AC – 07/07/2023
Item No. – 8.9(N)

As Per NEP 2020

University of Mumbai

Title of the program

A- P.G. Diploma in Environmental Science **2023-24**

B- M.Sc. (Environmental Science) (Two Year) **2023-24**

C- M.Sc. (Environmental Science) (One Year) **- 2027-28**

Syllabus for

Semester – Sem I & II

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

Preamble

1) Introduction

The Ratnagiri Sub-Campus University of Mumbai is running M.Sc. Environmental Science with 20 seats. This job oriented course is aimed to inculcate the knowledge based on sustainable environment applicable to different sectors viz. research, academics, industries, NGOs and service sector. The program equips individuals to solve problems in these fields at source rather than through end-of-pipe interventions. It aims to satisfy an industrial and public sector demand for trained environment management and sustainability professionals.

2) Aims and Objectives

This job oriented course is aimed to inculcate the knowledge based on sustainable environment applicable to different sectors viz. research, academics, industries, NGOs and service sector. The program equips individuals to solve problems in these fields at source rather than through end-of-pipe interventions. It aims to satisfy an industrial and public sector demand for trained environment management and sustainability professionals.

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) Any other point (if any) –Nil

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

6) Credit Structure of the Program (Table as per ifjf'k"V 1 with sign of HOD and Dean)

7) Credit Structure of the Program (Sem I, II, III & IV) (Table as per Parishisht 1 with sign of HOD and Dean)

R_____

Post Graduate Programs in University Parishishta - 1

Year (2 Yr PG)	Level	Sem. (2 Yr)	Major		RM	OJT / FP	RP	Cum. Cr.	Degree
			Mandatory*	Electives Any one					
I	6.0	Sem I	Course 1 PSEVS 101 Credits 4 Course 2 PSEVS 102 Credits 4 Course 3 PSEVS 103 Credits 4 Course 4 PSEVSP 104 Credits 2	**Credits 4** Course 1 PSEVS 105 A OR Course 2 PSEVS 105 B	**Credits 4** PSEVS 106			22	**PG Diploma (after 3 Year Degree)**
		Sem II	Course 1 PSEVS 201 Credits 4 Course 2 PSEVS 202 Credits 4 Course 3 PSEVS 203 Credits 4 Course 4 PSEVSP 204 Credits 2	**Credits 4** Course 1 PSEVS 205 A OR Course 2 PSEVS 205 B		**Credits 4** PSEVS 206		22	
Cum. Cr. For PG Diploma			**28**	**8**	**4**	**4**	**-**	**44**	

Exit option: PG Diploma (44 Credits) after Three Year UG Degree									
II	**6.5**	**Sem III**	Course 1 PSEVS 301 Credits 4 Course 2 PSEVS 302 Credits 4 Course 3 PSEVS 303 Credits 4 Course 4 PSEVSP 304 Credits 2	**Credits 4** Course 1 PSEVS 305 A OR Course 2 PSEVS 305B			**Credits 4** PSEVS 306	22	**PG Degree After 3-Yr UG**
		Sem IV	Course 1 PSEVS 401 Credits 4 Course 2 PSEVS 402 Credits 4 Course 3 PSEVS 403 Credits 4	**Credits 4** Course 1 PSEVS 403 OR Course 2 PSEVS 404 B			**Credits** 6 PSEVS 405	22	
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

Syllabus
M.Sc. (Environmental Science)
(Sem. I & II)

SEMESTER – I

Mandatory:-

PSEVS 101
Ecology and Ecosystem (Credit: 4)

Unit I **(10L)**

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 **(20L)**

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 adapta- tions, 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 ad- aptations 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 tropical level.

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. Primary succession, secondary succession and ecological climax, impacts

of development of ecosystem, population, community ecology, predatorand 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 Del- hi.
10) Environment And Ecology-EAS105/EAS 205-R.Rajagopalan
11) Environmental Studies from Crisis To Cure-2nd Edition-R. Rajagopalan
12) 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.

Unit II (20L)

Biodiversity and evaluation: Biodiversity values, Biodiversity status: National status and Globalstatus, hotspot; threatened species, 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 macrophyes. 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.

