biotechnology & Nanotechnology PSEVSEL 306A Or Environmental Toxicology (Credits 4) PSEVSEL 306B	—	—	Research Project-I (Credits 4) PSEVSPR 305	22	PG Degree (after 3 Year UG)
			Geospatial Technology & Applications PSEVS 302 – (Credits 4) Practicals of PSEVS 301 & 302 PSEVS P 303 – (Credits 4) Advances in Waste Water Technology PSEVS 304 - Credits 2						
		Sem IV	Industrial Hygiene & Chemical Safety SEVS 401 – (Credits 4)	Intellectual Property Rights PSEVSEL 405A Or Sustainable Management (Credits 4) PSEVSEL 405B	—	—	Research Project- II (Credits 6) PSEVSPR 404	22	
			Environmental Management PSEVS 402 – (Credits 4) Practicals of PSEVS 401 & 402 PSEVSP 403 - Credits 4						
Cum. Cr. for 1 Yr PG Degree			26	8			10	44	
Cum. Cr. for 2 Yr PG Degree			54	16	4	4	10	88	



Sign of HOD

Name of the Head of the Department
Name of the Department

Sign of Dean,

Name of the Dean
Name of the Faculty

M. Sc. - II Environmental Sciences Syllabus

(As per NEP 2020)

From the Academic Year 2024-25

Semester - III papers		
Mandatory	Paper Code	Credits
1. Eco Technology	PSEVS 301	4
2. Geospatial Technology & Applications	PSEVS 302	4
3. Practicals of PSEVS 301 & 302	PSEVSP 303	4
4. Advances in Waste Water Technology	PSEVS 304	2
5. Research Project-I	PSEVSPR 305	4
Elective (Any one)		
1. Environmental Biotechnology & Nanotechnology Or 2. Environmental Toxicology	PSEVSEL 306A Or PSEVSEL 306B	4
Semester - IV papers		
Mandatory		Credits
1. Industrial Hygiene & Chemical Safety	PSEVS 401	4
2. Environmental Management	PSEVS 402	4
3. Practicals of PSEVS 401 & 402	PSEVSP 403	4
4. Research Project- II	PSEVSPR 404	6
Elective (Any one)		
1. Intellectual Property Rights Or 2. Sustainable Management	PSEVSEL 405A Or PSEVSEL 405B	4

SEMESTER – III

Mandatory:-

PSEVS 301 Eco Technology (Credits: 4)

Course Objectives:

1. Apply ecotechnology principles and solutions
2. Evaluate technologies for sustainable development
3. Develop and implement phytosanitation techniques

Course outcomes:

By the end of this course, students will be able to:

1. To understand principle of Ecotechnology and its applications
2. To analyze appropriate technology for rural community with respect to their needs
3. To understand and develop appropriate phytosanitation technologies
4. To study C-sequestration projects their modalities & procedures
5. To explore restoration methods for different ecosystem

Unit I (15L)

Introduction to Ecotechnology: Definition, Principles and Concept of Ecotechnology, Ecotechnology approaches, Applications of Ecotechnology, Ecotechnology 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.

Unit II (15L)

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. Eco engineering technology. Green Building, Biosenitizer Ecotechnology, Odorless self- flushing bio toilets.

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.

Biochemical conversion - anaerobic digestion; Types of biogas Plants; Applications – Bioethanol production, Biohydrogen production; Bio-fuel production - Urban waste to energy conversion - Biomass energy programme in India

Unit III

(15L)

Carbon Sequestration and Climate Change Mitigation: Carbon related definitions C-pool, C-stock, C-Flux, C-sink, C-source, sequestration/uptake.

Concept of Carbon footprint, carbon credits and carbon trading Concept of water footprint, water trading and its relationship to climate change

Development of C-sequestration projects their modalities & procedures- reducing emissions from degradation and deforestation (REDD and REDD+)

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,

India's take on Climate Change; takes of Developing and Developed Nations, Mitigation measures at different scales – global, National, organizational, Individual

History of Global Action Plans:

Stockholm Declaration 1972, Nairobi Declaration 1982, 1st Earth Summit Rio 1992, Kyoto Protocol 1997, Copenhagen Summit 2008, Durban Summit 2011, and Paris Agreement 2015. Intergovernmental Panels working towards mitigating Climate Change: IPCC, UNFCCC. India's Perception to Climate Change-India's National Action Plan (Eight Mission), Role of MOEF & other national agencies, UNDP in India addressing climate change, Concept of Adaptation, Factors affecting adaptation strategies. Mitigations Strategies-Policy, Planning, strategies and Program implementation.

Unit IV

(15L)

Restoration Ecology: Definitions, aims and objectives, principles, concept & strategies (long term vs short term), physical chemical & biological restoration, role of ecological principles in restoration, holistic approach in restoration, applications

Restoration of urban eco-system – e.g. ponds, lakes, river banks, avenue trees, biodiversity restoration through gardens, park, restoration of dumping grounds, restoration of eco system on hills, restoration of soil in urban areas, ground water resource – replenishment, sewage or wastewater – recycling for supporting ecosystems Eco-restoration and industrial environment

Restoration of other natural habitats/eco-systems

Mangroves, grasslands, wetlands, restoration of streams, degraded forest patches, coastal ecosystems, etc.

