

INSTITUTE OF SCIENCE, NAGPUR.

(An Autonomous Institute of Government of Maharashtra)

DEPARTMENT OF ENVIRONMENTAL SCIENCE



Syllabus

Bachelor of Science (B.Sc.) Semester Pattern

Environmental Science

(EVS/UG /2021/01)

Approved by BoS, Environmental Science in the First Meeting conducted on dated 20.12.2021, Page. No. 1-56

(To be Implemented from 2021-2022)

B.Sc. (Semester Pattern) Syllabus
Semester wise Name of Papers
Subject : Environmental Science
UG Program and Paper Code

Semester	Paper	Name of the Paper	Paper Code
I	I	Fundamentals of Environmental Science	BESFS11
	II	Environmental Biology	BESFS12
	Laboratory Coursework Practical (if applicable)	Practical – I	BESFS13
II	I	Monitoring of Water, Soil and Air	BESFS21
	II	Biodiversity Conservation And Environmental Management	BESFS22
	Laboratory Coursework Practical (if applicable)	Practical - II	BESFS23
III	I	Introduction to Green Chemistry, Soil Pollution and Water Resources	BESSS31
	II	Environmental Microbiology	BESSS32
	Laboratory Coursework Practical (if applicable)	Practical – I	BESSS33
IV	I	Solid and Hazardous Waste Management	BESSS41
	II	Natural Resources and GIS	BESSS42
	Laboratory Coursework Practical (if applicable)	Practical - II	BESSS43
V	I	Principles of Air & Noise Pollution	BESTS51
	II	Environmental Management	BESTS52
	Laboratory Coursework Practical (if applicable)	Practical – I	BESTS53
VI	I	Water Pollution: Monitoring & Management	BESTS61
	II	Water Supply & Wastewater Treatment	BESTS62
	Laboratory Coursework Practical (if applicable)	Practical - II	BESTS63

Ex. BESFS11 : B -B.Sc, ES-Environmental Science, F-First Year, S1- Semester-1, 1- Subject Paper-1



INSTITUTE OF SCIENCE, NAGPUR
(An Autonomous Institute of Government of Maharashtra)
Department of Environmental Science

UG Structure
Bachelor of Science (B. Sc.) Environmental Science
Implemented from Academic Year 2021 -22

Semester	Paper	Name of the Paper	Paper Code	Credits
I	I	Fundamentals of Environmental Science	BESFS11	06
	II	Environmental Biology	BESFS12	
	Laboratory Coursework Practical (if applicable)	Practical – I	BESFS13	
II	I	Monitoring of Water, Soil and Air	BESFS21	06
	II	Biodiversity Conservation And Environmental Management	BESFS22	
	Laboratory Coursework Practical (if applicable)	Practical - II	BESFS23	
III	I	Introduction to Green Chemistry, Soil Pollution and Water Resources	BESSS31	06
	II	Environmental Microbiology	BESSS32	
	Laboratory Coursework Practical (if applicable)	Practical – I	BESSS33	
IV	I	Solid and Hazardous Waste Management	BESSS41	06
	II	Natural Resources and GIS	BESSS42	
	Laboratory Coursework Practical (if applicable)	Practical - II	BESSS43	
V	I	Principles of Air & Noise Pollution	BESTS51	06
	II	Environmental Management	BESTS52	
	Laboratory Coursework Practical (if applicable)	Practical – I	BESTS53	
VI	I	Water Pollution: Monitoring & Management	BESTS61	06
	II	Water Supply & Wastewater Treatment	BESTS62	
	Laboratory Coursework Practical (if applicable)	Practical - II	BESTS63	

Marking Scheme of Syllabus

Faculty of Science B.Sc. Semester-I to VI (Environmental Science)

Semester	Paper	Total Periods / Week	Marks		Total Marks	Total Marks
			Theory / Practical	Internal		
I to VI	I	03	50	10	60	150
	II	03	50	10	60	
	Laboratory Course (Practical) If Applicable	06	30	--	30	

Note : The Syllabus is based on 6 theory periods per week and 6 practical periods per week per batch.

1. Minimum marks for passing will be 40% of the total marks allotted to that paper / practical.
2. Candidate has to pass theory papers and practical separately

Guidelines for Internal Assessment, Theory paper pattern and Practical

1. The internal assessment marks assigned to each theory paper as mentioned shall be awarded on the basis of assignments like class test, attendance, project assignments, seminar, group discussions or any other innovative practice / activity.
2. There shall be one / two assignments (as described above) per Theory paper.
3. The theory question papers shall be of 3 hours duration and comprise of 5 questions with equal weightage to all units.

The pattern of question papers is

1. Each theory paper will be of 50 marks
2. All questions are compulsory and will carry equal marks.
3. Question paper for any theory paper will comprise of five questions of 10 marks
4. Question No. 1 to 4 will be from four units each with an internal choice. The questions can be asked in the form of long answer type for 10 marks or two questions / short notes of 5 marks each or four questions / short notes of 2½ each
5. Question No. 5 shall be compulsory with three questions / notes of very short answer type from each of the four units having 1 mark each. The student shall have an option of answering any 10 questions out of the 12 questions.

Practical:

Practical exam shall be of 4 to 8 hours duration for one or two days, depending on subject and number of students.

SUBJECT: ENVIRONMENTAL SCIENCE
B.SC. - I SEMESTER - I
BESFS11: PAPER- I (Fundamentals of Environmental Science)

The Syllabus is based on 6 theory periods and 6 practical periods per week. Theory paper is divided into four units. Each unit shall be covered in 7.5 hours. Eight periods are allotted for each unit. The examination shall comprise two theory papers of 3 hours duration of 50 marks each. One internal assessment based on two theory papers for 10 marks each. Practical examination will be of 6 to 8 hours for one day and carry 30 marks. Candidates are expected to pass separately in theory and practical examination.

OBJECTIVES:

To make Students:

1. Understand the basic concept of Environmental Science and Atmospheric Science
2. Comprehend the Atmospheric Chemistry and Components of Environment
3. Recognize the Effects of Green House Gases and Acid Rains
4. Extricate the Aquatic and Soil Chemistry
5. Know the physical and chemical characteristics and properties of Water and Soil

OUTCOMES:

Students shall be able to:

1. Explain the basics of Environmental Science and Atmospheric Science along-with the components of Environment
2. Explicate the importance of Environmental Education.
3. Elucidate the fundamentals of atmospheric science including formation, depletion and effects of ozone layer and acid rain on environment.
4. Reveal the estimation methods of physico-chemical methods for characteristics of Water and Soil
5. Expound the prescribed limits in potable water as per WHO guidelines
6. Describe the various physical and chemical characteristics and properties of Water and Soil

Unit-I: Basics of Environmental Science

(7.5 Hrs)

A. Introduction of Environmental Science: Definition, Types, Classification, Characteristics, Components and principles of environment. Scope and need for environmental science, Multidisciplinary nature of environmental science, Environmental ethics.

B. Environmental Education: Goals, Objectives and principles of environmental education, formal and non-formal environmental education, environmental programme, importance of environmental education, environmental awareness, Environmental days.

C. Components of Environment: Atmosphere (Structure and composition), hydrosphere – distribution of water, hydrological cycle, global water balance, lithosphere – Internal structure of Earth, types of rocks, Biosphere- Boundaries of biosphere.

Unit-II: Basics of Atmospheric Science

(7.5 Hrs)

A. Atmospheric Chemistry: Structure of atmosphere based on temperature, photochemical reaction in the atmosphere, temperature inversion and lapse rate, smog formation, types of smog (sulphur and photochemical smog), adverse effect of smog on human being, aerosol.

B. Green House Effect: Greenhouse gases, relative contribution and effects of greenhouse effect, control of greenhouse gases. Ozone depletion: chemistry of ozone depletion, Dobson Unit, ozone depleting substances (ODS), ozone hole, consequences of ozone depletion, mitigation measures and international protocols.

C. Acid Rain: Chemistry of Acid Rain, effect of acid rain on ecosystem, control measures. Precipitation – Forms of precipitation (rain, drizzle, snow, sleet, and hail), types of precipitation (conventional, orographic, and cyclonic).

Unit III: Aquatic Chemistry

(7.5 Hrs)

A. Characteristics of Water: Physical properties of water (solvent, specific and latent heat, surface tension, viscosity, heat conduction, salinity, transparency, and pressure), chemical properties- solubility of gases in water, CO₂, oxygen, Nitrogen and H₂S.

B. Physical Parameter of Water: Colour, temperature, taste and odour, turbidity, conductivity, pH, total solids.

C. Chemical Parameter: Alkalinity & Acidity, Hardness, Chlorides, Dissolved Oxygen (DO), principle and method of estimation, prescribed limit in potable water as per WHO guidelines.

Unit-IV: Soil Chemistry

(7.5 Hrs)

A. Soil: Definition, composition of soil, types of soil, soil formation, soil profile, soil structure, soil organism.

B. Physical Properties of Soil: Soil density, porosity, soil texture, soil permeability, soil temperature, soil air, soil water, soil colour.

C. Chemical Properties of Soil: Soil component (inorganic & organic) soil pH, soil humus, cation and anion exchange reaction of soil, nitrogen, phosphorus and potassium in soil.

SUBJECT: ENVIRONMENTAL SCIENCE
B.SC. - I SEMESTER - I
BESFS12: PAPER - II (Environmental Biology)

OBJECTIVES:

To make Students:

1. Understand the Ecology and its allied branches
2. Comprehend about Population and Community Ecology
3. Study the changes in Population by understanding the concept of Population ecology
4. Recognize the type, measurement and factors affecting primary productivity
5. Distinguish between S and J shaped population growth curve, biogeochemical cycles
6. Extricate types, Causes, process, pattern, and significance of ecological succession.
7. Know the Food chain and Food web and Ecological pyramids, adaptation in plants and animals

OUTCOMES:

Students shall be able to:

1. Explain the basic concepts of Ecology and environmental factors: Abiotic and Biotic
2. Understand Food chain and Food web and Ecological pyramids, adaptation in plants and animals and explain the concept of ecological relationships and ecological adaptations.
3. Explain community ecology and ecological succession.
4. Elucidate types, Causes, process, pattern, and significance of ecological succession
5. Describe type, measurement and factors affecting primary productivity
6. Expounds and J shaped population growth curve, biogeochemical cycles

Unit-I: Basics of Ecology

(7.5 Hrs)

A. Ecology: Definition, subdivision and modern branches of ecology, ecology spectrum, scope of ecology. Application and significance of ecology to human beings.

B. Abiotic Factors: Temperature: effect of temperature on plants and animals, Adaptation to meet extreme temperature. **Light:** Zonation in marine habitat, effects of light on plants and animals, Microclimate and fire, Shelford law of tolerance, Leibigs law of minimum.

C. Biotic Factor: Inter specific relationship **Positive:** Mutualism (symbiosis), commensalism, proto-cooperation **Negative:** Parasitism, predation, competition, Antibiosis, Neutralism

Unit-II: Population and Community ecology (7.5 Hrs)

A. Population Ecology: Definition and types, characteristic of population: Natality, mortality, population density, population dispersal and dispersion, population fluctuation, population growth curve (S & J), shaped curve, Biotic potential, Environmental resistance, concept of carrying capacity.

B. Community Ecology: Definition, characteristic of community, community structure, ecological dominants and indicators, Ecotone and edge effect, ecological equivalents, ecological niche (definition and types) Major and minor communities, ecotypes, and its significance.

