

M.Sc. Environmental Science & Technology

Course Description and Learning Outcome

SEMESTER - 1

Subject: PS01CEST21: ENVIRONMENTAL BIOLOGY & RESTORATION ECOLOGY

Faculty: Prof. Dr. Nirmal Kumar, J.I.

Course Description

The course introduces basic concepts of environmental biology and restoration ecology in different types of ecosystems. It provides important information regarding various types of terrestrial ecosystems such as forests, deserts, grasslands etc., as well as aquatic ecosystems like ponds, lakes, rivers, estuaries, and marine environment. The course focuses on different aspects of ecology such as autecology, population ecology, and community ecology, with special reference to restoration of degraded habitats and ecosystems.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Basic concepts of ecology and environmental biology
- Environmental complexes - Ecology, Ecosystem, Environment and their concepts
- Limiting and inhibiting factors of light and temperature
- Food chain, food web, and ecological pyramids
- Restoration of wastelands and degraded soils
- Bio-geo-chemical cycles

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Course Description and Learning Outcome

SEMESTER - 1

Subject: PS01CEST22: AIR POLLUTION & CLIMATE CHANGE

Faculty: Dr. Hiren B. Soni

Course Description

The course introduces basic concepts of air pollution, climate change and disaster management. It covers history of air pollutants, different types of air pollutants, their sources, causes, and consequences on plants, animals, humans, and materials. The course spans various case studies of air pollution in different provinces of the world. It also highlights the general effects as well as specific effects on biological components including humans. Environmental factors of air pollution, sampling and measurement of air pollution, prevention and control of air pollutants, and control technologies are included. Second part of

the course covers climate change, global warming, global effects of GHGs, causes and consequences of climate change, and concept of natural and man-made disasters, its causes, effects, and preventive measures.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Basic concepts of air pollution, climate change and disaster management
- Types of air pollutants, sources, causes, and consequences
- Effects of air pollution on biological components including humans
- Sampling and measurement of air pollution
- Prevention and control of air pollutants including control technologies
- Causes and consequences of climate change
- Concept of natural and man-made disasters, causes, effects, and preventive measures.

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Course Description and Learning Outcome

SEMESTER - 1

Subject: PS01CEST23: WATER POLLUTION & CONTROL TECHNOLOGY

Faculty: Dr. Dhruvi S. Patel

Course Description

The course provides basic information about sources of water and their characteristics, sampling and measurement of physical, chemical, and biological characteristics of water. It covers introductory aspects of groundwater, aquifers, ground water conservation, and causes and remedies of saline intrusion. The course also focuses on conventional as well as advanced water treatments such as coagulation and flocculation, sedimentation, filtration, disinfection, and chlorination. The advanced water treatment technologies include membrane technology, microfiltration, ultrafiltration, nanofiltration reverse osmosis, ion exchange, water softening, adsorption, and electrodialysis.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Fundamentals of water pollution and control technology
- Physical, chemical, and biological characteristics of water
- Groundwater, aquifers, ground water conservation

- Conventional water treatments: Coagulation and flocculation, sedimentation, filtration, disinfection, chlorination
- Advanced water treatments: Membrane technology, microfiltration, ultrafiltration, nanofiltration reverse osmosis, ion exchange, water softening, adsorption, electro dialysis.

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Course Description and Learning Outcome

SEMESTER - 1

Subject: PS01EEST21: ENVIRONMENTAL CHEMISTRY & GEOLOGY

Faculty: Dr. Dhruvi S. Patel, Dr. Hiren B. Soni

Course Description

The course provides an overview of fundamentals of chemistry, green environmental chemistry, environmental segments, and soil chemistry and its conservation. It introduces basic concepts of environmental chemistry and geology along with green chemistry. The course covers various tools of green chemistry, urban forestry, green buildings, green building practices, and approaches to green computing. It focuses on various environmental segments like lithosphere, atmosphere, hydrosphere, and biosphere, including physical geology, and structural geology. It also highlights soil chemistry, its composition, physical, chemical and biological properties of soil, leaching, erosion, denudation and conservation aspects of degraded soil ecosystems.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Fundamentals environmental chemistry, green chemistry, and geology
- Introductory aspects of soil chemistry
- Soil properties, causes and effects of soil pollution, and its conservation
- Tools of green chemistry and green practices including green buildings and green computing
- Physical and structural geology of lithosphere and its components