Steps involved in Restoration, Identifying problem, assessment of project sites and parameters, identifying threats, methods available for restoration, selection of restoration methods, monitoring techniques for effective restoration

References:

1. Andrew Dessler, Introduction to Modern Climate Change, 2nd Edition, Cambridge University Press, 2015.
2. Bruce Glavovic, Mick Kelly, Robert Kay, Ailbhe Travers, Climate Change and the Coast: Building Resilient Communities, CRC Press, 2015
3. David E. Kitchen, Global Climate Change: Turning Knowledge into Action, 1st Edition, Prentice Hall, 2013
4. Grégory Beaugrand, Marine Biodiversity, Climatic Variability and Global Change, Earthscan from Routledge, 2012
5. L.Hannah, Climate Change Biology, 2nd Edition, 2014
6. Ryo Fujikura, Tomoyo Toyota, Climate Change Mitigation and International Development Cooperation, Routledge, 2012
7. Wolfson Richard, Energy, Environment, and Climate, Second Edition, Norton, 2011
8. IPCC (Intergovernmental Panel on Climate Change) (1990). *Climate Change: The IPCC Assessment*. Cambridge University Press, Cambridge.
9. Sorokhtin, O.G., Chilingar, G.V. and Khilyuk, L.F. (2007). *Global warming and global cooling: Evolution of climate and earth*, Elsevier, Netherland.
10. Steffen, W., Sanderson A., Tyson P.D., Jager J., Matson P.M., Moore B., Oldfield F., Richardson K., Schnellhuber H.J., Turner B.L. and Wasson R.J. (2004). *Global change and the Earth system: a Planet under Pressure*, Springer-Verlag, New York, USA.
11. Restoration of Nature by Prakash Gole
12. Restoration Ecology the new frontier – edited by Jelte Van Andel and James Aronson – Wiley-Blackwell publication ISBN 9781444336368

13. A source book for Ecological Restoration by Foundation for Ecological Security 2008
14. Foundations of Restoration Ecology (The Science and Practice of Ecological Restoration Series) - Donald A. Falk, Margaret Palmer, Joy Zedler, Richard J. Hobbs
15. Environmental Science – Daniel Chiras (Case Studies)
16. Environment and Ecology-EAS105/EAS 205-R.Radagopalan.
17. Burroughs (2007). Climate Change: A multi-disciplinary approach, 2nd Edition, Cambridge, New York university press

PSEVS 302
Geospatial Technology and Applications (Credits: 4)

Course Objectives:

1. Grasp the fundamentals of remote sensing
2. Develop skills in geospatial data acquisition and processing
3. Gain expertise in geospatial data management and Geographic Information Systems (GIS)
4. Apply geospatial technologies for environmental problem solving

Course Outcomes:

By the end of this course, students will be able to:

1. Explain the principles and applications of remote sensing technologies.
2. Acquire, process, and analyze geospatial data using remote sensing and GIS software.
3. Design and manage geospatial databases for environmental applications.
4. Apply geospatial technologies to solve real-world environmental challenges.

Unit I **(15L)**

Introduction to Remote Sensing: Introduction to remote sensing: history, principles, and types of sensors. Electromagnetic spectrum and its relevance to remote sensing. Remote Sensing Data Acquisition and Processing, Satellite and aerial platforms for remote sensing. Types of remote sensing data: optical, thermal, radar, and LiDAR. Data acquisition and pre-processing techniques.

Unit II **(15L)**

Introduction to GIS Data and Database Management: Basics of GIS: concepts, components, and data models. Spatial data sources: GPS, remote sensing, and field surveys. Data input, editing, and management in GIS. Database design and management for environmental applications. Integration of remote sensing and GIS.

Unit III **(15L)**

Environmental Applications of RS and GIS and Advanced Technique: Land use and land cover mapping. Monitoring and managing natural resources (forests, water, soil). Environmental impact assessment and management. Climate change studies and modelling. Disaster management and mitigation (floods, droughts, earthquakes). Spatial analysis and modeling. Multispectral and

hyperspectral remote sensing. Temporal analysis and change detection. Integrating remote sensing and GIS for environmental modeling.

Unit IV

(15L)

Case Studies and Practical Applications: Real-world applications: deforestation, urban sprawl, water resource management, biodiversity conservation. Hands-on projects using remote sensing and GIS software. Google Earth Pro software and other GIS Softwares.

