

PET Syllabus in Environmental Science

PET Syllabus in Environmental Science subject is the same as the syllabus for M.Sc. Sem-I, II, III and IV

(Available on University website)

- Chairperson
PET, Environmental Science

AC-6-6-12

Item No. 4.121

UNIVERSITY OF MUMBAI



Syllabus for M.Sc. Semester I &II

Program: M.Sc.

Course: Environmental Sciences

UNIVERSITY OF MUMBAI

(Credit Based Semester and Grading System with
effect from the academic year 2012–2013)

M. Sc. Environmental Sciences Syllabus

Credit Based and Grading System

To be implemented from the Academic year 2012-2013

1. The credit system will be implemented from the year 2012-13.
2. Each student is expected to take 4 credits per theory paper and two credits per practical in each semester.
3. 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.
4. The candidate is expected to submit a journal certified by the head of the department or institution at the time of the practical examination.
5. 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
6. 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

(10 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

(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 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 trophical 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, 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-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 Global status, 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 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.

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.

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 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.

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 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, 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 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.

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 CO₂ 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.

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

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 out put 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- Bioremediation, 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.

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, 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.

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

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

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)

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 SO₂ by spectrophotometry using high volume sampler.
4. Determination of NO₂ from the atmosphere by Colorimetric method using high volume sampler.

PSEVSP203

GREEN CHEMISTRY

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.

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

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

M.Sc Environmental Sciences Semester II

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

A) Internal Assessment:- 40%

a) Theory

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

b) Practicals

Sr. No.	Evaluation type	Marks
1.	One Practical	10
2.	Journal	05
3.	Viva	05

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.

AC 29/4/13
Item no, 4.92



UNIVERSITY OF MUMBAI

Syllabus for M.Sc. Semester III &IV

Program: M.Sc.

Course: Environmental Sciences

(Credit Based Semester and Grading System with effect
from the academic year 2012–2013)

M. Sc. Environmental Sciences Syllabus

Credit Based and Grading System

To be implemented from the Academic year 2012-2013

Semester –III

Theory				
Course	Unit	TOPIC	Credits	L / Week
PSEVS301	I	Water and Wastewater Pollution Control	4	1
	II	Air Pollution Control		1
	III	Hazardous and Radioactive Waste Management		1
	IV	Biomedical Waste and Electronic (E-Waste Management)		1
PSEVS302	I	Environmental Monitoring and sampling	4	1
	II	Instrumental methods of environmental analysis-I		1
	III	Instrumental methods of environmental analysis-II		1
	IV	Statistical Aspects		1
PSEVS303	I	Basic concepts of Eco-toxicology	4	1
	II	Toxicants in the Environment		1
	III	Evaluation of toxicity		1
	IV	Organ toxicity		1
PSEVS304	I	Industrial Hygiene	4	1
	II	Industrial Work Environment		1
	III	Disaster Management and Risk Assessment		1
	IV	Safety		1
			16	16
Practicals				
PSEVS3P1		Practicals based on PSEVS301	2	4
PSEVS3P2		Practicals based on PSEVS302	2	4
PSEVS3P3		Practicals based on PSEVS303	2	4
PSEVS3P4		Practicals based on PSEVS304	2	4
Total			08	16
TOTAL			24	32

SEMESTER –IV

Theory				
Course	Unit	TOPIC	Credits	L / Week
PSEVS401	I	Introduction to Ecotechnology	4	1
	II	Sanitation -PhytosanitationAnd Green Inhibitors		1
	III	Climate Change Mitigation And Carbon Sequestration		1
	IV	Restoration Ecology& Remediation Technology		1
PSEVS402	I	Environmental Biotechnology	4	1
	II	Biotechnology in Protection and Conservation of the Environment		1
	III	Organic Farming		1
	IV	Environmental Nanotechnology		1
PSEVS403	I	Understanding sustainable development	4	1
	II	Business strategies and sustainability		1
	III	Sustainable urban development		1
	IV	Sustainability in practice		1
PSEVS404	I	Introduction to principles of Environment Management	4	1
	II	Environment Management Systems and Life Cycle Assessment		1
	III	Environmental Audit and Environmental Economics		1
	IV	Environmental Design(ED) and Modeling		1
			16	16
Practicals				
PSEVS4P1		Practicals based on PSEVS401	2	4
PSEVS4P2		Practicals based on PSEVS402	2	4
PSEVS4P3		Practicals based on PSEVS403	2	4
PSEVS4P4		Practicals based on PSEVS404	2	4
Total			08	16
TOTAL			24	32