Unit IV **(15L)**

Biodiversity Conservation: Importance of Biodiversity conservation, Different approaches for Biodiversity conservation-In-situ conservation: sanctuaries, biospheres reserves, national parks, nature re- serves, 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 Ecologi-cal Knowledge, Oxford and IBH, New Delhi
8) Global Biodiversity strategy: WRI, IUCN & UNEP

PSEVS 103
Environment and Natural Resources (Credit: 4)

Unit I **(10L)**

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

Unit II **(20L)**

Mass and energy: Transfer of mass and energy across various interfaces. First and second laws of thermodynamics, heat transfer processes, Biochemical cycles, gaseous and sedimentary

turnover rate and turnover item, General relationship between landscape and climate. Climates of India, Indian mon- soon, Drought, Tropical cyclones and western disturbances. Atmosphere stability and instability, temperature inversion and mixing heights, heat balance of the earth-atmosphere system, global climatechange.

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. 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 PublishingCorporation
3) S. Glassstone, 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; Ashish Publishing House
8) Geography and Energy – Commercial energy systems and national policies: J. D.Chapman

PSEVSP 104
Practicals of Semester I

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.

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 Indianmap.
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 quadrate method.
4. To study a plant community by using line transect method, using line, belt and profile transects.

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)

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.

Elective (Any One):-

PSEVS 105A
Environmental Geosciences (Credit: 4)

Unit I **(15L)**

Origin and evolution of Earth: Introduction to universe, plants, comets, asteroids, meteorites theories of origin of earth. Origin and evolution of life; spontaneous generation of life, chemical prokaryotic and eukaryotic cellular evolution, brief outline of crust, mantle, and core.

Unit II **(15L)**

Atmosphere: Earth's Atmosphere: Evolution, structure and chemical composition of atmosphere. Solar radiation and terrestrial radiation electromagnetic spectrum latitudinal and seasonal variations, effect of atmosphere, greenhouse effect heat budget. Temperature measurements and controls, Environmental lapse rate, dry and wetadiabatic lapse rate, inversion of temperature and atmospheric stability. Atmospheric pressure and winds: Pressure measurements and distribution; Wind observation, measurement, factors affecting wind; geostrophic wind and gradient wind,local winds, model of general circulation of the atmosphere, Jet stream. Atmospheric moisture: Forms of condensation; Precipitation, Hydrological cycle. Atmospheric disturbances: Thunderstorms, Cyclones, lightening, flood, and drought.

Unit III **(15L)**

Dynamic aspects of earth and Biogeochemical Cycles: Earthquake, volcano, mountain geotectonic, continental drifts and plate tectonics, introduction of structural geology fold, fault,

joints. Carbon cycle, Nitrogen cycle, Phosphorous cycle, Oxygen cycle, Gaseous and Sedimentary cycle.

Unit IV **(15L)**

Environmental Geology: Concepts of environmental geology, objectives of environment geology, scope of environment geology, significance of environment geology, major reliefs features of earth surface- the external and internal, processes responsible for the modification of earth's surface.

Texts/References:

1) Validya K. S. Book on Environmental geology
2) Edward A. Keuer. Book on Environmental geology
3) Patwardhan A. M. Book on The Dynamics Earth System Prentice publication 1999
4) Keller E. A. Book on Environmental geology, Turk & Turk.

PSEVS 105B
Environmental Economics (Credit: 4)

Unit I **(15L)**

The Economy and the Environment: Two Parts of a Whole – Interlinkages between the economy and the environment. Micro Foundations of Environmental Economics - Theory of Public goods, Externalities and Market failure – The Problem of Social Cost - Design of Environmental Policy.

Unit II **(15L)**

Economic growth, exploitation and sustainability: Economic Growth and the Environment: Environmental Kuznets' curve, Foreign Direct Investment Inflow and the Environmental quality. Economics of Natural Resource Exploitation – Renewable and Non-Renewable Resources – Methods of valuation of Environmental Costs and Benefits. Sustainable Development: Concept of and issues in Sustainable Development, Strategic Planning for Sustainable Development, Economic reforms and sustainable development.

Unit III **(15L)**

Environment Economical Techniques: 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,

Unit IV **(15L)**

Market Based Instruments: Introduction to Market based instruments and command control instrument for pollution control. Economic Instruments for Environmental Protection: Command & Control versus Incentives and Subsidies - Available Policy Options - Effectiveness of these instruments, International Comparisons.

Texts/References:

1) Vijay Kulkarni and T. V. Ramachandra, 2006. Environment Management, Common wealth of Learning, Canada, Centre for Ecological Sciences, Indian Institute of Science, KarnatakaEnvironment Research Foundation. TERI press.
2) Environmental Economics for Non-Economist, John Asafu Adjaye, World scientific publishing Co Pvt. Ltd., 1999
3) Arrow, K.J. and Scitovsky, T., Readings in Welfare Economics Part III, 1969.
4) James, D.E., Economic Approaches to Environmental Problems: Techniques and Results of Empirical Analysis, Elsevier Scientific Publishing Co., 1978.