References:

1. Shahab Fazal (2008): "GIS Basics", New Age international (P) Limited, Publishers, New Delhi.
2. Shefali Aggarwal: Principles Of Remote Sensing.
3. Kang-Tsung (Karl) Chang (2001): Introduction to Geographic Information Systems.
4. Ralph W. Kiefer, Thomas Lillesand (1976): Remote Sensing and Image Interpretation.
5. Shunlin Liang (2012): Advanced Remote Sensing: Terrestrial Information Extraction and
6. Applications.
7. P. A. Burrough (1998): Principles of geographical information systems.
8. Stanley Aronoff (2005): Remote Sensing for GIS Managers.

PSEVSP 303
Practical of PSEVS 301 & PSEVS 302 (Credits: 4)

Practical of PSEVS 301

A. Minor Experiments

1. Determination of Root density
2. Determination of Fertility rejuvenation index
3. Determination of Translocation factor by phytoremediation.
4. Case study on Tehri project, Silent Valley Project , Narmada Dam Project,
1. Biopiracy, Eco disaster of deforestation

B. Major Experiments

1. Tracing of watershed and their morphological features from topo sheets.
2. Interpretation of Aerial photographs/satellite imageries/GIS data.
3. Problems in water budgeting.
4. Designing structures for water conservation and harvesting based on field visits.

Practical of PSEVS 302

A. Minor Experiment

1. Introduction to GIS Softwares
2. To study data Input in GIS Softwares
3. To study Geo Referencing
4. Simple Applications of GIS
5. Applications of Google Earth (Aerial distance, Road distance, 3D Images, Change Detection using Historical imageries etc.)

B. Major Experiment

1. Interpretation of Aerial Photographs using mirror stereoscope
2. Interpretation of Aerial Photographs using pocket stereoscope
3. Calculations of Scale, Relief Displacement of Aerial Photographs
4. Digitization of Map/ Toposheet
5. Developing Digital Elevation Model

PSEVS 304
Advances Waste water Technology (Credits: 2)

Course Objectives:

1. Develop expertise in advanced wastewater treatment technologies
2. Gain knowledge about air pollution control technologies
3. Explore hazardous and radioactive waste management practices
4. Examine biomedical and electronic waste management regulations

Course Outcomes:

By the end of this course, students will be able to:

1. Design and implement advanced wastewater treatment systems for various purposes.
2. Apply air pollution control technologies to mitigate the impact of industrial and transportation emissions.
3. Manage hazardous and radioactive wastes following safe and sustainable practices.
4. Ensure proper handling and disposal of biomedical and electronic waste according to relevant regulations.

Unit I

(15 L)

Water and Wastewater Pollution Control: General scheme for the treatment of water for drinking purpose, Water Treatment: UV, H₂O₂, Ozonization, chemical precipitation, disinfection, adsorption, softening, desalinization / demineralization, membrane processes, Biological treatment processes for wastewater- aerobic processes: Suspended floc type- the activated sludge processes. Extended aeration, Aerated lagoons, Waste stabilization ponds, rotating biological contact system, the trickling filter process. Anaerobic processes: Flow through systems and contact systems, UASB reactors and modifications. Sludge types, treatment and disposal. Processing of sludges- conditioning, thickening, dewatering, drying, incineration and disposal, Concept of common effluent treatment plant (CETP) their importance and advantages, role in wastewater treatment. Unit processes involved. Effluent discharge standards, industry specific minimum and national standards. Zero Liquid Discharge (ZLD): Discharge norms, Statutory Bodies – role and duties. Concept and need of Zero Liquid Discharge, treatment technology up gradation as per discharge guidelines. Capital cost and Operational cost. Case Study of ZLD - Brewery, Textile and Dairy Industry with flow diagram

Unit II

(15 L)

Air Pollution Control: Treatment Processes for Particulate matter: Absorption in liquids by Scrubbers, adsorption on solids. Combustion: flaring, thermal incineration, catalytic oxidation, Treatment Processes for other gaseous pollutants: Odour, VOCs, oxides of sulphur and nitrogen emissions, Indoor air quality management, principles and control measures, steps for improving indoor air quality, Auto-exhausts, its components. Control of auto-exhausts emissions. Emission specific control options, use of after burners, engine modifications / tuning; importance of good maintenance

Unit III

(15 L)

Hazardous and Radioactive Waste Management: Hazardous wastes: Sources and characteristics. Classification. Health and environmental effects. Safe storage, transport and treatment of. Stabilization and disposal Criteria for selection for secured and unsecured landfill disposal sites, radioactive waste: sources, classification, health and safety aspects. Control and Management of radioactive wastes

Unit IV

(15 L)

Biomedical Waste and Electronic (E-Waste Management): Biomedical Waste: Definition, Sources of generation, categories, colour coding system for segregation, transportation specifications, treatment methods: Incineration, Microwave, Plasma, Pyrolysis, Hydroclave etc. Treatment and disposal of Plastic waste, Treatment and disposal of metal sharps. Biomedical Waste (Handling and Management) Rules, 1998, E-Waste: Sources of generation, categories, segregation, transportation, treatment methods, Plastic waste treatment and disposal. E-Waste (Handling and Management) Rules 2011

References:

1. Wastewater Treatment for Pollution Control: Soli J. Arceivala, Tata McGraw Hill Publishing Company, New Delhi.
2. Water Supply & Sanitary Engineering: G.S. Birdie
3. Textbook of Water Supply & Sanitary Engineering: S.K. Husain
4. Water Supply & Sanitary Engineering: R. C. Rangwala and S. C. Rangwala, Charotal Publishing House, Anand.
5. Wastewater Treatment: M. N. Rao, A. K. Datta, IBH Publishing Company, New Delhi.
6. A Textbook of Sanitary Engineering: Vinayak Gharpure, Engineering Book Publishing

Company, Pune.