C. Ecological Succession: Definition and types, Causes, process, pattern, and significance of ecological succession. Micro succession, Theories of climax communities. (monoclimax and polyclimax theory)

Unit-III: (7.5 Hrs)

A. Ecosystem: Definition, structure and function of ecosystem, types of ecosystem: Terrestrial (forest, grassland, desert, cropland), Aquatic (Marine and freshwater)

B. Food chain: Definition & types: Grazing food chain, detritus food chain, and parasitic food chain, food web in forest and grassland ecosystem. Ecological pyramids (number biomass and energy), energy flow in ecosystem (Y- shaped). Energy flow and the law of thermodynamics.

C. Biogeochemical Cycles: Definition, classification, gaseous cycle (oxygen, carbon and nitrogen) Sedimentary cycle (phosphorus and sulphur).

Unit-IV: Productivity and Ecological Adaptation (7.5 Hrs)

A. Productivity: Definition and types of productivity, (primary and secondary) GNP, GPP, NPP, NCP, Measurement of primary productivity: Harvest method, chlorophyll method, O₂ (Light and Dark bottle method). CO₂ method, Factors affecting primary productivity.

B. Adaptation: Types of adaptation, Adaptation in plants: Hydrophytes, mesophytes and xerophytes. Adaptation in animal: Aquatic and desert.

C. Mimicry: Definition, types: protective, aggressive, and conscious mimicry, evolution and significance of mimicry, bio-mimicry.

BESFS12: LABORATORY COURSE

Practical-I

OBJECTIVES:

To make Students:

1. Learn Water sampling for ground and surface water and its storage techniques
2. Acquire skill about Estimation of Chloride, Alkalinity, Acidity, free CO₂, Total solids, and dissolved solids, suspended solids of water and wastewater sample.
3. Study about determination of moisture content, bulk density, water holding capacity of soil
4. Realize measurement of primary productivity in a water body by Light and Dark bottle method and rainfall by Rain gauge

OUTCOMES:

Students shall be able to:

1. Carry-out Water sampling for ground and surface water and its storage techniques
2. Estimate Chloride, Alkalinity, Acidity, free CO₂, Total solids, and dissolved solids, suspended solids of water and wastewater sample.
3. Measure primary productivity in a water body by Light and Dark bottle method and rainfall by Rain gauge
4. Determine moisture content, bulk density, water holding capacity of soil

Practical-I

1. Water sampling for ground and surface water and its storage techniques.
2. Estimation of Chloride of water and wastewater sample by Argentometric method
3. Estimation of Alkalinity of water and wastewater sample.
4. Estimation of Acidity of water and wastewater.
5. Estimation of free CO₂ of water and waste water sample
6. Estimation of Total solids, dissolved solids, suspended solids of water and wastewater sample
7. Determination of moisture content of soil
8. Determination of bulk density of soil
9. Determination of water holding capacity of soil
10. Measurement of rainfall by Rain gauge
11. Measurement of primary productivity in a water body by Light and Dark bottle method.

12. Study of plant communities by Quadrante method and to study its characteristics i.e. density, frequency, and abundance

Visit:

1. Visit to water body to study Pond as an ecosystem.
2. Visit to Nearby Forest to study the flora and fauna in its Natural Environment.

All students shall undertake field visits, soon after their visit, students shall submit study tour report which is certified by the HOD is to be submitted at the time of Annual practical examination.

Field Diary:

The students shall prepare their field diary under the following heads:

1. Issue on Regional problems of Environmental interest (Case study).
2. Issue on National interest (Case study).
3. Famous personalities in Environmental Movements.

Distribution of Marks:

1. Long experiment (Any one) : **10** Marks
2. Short experiment (Any two) : **10** Marks
3. Viva – voce : **04** Marks
4. Tour report / field diary : **03** Marks
5. Practical Record : **03** Marks

Total Marks : 30 Marks

Books for Reference (Practical)

1. A Manual of Water and Wastewater Analysis: Dr D.S. Ramteke and Dr C.A. Moghe, Published by NEERI, Nagpur, 1996.
2. Laboratory Manual of Environmental Chemistry: Dr Snita Hooda and Dr Sumanjeet Kaur, S. Chand and Co. Ltd. New Delhi.1997.
3. Physico-chemical Examination of Water Industrial Effluents: N. Manivaskaram, Pragti Prakashan, Meerut (U.P) 1996.
4. Chemical and Biological Methods of Water Pollution Studies: R.K. Trevedi and P.K. Goel, EnviroMedia Publication.

Books for Reference:

1. Text Book of Environment: K M Agrawal, P.K. Sikdar, and S.C. Deb, Mc'Millan Publication, Mumbai.
2. Man and Environment: M.C. Dash and P.C. Mishra, Mc'Millan Publication, Mumbai.
3. Environmental Science: S.C. Santra, New Central Book Pvt.Ltd, Kolkatta.
4. Environmental Problems and Solution: D.K. Asthana, S.Chand Publication, New Delhi.
5. Environmental Chemistry: S.S. Dara, S.Chand Publication ,New Delhi.
6. Environmental Chemistry: B.K. Sharma, Goel Publication, Meerut.
7. Environmental Chemistry: A.K. Dey, New Age International Publishers,2001.
8. Man and Environment: P.R. Trivedi and Gurdeep Raj, Akashdeep Publishing House, New Delhi.
9. Fundamentals Concepts in Environmental Studies: Dr. D.D. Mishra , S.Chand Publication, New Delhi.
10. Climatology: D.S.Lal, Sharda Pustak Bhavan, Allahabad ,2003.
11. A Textbook of Environmental Studies: Dr S.Satyanarayan, Dr S.Zade, Dr S Sitre and Dr P.U. Meshram, Allied Publishers, New Delhi.
12. Environmental Biology: Biswarup Mukherjee, Tata McGraw-Hill Publishing Company Ltd, New Delhi,1996.
13. Animal Ecology and Distribution of Animals: Veer Bala Rastogi , Rastogi Publication, Meerut (U.P).
14. Ecology and Environment: P.D.Sharma, Rastogi Publication ,Meerut (U.P).
15. Fundamentals of Environmental Biology: S. Arora, Kalyani Publishers.
16. Plant Ecology and Soil Science: R.S. Shukla and P.S. Chandel , S.Chand Publication, New Delhi.
17. Animal Ecology and Environmental Biology: H.R Singh ,Vishal Publication.
18. Environmental Biology: P.S.Verma and V.K.Agrawal, S. Chand Publication,New Delhi.
19. Environmental Biology: P.K.G. Nair, Himalaya Publication.
20. Environmental Biology: K.C. Agrawal, Agro Botanical Publisher ,Bikaner,1994.

SUBJECT: ENVIRONMENTAL SCIENCE

B.SC. - I SEMESTER - II

BESFS21: PAPER- I (Monitoring of Water, Soil and Air)

The Syllabus is based on 6 theory periods and 6 practical periods per week. Theory paper is divided into four units. Each unit shall be covered in 7.5 hours. Eight periods are allotted for each unit. The examination shall comprise two theory papers of 3 hours duration of 50 marks each. One internal assessment based on two theory papers for 10 marks each. Practical examination will be of 6 to 8 hours for one day and carry 30 marks. Candidates are expected to pass separately in theory and practical examination.

OBJECTIVES:

To make Students:

1. Understand Water Sampling and Analysis its need
2. Comprehend Soil erosion, types, causes and control measures of soil erosion
3. Recognize Water quality monitoring and on-field test parameters as well as off-field parameters
4. Extricate the Soil sampling methodology; site selection, in-field sampling technique, soil profile, site description and equipment
5. Know Basics of Meteorology and Measurement of Meteorological Parameters

OUTCOMES:

Students shall be able to:

1. Explain the Significance of topmost layer, Soil erosion (definition and types), causes of soil erosion (water, wind, and biotic agencies), and control measures of soil erosion.
2. Explain Availability and quality of surface water (River, lake and dam) and ground water (Open well and Bore well), water requirement for domestic consumption, specification for drinking water (physical, chemical and bacteriological) by Bureau of Indian Standards and WHO
3. Elucidate Soil sampling methodology; site selection, in-field sampling technique, soil profile, site description and equipment
4. Describe Water quality monitoring and on-field test parameters as well as off-field parameters
5. Expound Measurement of Meteorological Parameters

Unit-I: Land and Water Resources**(7.5 Hrs)**

A. Land Resources: Significance of topmost layer, Soil erosion (definition and types), causes of soil erosion (water, wind, and biotic agencies), control measures of soil erosion.

B. Water Sources: Availability and quality of surface water (River, lake and dam) and ground water (Open well and Bore well), water requirement for domestic consumption, specification for drinking water (physical, chemical and bacteriological) by Bureau of Indian Standards and WHO, significance of World Water Day.

C. Conservation and Management of Water: Traditional methods, Ground water recharge and Rainwater Harvesting, Concept of Watershed Management

Unit-II: Water Sampling and Monitoring:**(7.5 Hrs)**

A. Water Sampling and Analysis: Necessity of analysis, water sampling, types of water samples, selection of sample sites, collection, handling and preservation of samples, information to be submitted along with samples, presentation and interpretation of results.

B. Water Sampling and Monitoring: Water quality monitoring on-field test parameters, off-field parameters, tools/instruments used for water sampling, drinking water standard (IS 10500 and WHO), safety practices.

C. Environmental Analysis: Theory, principle and working of pH meter, turbidometer and conductivity meter. Application of pH meter, turbidometer and conductivity meter in environmental analysis.

Unit-III: Soil Monitoring and Management**(7.5 Hrs)**

A. Soil Monitoring: Objectives of soil monitoring/testing, sampling and sample units (sample number, frequency and timing), sampling methodology; site selection, in-field sampling technique, soil profile, site description and equipment used.

B. Soil Analysis: Important soil quality indicators: pH, Electrical Conductivity (EC), Total nitrogen(N), sodium and potassium, useful soil microbes, guidelines for handling and storage of soil samples.

C. Soil Management: Soil as a sink for waste disposal, remediation of contaminated soil, National Waste Land Development (NWLD), GIS-application for management of soil resources.

Unit-IV: Basics of Meteorology**(7.5 Hrs)**

A. Meteorology: Aims and objectives of meteorology, Primary meteorological parameters (temperature, wind direction, wind speed and wind patterns), Secondary meteorological parameters (humidity, precipitation, atmospheric pressure, and solar radiation), importance of meteorology.

B. Measurement of Meteorological Parameters: Relative humidity by Psychrometer, Wind speed by Anemometer and Atmospheric pressure by monometer and barometer. weather forecasting (methods and types), role of satellite in weather forecasting.

C. Climatology: Definition, aim and objectives, sub-division of climatology, difference between meteorology and climatology, fog and clouds (definition types and classification).

SUBJECT: ENVIRONMENTAL SCIENCE

B.SC. - I SEMESTER - II

BESFS22: PAPER- II (Biodiversity Conservation And Environmental Management)

OBJECTIVES:

To make Students:

1. Comprehend Types of forest, forest products, significance or importance of forest as an ecosystem
2. Recognize the types, Hotspots of biodiversity, Causes for the loss of biodiversity, preservation & Conservation strategies, Values, importance and benefits of biodiversity and Biodiversity at National and International level
3. Extricate the Importance of wildlife, Categories of threatened species and Wildlife Management
4. Know the concept, principle and planning for sustainable development and case studies

OUTCOMES:

Students shall be able to:

1. Explain the types, Hotspots of biodiversity, Causes for the loss of biodiversity, preservation & Conservation strategies, Values, importance and benefits of biodiversity and Biodiversity at National and International level
2. Explain Importance of wildlife, Categories of threatened species and Wildlife Management
3. Elucidate Types of forest, forest products, significance or importance of forest as an ecosystem
4. Describe concept, principle and planning for sustainable development and case studies

Unit-I: Forest and its conservation

(7.5 Hrs)

A. Forest: Definition, Types of forest in India, Minor forest products in India, significance or importance of forest, forest as an ecosystem, Ethnobotany and its role.

