

# University of Mumbai



No. AAMS(UG)/ **59** of 2022-23

## CIRCULAR:-

Attention of the Principals of the Affiliated Colleges, the Head of the University Departments and Directors of the Recognized Institutions in Inter-disciplinary studies Faculty is invited to the syllabus uploaded by Academic Authority Unit which was accepted by the Academic Council at its meeting held on 6<sup>th</sup> June, 2012 vide item No. 4.121 relating to the revised syllabus as per the (CBSGS) for the M.Sc.(Environmental Science) (Sem- I & II) .

They are hereby informed that the recommendations made by the Ad-hoc Board of Studies in **Environmental Science** at its meeting held on 19<sup>th</sup> January, 2022 and subsequently passed in the faculty and then by the Board of Deans at its meeting held on 2<sup>nd</sup> May, 2022 vide item No. 8.5 (R) have been accepted by the Academic Council at its meeting held on 17<sup>th</sup> May, 2022 vide item No.8.5(R) and that in accordance therewith, the revised syllabus of **M.Sc.(Environmental Science) – Sem I and II (CBCS)** has been brought into force with effect from the academic year 2022-23. (The same is available on the University's website [www.mu.ac.in](http://www.mu.ac.in)).

MUMBAI – 400 032

**28<sup>th</sup>** June, 2022

To

The Principals of the Affiliated Colleges, the Head of the University Departments and Directors of the Recognized Institutions in Faculty of Inter-disciplinary.

A.C/8.5(R)/17/05/2022

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No. AAMS(UG)/ **59** -A of 2022-23

**28<sup>th</sup>** June, 2022

Copy forwarded with Compliments for information to:-

- 1) The Dean, Faculty of Inter-disciplinary Studies,
- 2) The Chairman Ad-hoc Board of Studies Environmental Science,
- 3) The Director, Board of Examinations and Evaluation,
- 4) The Director, Board of Students Development,
- 5) The Director. Department of Information & Communication Technology,
- 6) The Co-ordinator, MKCL.

(Dr. Vinod Patil)  
I/c Registrar

**Copy to :-**

- 1. The Deputy Registrar, Academic Authorities Meetings and Services (AAMS),**
- 2. The Deputy Registrar, College Affiliations & Development Department (CAD),**
- 3. The Deputy Registrar, (Admissions, Enrolment, Eligibility and Migration Department (AEM),**
- 4. The Deputy Registrar, Research Administration & Promotion Cell (RAPC),**
- 5. The Deputy Registrar, Executive Authorities Section (EA),**
- 6. The Deputy Registrar, PRO, Fort, (Publication Section),**
- 7. The Deputy Registrar, (Special Cell),**
- 8. The Deputy Registrar, Fort/ Vidyanagari Administration Department (FAD) (VAD), Record Section,**
- 9. The Director, Institute of Distance and Open Learning (IDOL Admin), Vidyanagari,**

**They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above circular and that on separate Action Taken Report will be sent in this connection.**

- 1. P.A to Hon'ble Vice-Chancellor,**
- 2. P.A Pro-Vice-Chancellor,**
- 3. P.A to Registrar,**
- 4. All Deans of all Faculties,**
- 5. P.A to Finance & Account Officers, (F.& A.O),**
- 6. P.A to Director, Board of Examinations and Evaluation,**
- 7. P.A to Director, Innovation, Incubation and Linkages,**
- 8. P.A to Director, Board of Lifelong Learning and Extension (BLLE),**
- 9. The Director, Dept. of Information and Communication Technology (DICT) (CCF & UCC), Vidyanagari,**
- 10. The Director of Board of Student Development,**
- 11. The Director, Department of Students Welfare (DSD),**
- 12. All Deputy Registrar, Examination House,**
- 13. The Deputy Registrars, Finance & Accounts Section,**
- 14. The Assistant Registrar, Administrative sub-Campus Thane,**
- 15. The Assistant Registrar, School of Engg. & Applied Sciences, Kalyan,**
- 16. The Assistant Registrar, Ratnagiri sub-centre, Ratnagiri,**
- 17. The Assistant Registrar, Constituent Colleges Unit,**
- 18. BUCTU,**
- 19. The Receptionist,**
- 20. The Telephone Operator,**
- 21. The Secretary MUASA**

**for information.**

# **UNIVERSITY OF MUMBAI**



**Revised Syllabus for M.Sc. (Environmental Science)**  
**Semester - Sem I and II**  
**(Choice Based Credit System)**

**(With effect from the academic year 2022-23)**

# UNIVERSITY OF MUMBAI



## Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	M.Sc. (Environmental Science)
2	Eligibility for Admission	As per University norms
3	Passing Marks	40%
4	Ordinances / Regulations ( if any)	
5	No. of Years / Semesters	Sem I and II
6	Level	P.G. ( <b>Strike out which is not applicable</b> )
7	Pattern	Semester ( <b>Strike out which is not applicable</b> )
8	Status	New ( <b>Strike out which is not applicable</b> )
9	To be implemented from Academic Year	2022-23_____

Name & Signature of BOS Chairperson :

Name & Signature of Dean:

## **M. Sc. (Environmental Science) Syllabus**

1. Each student is expected to take 4 credits per theory paper and two credits per practical in each semester.
2. At the end of each semester each student will be examined both in the theory and in the practicals. Similarly the student has to appear for the internal examination of theory and practicals as per the ordinances.
3. The candidate is expected to submit a journal certified by the head of the department or institution at the time of the practical examination.
4. A candidate will not be allowed to appear for the practical examination unless he or she produces a certified journal or a certificate from the head of the institution or department stating that the journal is lost and the candidate has performed the required number of experiments satisfactorily. The list of the experiments performed by the candidate should be attached with such certificate
5. Use of non programmable calculators is allowed both at the theory and the practical examination.

