

# SHIVAJI UNIVERSITY, KOLHAPUR

## SYLLABUS

For

### M.Sc. ENVIRONMENTAL SCIENCE

(Semester Pattern)

Sem. III to IV



Estd. 1962

NAAC 'A' Grade

Choice Based Credit System  
(CBCS)

To be implemented From

**June, 2020 onwards**

**DEPARTMENT OF ENVIRONMENTAL SCIENCE,  
SHIVAJI UNIVERSITY, KOLHAPUR  
M. Sc. Programme Structure and Syllabus (CBCS PATTERN) (2020-21)**

**Environmental Science**

• **PROGRAMME OUTCOMES (PO'S)**

The post graduates are able to

PO-1) Acquire in-depth knowledge and integrate with existing knowledge to sensitize the people about global and local environmental issues.

PO-2) Develop an ability to identify, critically analyze, formulate and solve environmental problems using basic principles of nature conservation.

PO-3) Get acquainted with environmental and social impacts of any developmental activity.

PO-4) An ability to design a system and process to meet desired needs of society within realistic limitations such as health, safety, security and environmental considerations.

PO-5) An ability to design and conduct experiments, interpret data, and provide well informed conclusions.

PO-6) Communicate effectively socio-economic problems related to environment by appropriate documentations and presentations.

PO-7) Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO-8) Apply ethical principles and commit to professional ethics and responsibilities and follow the norms of the any surrounding practice.

• **PROGRAM SPECIFIC OUTCOMES (PSO's):**

**PSO-I: Professional skills**

Ability to monitor the present status of environmental parameters through monitoring for design and development of new concept or technology.

**PSO-II: Industrial Skills**

Successfully tackle with the industrial pollution problems through appropriate technology and tools.

**PSO-III: Environmental and Social values within individual**

Inclusion of environmental and social values within the individual's life.

**PSO-IV: Problem solving approach:**

Identify, formulate, review literature and analyze complex environmental problems and suggest suitable solutions reaching substantiated conclusions using first principles of natural science.

**PSO-V: Successful development of Career and Entrepreneurship**

To prepare the students with broad environmental perspective and become a successful in career and entrepreneurship.

**PSO –VI: Modern tool usage:**

Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with understanding of the limitations.

**M.Sc. Part II  
Sem.III (Duration Six Months)**

<b>Sr. No.</b>	<b>Course Code</b>	<b>Title of the course</b>
1.	CC-301	Natural Resources and their Conservation
2.	CCS-302	Environmental Statistics and Computer Applications
3.	CCS-303	Environmental Policy and Legislation
4.	DSE-304	Environmental Toxicology and Public Health
5.	CCPR-305	Project , Inplant training, Envi. Statistics and toxicology
6.	AEC- 306	
7.	EC- (SWM MOOC) 307	

**Sem. IV (Duration Six Months)**

<b>Sr. No.</b>	<b>Course Code</b>	<b>Title of the course</b>
1.	CC-401	Socioeconomic aspects of Environment
2.	CCS-402	Environmental Hazards and Disaster Management
3.	CCS-403	Environmental Planning and Management
4.	DSE-404	Environmental Biotechnology
5.	CCPR-405	Project and Environmental Biotechnology
6.	SEC- 406	
7.	GE- 407	Vermicomposting

## **CC-301: Natural Resources and their Conservation**

Students are able to

**CO1:** Classify the natural resources into renewable and non-renewable resources.

**CO2:** Understand the role of abiotic natural resources like minerals fossil fuels and soil.

**CO3:** Introduce the concept of biodiversity with its aspects of conservation.

**CO4:** Conserve the wetlands and ground water through related knowledge.

**CO5:** Identify the potential of forest resources with the concept of natural resource accounting.

### **Syllabus**

#### **Unit – 1**

**(15)**

##### **a) Introduction to natural resources**

Definition and concept of resources, types of resources, uses and values of a resource, Abiotic resources- minerals, fossil fuels, water, soil, Biotic resources - Wild animals, fisheries, domesticated animals, plants.

##### **b) Abiotic resources :**

Soil as resource, Soil classification, genesis, causes of soil degradation and their effects, Soil conservation practices, wasteland reclamation.

Mineral resource : important minerals; mineral exploitation; use of minerals; environmental problems due to mining; reclamation of mining areas;

Energy resources : conventional energy resources (fossil fuels, biomass), nonconventional energy resources (wind energy, solar energy) energy use patter; environmental problems due to energy use.

#### **Unit – 2**

##### **a) Biodiversity conservation**

**(15)**

Biodiversity as life support system for man, types of biodiversity, ecosystem, species and genetic, Values of biodiversity, Indian ethos of wildlife conservation, Hotspots of Biodiversity, Causes for loss of biodiversity, measurement of biodiversity; listing of threatened biodiversity.