Semester -III

PSEVS 301: Advanced Pollution Control Technology

PSEVS 302: Instrumentation and Biostatistics

PSEVS 303: Environmental Toxicology

PSEVS 304: Industrial Hygiene and Chemical Safety

Semester -IV

PSEVS 401: Eco Technology

PSEVS 402: Environmental Biotechnology and Nanotechnology

PSEVS 403: Sustainable Management

PSEVS 404: Environmental Management

SEMESTER -III PSEVS 301

Advanced Pollution Control Technology

Unit I: Water and Wastewater Pollution Control

15 L (1 Credit)

- General scheme for the treatment of water for drinking purpose.
- Water Treatment: UV, H_2O_2 , 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.

Unit II: Air Pollution Control

37

15 L (1 Credit)

- 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 and driving habits.

Unit III: Hazardous and Radioactive Waste Management

15 L (1 Credit)

- 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: Biomedical Waste and Electronic (E-Waste Management)

15 L (1 Credit)

- 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

TEXTS/REFERENCES

1. Wastewater Treatment for Pollution Control: Soli J. Arceivala, Tata McGrawHill 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.

SEMESTER -III PSEVS 302

Instrumentation and Biostatistics

Unit I:Environmental Monitoring and sampling

15 L (1 Credit)

- Concepts of environmental monitoring and its significance.
- Methods of physical characterization of samples.
- Sampling of air ,water and soil:- Protocol and methods of sampling, sampling devices, Preservation, storage and processing of air, water and soil samples

Unit II:Instrumental methods of environmental analysis- I

15 L (1 Credit)

- Conductometry, Potentiometry, Voltammetry :Theory, instrumentation and applications.
- Colorimetry and spectrophotometry: Electromagnetic radiation spectrum. Interaction of radiation with matter. Beer- Lambert's law, Flame photometry.
- Conventional microscopy and Scanningelectron microscopy.
- Hyphenated techniques for analysis – GC-MS, HPTLC, GC-AES. Electrophoresis: Theory , classification , instrumentation and applications.

Unit III:Instrumental methods of environmental analysis- II

15 L (1 Credit)

- Principle, instrumentation and environmental applications of Neutron Activation Analysis, X-Ray Fluorescence, X-Ray Diffraction, Thermogravimetry.
- Continuous monitoring analysis – fluorescent analyzer for SO₂, chemiluminescentanalyzer for NO_x, NDIR for CO, Flow injection analyzer.

Unit IV:Statistical Aspects

15 L (1 Credit)

- Collection, classification and tabulation of data. Essentials of good tabular form. Preparation of one-way and two-way frequency tables. Diagrammatic and graphical representation of data (data bar, pie, picot and histograms, frequency polygons), frequency curves and cumulative curves.
- Measures of central tendency and dispersion : mean. median, mode , range, standard and relative deviation,coefficient of variation, skewness, kurtosis confidence limits and confidence intervals and normal distribution curve, Analysis of variance one way and two way classification, probit analysis
- Accuracy, precision and errors: Classification, Minimisation of errors, Rejection of data . Z, t, F, and chi-square tests
- Correlation and Regression: Pearson's coefficient, Spearman's coefficient, regression lines and their use. Curve fitting.
- Probability: Exclusive and independent events, addition and multiplication theorems, dependent events and conditional probability

TEXTS/REFERENCES

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

SEMESTER -III PSEVS 303

Environmental Toxicology

Unit I: Basic concepts of Eco-toxicology

15 L (1 Credit)

- Introduction to ecotoxicology, Principles of toxicology, scope of toxicology.
- Types of toxic substances - degradable and non-degradable. Factors influencing toxicity, drug toxicity.
- Biochemical basis toxicity – mechanism of toxicity and receptor mediated events, acute and chronic toxicity.
- Sigmoid relationships, Corollary of toxicology. Influence of ecological factors on the effects of toxicity.