**Semester-I papers:**

- 1) Ecology and Ecosystem
- 2) Biodiversity
- 3) Environment and Natural resources
- 4) Environmental Pollution

**Semester-II papers:**

- 1) Environmental monitoring and Assessment
- 2) Pollution control technology
- 3) Green Technology
- 4) Environment Acts Rules and Regulations



## **SEMESTER-I**

### **PSEVS101**

#### **Ecology and Ecosystem: (Credit: 4)**

##### **Unit I**

**(15 L)**

**Ecology:** Definition, principle and scope of ecology, aquatic and terrestrial ecology, freshwater ecology, marine ecology, estuarine ecology, Community concept, types of community, succession process, competition and Coexistence, types of interactions: predation, parasitism, antibiosis, commensalism, cooperation and mutualism, population growth.

##### **Unit II**

**(15L)**

**Concept of Biosphere and ecosystem:** Biomes, Population parameters, structure, Growth Regulation, Interaction between populations, life, history, strategies. Types of ecosystem, eco system of India, Characteristics of eco system, structure of ecosystem and function of an ecosystem, population Dynamics, Carrying capacity. Abiotic and Biotic environment, limiting factors, adaptation, Habitat and niche, nature of environment. Littoral Zones: Fauna of intertidal zones, their distribution and adaptations, ecological importance of mangrove vegetation, distribution of mangrove areas in India, salinity ingress in coastal areas.

Marine Environment: Biota in different types of zones, its diversity-plankton, nekton, benthos, their adaptations and productivity, Indian marine territory, Exclusive Economic Zones (EEZ)

Dynamic biogeography: routes of migration of plants and animals, their impact on local ecosystems, trade routes, shipping, accidental import, weeds, ballast water.

##### **Unit III**

**(15L)**

**Organization of Ecological systems:** Ecosystem components, Producers, consumers and decomposer, Food chains, food web and ecological pyramids, Biotic and abiotic components, Ecological pyramids, Bioaccumulation and biomagnifications, mass and energy transfer in successive trophic level, **Ecosystem Services, Ecological Footprint, Biocapacity, Quantification of Ecological Footprint.**

#### Unit IV

(15L)

**Energy and Ecological succession:** Flow and energy fixation, construction of ecological pyramids. Biogeochemical cycles: Hydrological cycles, carbon cycle, oxygen cycle, nitrogen cycle, sulfur cycle, phosphorus cycle-its importance and applications. **Biogeochemical Cycles with perspective to Organisms, Perspectives of Sustainability**, Primary succession, secondary succession and ecological climax, impacts of development of ecosystem, population, community ecology, predator and prey relationship.

#### Texts/References:

- 1) E. P. Odum (1996) Fundamentals of Ecology, Nataraj Publisher, Dehra Dun.
- 2) K.M.M. Dakshini (1999) Principle and Practices in Plant Ecology, CRC, Boston.
- 3) M.C. Dash (1994) Fundamentals of Ecology, Tata McGraw Hill, New Delhi.
- 4) M.C. Molles Jr. (1999) Ecology- Concepts and Application, McGraw Hill, New Delhi.
- 5) V. Ingegnoli (2002) Landscape Ecology: a widening foundation, Springer, Bonn.
- 6) E.J. Kormondi (1999) Concepts of Ecology, Prentice Hall of India, New Delhi.
- 7) Chapman, J.L. and Reiss M.J. (2005) Ecology Principles and Applications, Cambridge University Press, London.
- 8) E.P. Odum and G. W. Barrett (2005) Fundamentals of Ecology, Thomson Asia Pvt. Ltd., Singapore.
- 9) S.V.S. Rana (2005) Essentials of Ecology and Environmental Sciences, Prentice Hall of India, New Delhi.
- 10) Environment And Ecology-EAS105/EAS 205-R.Rajagopalan
- 11) Environmental Studies from Crisis to Cure-2<sup>nd</sup> Edition-R.Rajagopalan
- 12) Fundamentals of Environmental Science and Ecology (Zigma Publication)
- 13) Environmental Biotechnology-Alan Scragg,Oxford University Press.



## PSEVS 102

### Biodiversity: (Credit: 4)

#### Unit I (15L)

**Biodiversity concept and components:** Biodiversity concept, Biodiversity-components, Biodiversity-Types, Biodiversity-importance, ecological importance, economical importance, key stone umbrella and flagship species, Economic value of biodiversity, ecotone and niche. **Biodiversity Hotspot, Wildlife Act, CBD, AICHI Biodiversity targets,**

#### Unit II (20L)

**Biodiversity and evaluation:** Biodiversity- values, Biodiversity status: National status and Global status, hotspot; threatened species, **IUCN Category**, IUCN Red list, endangered species, vulnerable species, rare species, extinct species and endemic species. Climate change, induced losses. common flora and fauna in India-Aquatic: phytoplankton, Zooplankton and macrophytes. Terrestrial: Forests; Endangered and threatened species.

#### Unit III (10L)

**Biodiversity Convention and Biodiversity Act:** IPRs, national and international programs for biodiversity conservation. Wildlife values and eco-tourism, wildlife distribution in India, problem in wildlife protection, role of WWF, WCU, CITES, TRAFFIC, Wildlife Protection Act 1972. **Joint Forest Management, People's Biodiversity Register, Current status and Case Studies of Biodiversity Conservation Projects (flora and fauna) Speciation in PAN India, NAGOA protocol.**

#### Unit IV (15L)

**Biodiversity Conservation:** Importance of Biodiversity conservation, Different approaches for Biodiversity conservation-In-situ conservation: sanctuaries, biospheres reserves, national parks, nature reserves, preservation plots. Ex-situ conservation: botanical gardens, zoos, aquaria, homestead garden; herbarium; In-vitro Conservation: germplasm and gene Bank; tissue culture: pollen and spore bank, DNA bank.