B. Forest Destruction: Forest fires (types, causes and effects), Deforestation (causes, effects, and control measures), Soil erosion and Dams and their effects on forest.

C. Forest Conservation: Social forestry (Need, objectives, mission, types and benefits), National Forest Policy of India, Chipko Movement, Afforestation, Tissue culture technique for forest conservation, Forest conservation Act, 1980 (Amended 1988), Joint Forest Management (JFM).

Unit-II: Biodiversity and its conservation (7.5 Hrs)

A. Biodiversity: Definition and types, Hotspots of biodiversity, Causes for the loss of biodiversity, preservation strategies for biodiversity, Values, importance and benefits of biodiversity, International Union for Conservation of Nature and Natural Resources (IUCN), Red List categories of species.

B. Biodiversity Conservation: “In-situ” conservation (Biosphere Reserves, National Parks and Sanctuaries), “Ex-situ” conservation (Botanical and zoological gardens, gene banks, seed and seedling banks), recent methods of conservation, Red Data Book.

C. Biodiversity at National and International level: India as a mega diversity nation, Phytogeography and zoogeography zones of the country, Biodiversity Act 2002, Community Biodiversity Register (CBD), International efforts for conservation of biodiversity: Convention on International Trade in Endangered Species (CITES), World Conservation Union (WCU) and Convention on Biological Diversity (CBD)

Unit-III: Wildlife Management and Conservation (7.5 Hrs)

A. Wildlife: Definition, Importance of wildlife, Categories of threatened species: Rare, endangered, vulnerable, and extinct species of wildlife in India, Wildlife Management, Science in wildlife studies: Mammology, Ornithology, Ichthyology, Entomology, Animal ethology and Phenology.

B. Causes of Wildlife Depletion: Habitat destruction, hunting, urbanization and industrialization, pollution and climate change, excessive harvesting and poaching, man-animal conflicts.

C. Wildlife Conservation: Necessity of conservation, Modes of conservation (Biosphere Reserves, National Parks and Sanctuaries), Project Tiger, Project Elephant and Crocodile Breeding Project, Wildlife Protection Act’1972 (Objectives and salient features), Agencies involved in wildlife conservation (IUCN, UNEP and WWF).

Unit-IV: Environmental Management and Sustainable Development (7.5 Hrs)

A. Sustainable Development: Definition, concept, principle and planning for sustainable development, Preventive Environmental Policy (PEP), Case study of sustainable development.

B. Environmental Management: Definition, objectives, components, principle, and importance of Environmental Management.

C. NGO’s in Environmental Protection: Different NGO’s in Environmental Protection and their role at local, National and International level, Role of Bishnoi community in environmental protection.

BESFS23: LABORATORY COURSE

Practical-II

OBJECTIVES:

To make Students:

1. Learn determination of pH, Conductivity, Turbidity of water and wastewater sample
2. Acquire skill to Estimate Hardness, Free chlorine, Dissolved Oxygen (DO) of water and wastewater sample
3. Study the determination of pH, Electrical Conductivity (EC), Total hardness, of soil

OUTCOMES:

Students shall be able to:

1. Carry-out the determination of pH, Conductivity, Turbidity of water and wastewater sample
2. Estimate Hardness, Free chlorine, Dissolved Oxygen (DO) of water and wastewater sample
3. Determine pH, Electrical Conductivity (EC), Total hardness, of soil
4. Determine Relative humidity, Wind speed and wind direction

Practical-II

1. Determination of pH of water and wastewater sample.
2. Determination of Conductivity of water and wastewater sample.
3. Determination of Turbidity of water and wastewater sample.
4. Estimation of Hardness of water and wastewater sample by Complexometric method.
5. Estimation of Free chlorine of water and wastewater sample.
6. Estimation of Dissolved Oxygen (DO) of water and wastewater sample.
7. Determination of Electrical Conductivity (EC) of soil.
8. Determination of pH of soil.
9. Determination of Total hardness of soil.
10. Determination of Relative humidity by Psychrometer.
11. Determination of Wind speed and wind direction by Anemometer.
12. Measurement of Solar Constant.

Visit:

1. Regional Meteorology Centre, Nagpur
2. Biodiversity Park
3. National Park and Sanctuaries
4. Visit to Nearby Forest to study the flora and fauna in its Natural Environment.

All students shall undertake field visits, soon after their visit, students shall submit study tour report which is certified by the HOD is to be submitted at the time of Annual practical examination.

Field Diary:

The students shall prepare their field diary under the following heads:

- a. Issue on Regional problems of Environmental interest (Case study).
- b. Issue on National interest (Case study).
- c. Famous personalities in Environmental Movements

Distribution of Marks:

1. Long experiment (Anyone) : **10** Marks
2. Short experiment (Any two) : **10** Marks
3. Viva – voce : **04** Marks
4. Tour report / field diary : **03** Marks
5. Practical Record : **03** Marks

Total Marks : 30 Marks

Books for Reference (Practical)

1. A Manual of Water and Wastewater Analysis: Dr D.S. Ramteke and Dr C.A. Moghe, Published by NEERI, Nagpur, 1996.
2. Laboratory Manual of Environmental Chemistry: Dr S Unita Hooda and Dr Sumanjeet Kaur, S. Chand and Co. Ltd. New Delhi. 1997.
3. Physico-chemical Examination of Water Industrial Effluents : N. Manivaskaram, Pragti Prakashan , Meerut (U.P) 1996.
4. Chemical and Biological Methods of Water Pollution Studies: R.K. Trevedi and P.K. Goel, Enviro Media Publication.

Books for Reference:

1. Text Book of Environment: K M Agrawal, P.K.Sikdar, and S.C.Deb, Mc'Millan Publication, Mumbai.
2. Man and Environment: M.C. Dash and P.C.Mishra, Mc'Millan Publication, Mumbai.
3. Environmental Science: S.C. Santra, New Central Book Pvt. Ltd, Kolkatta.
4. Environmental Problems and Solution: D.K. Asthana, S.Chand Publication, New Delhi.
5. Environmental Chemistry: S.S. Dara, S. Chand Publication, New Delhi.
6. Environmental Chemistry: B.K. Sharma, Goel Publication, Meerut.
7. Environmental Chemistry: A.K. Dey, New Age International Publishers,2001.
8. Man and Environment: P.R.Trivedi and Gurdeep Raj, Akashdeep Publishing House, New Delhi.
9. Fundamentals Concepts in Environmental Studies: Dr. D.D. Mishra , S. Chand Publication, New Delhi.
10. Climatology: D.S.Lal,Sharda Pustak Bhavan,Allahabad,2003.
11. A Textbook of Environmental Studies: Dr S. Satyanarayan, Dr S.Zade, Dr S Sitre and Dr P.U. Meshram , Allied Publishers, New Delhi.
12. Environmental Biology: Biswarup Mukherjee, Tata McGraw-Hill Publishing Company Ltd,New Delhi,1996.
13. Animal Ecology and Distribution of Animals: Veer Bala Rastogi, Rastogi Publication, Meerut (U.P).
14. Ecology and Environment: P.D. Sharma, Rastogi Publication, Meerut (U.P).
15. Fundamentals of Environmental Biology: S. Arora, Kalyani Publishers.
16. Plant Ecology and Soil Science: R.S. Shukla and P.S. Chandel, S. Chand Publication, New Delhi.
17. Animal Ecology and Environmental Biology: H.R Singh,Vishal Publication.
18. Environmental Biology: P.S. Verma and V.K. Agrawal, S.Chand Publication, New Delhi.
19. Environmental Biology: P.K.G. Nair, Himalaya Publication.
20. Environmental Biology :K.C. Agrawal, Agro Botanical Publisher,Bikaner,1994.

SUBJECT: ENVIRONMENTAL SCIENCE

B.SC. - II SEMESTER - III

BESSS31: PAPER- I (Introduction to Green Chemistry, Soil Pollution and Water Resources)

The Syllabus is based on 6 theory periods and 6 practical periods per week. Theory paper is divided into four units. Each unit shall be covered in 7.5 hours. Eight periods are allotted for each unit. The examination shall comprise two theory papers of 3 hours duration of 50 marks each. One internal assessment based on two theory papers for 10 marks each. Practical examination will be of 6 to 8 hours for one day and carry 30 marks. Candidates are expected to pass separately in theory and practical examination.

OBJECTIVES:

To make Students:

1. Understand the principles of Green Chemistry and Green Technology and its application
2. Comprehend the sources, detrimental effects and control measures of soil pollution
3. Recognize the different types of pesticides and control measures of pesticides pollution
4. Extricate the Classification of water resources and Wetland and their Management
5. Know the Classification and zonation of marine environment and Estuary Environment and its environment

OUTCOMES:

Students shall be able to:

1. Explain the principles of Green Chemistry and applications of Green Technology
2. Explicate the sources, detrimental effects and control measures of soil pollution
3. Elucidate the Classification and zonation of marine environment and Estuary Environment and its environment
4. Describe the Classification of water resources and Wetland and their Management

Unit I: Green Chemistry and Green Technology:

(7.5 Hrs)

A. Green Chemistry: Definition and principles, bio-degradable and bio-accumulative products in environment, importance and examples of green chemistry, green bench.

B. Green Technology: Introduction and definition, 4R's of green technologies (reduction, reuse, recycling, and recovery), successful green technologies (wind turbines and solar panels), benefits of green technology.

C. Application of Green Technologies: Green House Gas (GHG) emission reduction, carbon capture and storage technologies, fuel efficient vehicles, methane emission reduction and/or use, Compact Fluorescent Lights (CFL).

Unit II: Soil and Pesticides Pollution: (7.5 Hrs)

A. Soil Pollution: Definition and sources, detrimental effects of soil pollutants and control measures of soil pollution, bio- remediation of contaminated soil. Soil conservation and methods of soil conservation.

B. Land Use Planning: Sustainable land use planning, impact of human activities on land use pattern, wasteland (definition and types), wasteland management, desertification, and major causes of desertification.

C. Pesticides Pollution: Types of pesticides, impact/effect of pesticides on soil, physical, chemical and biological methods to degrade pesticides, bio-accumulation and bio-magnification of pesticides, neem pesticides, control measures of pesticides pollution (thermal desorption and incineration, soil flushing and washing, phyto remediation and bio-remediation, reclamation of degraded lands.

Unit III: Water Resources and Wetland Management: (7.5 Hrs)

A. Water Resources: Classification of water resources, introduction to surface and ground water, techniques for ground water recharge (watershed management, rainwater harvesting), Organization for water resource management.

B. Properties of Water: Physical (Specific & Latent heat, buoyancy, solvency, viscosity, surface tension and salinity), Chemical (BOD, COD, fluoride, nitrogen, sulphate and phosphate), Biological (phyto and zooplankton, phyto-benthos).

C. Wetland and their Management: Definition, types (fresh and marine) ecological significance of wetland, wetland conservation management, Ramsar convention,1971, Major wetland of India.

Unit IV: Marine and Estuary Environment: (7.5 Hrs)

A. Marine Environment: Classification and zonation of marine environment, physical properties (temperature, tides, current and waves), chemical properties (salinity, oxygen, carbon dioxide, pH and organic matter).

B. Adaptation in Marine Environment: Ecology of deep marine water, Pelagic and deep adaptation in marine environment, marine resources (food, medicinal ornamental and petroleum deposits).