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Course Description and Learning Outcome

SEMESTER - 2

Subject: PS02CEST21: REMOTE SENSING & GEOGRAPHIC INFORMATION SYSTEM

Faculty: Dr. Himanshu Kapse, Mrs. Unnati Patel

Course Description

The course provides basic information about remote sensing, image classification and remote sensing applications, geographic information system, data quality, and basic spatial analysis. It introduces basic concepts of electro-magnetic radiation, image resolution, image classification, environmental planning using RS & GIS, mapping of habitats and ecosystems, mapping of natural disasters, and mapping of urban sprawls. The course highlights applications of GIS in temporal and spatial analysis, geo-referencing, and projection of environmental attributes. It covers measurement, classification, symbolization, intersection, and data merging using RS & GIS.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Basic concepts of RS & GIS in environmental monitoring
- Image classification, remote sensing applications, geographic information system, data quality, and basic spatial analysis
- Electro-magnetic radiation, image resolution, image classification, environmental planning using RS & GIS
- Mapping of habitats and ecosystems, mapping of natural disasters, and mapping of urban sprawls
- Applications of GIS in temporal and spatial analysis, geo-referencing, and projection of environmental attributes
- Measurement, classification, symbolization, intersection, and data merging using RS & GIS

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Course Description and Learning Outcome

SEMESTER – 2

Subject: PS02CEST22: METEOROLOGICAL & ENVIRONMENTAL INSTRUMENTS & ITS APPLICATIONS

Faculty: Dr. Dhruvi S. Patel, Dr. Hiren B. Soni

Course Description

The course covers meteorological instruments, analytical instruments at lab-scale, sophisticated instruments, and applications of biostatistics in environmental assessment. It introduces basic concepts of meteorology, meteorological instruments, environmental monitoring, environmental methodologies, environmental instruments, working of various

types of samplers, methodologies for air, water, and soil monitoring, and applications of environmental instruments. The course highlights applications of biostatistics in sampling, data presentation, various biostatistical tests, and applications of different statistical softwares.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Fundamentals of meteorology and environment, and meteorological observatory and meteorological instruments
- Environmental monitoring and related Instruments such as air, water and soil samplers
- Mechanisms and applications of analytical instruments such as Spectrophotometer, Atomic Absorption Spectrophotometer, Flame Photometer, Bomb Calorimeter, TOC Analyzer, ICPA, FT-IR, NMR, GC-MS, LC-MS, Electrophoresis, Centrifuge
- Paper Chromatography, Thin Layer Chromatography, HPLC, Microscopy: Light Microscope, Dark Field Microscope, Bright Field Microscope, Phase Contrast Microscope, Electron Microscope
- Applications of various biostatistical tests and demonstration of statistical softwares for data analysis and environmental modelling

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Course Description and Learning Outcome

SEMESTER - 2

Subject: PS02CEST23: OCCUPATIONAL & ENVIRONMENTAL TOXICOLOGY

Faculty: Prof. Dr. Nirmal Kumar, J.I.

Course Description

The course introduces types of occupational pollutants, classification of hazardous substances, effects and entry of pollutants into human body, preventive measures, agents, substances, and processes causing occupational diseases and toxicology. It covers structure and functions of human tissues, organs, and systems in relation to dermal, nervous, cardiac, pulmonary, hepatic, and nephric toxicity. It introduces adverse effects of different types of toxicity in human systems on metabolic and physiological activities. The course spans mode of action of herbicide, absorption, translocation, biochemical fate, metabolic response, morphological variations of herbs, herbicide toxicology, heavy metal toxicity, teratogenicity, and carcinogenicity.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Basic concepts of occupational pollutants, types, characteristics, and their effects on environment and humans
- Hazardous substances, their effects, entry of pollutants into human body, preventive measures, agents, substances, and processes causing occupational diseases and toxicology
- Structure and functions of human tissues, organs, and systems in relation to dermal, nervous, cardiac, pulmonary, hepatic, and nephric toxicity
- Adverse effects of different types of toxicity in human systems on metabolic and physiological activities
- Mode of action of herbicide, absorption, translocation, biochemical fate, metabolic response, morphological variations of herbs, herbicide toxicology, heavy metal toxicity, teratogenicity, and carcinogenicity