### **Texts/References:**

- 1) Sustaining Life: How Human Health Depends on Biodiversity Eric Chivian Aaron Bernstein (2008)
- 2) Shahid Naeem, Daniel E. Bunker, Andy Hector and Michel Loreau (2009) Biodiversity, ecosystem functioning and human well being: An ecological and economic perspective
- 3) S.K. Agarwal et al (1996) Biodiversity and Environment, APH, Dehra Dun.
- 4) S.S. Negi (1993) Biodiversity and its Conservation in India, Indus Publications, New Delhi.
- 5) W.W. Collins and C.O. Qualset (1998) Biodiversity in Agro-ecosystem, CRC, Boston.
- 6) V.K. Krishnamurthy (2003) Text Book of Biodiversity, Science Publisher, Chennai.
- 7) P.S. Ramakrishnan (2000) Mountain Biodiversity, Land Use Dynamics and Traditional Ecological Knowledge, Oxford and IBH, New Delhi
- 8) Global Biodiversity strategy: WRI, IUCN & UNEP
- 9) Ecotourism and Sustainable Development: Singh; Abhijeet Pub

### **PSEVS103**

#### **Environment and natural resources: (Credit: 4)**

#### **Unit I (10L)**

**Environment:** Definition of Environment, Earth, Man and Environment, Evolution of environment, Physico-chemical and Biological Characteristics of environment. Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. Geographical classification, Distribution and zones.

**Minerals and their Classification, Characteristics of Soil.**

#### **Unit II (20L)**

**Mass and energy:** Transfer of mass and energy across various interfaces. First and second laws of thermodynamics, heat transfer processes, Biogeochemical cycles, gaseous and sedimentary turnover rate and turnover time, General relationship between landscape and climate. Climates of India, Indian monsoon, Drought, Tropical cyclones and western disturbances. Atmosphere stability and instability, tem-

perature inversion and mixing heights, heat balance of the earth- atmosphere system, global climate change. **El NINO Effect, Meteorological and Climatic Aspects, Mass and Energy.**

### **Unit III**

**(20L)**

**Natural resources:** Types of natural resources, Forest resources: use and over-exploitation, deforestation, timber extraction, mining, dams and their effects on forests and tribal people. Water resources: use and utilization of surfaces and ground water, floods drought, dams-benefits and problems. Mineral resources: environmental effects of extracting and using mineral sources. Food resources: World food problems overgrazing, effects of modern agriculture, fertilizers-pesticides problems, Water logging, salinity. Land resources: Land as a resource, Land degradation, man induced landslides, soil erosion and desertification

### **Unit IV**

**(10L)**

**Energy resources:** Concept and demand of energy, Growing energy needs, Renewable and non-renewable sources, use of alternate energy sources, Wind energy, Solar energy, water as source of energy, Biofuels production, use and sustainability, use and over exploitation of energy sources and associated problems. **Waste to Energy, Clean Energy, Sustainable Energy**, Role of an individual in conservation of natural resources. Equitable use resources for sustainable lifestyles.

### **Texts/References:**

- 1) Renewable Energy – Environment and Development: M. Dayal; Konark Pub. Pvt. Ltd.  
Alternative Energy: S. Vandana; APH Publishing Corporation
- 2) Nuclear Energy – Principles, practice and prospects: S. K. Agarwal; APH Publishing Corporation
- 3) S. Glasstone, D. Van Nastrand, Source book on atomic energy, 3rd Edition, Germany, 1967
- 4) M. Eisendbud, Environmental radioactivity, Academic Press
- 5) E.D.Enger, B.E. Smith, Environmental Sciences- A study of Inter relationships, WCB Publication
- 6) Bio-Energy Resources: Chaturvedi; Concept Pub.
- 7) National Energy – policy, crisis and growth: V S. Mahajan; Ashis Publishing House
- 8) Geography and Energy – Commercial energy systems and national policies: J. D. Chapman

**PSEVS104**  
**Environmental Pollution: (Credit: 4)**

**Unit I** **(20L)**

**Introduction to Environmental pollution, Air and Water Pollution:** Definition and sources of pollution; Different types of pollution and their global, regional and local aspects. Types and sources of air pollutants; Reaction of pollutants in air forming smog, **Ozone Formation and Depletion**, PAN, Acid rain; Atmospheric diffusion and stack performance; Transport of pollutants; Effects of air pollutants on flora and fauna; Sinks of atmospheric gases. Sources of water and their contamination; Types of pollutants, various industrial effluents such as pulp and paper mills, oil exploration and refinery, petrochemicals, iron and steel industries, domestic wastes ,organic debris, agricultural wastes, pesticides; Eutrophication – causes, effects and control measures.

**Unit II** **(10L)**

**Soil pollution and solid waste pollution:** **Soil Microbiology**, Causes of soil pollution; Effects of Fungicides and weedi-cides on soil components, residual toxicity and pollution. Different kinds of synthetic fertilizer (N, P, K), and their interactions with different components of soil, their toxicity and pollution. Industrial effluents and their interactions with soil components, Contamination by radio nuclides. Solid waste pollution: sources, nature, classification and environmental effects.

**Unit III** **(15L)**

**Radiation and Noise pollution:** Radioactive decay; Interaction of radiation with matter; Biological impact and health hazards associated with radiation, Units of radioactivity and radiation dose; **Sources of Nuclear Energy, Radioactive Decay, Half Life Hazards**, Protection against ionizing isotopes and their applications in waste water and air pollution analysis and treatment; Radioactive waste disposal. Basic properties of sound waves – plane and spherical waves, sound pressure, loudness and intensity levels, decibel; Sources of Noise Pollution–Measurement and analysis of sound, Measures to control noise pollution.