C. Estuarine Environment: Definition, Types of estuary, characteristic of estuary (salinity, turbulence, silt or mud), classification of estuaries, Estuarine fauna(permanent and temporary), Estuarine adaptation, major estuaries of India.

SUBJECT: ENVIRONMENTAL SCIENCE
B.SC. - II SEMESTER - III
BESSS32: PAPER- II (Environmental Microbiology)

OBJECTIVES:

To make Students:

1. Comprehend the Introduction to Environmental Microbiology with respect to sources and classification of Air, water and Soil Microbiology
2. Study the Water Sampling: site selection, method, frequency, equipment and Analysis of different parameters
3. Recognize the Epidemiology, Environmental Sanitation, its measures and Disinfection methods
4. Extricate modern water treatment and Water Supply and Distribution

OUTCOMES:

Students shall be able to:

1. Explain the Environmental Microbiology with respect to sources and classification of Air, water and Soil Microbiology
2. Elucidate Water Sampling: site selection, method, frequency, equipment and Analysis of different parameters
3. Describe Epidemiology, Environmental Sanitation, its measures and Disinfection methods
4. Expound modern water treatment and Water Supply and Distribution

Unit I: Introduction to Environmental Microbiology

(7.5 Hrs)

A. Air Microbiology: Definition, sources of microorganisms in air, classification of microbes, beneficial and harmful effect of air micro-organism, aeroallergens, air borne diseases, Enumeration method of micro-organism in air (microscopic method), control microbes in air.

B. Water Microbiology: Sources of microorganism, significance of bacteriological analysis of water, enumeration of coliforms by MTDT, Standard of drinking water prescribed by WHO and ICMR, Water- borne diseases.

C. Soil Microbiology: Importance of microorganisms in soil, types of microorganisms, role of microorganisms in soil fertility, function of microorganisms in soil, soil microorganism diseases, role of microorganism in soil reclamation, enumeration method of soil microorganism.

Unit II: Water Sampling**(7.5 Hrs)**

A. Sampling: Site selection for river and lake, Sampling method, Sampling frequency, Sampling equipment's, Types of sample, Sampling container, Preservation of water sample.

B. Water Analysis: Analysis of water sample for different parameters (Physical, chemical & biological), Importance of water analysis, Scope, Significance and objectives, Plankton, Nekton, Benthos.

C. Applied Microbiology: Control of pest and diseases by microorganisms, role of microbes in sewage (Activated sludge process and oxidation pond), Bio-control agents:- bio-pesticides and bio-insecticides.

Unit III: Environmental Sanitation**(7.5 Hrs)**

A. Epidemiology: Definition, basic concept, epidemiological issues (Goitre, fluorosis), public health, cholera, typhoid, hepatitis, pandemic disease, safety measures, Defluoridation, health effects.

B. Environmental Sanitation: Significance, Rural and urban sanitation, principle of sanitation, Low cost sanitation, Community sanitation measures, health education & public awareness.

C. Disinfection: Theory, methods and necessity of disinfection, Application of chemicals use for disinfection of treated water, Chlorination- Pre, Post, Super, Double Chlorination, Break-point chlorination, Role of ozone and UV as a disinfectant.

Unit IV: Water Treatment**(7.5 Hrs)**

A. Introduction: Potability of water: Definition, significance, Importance, objectives, principle of water treatment and significance of aeration, coagulation, flocculation, sedimentation and filtration (Slow and Rapid sand filter).

B. Modern Water Treatment: Water softening process, necessity of water softening, Lime Soda and Zeolite process. Swimming pool water treatment.

C. Water Supply and Distribution: Beneficial uses of water, Water demand, Per-capita demand, Detection and Prevention of wastage of water, Sources of water supply, Surface and Underground water sources, methods of distribution system, types of service reservoirs.

BESS33: LABORATORY COURSE

Practical-I Section A & Section B

OBJECTIVES:

To make Students:

1. Learn the determination of potability, chlorine demand and dose, Alkali metals (Sodium and Potassium), optimum coagulant dose, pH in a water sample
2. Study the zinc in soil sample, Total Organic Carbon (TOC) and percent organic matter, cation exchange capacity, sodium, nitrogen, phosphorus and potassium of soil sample
3. Acquire the skills of Enumeration and demonstration of bacteria from Air, Water and Soil
4. Study the analysis of Total Coliform by MPN and microorganism by MTDT

OUTCOMES:

Students shall be able to:

1. Estimate zinc in soil sample, Total Organic Carbon (TOC) and percent organic matter, cation exchange capacity, sodium, nitrogen, phosphorus and potassium of soil sample
2. Determine the potability, chlorine demand and dose, Alkali metals (Sodium and Potassium), optimum coagulant dose, pH in a water sample.
3. Analyze Total Coliform by MPN and microorganism by MTDT
4. Examine Enumeration and demonstration of bacteria from Air, Water and Soil

Practical-I

Section A

1. Analysis of water for its potability test.
2. Determination of chlorine demand and dose in a water sample.
3. Determination of zinc in soil sample.
4. Determination of Alkali metals (Sodium and Potassium) in various samples by Flame Photometry.
5. Defluoridation of water sample using Nalgonda technique.
6. Determination of optimum coagulant dose, pH and time by Jar Test Apparatus.
7. Determination of Total Organic Carbon (TOC) and percent organic matter in the soil sample.
8. Determination of cation exchange capacity of a soil sample.
9. Determination of sodium in soil sample.
10. Determination of nitrogen, phosphorus and potassium of soil.

Section B

1. Enumeration and Demonstration of Bacteria from Air.
2. Enumeration and Demonstration of Bacteria from Water.
3. Enumeration and Demonstration of Bacteria from Soil.
4. Differential Gram's Staining.
5. Determination of Total Coliforms of water by MPN Technique.
6. Study of microorganisms by Standard Plate Count Method (SPC Method)
7. Study of microorganisms by MTDT method.

Visit:

1. Anacon Laboratories Pvt. Ltd., Near Ram Nagar Square, Nagpur
2. Gorewada Water Purification Plant
3. Kanhan Water Treatment Plant

All students shall undertake field visits to the above mention research institution and industries which are important for understanding the subject. Soon after their visit, 15 students shall submit study tour report which is certified by the HOD is to be submitted at the time of Practical Examination.

Field Diary:

The student shall prepare their Field Diary under the following heads:

1. Issue on Regional Problem of Environmental Interest (Case Studies)
2. Issue of National Interest (Case Studies)
3. About Famous Personalities in Environmental Movements.

Guest Lectures Series:

In each semester, guest lectures will be given by the faculty and other invited speakers on current topics and environmental issues. The course would run as a guest lecture series (at least two guest lectures in chosen topic) with compulsory attendance.

Distribution of Marks:

1. Long Experiment (Any one) : **10 Marks**
2. Short Experiment (Any two) : **10 Marks**
3. Viva-voce : **04 Marks**
4. Tour Report/ Field Diary : **03 Marks**
5. Practical record : **03 Marks**

Total Marks : 30 Marks

Books for Reference:

1. A Textbook of Environmental Studies by Dr. Shanta Satyanaran, Dr. Suresh Zade, Dr. Shashikant Sitre & Dr. Pravin Meshram, Allied Publishers Pvt. Ltd., New Delhi
2. A Textbook of Air Pollution and Control Technologies by Y. Anjaneyulu, Allied Publishers & Ltd. New Delhi, 2002
3. A Textbook of Environmental Chemistry and Pollution Control by S.S.Dara, S.Chand & Company New Delhi.
4. A Textbook of Environmental Chemistry by O.D. Tyagi & M. Mehra Amol Publication New Delhi, 1996
5. A Textbook of Environmental Sciences by R. N. Trivedi, Amol Publication New Delhi.
6. A Textbook of Environmental Pollution by H.V. Jadhav, Himalaya Publishing House, Nagpur, 1997
7. Atmospheric Science and Environment by S.N. Gosh, Allied Publishers Ltd.,2000 New Delhi
8. Environmental Pollution Control Engineering by C.S. Rao, Wiley Eastern Ltd. New Age International Ltd. New Delhi, 1995.
9. Environmental Chemistry by Ajay Kumar Bhagi & G.R. Chatwal Himalaya Publishing House, Nagpur, 2003
10. Environmental Chemistry by Anil Kumar, De New age International (P) Ltd. 1999
11. Environmental Chemistry by B.K. Sharma, Goel Publishing House Meerut, / Krishna Prakashan Ltd, 2003.
12. Environmental Chemistry by H. Kaur, Pragati Prakashan , Meerut, 2007
13. Environmental Chemistry by M. Sataje, Y. Mido, S.A. Iqbal & M.S. Sethi, Discovery Publishing House New Delhi, 1994
14. Environmental Issues and Options by C.S.K Mishra, J. W. Kim & Amita Saxna, Daya Publishing House Delhi, 2006
15. Environmental Problems and Solutions by D.K. Asthana & Meera Asthana, S.Chand & Company Ltd. New Delhi, 2003
16. Environmental Science by S.C. Santra, New Central Agency Ltd. Kolkata, 2005.
17. Manual of Water and Wastewater Analysis by Dr. D.S. Ramteke, C.A. Moghe & R.Sarin, NEERI, Nagpur
18. Our Environment Pollution Control and Future Strategies by M.P. Mishra, S.Chand & Company Ltd. New Delhi, 2000.
19. Principals of Environmental Science by H.V. Jadhav, Himalaya Publishing House, New Delhi, 1994

20. Water and Wastewater Technology by Mark J. Hammer, Prentice Hall of India Pvt. Ltd., New Delhi, 1998
21. Water Pollution by B. K. Sharma, Krishna Prakashan Media Pvt. Ltd., 2001
22. Water Treatment Technologies and Environment by S.N. Kaul, Lidia Szpyrkowicz & Arvind Kumar, Dyaya Publishing House Delhi, 2004.
23. Environmental Chemistry by P.S. Sindhu, New International Pvt. Ltd, New Delhi.2002
24. Textbook of environmental Chemistry, Pani, Balram, I. K. International Publishing House, New Delhi, 2007
25. Instrumental Methods of Chemical Analysis by Gurdeep R. Chatwal & Sham K. Anand, Himalaya Publishing House. Delhi, 2009.
26. Elements of Environmental Engineering by K.L. Duggal S. Chand. Comp.
27. Instrumental Methods of Chemical Analysis by B.K. Sharma, Goel Publishing House Meerut
28. Textbook of Environmental Engineering by P.V. Prentice Hall Of India 2002.
29. Water Microbiology Vol.I & II by C.B.Powar & H. F. Daginawala, Himalaya Publication Corp.
30. Chemistry For Environmental Engineering by E.N.Sawyer, Mcgraw Hill Book Co, New York.1978
31. Environmental Chemistry by M,Satake, Y.Mido, Discovery Publishing House, New Delhi, 2003.
32. Chemical and Biological Methods of Water of Water Pollution Studies, by R.K.Trivedi &P.K.Goel, Enviro Media Pub. Karhad, 2000.
33. Textbook of Environmental Chem by S.S. Dara. S. Chand & Co-New Delhi.2002.
34. Environmental Chemistry, Baird. Colin, W H Freeman and Company, New York.
35. Environment Measurement (Concept and Approach), N. Rajvaidya and Dilip, APH Publishing corporation, New delhi,2011.
36. Tade, RL 1995. Soil Microbiology. John Wiley and sons, New York. p.398.
37. Dirk van Elsas, J., T. Trevors and MH Wellington, 1998. Modern Soil Microbiology.
38. Environmental C Gerard Kiely, The McGraw-Hill Company
39. Environmental Science and Engineering- J Glynn Henry and G W Heinke, PHI Learning Private Limited.
40. Water Supply and Sanitary Engineering: R. C. rangwala and S. C. rangwala (Charotal publishing house, Anand).
41. A Textbook of Sanitary Engineering: Vinayak Gharpure (Engineering Book Publishing Company, Pune)

42. Wastewater Engineering: Metcalf and Eddy (Tata Mc-Grew Hill Publishing Company, New Delhi).
43. Technical Manual for Water and Wastewater Analysis by Sunil P. Pande & Leena S. Deshpande , Himalaya Publishing House.
44. Manual of Environmental Analysis by N.C. Aery, Ane Books Pvt. Ltd.