7. Water Pollution: V. P. Kudesia, Pragati Prakashan, Meerut.
8. Environmental Problems and Solution: D.K. Asthana, S. Chand and Company, New Delhi.
9. A Textbook of Environment: K. M. Agarwal and P.K. Sikdar, Macmillon India Ltd, Nagpur
10. Environmental Chemistry: B.K. Sharma, and H. Kaur.
11. Elements of Environmental Chemistry: H.V. Jadhav.
12. Environmental Chemistry: S. K. Banerjee.
13. A text book of Environmental Chemistry and Pollution Control: S. S. Dara.

PSEVSPR 305
Research Project- I (Credits: 4)

Course Objectives:

1. Develop research skills in environmental science
2. Master research methodology
3. Enhance scientific communication skills
4. Foster critical thinking and problem-solving abilities

Course Outcomes:

By the end of this course, students will be able to:

1. Conduct independent research on a chosen environmental science topic.
2. Apply scientific methodologies to collect, analyze, and interpret data.
3. Communicate research findings in a professional and comprehensive written report.
4. Critically evaluate research outcomes and propose future research directions.

It is essential for students to choose a research topic within the field of environmental science. In order to reach a final result, the work involves data collection, analysis, and interpretation. The preparation pages (title page, certificate, acknowledgement page, table of contents, list of tables and figures), References, and Appendices should all be included in the thesis. At the end of the session, the report should be submitted in by the students in the format below.

Title Page

Table of Contents

1. Introduction: This part of a research project should explain to readers the significance of the subject. Also, pertinent information on the subject should be included. In simple terms, the 18 introduction should explain to readers why you have selected the subject or problem and what makes it relevant.
2. Literature Review: It is basically a survey about what other professionals have written or demonstrated about the problem that one is addressing.
3. Materials and Methods or Experimental: The research design should be such that it is able to explain a set of questions like, what experiments were used in the study and what the purpose of those experiments was.
4. Results and Discussion: The writing of this thesis chapter should enable it to explain the findings

using the relevant figures and tables. The results need to be presented, clarified, and analysed in order to improve understanding and drawing conclusions.

5. Summary and Conclusion: This part should act as a summary of the whole thesis for the readers. The conclusion must contain a very brief synopsis of research and design, a summary of the approach used and a glimpse of the results. One has to make sure that the conclusion part is brief, crystal clear and very concise.

6. References: It includes list of all sources cited in the report, formatted according to the specified citation style and proper citation of all external references, including books, journals, articles, and online resources.

Elective (Any One):-

PSEVSEL 306A

Environmental Biotechnology & Nanotechnology (Credits: 4)

Course Objectives:

1. Gain a comprehensive understanding of environmental biotechnology
2. Explore the role of biotechnology in environmental protection and conservation
3. Develop knowledge of organic farming practices
4. Introduce environmental nanotechnology

Course Outcomes:

By the end of this course, students will be able to:

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

Unit I

(15 L)

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: 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.

Unit II

(15 L)

Biotechnology in Protection and Conservation of the Environment: Degradation of Xenobiotic compounds, Microbial degradation of surfactants, Biological Odorization, Bioleaching- Thiobacillusferrooxidans 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.

Unit III (15 L)

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, Bio fertilizers: 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.

Unit IV (15 L)

Environmental Nanotechnology: Nanotechnology and its Applications in Agriculture and Food Industry, Nanotechnology: Materials and Manufacture, 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.

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 Biosystems Approach, 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.

PSEVSEL 306B
Environmental Toxicology (Credits: 4)

Course Objectives:

1. Grasp the fundamental concepts of environmental toxicology
2. Understand the principles governing toxic effects
3. Evaluate the presence and impact of toxicants in the environment
4. Develop strategies for managing environmental toxicology

Course Outcome:

By the end of this course, students will be able to:

1. Students will be able to define environmental toxicology and articulate its significance.
2. Students will understand the factors that affect toxicity, including exposure routes, metabolism, and individual susceptibility.
3. Students will understand the environmental fate and transport of toxic compounds, including bioaccumulation and biotransformation processes.
4. Students will understand and evaluate various control and mitigation strategies to manage and reduce exposure to toxicants, including regulatory frameworks and technological interventions.

Unit I **(15 L)**

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.