#### Unit IV

(15L)

**Thermal pollution, Oil Pollution, Electronic waste (E-waste) and Plastic Waste:** Definition and sources, Chemical and biological effects of thermal pollution, Effect on marine life, bacteria and water quality and other aquatic biota; Thermal pollution from power plants and their control. Oil pollution and marine ecology, sources of oil pollution, factors effecting fate of oil after spillage movement, spreading, evaporation, emulsification, dispersion, remote sensing in water quality monitoring. **Classification of E Waste and its Impacts,** Sources and types and constituents of E-wastes and its environmental consequences, **Types of Plastics and its pollution Impacts**

#### Texts/References:

- 1) J.N.B. Bell (2002) Air Pollution and Plant Life, 2nd Edition, John Wiley and Sons, New Delhi.
- 2) Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.
- 3) Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
- 4) Air Pollution – Stern
- 5) Environmental Pollution Control Engineering: C. S. Rao
- 6) Environmental Chemistry : B.K. Sharma, and H. Kaur
- 7) Air pollution – threat and response: D. A. Lynn
- 8) Air pollution and Environmental Protection – Legislative policies, Judicial trend and Social perceptions: N. Kumar; Mittal Publication

## **SEMESTER I**

### **PSEVSP101 ECOLOGY AND ECOSYSTEMS**

#### **A. Minor Experiments**

1. Determination of diversity indices in plant communities.
2. To construct ecological pyramids of population sizes in ecosystem.
3. Determination of Chlorophyll content from plant species.
4. Determination of Harvest method from plant species.

#### **B. Major Experiments**

1. Determination of Importance value index of species in a plant community.
2. To compare two plant communities
3. Quantitative measurement of plankton in fresh and marine water samples.
4. Determination of primary productivity by light and dark bottle method.
5. To analyse the carbon sequestration of plant species.

### **PSEVSP102**

#### **Biodiversity**

#### **A. Minor Experiments**

1. Prepare a map of India, showing bio-geographical zones and expanse of territorial waters.
2. Identification and description of plant species.
3. To plot biosphere reserve on a map of India.
4. Prepare a document of endemic and exotic species of plants and animals for a selected PAN.

#### **B. Major Experiments**

1. Indicate distribution range of a plant and animal species identified as endangered on an Indian map.
2. Prepare a map of Maharashtra showing Protected Area Network (PAN) in it.
3. To study qualitative and quantitative characters of a plant community by quadrat method.
4. To study a plant community by using line transect method, using line, belt and profile transects.



### **PSEVSP103**

#### **Environment and Natural Resources**

##### **A. Minor Experiments**

1. Determination of total organic matter in soil.
2. Determination of pH value of different types of soil.
3. Determination of water holding capacity of soil.
4. To quantify hydrological cycle in different land use types in or around specified premises.

##### **B. Major Experiments**

1. Determination of mechanical composition of soil by Pipette method.
2. To study the soil profiles for their height, color, texture and electrical conductivity.
3. Determination of total nitrogen value of the soil by Kjeldahl's method
4. Determination of SAR value of soil.(Sodium Absorption Ratio)

### **PSEVSP104**

#### **Environmental Pollution**

##### **A. Minor Experiments**

1. Determination of Total Dissolved Solids from the lake water.
2. Determination of Total Hardness of well water.
3. Measurement of photo density flux by Luxmeter.
4. Measurement and classification of noise pollution.

##### **B. Major Experiments**

1. Determination of CO<sub>2</sub> in the atmosphere by volumetric method.
2. Determination of physical parameters of (I) Well water (ii) Industrial of given type effluent (iii) River water (iv) Sea water.
3. Determination of Dissolved Oxygen from Sea water by Winkler's method.
4. Determination of Chemical Oxygen Demand value for industrial waste effluent.

#### **5. Free Lime Analysis**

#### **6. Estimation of Silicates & Sulphates**



**Texts/References:**

1. Standard methods for examination of water and waste water , American Public Health Association.
2. A comprehensive laboratory manual for Environmental Sciences and Engineering By P.R. Sreemahadevan Pillai. New Age International Publishers.
3. Chemical and biological methods for water pollution studies By R.K. Trivedi
4. Handbook of water and waste water analysis By S.K. Maiti.
5. Soil and air analysis by S.K. Maiti.

## **SEMESTER-II**

### **PSEVS201**

#### **Environmental Monitoring and Assessment: (Credit: 4)**

##### **Unit I (15L)**

**Environmental Monitoring:** What is environmental quality? Quality of environment for life on earth and man; Advantages of Environmental Monitoring, Deterioration of environmental quality with reference to anthropogenic impact; Methods of assessment of environmental quality; Short term studies/surveys; Rapid assessment; Continuous short and long term monitoring, **Environmental Samplings, Instrumentation and Sampling Equipments.**

##### **Unit II (15L)**

**Environmental Impact Assessment (EIA):** Need of EIA; Scope and objectives; Types of environmental impacts; Steps involved in conducting the EIA Studies; Environmental Impact Assessment techniques-Ad-hoc method, checklist method, overlay mapping method, network method, simulation and modeling technique, matrix method, and system diagram technique; Merits and Demerits of EIA studies.

##### **Unit III (15L)**

**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.

##### **Unit IV (15L)**

**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 output of geographical data; Importance of Geographical

Information System in environmental studies. Global Positioning System (GPS): basic principles, Applications to environmental studies -Point source pollution, hazard monitoring and assessment.