SUBJECT: ENVIRONMENTAL SCIENCE
B.SC. - II SEMESTER - IV
BESSS41: PAPER- I (Solid and Hazardous Waste Management)

The examination shall comprise two theory papers of 3 hours duration of 50 marks each. One internal assessment based on two theory papers for 10 marks each. Practical examination will be of 6 to 8 hours for one day and carry 30 marks. Candidates are expected to pass separately in theory and practical examination. Theory paper is divided into four units. Each unit shall be covered in 8 periods.

OBJECTIVES:

To make Students:

1. Understand the Basics of Solid Waste, its categories and Municipal Solid Waste: Sampling, composition, Physical and Chemical properties and generation rate
2. Comprehend Municipal Solid Waste Management: Collection, Handling and Transportation, Treatment and Disposal, Existing Scenario
3. Recognize Hazardous Waste Management: Classification, Components, physical, chemical, and biological methods of disposal and Secured Landfill
4. Extricate the Leachate generation, characteristics, Environmental effects and Biomedical Waste Management and Electronic Waste Management

OUTCOMES:

Students shall be able to:

1. Explain Basics of Solid Waste, its categories and Municipal Solid Waste: Sampling, composition, Physical and Chemical properties and generation rate
2. Elucidate Municipal Solid Waste Management: Collection, Handling and Transportation, Treatment and Disposal, Existing Scenario
3. Describe Hazardous Waste Management: Classification, Components, physical, chemical, and biological methods of disposal and Secured Landfill
4. Expound Leachate generation, characteristics, Environmental effects and Biomedical Waste Management and Electronic Waste Management

Unit I: Basics of Solid Waste**(7.5 Hrs)**

A. Introduction of Solid Waste: Definition, categories of solid waste (municipal, biomedical, hazardous, construction & demolition, E-Waste, Plastic Waste).

B. Introduction of Municipal Solid Waste (MSW): Definition, classification (type based, and source based), composition of MSW, Solid waste generation rate, Factors affecting waste generation, Problems caused by MSW.

C. Properties of Municipal Solid Waste: Sampling of municipal solid waste by quartering & coning method, Properties- Physical (density, particle size and distribution), Chemical (moisture content, volatile matter, fixed carbon, calorific value)

Unit II: Municipal Solid Waste Management:**(7.5 Hrs)**

A. Collection, Handling and Transportation: Source segregation, storage of waste (Containers and types of Containers), solid waste collection (types of collection, frequency of collection, collection crew, collection route, factors affecting collection), Transportation and vehicles used for transportation, Transfer stations.

B. Treatment and Disposal of Solid Waste: Need of treatment, types of treatment methods - Biological (composting, bio-gasification), Thermal (incineration, pyrolysis), sanitary landfill, waste to energy.

C. Existing Scenario: Existing Indian Scenario of Municipal Solid Waste Management, Best Solid Waste Management Practices in India (Case Studies), Solid Waste Management Rules, 2016.

Unit III: Hazardous Waste Management**(7.5 Hrs)**

A. Introduction of Hazardous Waste: Definition, classification (radioactive waste, nuclear waste, biomedical waste, chemical waste and electronic waste), Identification of hazardous waste based on its characteristics, Environmental effects of improper handling and management of hazardous waste.

B. Introduction to Hazardous Waste Management: Components of hazardous waste management plant, On-site hazardous waste treatment and disposal method (physical, chemical, and biological), Off-site hazardous waste treatment and disposal method.

C. Secured Landfill: Site selection, site investigation, site Characterization, landfill planning and designing, construction and operational practices, liners system, difference between secured and sanitary Landfill.

Unit IV: Other Hazardous Waste Management:

(7.5 Hrs)

A. Leachate Management: Leachate generation, characteristics of leachate, Environmental effects of disposing untreated Leachate, Leachate Treatment Technologies

B. Biomedical Waste Management: Categories of biomedical waste based on colour coding (yellow, red, white, blue), type of container used for disposal of biomedical waste, various methods used for treatment and disposal of biomedical waste as per Biomedical Waste Management Rules 2016.

C. Electronic Waste Management: Sources of electronic waste, environmental and health effects of electronic waste, Existing Indian scenario of handling and treating electronic waste, scientific disposal of electronic waste, Extended Producer Responsibility as per E-Waste (Management & Handling) Rules 2016.

SUBJECT: ENVIRONMENTAL SCIENCE
B.SC. - II SEMESTER - IV
BESSS42: PAPER- II (Natural Resources and GIS)

OBJECTIVES:

To make Students:

1. Comprehend Basic concept, classification- Renewable, Non- Renewable and Mineral Resources, its Sources, Land and Water Resources, Advantages and Disadvantages
2. Recognize the concept of management of resources, its preventive and control measures, and Geosciences: types, causes, impacts, control measures
3. Extricate Remote Sensing and GIS, Geographical Information and its application in Environment
4. Know about Environmental Disaster Management: prediction, magnitude of problem, Geological Hazards

OUTCOMES:

Students shall be able to:

1. Explain Basic concept, classification- Renewable, Non- Renewable and Mineral Resources, its Sources, Land and Water Resources, Advantages and Disadvantages
2. Elucidate Recognize the concept of management of resources, its preventive and control measures, and Geosciences: types, causes, impacts, control measures
3. Describe Remote Sensing and GIS, Geographical Information and its application in Environment
4. Expound about Environmental Disaster Management: prediction, magnitude of problem, Geological Hazards

Unit I: Energy Resources:

(7.5 Hrs)

A. Natural Resources: Basic concept, Definition and classification- Renewable, Non- Renewable and Mineral Resources, Sources of energy, Renewable (Non- Conventional Sources of Energy), Non-Renewable (Conventional Source of Energy), Solar Energy, Wind Energy, Geothermal Energy, Biogas Manufacturing Process, Applications of Biogas, Advantages and Disadvantages, Impacts on environment and their applications of energy.

B. Land Resources: Agricultural practices in India- Exploitation of agricultural land, Natural Gas, Bio-Fuels, Liquid Petroleum Gas (LPG), Compress Natural Gas (CNG), Mineral Resources,

Formation of Mineral Deposits, Conservation of Mineral Resources, uses, importance, significance.

C. Water Resources: Types of Water Sources, Surface Sources- General, Sources of Water, Streams, Lakes, Rivers, Introduction to Watershed, Basic concept and significance, Types- Macro and Micro watershed, Big dams, Rainwater harvesting- Aims and Objectives, Roof top rainwater harvesting- Conservation, Major uses of water resources, Importance, Wetland its function and importance.

Unit II: Management of Resources: (7.5 Hrs)

A. Resources: Water-Self-purification process, preventive measures, control measures for water and land resource, Eutrophication process.

B. Conservation of Energy: Importance, methods of conservation, environmental degradation, conservation techniques, management of natural resources.

C. Geosciences: Natural Catastrophes-types, causes, impacts, control measures, Flood, Cyclone, Volcano, Cloud Bursting, Snow Avalanches.

Unit III: Remote Sensing and GIS (7.5 Hrs)

A. Remote Sensing: Definition, concept of Remote sensing, development of Remote sensing, emission of Electromagnetic Radiation (EMR), Use of microwave for Remote Sensing. EMR and its interaction with matter, Sensor- Types of sensors, Sensor and platforms, IRS satellite and their sensor, Application of remote sensing and GIS in natural disaster.

B. Geographical Information: Concept, definition, Maps and GIS cartography, digital representation of geographical data, types of geographical data- Raster and Vector based GIS data processing, uses and application.

C. Remote Sensing and GIS in Environmental Management: Role in pollution monitoring, Forest cover, Earthquake, Landslide, Nuclear, Chemical, and measuring wetland loss. digital image processing, image restoration, spectra of environmental components, spectral characteristic of earth features (vegetation, soils, reflectance of rocks and water).

Unit IV: Environmental Disaster Management: (7.5 Hrs)

A. Environmental Hazards: Introduction, types, concept, causes, impacts, control measures, Disaster preparedness, Disaster Mitigation Programmes in India, Rescue and Relief operation, Risk mitigating strategies, National Magnitude of problem, Consolidated preparation for next disaster, disaster mitigation mapping, natural and manmade hazards.

B. Geological Hazards: Earthquake, Landslides, Tsunami, Man induced hazards- Dam and Dam bursts, Droughts, Desertification, effects, and control measures.

C. Disaster Management: Definition, prediction, magnitude of problem, assessment of disaster, warning and evacuation, analysis and mapping, Earthquake resistance buildings, disaster management and risk reduction strategy, disaster preparedness, Management Authority of India-its role and salient features.

BESSS43: LABORATORY COURSE

Practical-II

OBJECTIVES:

To make Students:

1. Learn Solid waste sampling by quartering and coning method and determination of Total Organic Carbon & Percent Organic matter in the given soil sample
2. Acquire knowledge of composition, density, moisture content, volatile and non-volatile matter, calorific value of Municipal Solid Waste (MSW)
3. Study normal compost and vermi-compost with respect to physic-chemical parameters (total nitrogen and phosphate)
4. Analyze Biogas Slurry: pH, Acidity, Alkalinity, Total solids, Volatile and non-volatile solids
5. Study of Remote Sensing techniques and Demonstration of Land use pattern of the region.

OUTCOMES:

Students shall be able to:

1. Carry-out Solid waste sampling by quartering and coning method and determine of Total Organic Carbon & Percent Organic matter in the given soil sample
2. Estimate composition, density, moisture content, volatile and non-volatile matter, calorific value of Municipal Solid Waste (MSW)
3. Determine pH, Acidity, Alkalinity, Total solids, Volatile and non-volatile solids of Biogas Slurry
4. Demonstrate Remote Sensing techniques, Land use pattern of the region

Practical-II

Section A

1. Solid waste sampling by quartering and coning method.
2. Determination of composition of Municipal Solid Waste (MSW) from the given mixed MSW.
3. Determination of density of solid waste sample.

4. Determination of moisture content of solid waste sample by Gravimetric method.
5. Determination of volatile and non-volatile matter in an MSW.
6. Determination of calorific value of MSW by Bomb Colorimeter.
7. Comparative analysis of normal compost and vermin-compost with respect to physicochemical parameters (total nitrogen and phosphate).
8. Determination of Total Organic Carbon & Percent Organic matter in the given soil sample.

Section B

1. Demonstration on non-conventional energy system: Solar cooker and solar water heater.
2. Determination of solar intensity by Lux Meter
3. Analysis of biogas slurry for the study of biogas plant:
a. pH **b.** Acidity and Alkalinity **c.** Total solids **d.** Volatile and non-volatile solids.
4. Analysis of ground water quality for total solids, fluoride, and iron for its potability test.
5. Study of Remote Sensing techniques.
6. Demonstration of Land use pattern of the region.

Visit:

1. Visit to a Solid Waste Dumping Site.
2. National Bureau of Soil Survey and Land Use Planning, Nagpur
3. Maharashtra Remote Sensing Application Centre, Nagpur.
4. Nearest Biogas Plant

All students shall undertake field visits to the above mention research institution and industries which are important for understanding the subject. Soon after their visit, students shall submit study tour report which is certified by the HOD is to be submitted at the time of Annual Practical Examination.