Unit II: Toxicants in the Environment

15 L (1 Credit)

- Toxic substances in the environment, their sources and entry routes.
- Transport of toxicants by air and water: Transport through food chain - bioaccumulation and biomagnification of toxic materials in food chain.
- Toxicology of major pesticides- biotransformation, biomonitoring, programs and parameters of biomonitoring, concept of bioindicator, bioindicator groups and examples.
- Environmental impacts of pesticides: Physiological and metabolic effects on flora and fauna.

Unit III: Evaluation of toxicity

15 L (1 Credit)

- Methods used to assess toxicity classification of toxic materials.
- Concepts of Bioassay- types, characteristics. Importance and significance of bioassay,

Microbial bioassay for toxicity testing, Bioassay test models and classification.

- Threshold limit value, LC50 LD50. Toxicity Testing, Concept of Dosimetry: lethal, sub-lethal & chronic tests
- Dose response curves

Unit IV: Organ toxicity

15 L (1 Credit)

- Hepatotoxicity: Common examples of hepatotoxicants, injuries caused to liver
- Nephrotoxicity: Common examples of nephrotoxicants, injuries caused to kidney
- Pulmonary toxicity: Common examples of pulmonary toxicants, injuries caused to lungs.
- Neurotoxicity: Common examples of neuro toxicants, injuries caused to nervous tissues.

TEXTS/REFERENCES

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

SEMESTER -III PSEVS304

Industrial Hygiene and Chemical Safety

Unit I: Industrial Hygiene

15 L (1 Credit)

- Introduction, definition, scope, significance and applications.
- Occupational environmental stresses i.e Physical, stresses – Noise, vibration, illumination, ventilation, heat stresses, Chemical stresses: Toxic chemicals, hazardous chemicals. Flammable chemical, explosive chemicals. etc. Inhalation and ingestion risks.
- Airborne Chemicals: 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: Industrial Work Environment

15 L (1 Credit)

- 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: Substitution, isolation, ventilation, local exhaust system and engineering control methods.
- House keeping and maintenance. Modification of the processes and operation. Process and product specific control measures. Report writing

Unit III: Disaster Management and Risk Assessment

15 L (1 Credit)

- 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, explosion, toxic release and dispersion.
- Disaster management: Components of disaster management plan on-site and off-site emergency plans.
- Technical hazards control system- incident reduction, incident management Techniques of hazards assessment: PHA, HAZOP, HAZAN, MCAA

Unit IV: Safety

15 L (1 Credit)

- Precautions in the processes and operations involving explosives, flammables, toxic substances, dusts, vapours, cloud formation and combating.
- Safety precautions for transportation for hazardous chemicals. Handling and storage of hazardous chemicals. Safety in pipelines and colour coding.
- Risk assessment and on site and off site emergency planning. Safety audit in chemical industry. Accidents and unusual occurrences reporting .
- Respiratory personal protective equipment (RPPE)& non respiratory personal protective equipment (NRPPE): head protection , ear protection , face and eye protection , hand protection, foot protection and body protection. Quality control of protective equipments.

TEXTS/REFERENCES

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

PRACTICALS

Semester -III

PSEVSP301

Advanced Pollution Control Technology

A. Minor Experiments

1. Determination of heavy metals (Fe/Cu) by spectrophotometric methods
2. Removal of suspended solids by sand filter method.
3. Detection/estimation of Cr (VI) in presence of Cr (III)
4. Estimation of mixed liquor suspended solids (MLSS) and Sludge Volume Index (SVI) in activated sludge.

B. Major Experiments

1. Jar Test (removal of suspended solids by coagulation, e.g. use of alum).
2. Waste water analysis for pH, conductivity, TDS, DO, COD, BOD, alkalinity, chloride and hardness.
3. Estimation of fluoride in waste samples by spectrophotometry.
4. Study of adsorption isotherm : Removal of Cr by activated charcoal.