**Text/References:**

1. D. P. Lawrence (2003) Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley and Sons, New Delhi.
2. Environmental Impact Analysis Handbook: J. G. Rau and D. C. Wooten; McGraw-Hill Book Co.
3. Environmental Impact Assessment, L. W. Canter, Mc Graw Hill Publication.
4. P. Morris and R. Therivel (2001), Methods of Environmental Impact Assessment, Spoon Press.
5. J. Weston (1997) Planning and EIA in Practice, Longman.
6. Jos Arts and Angus Morrison-Saunders (2004) Assessing Impact - Handbook of EIA and SEA follow-up, Earthscan, London.
7. website of MoEF, GOI, New Delhi
8. Srivastava, D. C. (2005) Readings in Environmental Ethics: Multidisciplinary perspectives, Rawat Publications, Jaipur.

## PSEVS202

### Pollution Control Technology: (Credit: 4)

#### Unit I

(15L)

**Water Pollution control technologies:** Sewage and waste water treatments systems; Primary, secondary and tertiary treatments; Measurement of treatment efficiencies; Biological treatments - aerobic versus anaerobic treatments; Environmental pollution control- Bioaugmentation and Biostimulation; Biofilms in treatment of waste water; Bioreactors for waste water treatments; Reactors types and design; Reactors in series; Development and optimization of membrane bioreactor process for use in sanitary and industrial sewage treatment. **Water Pollution Control Acts.**

#### Unit II

(15L)

**Air pollution control technologies and devices:** Methods to control air pollution in the environment, Limestone injection and fluidized bed combustion, Desulfurization; Catalytic converter and control of vehicular emission, Gravity settling chamber, Centrifugal collectors- cyclone collector and dynamic precipitators; Electrostatic precipitators; Fabric filters, **Air Quality Index.**

#### Unit III

(15L)

**Solid, Toxic, and Hazardous waste management:** solid waste disposal methods – open dumps, ocean dumping, Land fills, Incineration; Recycling and reuse. Organic pollutants and Hazardous waste disposal and management. Management of Radiation, noise, thermal, oil and e-wastes: recycling of waste. Biosorption - Biotechnology and heavy metal pollution; Oil field microbiology; Improved oil recovery; Biotechnology and oil spills; Hydrocarbon degradation, **Solid Waste Management and its Guidelines etc.**

#### Unit IV

(15L)

##### **Biotechnological methods to control pollution:**

Bioremediation, Biotransformation Biodegradation and Phytoremediation: In situ and Ex situ bioremediation; Evaluating Bioremediation; Bioremediation of VOCs. Factors affecting process of biodegradation; Methods in determining biodegradability; Contaminant availability for biodegradation.; Use of microbes(bacteria and fungi) and plants in biodegradation and Biotransformation; Phytoremediation: Waste water treatment using aquatic plants; Root zone treatment.

**Text/References:**

- 1) M.H.Fulekar (2005) Environmental Biotechnology Oxford IBH Publishing cooperation.
- 2) M.H.Fulekar (2010) Bioremediation technology recent advances, springer
- 3) N.P Cheremisinoff (1996) Biotechnology for Waste and Wastewater Treatment, William Andrew Publishing, New York.
- 4) Bruce Rittman, Perry L. McCarty, Environmental Biotechnology: Principles and Applications, 2nd edition, McGraw-Hill, 2000.
- 5) Christon J. Hurst, Ronald L. Crawford, Guy R. Knudsen, Michael J. McInerney, Manual of Environmental Microbiology, 2nd edition, ASM Press. 2001.
- 6) Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications, 2nd Edition, McGraw-Hill, 2000.
- 7) Mizrahi & Wezel, Advances in Biotechnological Process
- 8) Raina M. Maier, Ian L. Pepper, Charles P. Gerba. Environmental Microbiology, Academic Press, 2000.
- 9) Gabriel Bitton, Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edition, 1999



## PSEVS203

### Green Technology: (Credit: 4)

#### Unit I (15L)

**Overview, Principle, concepts and Tools of Green technology:** Overview of green chemistry, Chemistry of the atmosphere, principles of sustainable and green chemistry. Basic principles of green technology, concepts of atom economy and carbon trading, tools of green technology. waste minimization and climate change, Zero waste technology, concept of environmentally balanced industrial complexing and industrial ecology, green house effect, climate change, photochemical smog.

#### Unit II (15L)

**Green synthetic methods and designs:** catalytic methods in green synthesis, safer chemicals - different basic approaches; selection of auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements-use of microwaves, ultrasonic energy; selection of starting materials; use of blocking/protecting groups, catalytic reagents; designing of biodegradable products.

#### Unit III: (15L)

**Green Nanotechnology:** Introduction to Nanomaterials and green nanotechnology, Fullerene, carbon nanotubes, Nanoparticles; Green nanoparticle production and characterization; Biocompatibility; Nanomedical applications of green nanotechnologies; use of nanotechnologies and materials impact on biodiversity, resource conservation, ecosystems and human.

#### Unit IV: (15L)

**Green technology applications:** Biocatalysis, green chemistry in industries, fuel cell and electric vehicles, solar energy and hydrogen production, energy from alternate sources; Solar photovoltaic technology, Biofuel production (bio-ethanol and biodiesel), Biomass, prevention/minimization of hazardous/toxic products. Agricultural related practices and food processing, Production of biodegradable materials, concept of green building, Pollution free engineering processes.