Unit II **(15 L)**

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,

Unit III **(15 L)**

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. Bioindicators, Examples of toxic compounds and their toxicity effect: Pesticides, Environmental disasters: Chornobyl, Bhopal gas tragedy. Measurement of toxicity

Unit IV

(15 L)

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

References:

11. Principles of Environmental Toxicology: I. C. Shaw and J. Chadwick; Taylor & Francis ltd
12. Basic Environmental Health (2001): Annalee Yassi, TordKjellstom, Theo de Kok, Tee Guidotti
13. Environmental Health : Monroe T. Morgan
14. Handbook of Environmental Health and Safety – principle and practices : H. Koren; Lewis Publishers
15. 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.
16. Environmental biology and Toxicology, by Sharma P.D. Rastogi and Lamporary., 1994.
17. Environmental pollution and Toxicology by MeeraAsthana and Astana D.K., Alka printers, 1990. 3. Toxicology, by A.Sood, Sarup and sons New Delhi, 1999
18. Text book of Preventive and Social Medicine, by Park J.E. and Park K., Banosidas Bharat Publishers, Jabalpur, 1985
19. Environmental Epidemiology, by AnisaBasheer, Rawat Publication Jaipur, New Delhi 1995.

SEMESTER-IV

PSEVS 401
Industrial Hygiene & Chemical Safety (Credits: 4)

Course Objectives:

1. Develop a comprehensive understanding of industrial hygiene principles
2. Gain expertise in industrial work environment monitoring.
3. Develop disaster management and risk assessment skills:
4. Master safe handling practices for hazardous materials.
5. Gain expertise in personal protective equipment (PPE)

Course Outcomes:

By the end of this course, students will be able to:

1. Implement industrial hygiene practices to ensure worker health and safety.
2. Monitor and evaluate industrial work environments for potential hazards.
3. Develop and implement disaster management and risk assessment plans.
4. Handle hazardous materials safely and follow appropriate safety protocols in various industries.

5. Select, use, and maintain personal protective equipment effectively.

Unit I

(15L)

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 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.

Unit II

(15L)

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

Unit III (15L)

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

Unit IV (15L)

Safety: Safety precautions for transportation for hazardous chemicals. Handling and storage of hazardous chemicals. Precautions in the processes and operations involving explosives, flammables, toxic substances, dusts, vapours, cloud formation and combating, 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.

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

PSEVS 402
Environmental Management (Credits: 4)

Course Objectives:

1. Develop a comprehensive understanding of environmental management principles.
2. Master environmental management systems and life cycle assessment.
3. Gain expertise in environmental audits and environmental economics.
4. Develop knowledge of environmental design (ED) and modeling.

Course Outcomes:

By the end of this course, students will be able to:

1. Implement environmental management principles to promote sustainable practices.
2. Analyze and apply environmental management systems like ISO 14001 and conduct life cycle assessments.
3. Conduct environmental audits and evaluate environmental costs and benefits using economic principles.
4. Integrate environmental design concepts into product development and utilize environmental modeling tools.

Unit I

(15L)

Introduction to principles of Environment Management: Resources and wealth-meaning, types of resources and its exploitation, Wealth-meaning, distinction between wealth and resources, optimum conversion of resources into wealth. Definition, Goals of Environment Management, significance of environmental management, scope of environmental management, 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., Ministry of Environment & Forest, Changes in Environmental Management Practices, Introduction Environmental Management Tools

Unit II

(15L)

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. 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 methods like ecoindicator-95

Unit III

(15L)

Environmental Audit and Environmental Economics: Introduction to environmental audit, Types of environmental audits: objectives- based and clientdriven types. General audit methodology and audit process: Introduction, the basic steps of an environmental audit program. Element of audit process, audit protocols (why, who, what and how). Waste audits and pollution prevention assessments, Waste minization audit examples. Site assessment and liability audit, Introduction to macroeconomics, microeconomics, environmental economics, difference between natural resource economics and environmental economics. 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, Introduction to Market based instruments and command control instrument for pollution control.

Unit IV

(15L)

Environmental Design (ED) and Modeling: Environmental Design; Principles of Environmental Design (ED). Benefits of environmental design, ED of manufactured products, ED considerations in products life stages-DfE concepts, tools for ED of products, Examples of environmental design: Concept of Ecolabel. 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

References:

1. Vijay Kulkarni and T. V. Ramachandra, 2006. Environment Management, Common wealth
2. of Learning, Canada, Centre for Ecological Sciences, Indian Institute of Science, Karnataka
3. Environment Research Foundation. TERI press.
4. Environmental Economics for Non-Economist, John Asafu-Adjaye, World scientific publishing Co Pvt Ltd, 1999
5. Camborne D F, Environmental Life Cycle Analysis, Lewis Publishers, 1997
6. 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
7. Manufacturing Sciences (NCMS), Irwin Publications, 1995
8. Fundamental concepts of Environmental chemistry, 2009, G. S. Sodhi, Narosa Publishers
Environment Management Systems <http://www.iso.org/iso/home/standards/management-standards/iso14000.htm>

PSEVSP 403
Practical of PSEVS 401 & PSEVS 402 (Credit: 4)

Practical of PSEVS 401

A. Minor Experiment

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/Textile industry.