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Course Description and Learning Outcome

SEMESTER - 2

Subject: PS02EEST21: INDUSTRIAL HYGIENE & OCCUPATIONAL HEALTH

Faculty: Dr. Hiren B. Soni, Mr. Baiju Verghese

Course Description

The course covers introductory facets of industrial hygiene and occupational health. It includes industrial hygiene practices, role of industrial hygienist and scope, difference between industrial hygiene and occupational health, environmental benefits of industrial hygiene in workplace environment. It spans occupational hazards, classification, adverse health effects and controls, and physical, chemical, and biological hazards. The course introduces occupational health hazards in specific industries like power plants, textile mills, cement industries, chemical and pharmaceutical industries, petrochemical industries, coal mines, etc. It also encompasses recognition and evaluation of occupational health hazards, exposure assessment, types of monitoring: air, workplace area, personal exposure, work physiology, assessment of workload, assessment of work capacity, nutrition, diets, physical fitness and their relationship, ergonomics, and work station design. The course highlights occupational health services e.g. occupational health centre, staff and equipments, ambulance van, accident statistics, and medical emergency plan.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Basic concepts of industrial hygiene and occupational health including industrial hygiene practices
- Occupational hazards, classification, adverse health effects and controls, and physical, chemical, and biological hazards
- recognition and evaluation of occupational health hazards, exposure assessment,
- Types of monitoring: air, workplace area, personal exposure, work physiology, assessment of workload, assessment of work capacity, nutrition, diets, physical fitness and their relationship, ergonomics, and work station design.
- Occupational health services e.g. occupational health centre, staff and equipments, ambulance van, accident statistics, and medical emergency plan

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Course Description and Learning Outcome

SEMESTER - 3

Subject: PS03CEST21: ENVIRONMENTAL BIOTECHNOLOGY

Faculty: Prof. Dr. Nirmal Kumar, J.I.

Course Description

The course highlights single cell protein technology including types of media, substrates used in algal cultivation, biofertilizer technology, mass cultivation, and applications of microbes, fungal technology, vermitechnology, and mushroom technology. It focuses on enzyme technology, use of industrial enzymes, immobilized enzymes and their types, fermentation technology, biogas technology, methane production, and biofuel production. It also introduces recombinant DNA technology, isolation of gene, isolation of plasmid vector, types of vectors, restriction enzymes, gene cloning, and gene amplification. The course spans plant tissue culture technology and its significance, pollution monitoring biotechnology such as bioremediation, phytoremediation, biosensors, root zone technology, biodegradation, biosorption, biomineralization, and biological control of pests.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Basic concepts of environmental biotechnology and its applications in applied sciences
- single cell protein technology including types of media, substrates used in algal cultivation, biofertilizer technology, mass cultivation, and applications of microbes, fungal technology, vermitechnology, and mushroom technology

- Enzyme technology, use of industrial enzymes, immobilized enzymes and their types, fermentation technology, biogas technology, methane production, and biofuel production.
- Recombinant DNA technology, isolation of gene, isolation of plasmid vector, types of vectors, restriction enzymes, gene cloning, and gene amplification
- Plant tissue culture technology and its significance, pollution monitoring biotechnology such as bioremediation, phytoremediation, biosensors, root zone technology, biodegradation, biosorption, biomineralization, and biological control of pests.