### **Text/References:**

- 1) M. H. Fulekar (2010) Nanotechnology Importance and applications, I K international publishing house Pvt.Ltd.
- 2) Lynn Goldman, Christine Coussens, Implications of nanotechnology for environmental health research, National Academic Press, Washington, 2007
- 3) Matlack, A. S. Introduction to Green Chemistry. Marcel Dekker: New York, 2001
- 4) Anastas, P. T.; Warner, J. C. Green Chemistry: Theory and Practice. Oxford Univ. Press:Oxford, 1998.
- 5) Lynn E. Foster: Nanotechnology: Science, Innovation, and Opportunity, December 21, 2005, Prentice Hall
- 6) Fei Wang & Akhlesh Lakhtakia (eds) (2006). Selected Papers on Nanotechnology—Theory & Modeling (Milestone Volume 182). SPIE Press
- 7) Caye Drapcho, Nhuan Phú Nghiêm, Terry Walker (2008). Biofuels Engineering Process Technology. [McGraw-Hill].
- 8) Akhlesh Lakhtakia (ed) (2004). The Handbook of Nanotechnology. Nanometer Structures: Theory, Modeling, and Simulation. SPIE Press, Bellingham, WA, USA
- 9) Green Chemistry: A Textbook by V.K.Ahluwalia
- 10) Handbook of Green Chemistry by Paul Anastas

## **PSEVS204**

### **Environmental Policies and Regulations (4 credit)**

#### **UNIT-I – Evolution of International Environmental Policy (15L)**

- Fundamental principles of environmental protection - sustainable development- Brundtland report 1987.
- Intergenerational and intra-generational Equity, Polluter pays principle, precautionary principle, Public Trust Doctrine.
- Constitutional Perspective: Fundamental right to wholesome environment. Directive principles of state policy. Fundamental duty.
- National Environmental Policy.
- Environmental Regulatory Framework in India.
- Role of International Environmental Agencies -UNEP, GEF, UNFCCC and IPCC

#### **UNIT- II – Environmental Movement In India (15L)**

- Movements related to Environment Sacredgroves, Bishnoi tradition, Chipko movement, Tehridam, Sardar Sarovar, Narmada dam, Almatti dam, Silent Valley.
- Supreme Court Cases – Ratlam Municipality, Ganga Action Plan, Taj Trapezium, Delhi CNG, Tamil Nadu Tanneries, Doon Valley, Span motels private limited case, Oleum gas case

#### **UNIT-III – International Environmental Treaties and Conventions (15L)**

- Stockholm Conference on Human Environment, 1972
- Ramsar Convention on Wetlands, 1971
- Montreal Protocol, 1987,
- Basel Convention (1989, 1992),
- Earth Summit at Rio de Janeiro, 1992
- Kyoto Protocol, 1997
- Earth Summit at Johannesburg, 2002.
- Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade

- Convention on Desertification 1996
- Convention on Biodiversity & Cartagena Protocol on Bio safety
- **Climate Change and Agreements**
- **Paris Agreement**
- **CERP**

#### **UNIT-IV - Objectives and Provisions of Acts and Rules**

**(15L)**

- Indian Forest Act 1927
- Indian Wildlife (Protection) Act, 1972
- Forest Conservation Act 1980
- Forest Rights Act
- Water (Prevention and Control of Pollution) Act, 1974
- Air (Prevention and Control of Pollution) Act 1981
- Environment (Protection) Act, 1986
- Public Liability Insurance Act, 1991
- Bio-Medical Waste (Management & Handling) Rules, 1998
- Recycled Plastics Manufacture and Usage Rules, 1999
- Noise Pollution (Regulation and Control) Rules, 2000
- Municipal Solid Waste (Management and Handling Rules) 2000
- Biodiversity Act 2002
- Water (Prevention and Control of Pollution) Cess (Amendment) Act, 2003
- EIA Notification 2006
- The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008
- Wetland Rules 2009
- National Green Tribunal Act 2010
- Coastal Regulation Zones (CRZ) Rules 2011.
- E-waste Management and Handling Rules 2011
- Plastics Manufacture, Sale and Usage Rules, 2011

**Text/References:**

- Shyam Divan and Armin Rosencranz, 2005, *Environmental Law and Policy in India*, Oxford University Press, New Delhi, 2005
- Leelakrishnan. P, 2008, Environmental Law Case Book ,Lexis Nexis, Butterworths
- Mohanty. S. K., 2011, Environment and Pollution Law, Universal Law Publishing Co.Pvt. Ltd.
- Shastri S C, 2008, Environmental Law, (2nd Edn.), Eastern Book Company, Lucknow
- Singh Gurdip, 2004, Environmental Law in India, Mcmillan& Co.
- Shantakumar S,2005 Introduction to Environmental Law, (2nd Edn.), Wadhwa& Company, Nagpur
- Sahasranaman P B, 2008 Handbook of Environmental Law in India, Oxford University Press (India)
- Environmental Policy by Keith Neil
- Environmental Impact Assessment and Management by Khitoliya R.K



**SEMESTER II**  
**PSEVSP201**

**ENVIRONMENTAL MONITORING AND ASSESSMENT**

**A. Minor Experiments**

1. Interpretation of Aerial photographs and preparing weather report based on it.
2. Determination of relative humidity from the atmosphere.
3. Determination of particulate matter from the industrial area by High Volume Sampler/Settling method.
4. Determination of Salinity of water by volhard's method.

**B. Major Experiments**

1. Determination of Cation-exchange capacity, moisture content, alkalinity/acidity of soil sample.
2. To prepare the station based wind rose for an area.
3. Determination of Residual Chlorine from drinking water using colorimetric method.
4. Determination of hydrocarbon from fuel gas using Orsat's apparatus.

**PSEVSP202**

**POLLUTION CONTROL TECHNOLOGY**

**A. Minor Experiments**

1. To isolate and study a pure culture of microorganism's 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.

**B. Major Experiments**

1. Determination of  $K_2O$  value of soil by flame photometer.
2. Determination of  $P_2O_5$  from soil by Olson's colorimetric method.



3. Determination of SO<sub>2</sub> by spectrophotometry using high volume sampler.
4. Determination of NO<sub>2</sub> from the atmosphere by Colorimetric method using high volume sam-pler.