PSEVS 106

Research Methodology

Unit I **(15L)**

Research Methodology: An Introduction, meaning of research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, and Importance of Knowing how Research is done. Defining the Research Problem: What is Research Problem? Selecting the Problem? Necessity of Definingthe Problem.

Unit II **(15L)**

Research Design: Need for Research Design, Features of a Good Design, Important Concept Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs. Sampling Design; Census and Sample Survey, Implications of a sample Design, Steps in Sampling Design, Criteria for Selecting a Sampling Procedure, Characteristics of a Good Sample Design.

Unit III **(15L)**

Methods of Data Collection: Collection of Primary Data: Collection of Data through Questionnaires, Collection of Data through Schedules, Different between Questionnaires and

Schedules. Selection of Appropriate Method for Data Collection; Case Study Method, Appendices (i): Guidelines for Constructing Questionnaires/ Schedule, (ii): Guidelines for Successful Interviewing, (iii): Difference between Survey and Experiment.

Unit IV **(15L)**

Interpretation and Report Writing: Interpretation and Report Writing: Meaning of Interpretation, Why Interpretation? Technique of Interpretation: Precaution in Interpretation, Significance of Report Writing. Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precaution for Writing Research Reports.

Text/References:

1) Ahuja, Ram (2014). Research methods. Jaipur: Rawat Publications.
2) Babu, G. Ramesh (2008). Research methodology in social sciences. New Delhi: Concept Publishing.
3) Burns, Robert B. (2000). Introduction to research methods. London: Sage Publications.
4) Rajendar Kumar : Research Methodology, APH Publishing
5) Kumar R. Research Methodology: A Step by Step Guide for Beginners. 3rd Ed. London: Sage Publications; 2011.
6) Kothari CR. Research Methodology: Methods and Techniques. 2nd Ed. New Delhi: New Age International (P) Ltd; 2004. Tests of sound measurement.
7) Rastogi VB, editor. Biostatistics. 3rd Ed. New Delhi: Medtech Publications; 2015. Statistical data;
8) Ali Z, Bhaskar SB. Basic statistical tools in research and data analysis.
9) Kothari, C. R., 1985, Research Methodology-Methods and Techniques, New Delhi, Wiley Eastern Limited.
10) Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners, (2nd.ed), Singapore, Pearson Education
11) Shajahan S. : Research Methods for Management, 2004
12) The SAGE Handbook of Qualitative Research (Sage Handbooks) 4th Edition, by Norman K. Denzin (Editor), Yvonna S. Lincoln (Editor)

SEMESTER-II

PSEVS 201
Environmental Pollution (Credit: 4)

Unit I (20L)

Introduction to Environmental pollution, Air and Water Pollution: Definition and sources of pollu- tion; Different types of pollution and their global, regional and local aspects. Types and sources of air pollutants; Reaction of pollutants in air forming smog, 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 and effects and control measures.

Unit II (10L)

Soil pollution and solid waste pollution: Causes of soil pollution; Effects of Fungicides and weedicides 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; 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 and Electronic waste (E-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. Sources and types and constituents of E-wastes and its environmental consequences.

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 Applica-tions, 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 per-ceptions: N. Kumar; Mittal Publication

PSEVS 202
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- Bioremediation, Bio augmentation and Bio stimulation; 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.

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.

Unit III (15L)

Solid, Toxic, and Hazardous waste management: solid waste disposal methods – open dumps, ocean dumping, Landfills, 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.

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 An-drew 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 Enviornamental 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, AcademicPress, 2000.

9) Gabriel Bitton, Wastewater Microbiology, 2nd Edition. Wiley-Liss; 2nd Edition, 1999

PSEVS 203
Environmental Policies and Regulations (Credit: 4)

Unit I **(15L)**

Evolution of International Environmental Policy

- Fundamental principles of environmental protection - sustainable development-Brundtland report1987.
- Intergenerational and intra-generational Equity, Polluter pays principle, precautionary principle,Public Trust Doctrine.
- Constitutional Perspective: Fundamental right to wholesome environment. Directive principles ofstate policy. Fundamental duty.
- National Environmental Policy.
- Environmental Regulatory Framework in India.
- Role of International Environmental Agencies -UNEP, GEF, UNFCC and IPCC

Unit II **(15L)**

Environmental Movement in India

- 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 **(15L)**

International Environmental Treaties and Conventions

- Stockholm Conferenceon Human Environment, 1972
- Ramsar Convention on Wetlands, 1971
- Montreal Protocol, 1987,
- Basel Convention (1989,1992),
- EarthSummitatRiodeJaneiro,1992
- Kyoto Protocol, 1997
- Earth Summit at Johannesburg, 2002.
- Rotterdam Convention on Prior Informed Consent Procedure for Certain Hazardous Chemicals andPesticides in International Trade
- Convention on Desertification 1996
- Convention on Biodiversity & Cartagena Protocol on Bio safety

Unit IV **(15L)**

Objectives and Provisions of Acts and Rules

- 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 InsuranceAct,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) (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 2015
- E-waste Management and Handling Rules 2011
- Plastics Manufacture, Sale and Usage Rules, 2011

Text/References:

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

PSEVSP 204
Practicals of Semester II

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_2 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.