##### **b) Methods of biodiversity conservation**

– in situ conservation (sanctuaries, national parks and biosphere reserve); ex situ conservation (zoo, botanical gardens; gene/germ plasma banks),Convention on Biological Diversity (CBD), Biodiversity conservation efforts in the country.

### Unit – 3

(15)

#### a) Conservation of wetlands, ground water

**Wetlands** : Definition and classification of wetlands, values of wetland, present status of wetlands in India, RAMSAR convention ,conservation of wetlands,

**Ground water**: Definition – soil moisture, Water table, Aquifers, Geology of aquifers; Ground water flow; Environmental influences on ground water overuse, Ground water recharging and rain water harvesting.

#### b) Watershed Management:

Concept, objectives, planning and measures; Land use planning for watershed management; Water harvesting and recycling; flood control and watershed management; Socioeconomic aspects of watershed management

### Unit – 4

(15)

#### a) Forest resources

Forest as a resource in the past and present, causes of deforestation, Silviculture, Energy plantation, Social forestry, Joint forest management programme (JFM), Agro forestry Systems

#### b) Natural resource conservation and Natural Resource Accounting

Concept of resource conservation and its importance, economic aspects of resource conservation, planning for the conservation of resources, NRA for soil, water, air and biodiversity resource, Environmental Action Plan (EAP).

#### References:

1. Environmental Conservation: R. F. Dasman (1968) John Wiley and Sons , New York .
2. Environmental Science , Miller T. G. Jr., Wadsworth Publishing Company.
3. Environmental Biology and Toxicology, P.D. Sharma, Rastogi Publications , Meerut 1985
4. Global Biodiversity Assessment , V. H. Heywood and Watson , R.T.,
5. Essentials of Ecology and Environmental Science , Rana S.V.S ,Prentice Hill Publications , New Delhi

## **CCS-302: Environmental Statistics and Computer Applications**

Students are able to

**CO1:** Understand the concept of data analysis measures of dispersion.

**CO2:** Know the aspects and use of probability and distributions.

**CO3:** Recognise the sampling distribution, Chi-square test for variance, t-test for population Mean and equality

**CO4:** Aware about the mathematical models like exponential, logistic models for population growth.

**CO5:** Get acquainted with the basic idea of hardware and software systems with Computer applications

### **Unit – 1 : Data analysis (15)**

**a) Population,** Sample, variable, parameters, primary and secondary data, screening and representation of data, frequency distribution, histogram, frequency polygon, ogive curves. Mean, median, mode, quintiles, percentiles.

**b) Measures of dispersions :** range, quintile deviation, mean deviation, standard deviation, coefficient of variation, moments, skewness, kurtosis Bivariate data : Scatter diagram, correlation coefficient, properties (without proof) interpretation of correlation coefficient, linear regression, Fitting of lines of regression regression, coefficient, Coefficient of determination, partial and multiple correlation coefficient

### **Unit – 2 : Probability and distributions (15)**

**a) Probability :** Sample space, events, Definition of probability (mathematical and frequency approach) independent events, addition and multiplication laws, conditional probability examples

**b) Probability distributions :** Random variable p.m.f. Expectation and variance, Bernoulli, Binomial, Poisson, uniform, Normal distributions, mean and variance of these distributions (without proof) use of these distributions to describe biological medals. Example.

### **Unit – 3 : Testing of hypothesis (15)**

**a) Simple random and stratified random sampling,** sampling distribution, standard deviations of sample statistic, hypothesis critical region, errors, large sample test for mean, proportion, equality of means (when variance is known and when it is unknown)

- b) Chi-square test for variance, t-test for population mean and equality of population means, chi-square test for goodness of fit and independence of attributes, p-value of a statistic.

**Unit – 4 : Mathematical models and computer applications (15)**

**a) Mathematical models :**

Exponential, logistic models for population growth, Lotka- Voltera Prey and predator model, box model, Gaussian plume, point source stream model Leslie's matrix model.

- b) **Computer applications :** Introduction to computer : Input and output devices, computer software's, types of software's, hardware storage devices, Operating systems, programming languages ,Introduction to MS – EXCEL, use of worksheet to enter data edit data, copy data, move data, use of in built functions for computations of various statistical constraints, use of charts, Introduction to MS-Word, word processor, editing, coping, moving, formatting, table, insertion, etc.