PSEVSP302

Instrumentation and Biostatistics

A. Minor Experiments

1. Estimation of Chloride in water sample by conductometric titration.
2. Estimation of Fe^{+2} by potentiometric titration.
3. Determination of mean, median, mode, geometric mean, range, quartile using a given data
4. Determination of standard deviation, variance, coefficient of variation, skewness, kurtosis using a given data

B. Major Experiments

1. Separation of proteins using Polyacrylamide Gel Electrophoresis.
2. Determination Pesticides in soil/plants by GC-MS.
3. Analysis of a given data by t- test/ f test,
4. Analysis of a given data by z test /Anova

PSEVSP303

Environmental Toxicology

A. *Minor Experiments*

1. Study of instruments and equipment used in the Microbiology Laboratory.
2. Enrichment and Isolation of anaerobic bacteria
3. Isolation and Enumeration of microorganisms from soil
4. Effect of Heavy Metal toxicants on the behaviour pattern of earthworm

1. *Major Experiments*

1. Effect of effluents containing heavy metals on germination of groundnut.
2. Determination of LC50.
3. Effect of different concentrations of any 2 heavy metals on growth of microorganisms
4. Estimation of any toxicant by agar diffusion assay.

PSEVSP304

Industrial Hygiene and Chemical Safety

A. *Minor Experiments*

1. Preparation of Material Safety Data Sheet for some common chemicals.
2. To neutralize the given sample using NaOH / HCL/ CaCO_3
3. Determination of CO_2 from the atmosphere by volumetric method in a workplace Environment.
4. Estimate Noise Levels and Determine L_{10} , L_{50} , L_{90} by histogram method.

B. *Major Experiments*

1. Air sampling of gases (sulphur dioxide, nitrogen dioxide, carbon disulphide, carbon monoxide etc.) and analysis by UV-Visible spectrophotometer.
2. Estimation of sulphur in coal and calculation of release of SO_2 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

SEMESTER -IV PSEVS401

Eco Technology

Unit I:INTRODUCTION TO ECOTECHNOLOGY

15 L (1 Credit)

- Definition, Principles and Concept of Ecotechnology, Why Ecotechnology and Applications of Ecotechnology.
- 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:Sanitation -PhytosanitationAnd Green Inhibitors

15 L (1 Credit)

- 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 commandmentsof SPS agreement of WTO.
- Green inhibitors: Factors pertaining to metal samples, Inhibitors in use, Cooling systems, Processing with acid solutions, Corrosion ,Problems in oil industry, Corrosion inhibition in the mining industry, Atmospheric corrosion inhibition mechanisms, Standardized Environmental testing, Hybrid coating & corrosion inhibitors, Environmental green inhibitors, Industrial application of corrosion inhibition.

Unit III: Climate Change Mitigation And Carbon Sequestration

15 L (1 Credit)

- Carbon related definitions C-pool, C-stock, C-Flux, C-sink, C-source, sequestration/uptake.
- A brief understanding of the Clean Development Mechanism (CDM) to combat CC, Developing C market for combating CC, how India can benefit from CDM projects,.
- Development of C-sequestration projects their modalities & procedures- reducing emissions from degradation and deforestation (REDD and REDD+),International efforts in combating global warming & CC.A brief understanding of UNFCCC (Kyotoprotocol)NATCOM, IPCC,CBD,UNCCD,world heritage conventions , UN forum on forests etc.

Unit IV:Restoration Ecology& Remediation Technology

15 L (1 Credit)

- Definitions, aims and objectives, principles, concept & strategies (long tern vs short term), physical chemical & biological restoration, role of ecological principles in restoration, holistic approach in restoration.
- Greenness improvement & planting technologies, bamboo forest maintenance, biotopes, recycled water technology, soil & ground water contamination survey & cleaning technologies.