B. Major Experiment

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

Practical of PSEVS 402

A. Minor Experiments

1. To perform Water/Energy audit in the house/college building /society/laboratory
2. To study sustainability report of major business groups/environment compliance report for a company.
3. Report on Visit to NGO/Biomedical waste management site/hazardous waste
4. Management/Pollution control facility of any industry.
5. Report on Seminar/Conference attended.

B. Major Experiments

1. Report on study tour to the following places
2. Lakes/rivers/estuary/marine ecosystem.
3. National Park/Sanctuary
4. Mangrove Ecosystem/Open Cast Mining/Agricultural field.
5. Pollution Control Board/Research Institute/Meteorology Department.

PSEVS 404
Research Project-II (Credits: 6)

Course Objectives:

1. Develop research skills in environmental science
2. Master research methodology
3. Enhance scientific communication skills
4. Foster critical thinking and problem-solving abilities

Course Outcomes:

By the end of this course, students will be able to:

1. Conduct independent research on a chosen environmental science topic.
2. Apply scientific methodologies to collect, analyze, and interpret data.
3. Communicate research findings in a professional and comprehensive written report.
4. Critically evaluate research outcomes and propose future research directions.

It is essential for students to choose a research topic within the field of environmental science. In

order to reach a final result, the work involves data collection, analysis, and interpretation. The preparation pages (title page, certificate, acknowledgement page, table of contents, list of tables and figures), References, and Appendices should all be included in the thesis. At the end of the session, the report should be submitted in by the students in the format below.

Title Page

Table of Contents

1. Introduction: This part of a research project should explain to readers the significance of the subject. Also, pertinent information on the subject should be included. In simple terms, the 18 introduction should explain to readers why you have selected the subject or problem and what makes it relevant.
2. Literature Review: It is basically a survey about what other professionals have written or demonstrated about the problem that one is addressing.
3. Materials and Methods or Experimental: The research design should be such that it is able to explain a set of questions like, what experiments were used in the study and what the purpose of those experiments was.
4. Results and Discussion: The writing of this thesis chapter should enable it to explain the findings using the relevant figures and tables. The results need to be presented, clarified, and analysed in order to improve understanding and drawing conclusions.
5. Summary and Conclusion: This part should act as a summary of the whole thesis for the readers. The conclusion must contain a very brief synopsis of research and design, a summary of the approach used and a glimpse of the results. One has to make sure that the conclusion part is brief, crystal clear and very concise.
6. References: It includes list of all sources cited in the report, formatted according to the specified citation style and proper citation of all external references, including books, journals, articles, and online resources.
7. The assessment should be based on the supervisor's feedback, submission of report and an open presentation and viva-voce.

Elective (Any One):-

**PSEVSEL 405A
Intellectual Property Rights (Credits: 4)**

Course Objectives:

1. Develop a foundational understanding of Intellectual Property Rights (IPR)
2. Gain expertise in trademarks, particularly within the environmental science field.
3. Develop knowledge of patent rights and copyrights.
4. Analyze the contemporary landscape of IPR and its connection to environmental concerns

Course Outcomes:

By the end of this course, students will be able to:

1. Students could differentiate between various types of Intellectual Property Rights pertinent to environmental sciences:
2. Students will comprehend the historical development, legal definitions, and ecological significance of Trade Marks.
3. Students would acquire knowledge of patent rights and copyrights in the context of environmental conservation and innovation:

4. Students will evaluate the current status and challenges of IPR in environmental practices through case studies:

Unit I (15 L)

Introduction to Intellectual Property Rights: Concept, Definition, and significance of property Historical development and evolution, Nature and Scope of Intellectual Property Rights (IPR): Definition and fundamental characteristics of Intellectual Property Rights (IPR) Importance and role of IPR in innovation and creativity. Types of Intellectual Property Rights: Copyright, Patents, Trademarks, Trade Secrets and Trade Dress, Designs, Geographical Indications, Plant Varieties and Traditional Knowledge

Unit II (15 L)

Trade Marks: Origin, Meaning & Nature of Trade Marks, Types, Registration of Trade Marks, Infringement & Remedies, and Offences relating to Trade Marks, Passing Off, and Penalties Trademarks in the Environmental Science Field -Organic Products: USDA Organic, ECOCERT, And Biodegradable Materials: Biodegradable Products Institute (BPI) Certification, Eco-Friendly Cleaning Products, Energy-Efficient Appliances, Sustainable Fashion: Global Organic Textile Standard (GOTS), Environmental Technologies, Environmental technologies - Renewable energy, Waste Management: and water purification, Electric Vehicles, Green building appliances,

Unit III (15 L)

Patent Rights and Copy Rights: Origin, Meaning of Patent, Types, Inventions which are not patentable, Registration Procedure, Rights and Duties of Patentee, Assignment and license, Restoration of lapsed Patents, Surrender and Revocation of Patents, Infringement, Remedies & Penalties.