Field Diary:

The student shall prepare their Field Diary under the following heads:

1. Issue on Regional Problem of Environmental Interest (Case Studies)
2. Issue of National Interest (Case Studies)
3. About Famous Personalities in Environmental Movements.

Guest Lecture Series:

In each semester, guest lectures will be given by the faculty and other invited speakers on current topics and environmental issues. The course would run as a guest lecture series (at least two guest lectures in chosen topic) with compulsory attendance.

Distribution of Marks:

- 1) Long Experiment (Any one) : 10 Marks
- 2) Short Experiment (Any two) : 10 Marks
- 3) Viva-voce : 04 Marks
- 4) Tour Report/ Field Diary : 03 Marks
- 5) Practical record : 03 Marks

Total Marks : **30 Marks**

Books for Reference

Practical: Municipal solid Waste Management Manual (Part II), CPHEEO, Ministry of Urban Development, Swachh Bharat Mission, Govt. Of India. (Download Source- <http://cpheeo.gov.in/cms/manual-on-municipal-solid-wastemanagement-2016.php>)

Books for Reference:

1. Solid waste pollution: Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008.
2. Textbook of solid wastes management by Khan Iqbal and Ahsan Naved, CBS Publishers and distributors, New Delhi.
3. Environmental Problems and Solution: D.K. Asthana, S.Chand Publication, New Delhi.
4. Environmental Chemistry: S.S.Dara, S.Chand Publication, New Delhi.
5. Environmental Chemistry: B.K. Sharma, Goel Publication, Meerut.
6. Municipal solid Waste Management Manual (Part II), CPHEEO, Ministry of Urban Development, Swachh Bharat Mission, Govt. Of India.
7. Handbook of Solid Waste Management, George Tchobanoglous, McGraw Hills, Handbook
8. Sustainable Solid Waste Management- A systems engineering approach, IEEE Press, Wiley
9. Energy Resources and Environment by V.K. Prabhakar Anmol Publ.
10. Basic Concepts of Soil Sciences by A.K. Kolay, Wiley Eastern Ltd.
11. Non-Conventional Energy Sources by G.D. Rai. Khanna, Publ. New Delhi
12. Environmental Sanitation by Baljeet Kappor, S.Chand & Co. 2001.
13. Environmental Biology and Toxicology- P.D. Sharma, Rastogi Publication, 2004.
14. Environmental Science- W. Cunningham and Saigo, McGraw Hill, New York.
15. A Textbook of Environment- Agrawal, Mcmillion publication, Mumbai
16. Environmental Chemistry- S. S. Dara, S. Chand and Company, NewDelhi2002.
17. Environmental Chemistry- B.K. Sharma, Goel Publication, Meerut.
18. Environmental Science- S. C. Santra, New Central Book Agency private Limited, 2006.
19. Fundamental Concepts of Environmental Chemistry- G. S. Sodhi, Narosa Publishing House,

- New Delhi, 2002
20. A Textbook of Environmental Science- R.N. Trivedi, Anmol Publications Private Limited, 1997
 21. Manand Environment- P. R. Trivedi, Gurdeep Raj, Akshadeep Publishing House, New Delhi, 1997.
 22. Fundamental Concepts in Environmental Studies- Dr. D. D. Mishra, S. Chand Publication, 2009.
 23. Environmental Chemistry- A. K. De, New Age International Publishers, 2001.
 24. Industrial Safety and Environment- Anupama Prasar. S. K. Kataria & Sons, Delhi
 25. Environmental Chemistry- P. S. Sandhu, New Age International Publishers, Mumbai
 26. Environmental education and solid waste management, Nag, n. a.
 27. Solid Waste Management In Developing Countries (1983) by A.D.Bhide & B.B. Sundaresan, INSDOC, New Delhi.
 28. Remote sensing of the environment by John Jensen, Pearson, Second edition.
 29. Environmental risks and hazards by Susan Cutter, Prentice hall of India Pvt. Ltd, New Delhi.
 30. Fundamentals of Remote Sensing: George Joseph, Universities Press Hyderabad, 2005
 31. Remote Sensing and GIS: M. Anji Reddy, BS Publications, Hyderabad, 2008
 32. Remote Sensing Techniques in Agriculture: D. D. Sahu, R. M. Solanki, Agrobios . India, Jodhpur, 2008
 33. GIS Basics: Shahab Fazal, New Age International Publishers, New Delhi, 2008
 34. Geographical Information Systems: Anil K. Jamwal, Jnanda Prakashan, New Delhi, 2008
 35. Solid Waste Pollution: Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008
 36. Principals of Soil Science: M. M. Rai, McMillon Publication. Pollution & Soil organisms: P. C. Mishra
 37. Textbook of solid wastes management by Khan Iqbal and Ahsan Naved, CBS Publishers and distributors, New Delhi.

SUBJECT: ENVIRONMENTAL SCIENCE
B.SC. - III SEMESTER - V
BESTS51: PAPER- I (Principles of Air & Noise Pollution)

The Syllabus is based on 6 theory periods and 6 practical periods per week. Theory paper is divided into four units. Each unit shall be covered in 7.5 hours. Eight periods are allotted for each unit. The examination shall comprise two theory papers of 3 hours duration of 50 marks each. One internal assessment based on two theory papers for 10 marks each. Practical examination will be of 6 to 8 hours for one day and carry 30 marks. Candidates are expected to pass separately in theory and practical examination.

OBJECTIVES:

To make Students:

1. Understand the Basic Concepts of Air Pollution, Classification of Air Pollutants and Meteorology
2. Comprehend the Global Problems Associated, Prevention and Control, Control Equipments of Air Pollution and its Legislative Measures
3. Recognize the Genesis of Vehicular Emissions, Vehicular Air Pollution and Legislative Measures
4. Extricate the Basic Concepts of Noise Pollution, its Prevention and Control and Errors in Environmental Analysis

OUTCOMES:

Students shall be able to:

1. Explain the Basic Concepts of Air Pollution, Classification of Air Pollutants and Meteorology
2. Explicate the Global Problems Associated, Prevention and Control, Control Equipments of Air Pollution and its Legislative Measures
3. Elucidate the Genesis of Vehicular Emissions, Vehicular Air Pollution and Legislative Measures
4. Expound the Basic Concepts of Noise Pollution, its Prevention and Control and Errors in Environmental Analysis

Unit –I : Introduction to Air Pollution

(7.5 Hrs)

A. Basic Concepts of Air Pollution: Definition, Causes, Sources (Natural and Anthropogenic)

B. Air Pollutants: Chemistry of Air Pollutants, Classification, Primary Air Pollutants (Sulphur dioxide, Nitrogen dioxide, Carbon dioxide, Hydrocarbons & Particulate matter), Secondary Air Pollutants (Ozone, PAN & Photochemical smog) & their Effects on Human beings, Plants, Animals and Materials, Units of Air Pollutants.

C. Air Pollution and Meteorology: Factors Influencing Air Pollution, Methods for Measurement, Temperature, Inversion, Lapse Rates, Stability, Wind velocity, Wind Roses and Turbulence.

Unit II : Problems and Control Measures of Air Pollution (7.5 Hrs)

A. Global Problems Associated with Air Pollution: Acid rain and its Adverse Effects, Control Measures, Indoor air pollution and Mitigation Measures, Air pollution Episodes.

B. Prevention and Control of Air Pollution: Methods of Control of Air Pollution, Air Pollution Control Equipments and Devices - Gravity Settling Chambers, Cyclone Collectors, Fabric Filters, Electrostatic Precipitators (Tube and Plate type), Scrubbers-(Cyclonic and Ventury Scrubbers), Standards Prescribed for Air Quality in India.

C. Legislative Measures of Air Pollution: Air Pollution Control Act, Constitutional Provisions, Powers and Responsibilities of CPCB and MPCB.

Unit III : Introduction to Vehicular Air Pollution (7.5 Hrs)

A. Genesis of Vehicular Emissions: Vehicular Pollution, Sources of Air Pollution from Automobiles, Fuel tank, Carburettor, Crank case, Exhaust emissions, Mechanism of Origin of Air Pollution from Automobiles.

B. Vehicular Air Pollution: Automobile Emission, Population and Pollution loads of vehicles, Automobile Pollution Control, Control at Sources, Exhaust Gas Treatment Devices, Alternate Fuels Comparison, Diesel, CNG, Biofuels, Thermal Reactor, Catalytic Converter, Global Efforts in Reducing Vehicular Pollution; Indian Scenario.

C. Legislative Measures of Vehicular Pollution: Legal Measures, Government Efforts to Control Vehicular pollution, Euro Standards prescribed for Vehicular emission, Motor Vehicle Act, 1988.

Unit IV : Introduction to Noise Pollution (7.5 Hrs)

A. Basic Concepts of Noise Pollution: Definition, Sources of Noise Pollution, Measurement of Noise, The Decibel Scale, Effects of Noise Pollution, Auditory & Non auditory Effects.

B. Prevention and Control of Noise Pollution: Equipments used for Noise Measurements, Noise Control Criteria, Noise Control in Industrial Establishments, Important Parameters in Noise Control, Standards Prescribed for Noise with Reference to Indian Context.

C. Errors in Environmental Analysis: Definition, Determinate and Indeterminate Errors, Nature and Importance of Errors in Environmental Measurements, Methods of Minimization, Accuracy and Precision, Rejection of Measurement, Measures of Central Tendencies: Mean, Median Range, Average deviation, Standard deviation, Confidence limit and Numerical Problems. Statistical Methods in analysis, Statistical treatment of Environmental Data.

SUBJECT: ENVIRONMENTAL SCIENCE
B.SC. - III SEMESTER - V
BESTS52: PAPER- II (Environmental Management)

OBJECTIVES:

To make Students:

1. Understand the concept of Environmental Impact Assessment: Origin and Principles of EIA, Objectives, Need, Stages, Types and Limitations of EIA, EIS and Public Participation
2. Study the Impact Assessment Methodologies, Assessment of Impacts and Legislation of EIA
3. Comprehend the Environmental Audit: Concepts, Importance, Benefits, Scope, Objectives, Types, Methodology, Basic Structure and Environmental Audit in Polluting Industries
4. Distinguish between Significant Environmental Acts
5. Extricate Environmental Awareness and Sustainable Development, People's Participation in Environmental Protection and Environmental Issues

OUTCOMES:

Students shall be able to:

1. Explain the concept of Environmental Impact Assessment: Origin and Principles of EIA, Objectives, Need, Stages, Types and Limitations of EIA, EIS and Public Participation
2. Explain Impact Assessment Methodologies, Assessment of Impacts and Legislation of EIA
3. Elucidate Significant Environmental Acts
4. Describe Environmental Awareness and Sustainable Development, People's Participation in Environmental Protection and Environmental Issues
5. Expound Impact Assessment Methodologies, Assessment of Impacts and Legislation of EIA

UNIT I : Basic Concepts of Environmental Impact Assessment

(7.5 Hrs)

A. Environmental Impact Assessment (EIA): Definition, Origin and Principles of EIA, Objectives, Need, Limitations of EIA, Environmental Impacts of Industrialization and Urbanization, Stages in EIA, Types of EIA, Environmental Inventory, Baseline Information on EIA-Environmental Data, Project Alternatives and Data Management, EIA Monitoring, Risk Assessment, Positive and Negative Impact.

B. Environmental Impact Statement (EIS): Definition, Steps for EIS Preparation, Impact Indicators, Prediction of Environmental Impact and Methodologies.