### **PSEVSP203**

## **GREEN TECHNOLOGY**

### **A. Minor Experiments**

1. To study the Principle and application of Atomic absorption Spectrophotometry for analysis of metal ions from samples.
2. To study the Principle and application of Nephelometry and Turbidimetry: General discussion, Instruments for nephelometry and turbidimetry
3. To Study the chemical reactions involved in green nanotechnology: Nanoparticle production and characterization.

### **B. Major Experiments**

1. Extraction and separation of organic compounds from soil and biological materials
  - a. Ammonium sulphate method (Nichols method),
  - b. TCA method,
  - c. Acid digestion method,
  - d. Wet washing for metals,
  - e. Steam distillation for volatiles
2. To study different separation Techniques: Principle and process of solvent extraction,; Chromatography – principle and application of thin layer and ion exchange chromatography, Gas Chromatography and High Performance Liquid Chromatography.
3. Biofuel production methods and characterization for biodiesel and bioethanol.

## **PSEVSP204**

### **ENVIRONMENTAL POLICIES AND REGULATIONS**

#### **A. Minor Experiments**

1. Legal Case citation (one per student)
2. Reports on various study tours/academic visits.

#### **3. To attend/present research papers in National/International Conferences.**

#### **B. Major Experiments**

1. Preparation/drafting of EIA Report (Chemical Industry, Fertilizer Industry, hydropower station).
2. Report on Eco-tourism.

#### **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.

#### **Texts/References:**

1. Standard methods for examination of water and waste water , American Public Health Association.
2. A comprehensive laboratory manual for Environmental Sciences and Engineering By P.R. Sreemahadevan Pillai, New Age International Publishers.
3. Chemical and biological methods for water pollution studies By R.K. Trivedi
4. Handbook of water and waste water analysis By S.K. Maiti.
5. Soil and air analysis by S.K. Maiti.



### M.Sc Environmental Sciences Semester I

<b>Course Code No. &amp; Title</b>	<b>Unit No.</b>	<b>Credits</b>	<b>Internal as- sessment Marks</b>	<b>External As- sessment Marks</b>
<b>PSEVS 101 Ecology and Ecosystem</b>	<b>I,II,III,IV</b>	<b>4</b>	<b>40</b>	<b>60</b>
<b>PSEVS102 Bio-diversity</b>	<b>I,II,III,IV</b>	<b>4</b>	<b>40</b>	<b>60</b>
<b>PSEVS 103 En-vironment and Natural Re-sources</b>	<b>I,II,III,IV</b>	<b>4</b>	<b>40</b>	<b>60</b>
<b>PSEVS 104 En-vironmental Pollution</b>	<b>I,II,III,IV</b>	<b>4</b>	<b>40</b>	<b>60</b>
<b>PSEVSP 101</b>		<b>2</b>	<b>20</b>	<b>30</b>
<b>PSEVSP 102</b>		<b>2</b>	<b>20</b>	<b>30</b>
<b>PSEVSP103</b>		<b>2</b>	<b>20</b>	<b>30</b>
<b>PSEVSP104</b>		<b>2</b>	<b>20</b>	<b>30</b>

### M.Sc Environmental Sciences Semester II

<b>Course Code No. &amp; Title</b>	<b>Unit No.</b>	<b>Credits</b>	<b>Internal as- sessment Marks</b>	<b>External As- sessment Marks</b>
<b>PSEVS201 Environmental Monitoring and Assess-ment</b>	<b>I,II,III,IV</b>	<b>4</b>	<b>40</b>	<b>60</b>
<b>PSEVS202 Pollution Control and Technology</b>	<b>I,II,III,IV</b>	<b>4</b>	<b>40</b>	<b>60</b>
<b>PSEVS 203 Green Tech-nology</b>	<b>I,II,III,IV</b>	<b>4</b>	<b>40</b>	<b>60</b>
<b>PSEVS 204 Environmen-tal Policies and Regula-tions</b>	<b>I,II,III,IV</b>	<b>4</b>	<b>40</b>	<b>60</b>
<b>PSEVSP201</b>		<b>2</b>	<b>20</b>	<b>30</b>
<b>PSEVSP202</b>		<b>2</b>	<b>20</b>	<b>30</b>
<b>PSEVSP203</b>		<b>2</b>	<b>20</b>	<b>30</b>
<b>PSEVSP204</b>		<b>2</b>	<b>20</b>	<b>30</b>

### **A) Internal Assessment:- 40%**

#### **a) Theory**

<b>Sr. No.</b>	<b>Evaluation type</b>	<b>Marks</b>
<b>1.</b>	<b>Two Assignments/Case study/Project</b>	<b>20</b>
<b>2.</b>	<b>One Class Test (Multiple questions objective)</b>	<b>10</b>
<b>3.</b>	<b>Active participation in routine class instructional deliveries (case studies/seminars/presentations)</b>	<b>05</b>
<b>4.</b>	<b>Overall Conduct as a responsible student, manners, skill in articulation, leadership qualities demonstrated through co-curricular, etc.</b>	<b>05</b>

#### **b) Practicals**

<b>Sr. No.</b>	<b>Evaluation type</b>	<b>Marks</b>
<b>1.</b>	<b>One Practical</b>	<b>10</b>
<b>2.</b>	<b>Journal</b>	<b>05</b>
<b>3.</b>	<b>Viva</b>	<b>05</b>

### **B) External Assessment:- 60%**

#### **a) Semester end Theory Assessment- 60%**

**60 Marks**

- i) Duration – These examinations shall be of two hours duration for each paper.
- ii) Theory Question Paper Pattern:-
  - There shall be five questions each of 12 Marks. On each unit there will be one question and the first one will be based on entire syllabus.
  - All questions shall be compulsory with internal choice within the questions. Each question will be of 18 to 20 Marks with options.
  - Questions shall be subdivided into sub-questions a,b,c..... and the allocation of marks depend on the weightage of the topic