Innovative Technologies: Solar panels, wind turbines, recycling processes, waste-to-energy systems, eco-friendly pesticides, and non-toxic cleaning agents. Air and water quality sensors, soil remediation techniques, soil remediation techniques,

Copy Right - Origin, Definition &Types of Copy Right, Registration procedure, Assignment & license, Terms of Copy Right, Piracy, Infringement, Remedies, and Copyrights with special reference to software. Educational and Awareness Materials, Environmental Literature and Art, Documentaries and Films, Music, software,

Unit IV (15 L)

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 the current scenario with case studies. Intellectual Property Rights (IPR) and their intersection with environmental concerns Importance of Trademarks, Patents and Copyrights in the Environmental Field, Environmental Legislation and IPR, Biodiversity and Traditional Knowledge, Green Technologies and Patents, International Commitments, Public Health and Access to Medicines

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.

PSEVSEL 405B
Sustainable Management (Credits: 4)

Course Objectives:

1. Grasp the fundamentals of ESG (Environmental, Social, and Governance) criteria
2. Comprehend the Sustainable Development Goals (SDGs) and Mission LiFE.
3. Develop skills for integrating sustainability into business practices.
4. Apply sustainability knowledge through practical examples and case studies.

Course Outcomes:

By the end of this course, students will be able to:

1. Explain the principles and importance of sustainable management.
2. Evaluate the application of ESG criteria in organizational practices.
3. Analyze the UN Sustainable Development Goals and develop strategies to achieve them.
4. Understand the Mission LiFE initiative and its impact on promoting sustainable lifestyles.
5. Integrate sustainability into business operations and decision-making processes.

Unit I

(15L)

Introduction & Environmental, Social, and Governance (ESG) Criteria: Definition and

Scope, Historical Development and Evolution, Key Concepts: Sustainability, Triple Bottom Line, Corporate Social Responsibility (CSR), Importance of Sustainable Management in Contemporary Business, Overview of ESG , Environmental Criteria: Resource Management, Pollution Control, Climate Change Mitigation, Social Criteria: Labor Practices, Community Engagement, Human Rights, Governance Criteria: Ethical Leadership, Transparency, Accountability, ESG Reporting and Disclosure Standards, Case Studies of ESG Integration in Organizations

Unit II (15L)

Sustainable Development Goals (SDGs) and Mission LiFE (Lifestyle for Environment):

Introduction to the United Nations SDGs, Detailed Study of Each Goal (17 Goals), No Poverty, Zero Hunger, Good Health and Well-being, Quality Education, Gender Equality, Clean Water and Sanitation, Affordable and Clean Energy, Decent Work and Economic Growth, Industry, Innovation, and Infrastructure, Reduced Inequalities, Sustainable Cities and Communities, Responsible Consumption and Production, Climate Action, Life Below Water, Life on Land, Peace, Justice, and Strong Institutions, Partnerships for the Goals, Strategies for Achieving SDGs, Measuring Progress and Impact Assessment, Case Studies of Successful SDG Implementation, Introduction to Mission LiFE, Objectives and Vision, Key Components and Strategies, Promoting Sustainable Lifestyles, Community and Individual Actions for Sustainability, Monitoring and Evaluating the Impact of Mission LiFE, Case Studies of Mission LiFE in Action

Unit III (15L)

Integrating Sustainability into Business Practices: Developing a Sustainability Strategy, Stakeholder Engagement and Collaboration, Sustainability Reporting and Communication, Risk Management and Sustainability, Innovation and Sustainability, Tools and Techniques for, Sustainable Management (e.g., Life Cycle Assessment, Carbon Footprinting), Future Trends in Sustainable Management

Unit IV

(15L)

Practical Applications and Case Studies: Real-world Examples of Sustainable Management Practices, Industry-Specific Sustainability Challenges and Solutions, Group Projects on Sustainable Management Strategies, Analysis of Sustainability Reports from Leading Organizations

References:

1. "Sustainable Business: A One Planet Approach" by Peter Wells
2. "The Sustainable MBA: A Business Guide to Sustainability" by Giselle Weybrecht
3. "Managing Sustainability: First Steps to First Class" by Alan S. Gutterman
4. "The Triple Bottom Line: Does It All Add Up?" edited by Adrian Henriques and Julie Richardson
5. UN Sustainable Development Goals: Official Documentation and Reports
6. ESG Reporting Guidelines by Global Reporting Initiative (GRI)
7. Mission LiFE: Government of India Publications and Resources

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 environmentrelated issues.

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

Examination Scheme: M.Sc. Part II – Environmental Science (Sem III & IV)

A) Theory Examination Pattern:

a) Internal Assessment (CA) – 50%-50 Marks per paper (for 4 credit theory paper)

Particulars	Continuous Internal Assessment CA		Average Marks of Internal – I & Internal – II (Out of 50)
	Internal Test – I (Based on Unit-I, Unit-II)	Internal Test – II (Based on Unit-III, Unit-IV)	
Descriptive Type Exam	50	50	

Two internal examinations are conducted, the first at the middle of the semester, the second at the end of the semester. The average of both the marks is taken.

b) Internal Assessment (CA) – 50% for 2 credit paper of 25 marks.