TEXTS/REFERENCES

1. Faegri, K.vanderpifl (1976). The principles of pollination ecology.3rd Edition pergamon press, NY
2. Burroughs (2007). Climate Change: A multi disciplinary approach, 2nd Edition, Cambridge, New York university press ISBN 9780521690331
3. Cunningham. Principles of Environmental Science.
4. Green Corrosion Inhibitors by V.S.Sastri

SEMESTER -IV PSEVS402

Environmental Biotechnology and Nanotechnology

Unit I: Environmental Biotechnology

15 L (1 Credit)

- 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: Biotechnology in Protection and Conservation of the Environment

15 L (1 Credit)

- 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. 47

Unit III: Organic Farming

15 L (1 Credit)

- **Biopesticides:** Introduction, Biological Insecticides, Properties of *Bacillus thuringiensis*, Microbial Pesticides, Entomopathogenic Fungi or Viruses, Entomopathogenic Nematodes Biochemical Pesticides Plant-Incorporated Protectants (PIPs) like GM plants etc, Insect Pheromones and other Semiochemicals, Applications of Biopesticides.
- **Biofertilizers:** Classification, Nitrogen Fixation (Bacterial, with Blue Green Algae, VAM etc.), Symbiotic Nitrogen Fixers *Rhizobium* sp., Non-symbiotic, Free Living Nitrogen Fixers *Azotobacter*, *Azospirillum* etc. BGA Inoculants *Azolla-Anabaena*, Phosphate Solubilizing Microorganisms (PSM) *Bacillus Pseudomonas*, *Penicillium Aspergillus* etc. Mycorrhiza, Cellulolytic microorganisms and Organic fertilizers.

Unit IV: Environmental Nanotechnology

15 L (1 Credit)

- 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.

TEXTS/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, Indu Shekhar 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.

SEMESTER -IV PSEVS403

Sustainable Management

Unit I: Understanding sustainable development

15 L (1 Credit)

- Definition and dimensions of sustainability, The ecological footprint and carrying capacity
- Global challenges of sustainable development: Our common future report, Agenda 21 and Millennium Development Goals, Earth Charter, domains of sustainability-Economics, ecology, politics and culture.
- National Action Plan on Climate Change.
- National sustainable development strategies in India: Twenty point program of Govt. of India, Key programs introduced to increase agricultural productivity and profitability. Policies and programs relevant to sustainable development in India key legislations relative to sustainable development
- Strategies for promoting sustainable development-International Trade-TRIPS, IPR; finance, technology, Science and education
- Resistances to the concept and some alternative approaches, Important current issues and areas of debate in relation to sustainable development.

Unit II: Business strategies and sustainability

15 L (1 Credit)

- Business and sustainability-Concept of responsible business, CERES (coalition for environmentally responsible economics) principles and blended value.
- Principles of sustainable development in business planning and management
- Triple Bottom Line approach in sustainable business planning and development,
- Green Business profiles- The Body Shop, General Electric, Toyota etc.
- Indicators for sustainability: introduction to Nature's Living Planet Index developed by WWF, Happy Planet Index developed by New Economics Foundation, Gross domestic product, Human development index, Dow Jones sustainability index.

- Sustainability reporting: Corporate social responsibility –Global reporting initiatives guidelines for sustainability reporting

Unit III:Sustainable urban development

15 L (1 Credit)

- Urbanization and its impact on Environment, Rural and Urban planning for sustainable development
- Green city challenges-Ecological footprint, Principles of creating eco cities with two examples.
- Architecture- Eco industrial parks, Urban farming, Green roofs, Green Building-LEED certification, with two examples, walkable Urbanism, Xeriscaping,
- Transportation: improved public transport, car free cities, emphasis on proximity, zero emission transport, Diversity in modes of transportation
- Green city solutions - bicycle city, car-free day campaign ,green belt, compact development, carpooling ,bus rapid transit, parks, greenways and open space, traffic calming

Unit IV:Sustainability in practice

15 L (1 Credit)

- Current environmental Issues in India, Narmada Dam, Tehri, Almetti Dam, waste land & their reclamation, desertification, water crises, wetland conservation.
- Watershed management: Definition, Concepts, principals and classification in watershed management.Rainfall and runoff, water balance approach, water budgeting, topographic surveying, water conservation and harvesting methods – importance and techniques, artificial recharge of groundwater
- NGOs – characteristics and role of NGOs in sustainable development, Principles for NGOs, NGO-Community relations, NGO-Government relations , Some Indian NGOs working for saving environment