C. Public Participation: Public Participation in Environmental Decision Making, Regulatory Requirement, Techniques, Advantages and Disadvantages of Public Participation.

UNIT II : Impact Assessment Methodologies (7.5 Hrs)

A. Methods of EIA: Criteria for the Selection of EIA Methodologies, Assessment of Environmental Impact and Methods-Adhoc, Checklist, Matrices, Overlays, Basic Steps for Prediction and Assessment of Air Environment, Water Environment and Biological Environment.

B. Assessment of Impacts: Overview of Impacts, Directly and Indirectly Measurable Impacts of Air, Water, Land, Noise, Biological, Socio-Economic, Human Health and Environment, Environment Management Plan, Selection of Appropriate Procedures, Development of Green Belt in and around the Industries, Case Studies- EIA of Water Resources and Mining.

C. Legislation of EIA: Legislation of EIA in India and Modification, Role of Statutory Agencies in EIA Clearance.

UNIT III : Environmental Audit (EA) (7.5 Hrs)

A. Introduction to Environmental Audit: Definition, Concepts of Environment Audit and its Importance for Industries, Benefits of EA, Scope and Objectives, Types of Audits, General Audit Methodology , Basic Structure of Audit, Elements of an Audit Process and its Importance.

B. Environmental Audit in Polluting Industries: Introduction and Scope, Advantages of EA, Types of EA-Compliance Audit, Surveillance Audit and EMS Audit, Guidelines for Preparation of Audit Report, Pre-Audit Activities, Activities at Site, Post-Audit Activities and Problems Encountered During the Audit.

C. Significant Environmental Acts: The Environmental Protection Act 1986, The Wild Life (Protection) Act 1972, The Wild life Protection Rules 1995, The Indian Forest Act 1927, The Forest Conservation Act 1980, The Forest Conservations Rules 1981, Salient Features of Coastal Zone Regulations (CZR) Notification, The Convention of Biodiversity.

UNIT IV: Environmental Awareness and Sustainable Development (7.5 Hrs)

A. Sustainable Development: Definition, Basic Concept, Objectives and Consequences and Management of Sustainable Development, Principle of Sustainable Development, Case study of Sustainable Development, Global Environmental Democracy, North- South Debate, Emission Trading, Concept of Carrying capacity, Supportive Capacity along with Assimilative Capacity, Modern Concept of Capacity Building in Environmental Management.

B. People's Participation in Environmental Protection: Tehri Dam, Apiko Movement, Sardar Sarovar, Narmada Project, Different NGO's in Environment Protection and Their Role at Local, National and International Levels, Concept of ISO 9000 and ISO 14000 in Environmental System Management (ESM).

C. Environmental Issues: Ecological Restoration, Principles, Strategies, Restoration Plans and Rehabilitative Measures, Examples of Terrestrial and Aquatic Eco-systems, Restoring Degraded Eco-system in India, Rain Water Harvesting, Application of Remote Sensing in Environmental Protection, Basic Concept of Green Building, Guidelines for Green Rating for Integrated Habitat Assessment.

BESTS53: LABORATORY COURSE

Practical-I Section A and Section B

OBJECTIVES:

To make Students:

- Learn Demonstration of an Electrostatic Precipitator, Scrubbers, Cyclone Collector, Gravity Settling Chamber
- Acquire skill to determine Suspended Particulate Matter (SPM) & (RSPM), Settleable Particles, Carbon monoxide (CO)
- Study the Measurement of Noise Pollution by Noise Meter in Silent, Industrial, Residential, Commercial Zones & Comparison
- Study Sulphonation Rate, Ammonia and Air Pollution Index (API)
- Acquire knowledge of Environmental Audit Report, Environmental Impact Assessment Report and EIA legislation for environmental protection

OUTCOMES:

Students shall be able to:

- Carry-out Demonstration of an Electrostatic Precipitator, Scrubbers, Cyclone Collector, Gravity Settling Chamber
- Quantify Sulphonation Rate, Ammonia and Air Pollution Index (API)
- Estimate Suspended Particulate Matter (SPM) & (RSPM), Settleable Particles, Carbon monoxide (CO)
- Measure Noise Pollution by Noise Meter in Silent, Industrial, Residential, Commercial Zones & Comparison

- Prepare Environmental Audit Report, Environmental Impact Assessment Report and EIA legislation for environmental protection

Practical-I

Section A :

1. Determination of Suspended Particulate Matter (SPM) & (RSPM) in Ambient Air by Using High Volume Sampler.
2. Comparative Analysis of Air Sampling from Residential, Commercial & Industrial Zone using key parameters like SO_x & NO_x.
3. Determination of Settleable Particles in Air using Dust Fall Jar Apparatus.
4. Preparation and Interpretation of Wind roses.
5. Concentration of Carbon monoxide (CO) in a given auto exhaust air sample.
6. Concentration of Acid rain in a air sample.
7. Measurement of Noise Pollution by Noise Meter in Silent, Industrial, Residential, Commercial Zones & Comparison its Standards.
8. Demonstration of an Electrostatic Precipitator.
9. Demonstration of Scrubbers and its working.
10. Demonstration of Cyclone Collector and its working.
11. Demonstration of Gravity Settling Chamber and its working.

Section B :

1. Preparation of Environmental Audit Report.
2. Preparation of Model Environmental Impact Assessment Report.
3. Study of natural environment of the area with respect to air, noise, water, soil, socio-economics.
4. Study of environmental impacts of the industries with respect to air, noise, water, soil, socio-economics.
5. Study of EIA legislation for environmental protection.
6. Concentration of Hydrocarbons in a given auto exhausts air sample.
7. Determination of Sulphonation Rate by Lead per oxide Method.
8. Determination of Ammonia in Atmosphere.
9. Determination of Air Pollution Index (API).
10. Impact of air pollution on photo density flux of plant leaves.
11. To estimate the effect of exhaust gases on chlorophyll content in different plants.

FIELD VISITS :

1. Visit to National Environmental Engineering Research Institute (NEERI), Nagpur
2. Visit to Maharashtra Pollution Control Board (MPCB), UdyogBhavan, Nagpur.
3. Visit to Common effluent treatment plant
4. Visit to Indorama Synthetics, Butibori

All students shall under take field visits to the above mention research institution and industries which are important for understanding the subject. Soon after their visit, students shall submit study tour report which is certified by the HOD is to be submitted at the time of Annual Practical Examination.

FIELD DIARY :

The Student Shall Prepare their Field Diary Under the Following Heads:

1. Issue on Regional Problem of Environmental Interest (Case Studies)
2. Issue of National Interest (Case Studies)
3. New Acts & Judgments of Environmental Interest.
4. About Famous Personalities in Environmental Movements.

DISTRIBUTION OF MARKS :

- 1) Any two experiments from Section A : 08 Marks
- 2) Any two experiments from section B : 08 Marks
- 3) Viva-voce : 04 Marks
- 4) Tour Report : 04 Marks
- 5) Practical record : 03 Marks
- 6) Field Diary : 03 Marks

Total Marks : 30 Marks

BOOKS FOR REFERENCE

1. Air Pollution and its control : Sumit malhotra, Pointer publishers, Jaipur
2. Air Pollution : M. N. Rao , Tata McGraw – Hill publishing company, New Delhi
3. Air Pollution : B. K. Sharma, H. Kaur, Krishna prakashan media, Meerut
4. Pollution of our Atmosphere : B. Henderson, Sellers Adam Hilger Limited, Bristol
5. Fundamentals of Air Pollution : Richard W. Bowbel, Donald L. Fox, D. Bruce Tunner, and A. C. Stern, Academic Press, California

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9. Noise Pollution and Control Strategy: S.P. Singal, Narosa Publishing House, New Delhi.
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11. Biostatistics : P. N. Arora, P. K. Malhan, Himalaya publishing House, Delhi, 2008
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13. Biostatistics in theory and Practice : T. K. Saha, Emkay Publications, Delhi, 1992
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15. Statistical Methods : S. C. Gupta, S. Chand & Sons Publishers, New Delhi, 1997
16. Evolution Biostatistics & Computer Applications : A. Gopi, A. Meena, N. Arumugam, Saras Publications, Kanyakumari, 2003
17. Environmental Impact Assessment : Principles and Procedures, John Wiley and Sons, New York.
18. Environmental Impact Assessment :A.K. Shrivastav, APH Publishing Corporation, New Delhi.
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20. Environmental Pollution Control :Neelima Rajvidya and Dilipkumar Markandey, APH Publishing Corporation, New Delhi. (2005)
21. Environment Problems and Solutions :D.K. Asthana and Meera Asthana, S.Chand & Co. Ltd. New Delhi.
22. An Introduction to Environmental Management :Dr.Anand S. Bal, Himalaya Publishing House, New Delhi.
23. Environmental Impact Analysis Handbook : John G.R. and David C.Wooten, McGraw Hill Publications. (1987).
24. Encyclopedia of Ecology and Environment : Environmental Impact Assessment Vol. 7 : By Trivedi P.R., Indian Institute of Ecology and Environment, New Delhi (1999)
25. Environmental Law and Policy in India : Divan S and Rosencraz A, Oxford University Press, New Delhi. (2001)
26. Environmental Laws of India - An Introduction: CPR Environmental Education Centre, Chennai (2001).
27. Environmental impact assessment methodologies: Y. Anjaneyulu,Valli Manickam, Bs Publications

28. Ecology Environmental Science Conservation by J. S. Singh and S. P. Singh and S. R. Gupta ,
S. Chand Company Ltd.
29. Environmental Pollution, R.K. Khitoliya, S. Chand Company Ltd.
30. Textbook of Environmental Chemistry ,Balram Pani, I.K. International Publishing Ltd.

SUBJECT: ENVIRONMENTAL SCIENCE
B.SC. - III SEMESTER - VI
BESTS61: PAPER- I (Water Pollution: Monitoring & Management)

The examination shall comprise two theory papers of 3 hours duration of 50 marks each. One internal assessment based on two theory papers for 10 marks each. Practical examination will be of 6 to 8 hours for one day and carry 30 marks. Candidates are expected to pass separately in theory and practical examination. Theory paper is divided into four units. Each unit shall be covered in 8 periods.

OBJECTIVES:

To make Students:

1. Understand Basic Concepts of Water Pollution, Water Pollutants, Water Quality Monitoring and Management
2. Comprehend Global Problems Associated with Water Pollution, Marine Pollution, Oil Pollution, Eutrophication
3. Recognize the Basic Concepts of Thermal pollution, Effects of Thermal pollution and Mitigation Measures of Thermal Pollution
4. Extricate the Basic Concepts of Radioactive Pollution: Causes and Sources, Effects and Disposal

OUTCOMES:

Students shall be able to:

1. Explain Basic Concepts of Water Pollution, Water Pollutants, Water Quality Monitoring and Management
2. Elucidate Global Problems Associated with Water Pollution, Marine Pollution, Oil Pollution, Eutrophication
3. Describe Basic Concepts of Thermal pollution, Effects of Thermal pollution and Mitigation Measures of Thermal Pollution
4. Expound Basic Concepts of Radioactive Pollution: Causes and Sources, Effects and Disposal

Unit- I : Introduction to Water Pollution

(7.5 Hrs)

A. Basic Concepts of Water Pollution: Definition, Causes, Sources and Effects of Water Pollution, Ground Water Pollution, Requirement of Fresh Water in India, Case Studies Status of Polluted Rivers like Nag and Kanhan, Ganga Action plan, Interlinking of rivers, Minimata epidemic in Japan.