Particulars	Continuous Internal Assessment CA		Average Marks of Internal – I & Internal – II (Out of 25)
	Internal Test – I (Based on Unit-I)	Internal Test – II (Based on Unit-II)	
Descriptive Type Exam	25	25	

c) External Examination – 50% - 50 Marks paper pattern (for 4 credit theory paper)

Semester end theory examinations are conducted for each paper.

Duration - The duration of these examination is 2 hours.

Theory Question Paper Pattern: (for 4 credit paper of 50 marks)

All questions shall be compulsory with internal choice within the question.

Question	Options	Marks
Q. 1	Any 2 out of 4 (Unit I)	10
Q. 2	Any 2 out of 4 (Unit II)	10
Q. 3	Any 2 out of 4 (Unit III)	10
Q. 4	Any 2 out of 4 (Unit IV)	10
Q. 5	Any 4 out of 8 (Short notes based on Unit I, II, III, IV)	10
	Total	50

d) Theory question paper pattern: (for 2 credit paper of 25 marks)

Duration – Duration of these exam is one hour

Question	Options	Marks
Q. 1	Any 2 out of 4 (Unit I & II)	9
Q. 2	Any 2 out of 3 (Unit I)	8
Q. 3	Any 2 out of 3 (Unit II)	8
	Total	25

B) Practical Examination Pattern:

a) Internal Assessment (CA) – (Practical 50%)

Particulars	Continuous Internal Assessment CA		Average Marks of Internal – I & Internal – II (Out of 50)
	Internal Test – I	Internal Test – II	
Practical (1 Major of 25 marks, 1 Minor of 15 marks)	40	40	
Journal (05) + Viva (05)	10	10	

	50	50	
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Two internal examinations are conducted, the first at the middle of the semester, the second at the end of the semester. The average of both the marks is taken.

b) External Assessment (Practical 50%)

Sr. No.	Evaluation Type	Total Marks
1	Practical (1 Major of 25 marks, 1 Minor of 15 marks)	40
2	Journal (05) + Viva (05)	10
	Total	50

The semester end practical examination will be based on the practical activities conducted throughout the course, as determined by the Chairperson concerned. It will encompass all practical exercises outlined in the syllabus while maintaining the courses academic integrity.

C) Evaluation of Research Project (I & II): Total Marks 100

External Evaluation (50%): 50 marks

Internal Evaluation (50%): 50 marks

As a part of National Education Policy 2020, students are required to complete a research project in the Sem III (4 credits: 120 hrs.) & Sem IV (6 credits: 180 hrs.). The evaluation of this project will be based on supervisor's feedback, submission of report, an open presentation, and Viva-voce. The evaluation of this training will be conducted in accordance with University of Mumbai guidelines. The evaluation pattern may be changed if the University of Mumbai declares so.

Scheme of Examination M.Sc. Part II (Semester III & IV)

Semester	Course Code No.	Credits	Semester End University Examination			Internal Assessment		
			Out of Marks	Passing Marks	Duration in Hrs.	Out of Marks	Passing Marks	Duration in Hrs.
Semester I	PSEVS 301	4	50	20	2	50	20	2
	PSEVS 302	4	50	20	2	50	20	2
	PSEVSP 303	4	50	20	4	50	20	4
	PSEVS 304	2	25	10	1	25	10	1
	PSEVSPR 305	4	50	20	--	50	20	--
	PSEVSEL 306A Or PSEVSEL 306B	4	50	20	2	50	20	2
Semester II	PSEVS 401	4	50	20	2	50	20	2
	PSEVS 402	4	50	20	2	50	20	2
	PSEVSP 403	4	50	20	4	50	20	4
	PSEVSPR 404	6	50	20	--	50	50	--
	PSEVSEL 405A Or PSEVSEL 405B	4	50	20	2	50	20	2

Letter Grade and Grade Points

Semester GPA/ Program CGPA/ Program	% of Marks	Alpha-Sign/ Letter Grade Result
9.00-10.00	90.0-100	O (Outstanding)
8.00<9.00	80.0<90.0	A+ (Excellent)
7.00<8.00	70.0<80.0	A (Very Good)
6.00<7.00	60.0<70	B+ (Good)
5.50<6.00	55.0<60.0	B (Above Average)
5.00<5.50	50.0<50.0	C (Average)
4.00<5.00	40.0<50.0	P (Pass)
Below 4.00	Below 40	F (Fail)
Ab (Absent)		Absent

Sign of the BOS

Chairman

Name of the Chairman

BOS in

Sign of the

Associate Dean

Name of the Associate

Dean

Faculty of

Offg.

Sign of the

Offg. Associate Dean

Name of the Associate

Dean

Faculty of

Sign of the

Offg. Dean

Name of the Dean

Faculty of