TEXTS/REFERENCES

1. Our Common Future, Chapter 2: Towards Sustainable Development: *Report of the World Commission on Environment and Development*.
2. Edwards, Andres R., *The Sustainability Revolution: Portrait of a Paradigm Shift*. New Society Publishers, 2005.
3. Report of the Department for Policy Coordination and Sustainable Development (DPCSD), United Nations Division for Sustainable Development.
4. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF,2011.
5. World Resources Institute (1995) "Environmental Indicators: A Systematic Approach to Measuring & Reporting on Environmental Policy Performance in the Context of Sustainable Development", World Resources Institute, Washington, DC.
6. Adger, W.N., Brown, K., Fairbrass, J., Jordan, A., Paavola, J., Rosendo, S., Seyfang, G. (2003) Governance for sustainability: towards a 'thick' analysis of environmental decisionmaking. *Environment and Planning A* 35, 1095 –1110.

7. Connelly, J. and Smith, G. (2003). Politics and the Environment: from theory to practice. Routledge, London.
8. Carter, N. (2001) The politics of the environment. Cambridge University Press: Cambridge
9. Leach, M., Scoones, I., Wynne, B. (2005) Science and Citizens: Globalization and the Challenge of Engagement. Zed books, London.
10. Pearce, D.W., Barbier, E. (2000) Blueprint for a sustainable economy. Earthscan, London.

SEMESTER -IV PSEVS404

Paper –ENVIRONMENTAL MANAGEMENT

Unit I: Introduction to principles of Environment Management

15L (1 Credit)

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: Environment Management Systems and Life Cycle Assessment 15L (1 Credit)

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: Environmental Audit and Environmental Economics15L (1 Credit)

Introduction to environmental audit, Types of environmental audits: objectives- based and client-driven 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 macro economics, 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: Environmental Design(ED) and Modeling15L (1 Credit)

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

TEXT / REFERENCES

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

PSEVSP401

Eco Technology

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, Biopiracy, Ecodisaster of deforestation

B. Major Experiments

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

PSEVSP402

Environmental Biotechnology and Nanotechnology

Minor Experiments

1. Bioremediation of Heavy Metals by Green Plants in Aquatic/ Soil Environment.
2. Phytoremediation of Heavy Metals by Green Plants in Aquatic/ Soil Environment.
3. Development of Mycorrhizal Soil Using Pot Culture Technique.
4. Development of Compost from Organic Waste.

Major Experiments

1. Estimation of DNA by spectrophotometer
2. Determination of molecular weight of DNA by electrophoresis.
3. Determination of coliforms by Membrane Filter Technique
4. Determination of *Streptococcus faecalis*.

Sustainable Management

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 Management/Pollution control facility of any industry.
4. Report on Seminar/Conference attended.

Major Experiments

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

Environmental Management

Project work : 50 MARKS

Student will submit their independent project work at the end of semester IV. Assessment of the project and internship will be based on the submitted M. Sc. project report, seminar and viva-voice examination.

Report on Project work : 30 MARKS

The Internship/project report submitted by the student and the evaluation report by the externalexaminer.

Project Evaluations:20 MARKS

(Viva-voice + Presentation)

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. SreemahadevanPillai.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.

1. The candidate is expected to submit a journal certified by the head of the department or institution at the time of the practical examination.
2. 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
3. Use of non programmable calculators is allowed both at the theory and the practical examination.

University of Mumbai

**PET EXAMINATION in Environmental Science
Paper I**

Syllabus for Research Methodology

- 1) Research aptitude, logical reasoning, comprehension, communication and general knowledge.**
- 2) Scientific Research: Characteristics, Types and Methods**
- 3) Concepts, Constructs and Variables**
- 4) Hypothesis**
- 5) Designing of Research**
- 6) Sampling Methods**
- 7) Techniques of Data Collection**
- 8) Content Analysis**
- 9) Data Collection, Processing and Analysis**
- 10) Theory Building**
- 11) Statistical Techniques**
- 12) Academic Writing**
- 13) Measurement and Scaling Techniques**
- 14) Scientific Research**