#### **b) Practicals**

**30 Marks (Each Unit)**

## **SEMESTER I**

### **Practical Examination**

**Four Days Examination (Each 4 Hrs. Per day)**

**Marks 120**

#### **Day 1: PSEVSP 101 – Ecology and Ecosystem**

[I] – Major Experiment

20 Marks

[II] – Minor Experiment

10 Marks

#### **Day 2: PSEVSP 102 – Biodiversity**

[I] – Major Experiment

20 Marks

[II] – Minor Experiment

10 Marks

#### **Day 3: PSEVSP 103 – Environment and Natural Resources**

[I] – Major Experiment

20 Marks

[II] – Minor Experiment

10 Marks

#### **Day 4: PSEVSP 104 – Environmental Pollution**

[I] – Major Experiment

20 Marks

[II] – Minor Experiment

10 Marks

### **Note:**

1. 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.
2. A student is expected to submit a journal certified by the head of the Department/ Head of the institution.
3. A student will not be permitted to appear at the practical examination unless he/ she produce a certified journal. If the journal is lost, the students should produce a certificate from the Head of the Department/ Head of the institution stating that he/ she have satisfactory completed the experimental work.

## **SEMESTER II**

### **Practical Examination**

**Four Days Examination (Each 4 Hrs. Per day)**

**Total Marks 120**

#### **Day 1: PSESP 201 –Environmental Monitoring and Assessment**

[I] – Major Experiment	20 Marks
[II] – Minor Experiment	10 Marks

#### **Day 2: PSESP 202 – Pollution Control and Technology**

[I] – Major Experiment	20 Marks
[II] – Minor Experiment	10 Marks

#### **Day 3: PSESP 203 – Green Technology**

[I] – Major Experiment	20 Marks
[II] – Minor Experiment	10 Marks

#### **Day 4: PSESP 204 – Environmental Policies and Regulations**

[I] – Major Experiment	20 Marks
[II] – Minor Experiment	10 Marks

### **Note:**

4. 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.
5. A student is expected to submit a journal certified by the head of the Department/ Head of the institution.
6. A student will not be permitted to appear at the practical examination unless he/ she produce a certified journal. If the journal is lost, the students should produce a certificate from the Head of the Department/ Head of the institution stating that he/ she have satisfactory completed the experimental work.



**UNIVERSITY OF MUMBAI**  
**M.SC. ENVIRONMENTAL SCIENCES**  
**Semester I/Semester II Examination**  
**2012 – 2013**

**Course PSES\_**

**Maximum Marks: 60**  
**Duration: 2 Hrs.**  
**Marks Option 90**

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

**1. Answer any two questions from the following ( Based on Unit I)**

- |    |    |
|----|----|
| a. | 06 |
| b. | 06 |
| c. | 06 |

**2. Answer any two questions from the following ( Based on Unit II)**

- |    |    |
|----|----|
| a. | 06 |
| b. | 06 |
| c. | 06 |

**3. Answer any two questions from the following ( Based on Unit III)**

- |    |    |
|----|----|
| a. | 06 |
| b. | 06 |
| c. | 06 |

**4. Answer any two questions from the following ( Based on Unit IV)**

- |    |    |
|----|----|
| a. | 06 |
| b. | 06 |
| c. | 06 |

**5. Answer any two questions from the following ( Based on Unit IV)**

- |    |    |
|----|----|
| a. | 03 |
| b. | 03 |
| c. | 03 |
| d. | 03 |
| e. | 03 |
| f. | 03 |

**UNIVERSITY OF MUMBAI**  
**M.Sc. ES**  
**Semester I/Semester II**  
**PRACTICAL EXAMINATION PSESP 101/201**  
**(09:00 A.M. – 01:00 P.M.)**

**Total Marks: 30**

1. **Major Experiment:** 20 Marks
2. **Minor Experiment:** 10 Marks

**NOTE:**

1. Practical examination to be conducted as per the practical Syllabus enlisted.
2. Candidates are required to present certified journal on the day of practical examination.

**UNIVERSITY OF MUMBAI**  
**M.Sc. ES**  
**Semester I/Semester II**  
**PRACTICAL EXAMINATION PSESP 102/202**  
**(09:00 A.M. – 01:00 P.M.)**

**Total Marks: 30**

1. **Major Experiment:** 20 Marks
2. **Minor Experiment:** 10 Marks

**NOTE:**

1. Practical examination to be conducted as per the practical Syllabus enlisted.
2. Candidates are required to present certified journal on the day of practical examination.

**UNIVERSITY OF MUMBAI**  
**M.Sc. ES**  
**Semester I/Semester II**  
**PRACTICAL EXAMINATION PSESP 103/203**  
**(09:00 A.M. – 01:00 P.M.)**

**Total Marks: 30**

- 1. Major Experiment: 20 Marks**
- 2. Minor Experiment: 10 Marks**

**NOTE:**

1. Practical examination to be conducted as per the practical Syllabus enlisted.
2. Candidates are required to present certified journal on the day of practical examination.

**UNIVERSITY OF MUMBAI**  
**M.Sc. ES**  
**Semester I/Semester II**  
**PRACTICAL EXAMINATION PSESP104/204**  
**(09:00 A.M. – 01:00 P.M.)**

**Total Marks: 30**

- 1. Major Experiment: 20 Marks**
- 2. Minor Experiment: 10 Marks**

**NOTE:**

1. Practical examination to be conducted as per the practical Syllabus enlisted.
2. Candidates are required to present certified journal on the day of practical examination.