B. Water Pollutants: Classification of Water Pollutants and Their Detrimental Effects, Approaches to Prevent and Control of Water Pollution and Legislative Measures.

C. Water Quality Monitoring and Management: Basic concept, Significance and Measurement of BOD & COD, Heavy Metals Sources, Industrial Uses, Prescribed standards, Effects, Chemical Speciation Scheme, Speciation of Mercury (Hg), Cadmium (Cd) Instrumental Methods of Analysis viz Atomic Absorption Spectrophotometer and UV Visible Spectrophotometer and Gas Chromatography, Principle, Components and Application in Environmental Analysis.

Unit- II : Global Problems Associated with Water Pollution

(7.5 Hrs)

A. Marine Pollution: Types, Sources and Consequences, Specifications for Disposal of Sewage and Industrial Waste into Sea, Disposal of Sewage & Wash Water from Marine Vehicle (Cargo & Ships).

B. Oil Pollution: Sources, Effects, Coastal Management and Episodes, Counter Measures Against Oil Spills.

C. Eutrophication: Definition, Sources of Nutrients, N/P Ratio, Types of Eutrophication, Effects, Control and Treatment, Self Purification, Factors Affecting Self Purification, Oxygen Sag Curve, Zones of Pollution, Restoration of Indian lakes.

Unit- III : Introduction to Thermal Pollution

(7.5 Hrs)

A. Basic Concepts of Thermal pollution: Definition, Causes and Sources of Thermal Pollution.

B. Effects of Thermal pollution: Effects of Thermal pollution on Water Quality with Respect to DO Reduction, Interference with Reproduction of Aquatic Animals, Disruption of Food Chain.

C. Mitigation Measures of Thermal Pollution: Cooling and Spray Ponds, Cooling Towers, Criteria of Selecting Site for Thermal Power Plant, Clean Technology for Coal Fired Power Plants, Thermal Power Plant in India, Utilization of Flyash from Thermal Power Stations, Hazards Created by Flyash.

Unit- IV : Introduction to Radioactive Pollution

(7.5 Hrs)

A. Basic Concepts of Radioactive Pollution: Definition, Causes and Sources of Radioactive Pollution (Natural and Anthropogenic), Radioactive Fall-out (Mechanism and Types) Classification.

B. Effects of Radioactive Pollution: Effects of Ionizing and Non-Ionizing Radiation on Man, Biological Effects, Preventive Measures and Control of Radiation from Nuclear Power Plants, Classification and Management of Hazardous Waste, Treatment and Disposal of Hazardous Chemical Waste, Units of Radiation, Episode-Atom Bomb Disaster in Hiroshima and Chernobyl-World's Worst Nuclear Disaster.

C. Disposal of Radio-active Waste: Hazardous Waste, Methods (Dilution and Dispersal) and Decay Concentrate, Recent Methods to Dispose Critically Dangerous Radio-active Wastes

SUBJECT: ENVIRONMENTAL SCIENCE
B.SC. - III SEMESTER - VI
BESTS62: PAPER- II (Water Supply and Wastewater Treatment)

OBJECTIVES:

To make Students:

1. Comprehend Water Supply , Water Distribution System and Environmental Sanitation
2. Recognize the Wastewater Treatment, Preliminary Treatment, Primary Treatment
3. Extricate Biological Wastewater Treatment, Tertiary Treatment, Sludge Handling Treatment and Disposal
4. Know Industrial Pollution and Treatment Options, Industrial Wastewater Pollutants and Unit Operations

OUTCOMES:

Students shall be able to:

1. Explain Water Supply , Water Distribution System and Environmental Sanitation
2. Elucidate Wastewater Treatment, Preliminary Treatment, Primary Treatment
3. Describe Biological Wastewater Treatment, Tertiary Treatment, Sludge Handling Treatment and Disposal
4. Expound Industrial Pollution and Treatment Options, Industrial Wastewater Pollutants and Unit Operations

Unit I: Water Distribution System

(7.5 Hrs)

A. Water Supply: Classification, Gravity System, Direct Pumping System, Methods of Supply, System of Supplying Water (Continuous and Intermittent Systems), Economical and Topographical Considerations.

B. Distribution System: Service Reservoir, Classification and their Functions, Layout of Distribution System, Dead End System, Grid Iron System, Ring System, Radial System, Design Consideration of Distribution System, Maintenance of Distribution System, Pumps and Pumping- Necessity of Pumping, Pumps Classification (Displacement Pumps, Centrifugal Pumps), Operation of Pumps, Detection and Prevention of Leakages, Preventive Methods of Leakage.

C. Environmental Sanitation: Significance, Urban and Rural Sanitation, Principles of Sanitation, Low Cost Sanitation, Community Sanitation Measures, Health Education, Public Awareness & Role of Environmentalist, Existing Scenario.

Unit II : General Aspect of Wastewater Treatment (7.5 Hrs)

A. Wastewater Treatment: Sources of Wastewater, Objectives of Treatment.

B. Preliminary Treatment: Selection and Applications of Screens (Bar Screens, Fine Screens, Self Cleaning and Cutting Screens), Grit Chambers (Aerated & Plain), Primary Treatment-Sedimentation (Septic Tank & Imhoff Tank).

C. Primary Treatment: Plane Sedimentation with Coagulation, Filtration & Disinfection Methods.

Unit III : Biological Wastewater Treatment (7.5 Hrs)

A. Secondary Treatment (Biological Methods): Activated Sludge Process, Oxidation Pond & Trickling Filter and Up-flow Anaerobic Sludge Blanket Reactor.

B. Tertiary Treatment: Adsorption, Ion Exchange, Electrolysis, Reverse Osmosis & Treatment with Activated Carbon.

C. Sludge Handling Treatment and Disposal: Composition & Characteristics of Sludge, Need for Disposal, Operation & Maintenance of Wastewater Treatment Plant.

Unit IV : Industrial Pollution and Treatment Options (7.5 Hrs)

A. Industrialization: Scope and Importance, Distribution of Industries, Sources and Types of Industrial Effluents, Nature and Origin of Pollutants, Industrial Wastewater and Environmental Impacts on Air, Water and Soil Environment.

B. Industrial Wastewater Pollutants: Waste water from some typical Industries, Sources, Characteristics, Effects and Treatment Options for Textiles Industry, Paper and pulp Industry , Dairy Industry, Sugar Industry, Distillery, Polymer Industry, Plastic Recycling Techniques, Biodegradable Plastics.

C. Unit Operations: Selection of Appropriate Unit Operations, Monitoring and Designing for the Treatment and Flow Chart of Wastewater Treatment Plant for Electro-plating, Leather Tanning Industry and Fertilizer Industry, Low Cost Waste Treatment and Design.

BESTS63: LABORATORY COURSE

Practical-II Section A and Section B

OBJECTIVES:

To make Students:

1. Learn Determination of Sulphate, Phosphate, Nitrate, Total Kjeldahl's Nitrogen in Water Sample
2. Acquire skills to determine Zn^{++} , Cd^{++} , Pb^{++} in water
3. Study Estimation of Biochemical Oxygen Demand (B.O.D), Chemical Oxygen Demand (C.O.D) in a given Sample
4. Train in Determination of Sludge Volume Index (SVI), Phenol, Sodium and Potassium in Waste water Sample
5. Understand Gas Chromatography, Absorption Spectrophotometer (AAS)

OUTCOMES:

Students shall be able to:

1. Carry-out Determination of Sulphate, Phosphate, Nitrate, Total Kjeldahl's Nitrogen in Water Sample
2. Estimate Biochemical Oxygen Demand (B.O.D), Chemical Oxygen Demand (C.O.D) in a given Sample
3. Determine Sludge Volume Index (SVI), Phenol, Sodium and Potassium in Waste water Sample
4. Demonstrate Gas Chromatography, Absorption Spectrophotometer (AAS)

Practical-II

Section A :

1. Determination of Zn^{++} in water by Complexometric Titration.
2. Determination of Cd^{++} in water by Complexometric Titration.
3. Determination of Pb^{++} in water by Complexometric Titration.
4. Determination of Sulphate in a given Water Sample.
5. Determination of Phosphate in a given Water Sample.
6. Estimation of Nitrates by PDA method in a given Water Sample.
7. Estimation of Total Kjeldahl's Nitrogen in a given Water Sample.
8. Estimation of Biochemical Oxygen Demand (B.O.D) by three day method in a given Sample.

9. Determination of Chemical Oxygen Demand (C.O.D) in a given Sample.
10. Demonstration on Eutrophication on polluted lakes.

Section B :

1. Determination of Sludge Volume Index (SVI) of Wastewater Sample.
2. Estimation of Phenol in a given Waste water Sample.
3. Estimation of Sodium and Potassium in given sewage sample.
4. Demonstration of UV-Visible spectrophotometer.
5. Demonstration of Atomic Absorption Spectrophotometer (AAS).
6. Demonstration of Gas Chromatography.
7. Determination of Oxygen Consumption in Normal Fish/Small at Different Temperature.
8. Toxicity Estimation of Heavy Metals Using Fish/Snail as Test Animal Determination LC50 Value.
9. Estimation of Chromium in a given Waste Water Sample.
10. Demonstration of Poly Aromatic Hydrocarbons (PAH) in a Water and Waste water.

FIELD VISITS :

1. Visit to Thermal Power Plant, Koradi or Khaparkheda
2. Paper & Pulp. Industry, Bazargaon, Nagpur
3. Diary Plant, Nagpur
4. Jawaharlal Nehru Aluminium Research Design Development Center, Wadi, Nagpur

All students shall under take field visits to the above mention research institution and industries which are important for understanding the subject. Soon after their visit, students shall submit study tour report which is certified by the HOD is to be submitted at the time of Annual Practical Examination.

FIELD DIARY :

The Student Shall Prepare their Field Diary Under the Following Heads:

1. Issue on Regional Problem of Environmental Interest (Case Studies)
2. Issue of National Interest (Case Studies)
3. New Acts & Judgments of Environmental Interest.
4. About Famous Personalities in Environmental Movements.

DISTRIBUTION OF MARKS :

- 1) Any two experiments from Section A : 08 Marks
- 2) Any two experiments from section B : 08 Marks
- 3) Viva-voce : 04 Marks
- 4) Tour Report : 04 Marks
- 5) Practical record : 03 Marks
- 6) Field Diary : 03 Marks

Total Marks : 30 Marks

BOOKS FOR REFERENCE

1. Environmental Pollution by R. K. Kitholiya, S. Chand & Company Ltd. New Delhi, 2004
2. Environmental Problems and Solutions by D.K. Asthana & Meera Asthana, S.Chand & Company Ltd. New Delhi, 2003
3. Environmental Science by S. C. Santra, New Central Agency Ltd. Kolkata, 2005.
4. Manual of Water and Wastewater Analysis by Dr. D.S. Ramteke, C.A. Moghe & R.Sarin, NEERI, Nagpur
5. Our Environment Pollution Control and Future Strategies by M. P. Mishra, S.Chand & Company Ltd. New Delhi, 2000.
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12. Environmental Chemistry: A. K. De, Wiley Eastern Limited, New Delhi.
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26. Chemical And Biological Methods For Water Pollution Studies: R. K. Trivedy, P. K. Goel, Environmental Publication, Karad.
27. Water Pollution and disposal of Waste water on Land : U. N. Mahida (Tata Mc-Grew Hill Publishing Company, New Delhi.
28. Waste water treatment for pollution control : Soli J. Arceivala (Tata Mc-Grew Hill Publishing Company, New Delhi)
29. Waste water treatment : M. N. Rao, A. K. Datta (Oxford and IBH publishing company, New Delhi)
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