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_2 by spectrophotometry using high volume sampler.
4. Determination of NO_2 from the atmosphere by Colorimetric method using high volume sampler.

Environmental Policies and Regulation

A. Minor Experiments

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

B. Major Experiments

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

Elective (Any One):-

PSEVS 205A
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, greenhouse 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; Nano medical 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, and Pollution free engineering processes.

Text/References:

1) M. H. Fulekar (2010) Nanotechnology Importance and applications, I K international publishinghouse Pvt. Ltd.

2) Lynn Goldman, Christine Coussens, Implications of nanotechnology for environmental healthresearch, 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

Tech-nology. [McGraw-Hill].

8) Akhlesh Lakhtakia (ed) (2004). The Handbook of Nanotechnology. Nanometer Structures: Theo-ry, Modeling, and Simulation. SPIE Press, Bellingham, WA, USA

PSEVS 205B
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 stud ies/surveys; Rapid assessment; Continuous short and long term monitoring

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 RecurrentProblems, 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 SEAfollow-up, Earthscan, London.
7) website of MoEF, GOI, New Delhi
8) Srivastava, D. C. (2005) Readings in Environmental Ethics: Multidisciplinary perspectives,Rawat Publications, Jaipur.

PSEVS 206
OJT/FP (On Job Training, Internship/Apprenticeship/Field Project)

(OJT/RP) Students are expected to spend a minimum of 30 days during their semester break under the guidance of a competent professional/ scientist at a research institute or research centre with the aim of learning techniques and their applications Or internship in industry/ consultancy/ NGO. The assessments should be based on supervisor's feedback, submission of a training report and an open presentation and Viva voce.

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.

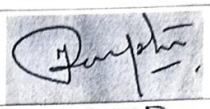
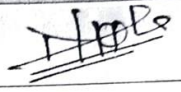
Reports on each of visit/ activity undertaken must be included in the journal.

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

Director (I/C)

Team for Creation of Syllabus

Name	College Name	Sign
Dr. Pandurang Y Patil	Associate Professor, Dept. of Environmental Science Ratnagiri Sub-Campus, University of Mumbai	
Prof. Nagesh Daptardar	S. H.Kelkar College Devgad	
Prof Nutan Kadam	S. H. Kelkar College Devgad	

Sign of HOD _____
Name of the Head _____
Name of the Department _____

Sign of Dean _____
Name of the Dean _____
Name of the Faculty _____

Appendix B

Justification for (M.Sc. – Environmental Science)

1.	Necessity for starting the course:	The MSc Environmental Science is concerned with the socioeconomic, scientific, technological, and policy-based issues concerning the environment and resource management. The MSc Environmental Science programme was established with the concept of sustainable development in mind and a concentration on research and application. This course meets the growing demand for knowledgeable professionals capable of developing new solutions for a more balanced future in the world.
2.	Whether the UGC has recommended the course:	Yes
3.	Whether all the courses have commenced from the academic year 2023-24	Already started from academic year 2002-2003
4.	The courses started by the University are self-financed, whether adequate number of eligible permanent faculties are available?	This decision is related with the concerned section of the University
5.	To give details regarding the duration of the Course and is it possible to compress the course?	02 Years, No
6.	The intake capacity of each course and no. of admissions given in the current academic year:	20. The admission process is yet to be started

7.	Opportunities of Employability / Employment available after undertaking these courses:	The curriculum of the MSc Environmental Science not only imparts in-depth knowledge in various subjects but also equips students with the necessary technical skills thus producing industry-ready graduates. These skills help students work in different work profiles. Some of which are given below: • Environment Photographer • Research Fellow • Manager-Waste Management • Forest Carbon Specialist • Lecturer or Professor • Wildlife Photographer • Environmental Consultant • Scientific Assistant • Political Advisor • Air Quality Inspector • Environmental Journalist • Activist • Conservation Hydrologist • Environment Technician • Wildlife Film-Maker • Urban Planner • Product Manager- Environmental Health and Safety

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