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Course Description and Learning Outcome

SEMESTER - 3

Subject: PS03CEST22: ENVIRONMENTAL IMPACT ASSESSMENT & LEGISLATION

Faculty: Dr. Hiren B. Soni

Course Description

The course introduces fundamentals of environmental impact assessment and legislation, including EIA project proposal, baseline conditions, types and attributes of impacts, types of EIA, screening, scoping, reviewing, public hearing, decision making, EIA report, environmental clearance, NOC, etc. It also covers concepts of EIA, origin, development, objectives, methodologies of impact analysis, GPCB guidelines, MoEF updates on EIA, Siting guidelines for industries, components of EIA, authorities involved in granting environmental clearance at Central & State Government levels, Appraisal and recommendations, and grant of environmental clearance and its validity. The course highlights environmental management plan, environmental information system, environmental auditing, preparing audit report, etc. It includes study of important provisions of environmental legislations like Water (Prevention and Control) of Pollution) Act, 1974,; Air (Prevention and Control of Pollution) Act, 1981; Environment Protection Act, 1986. Wildlife (Protection) Act, 1973. Energy Conservation Act, 2001. Forest Conservation Act, 1972; Public Liability Insurance Act, 1991, and Disaster Management Act, 2005.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Fundamentals of environmental impact assessment and legislation, including EIA project proposal, baseline conditions, types and attributes of impacts, types of EIA
- Screening, scoping, reviewing, public hearing, decision making, EIA report, environmental clearance, NOC, etc.

- Concepts of EIA, origin, development, objectives, methodologies of impact analysis, GPCB guidelines, MoEF updates on EIA, Siting guidelines for industries, components of EIA
- Authorities involved in granting environmental clearance at Central & State Government levels, Appraisal and recommendations, and grant of environmental clearance and its validity
- Environmental management plan, environmental information system, environmental auditing, preparing audit report, etc.
- Study of important provisions of environmental legislations

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Course Description and Learning Outcome

SEMESTER - 3

Subject: PS03CEST23: INDUSTRIAL SAFETY & CONTROL TECHNOLOGY

Faculty: Dr. Hiren B. Soni

Course Description

The course introduces concepts of safety management, overview of safety engineering, overview of safety appraisal, accident analysis, performance rates, risk assessment techniques, industrial safety approaches, overview of safety legislation, The Factories Act & Rules, Labour Acts, and Rules for Safety provisions. It also covers chemical hazards, material safety data sheet, hazard identification techniques, safety during material handling, safety during loading and unloading, safety devices systems, safety checklist, house keeping, methods of house keeping, management of house keeping, and housekeeping of specific industries. The course introduces work permit concept, safe operating procedures, safety audits, safety tag system, job safety analysis, electrical safety, and hazardous area classification. It highlights fire and explosion, chemistry of fire, classification of fire, types of fire extinguisher and explosion Phenomena, on-site and off-site emergency plans, need and types of emergency plans, and disaster management plan including risk assessment.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Basic concepts of safety management, overview of safety engineering, overview of safety appraisal, accident analysis, performance rates, risk assessment techniques
- Industrial safety approaches, overview of safety legislation, The Factories Act & Rules, Labour Acts, and Rules for Safety provisions

- Chemical hazards, material safety data sheet, hazard identification techniques, safety during material handling, safety during loading and unloading
- Safety devices systems, safety checklist, house keeping, methods of house keeping, management of house keeping, and housekeeping of specific industries
- Work permit concept, safe operating procedures, safety audits, safety tag system, job safety analysis, electrical safety, and hazardous area classification
- Fire and explosion, chemistry of fire, classification of fire, types of fire extinguisher and explosion Phenomena, on-site and off-site emergency plans, need and types of emergency plans, and disaster management plan including risk assessment.

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Course Description and Learning Outcome

SEMESTER - 3

Subject: PS03EEST21: INDUSTRIAL POLLUTION & CONTROL TECHNOLOGY

Faculty: Dr. Dhruvi S. Patel

Course Description

The course covers fundamental of industrial pollution and control technology including industrial scenario, types of industrial wastewater, sources of domestic and industrial wastewater, characteristics of domestic wastewater, wastewater collection point, types of sewers, types of sewerage systems, household drainage system, and treatment of domestic wastewater. It highlights wastewater unit operation including CETP, physical unit operation, chemical unit operation, biological unit operation, disposal standards, disposal of effluents, and residuals (Sludge) management. It also covers origin and characterization of effluent, standards of industrial wastewater, common and specialized treatment of industrial effluents. The course introduces radioactive pollution, types of radiation, radiation units, types of radioactive materials, radiation sources (natural, commercial and industrial), and effects and radiation protection, including thermal pollution.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Fundamentals of industrial pollution and control technology including industrial scenario, types of industrial wastewater, sources of domestic and industrial wastewater
- Characteristics of domestic wastewater, wastewater collection point, types of sewers, types of sewerage systems, household drainage system, and treatment of domestic wastewater

- Wastewater unit operation including CETP, physical unit operation, chemical unit operation, biological unit operation, disposal standards, disposal of effluents, and residuals (Sludge) management
- Origin and characterization of effluent, standards of industrial wastewater, common and specialized treatment of industrial effluents
- Radioactive pollution, types of radiation, radiation units, types of radioactive materials, radiation sources (natural, commercial and industrial), and effects and radiation protection, including thermal pollution

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Course Description and Learning Outcome

SEMESTER - 4

Subject: PS04CEST21: WASTE MANAGEMENT & CONTROL TECHNOLOGY

Faculty: Prof. Dr. Nirmal Kumar, J.I., Dr. Hiren B. Soni, Dr. Dhruvi S. Patel

Course Description

The course aims to provide knowledge about waste management and control technology including solid waste handling and management, biological and chemical techniques for energy and other resource recovery, incineration of solid wastes, disposal in landfills, leachate and landfill gas management, landfill closure, LFS post-closure, landfill remediation, and regulatory aspects of municipal solid waste management. It covers biomedical waste management, treatment systems, electronic waste, recycling of e-waste, environmental consequences, and transboundary movement and management of e-wastes. The course also introduces hazardous waste management, TSDF operation, site safety and sampling plans, remediation and feasibility study. It covers nanoscience and technology, including types of nonmaterial, nanoparticles in aquatic and terrestrial and atmospheric environment, instruments used in studying nanoparticles, occupational exposure to nanoparticles, toxicological properties of nanoparticles, nanoparticles to cure human diseases, and use of nanoparticles in mitigating water pollution.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Knowledge about waste management and control technology including solid waste handling and management, biological and chemical techniques for energy and other resource recovery

- Incineration of solid wastes, disposal in landfills, leachate and landfill gas management, landfill closure, LFS post-closure, landfill remediation, and regulatory aspects of municipal solid waste management
- Biomedical waste management, treatment systems, electronic waste, recycling of e-waste, environmental consequences, and transboundary movement and management of e-wastes
- Hazardous waste management, TSDF operation, site safety and sampling plans, remediation and feasibility study
- Nanoscience and technology, including types of nonmaterial, nanoparticles in aquatic and terrestrial and atmospheric environment, instruments used in studying nanoparticles, occupational exposure to nanoparticles, toxicological properties of nanoparticles, nanoparticles to cure human diseases, and use of nanoparticles in mitigating water pollution.

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Course Description and Learning Outcome

SEMESTER - 4

Subject: PS04CEST22: ENVIRONMENTAL RESOURCES & CONSERVATION

Faculty: Prof. Dr. Nirmal Kumar, J.I., Dr. Hiren B. Soni, Dr. Dhruvi S. Patel

Course Description

The course aims to introduce the fundamentals of energy and environment, environmental conservation, natural resources and their conservation, non-conventional energy sources, and conventional or renewable sources of energy. It introduces fossil fuels and related environmental impacts, household energy conservation, urbanization and environment, environmental impacts of mining, wasteland development and reclamation, and bioresource management. It spans concepts and types of biodiversity, importance of biodiversity, principles of biodiversity conservation, Hotspots, in-situ and ex-situ conservation strategies. It also highlights forestry including characters and classification of forests, major types of forests, uses of biodiversity, ethnobotany, agroforestry, forest management systems, and joint forest management.

Learning Outcomes/Capability Development

At the completion of this course, students will be able to understand:

- Fundamentals of energy and environment, environmental conservation, natural resources and their conservation
- Non-conventional energy sources, and conventional or renewable sources of energy

- Fossil fuels and related environmental impacts, household energy conservation, urbanization and environment, environmental impacts of mining
- Wasteland development and reclamation, and bioresource management
- Concepts and types of biodiversity, importance of biodiversity, principles of biodiversity conservation, Hotspots, in-situ and ex-situ conservation strategies
- Forestry including characters and classification of forests, major types of forests, uses of biodiversity
- Ethnobotany, agroforestry, forest management systems, and joint forest management