**References :**

1. Bio-statistic : A Foundation for analysis in the health sciences : Wayne W – Daniel John Wiley and sons Inc
2. Survival models and data analysis : Elandt – Johnson and Johnson, John Wiley and sons Inc.
3. Statistical Method for the analysis of Biomedical data : Wool son John Wiley and Sons Inc.
4. Statistical Methods for Environmental and Agricultural Sciences A – Reza Horseman CRC Press Boca Raton Network
5. Text book of Environmental Engineering : P. Venugopala Rao, Prentice – Hall of India Pvt. Ltd. Delhi
6. Computer Fundamental : P. K. Sinha BPB Publications New Delhi
7. Digital Computer fundamentals : Thomas C. Baste, Mc Graw Hall international book Company Tollyo.
8. Mathematical models in Biology and Medicine : J. N. Kapur Affiliated East-west Press Pvt. Ltd., Bangalore



## **CCS-303: Environmental Policy and Legislation**

Students are able to

**CO1:** Familiarise with the international treaties and agreements for environmental conservation.

**CO2:** Recognise the role of national policies and CPCB, SPCB for environmental management.

**CO3:** Aware about the constitutional provisions for environmental protection.

**CO4:** Understand the provisions in environmental legislations for water , air and mining .

**CO5:** Introduce the concept of CRZ, PIL and PLI.

### **Syllabus**

#### **Unit – 1**

**(15)**

##### **a) International Environmental Policies Agreements and Treaties**

Nature of Environmental Policies, Stockholm Conference (1972), Rio Conference (UNCED, 1992), merits of the Conference Agenda 21. Difference between agreement and treaty, Johannesburg treaty, GAAT and Environment, CITES, Montreal Protocol, Kyoto Protocol and COP under UNFCCC.

##### **b) Constitutional provisions for Environmental Protection**

Article 14, 15, 19, 21, 32, 39, 47, Article 48(A), Art. 49 fundamental duties of citizen, Art. 51A (g) directive principles of state policy, Art. 243, 243(G) and (W), Art. 246, 248 Writ provisions for the protection of environment.

#### **Unit – 2**

**(15)**

##### **a) National Environmental Legislation related to water, air, mining etc.**

The Water (Prevention and Control of Pollution) Act, 1974.

The Air (Prevention and Control of Pollution) Act, 1981.

The Environment (Protection) Act, 1986 , Sec. 12 of Mining Act, 1952.

Public Liability Insurance Act, 1991.

##### **b) National Legislation on Forest, Wildlife etc.**

The Forest (conservation) Act, 1980, The Wildlife (Protection) Act, 1972,

The Biodiversity (Protection) Act, 2002

#### **Unit – 3 :**

**(15)**

- a) Waste Management Rules: Plastic Waste Management Rules 2016, e-waste (Management) Rules, 2016, Bio-Medical Waste Management Rules, 2016, Construction and Demolition Waste Management Rules, 2016, Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, Solid Waste Management Rules, 2016.

- b) **National Policy on Environment** : National Forest Policy, National Water Policy, National Energy Policy, CPCB and SPCB and their role.

**Unit – 4**

**(15)**

**a) Environmental Legislation related to CRZ and PIL**

Concept and need of Public Interest Litigation, jurisdiction of High Courts and Supreme Court, Need of CRZ rules for regulation the activities in coastal zone.

**b) IPR, and patenting**

Introduction and the need for intellectual property right (IPR) , patents - rules and regulations, trademarks, Trade secrets, industrial designs, new plant varieties, geographical indications, Benefits from IPR, Problems of IPR.

**References:**

1. Environmental Law and Policy of India ,Diwan,S. and Rosencranz, A,2001, Oxford University Press.
2. Environmental Policy in India, Shekhar Singh, IIPA, New Delhi
3. Declaration of :The Stockholm Conference,Rio, Rio+5 and Rio +10
4. Our Common Future,WECD,1991
5. Universal Environment and Pollution Law Manual , S.K.Mohanty,1998
6. Legal Aspects of Environmental Pollution and Management ,S.M.Ali,1992

## **DSE-304: Environmental Toxicology and Public Health**

Students are able to

**CO1:** Classify the sources of toxicants in the environment.

**CO2:** Aware the concepts in Ecotoxicology.

**CO3:** Understand the fate of toxicants and transport of toxicants in food chain..

**CO4:** Know the dose response relationship of toxicants.

**CO5:** Introduce the concept of occupational health hazards with their effects.

### **Syllabus**

#### **Unit – 1**

**(15)**

##### **a) Introduction to Environmental Toxicology**

Definition, classification, Sources of toxicants in environment, Evaluation of toxicity, Bioassay, factors affecting toxicity, mutagenesis, spermatogenesis, carcinogens, hallucinogens, phyto-toxins, animal toxins.

##### **b) Ecotoxicology**

Introduction to eco-toxicology, Principles of toxicology, Types of toxic substances - degradable and non-degradable; Influence of ecological factors on the effects of toxicity.

#### **Unit – 2**

**(15)**

##### **a) Toxicants in the Environment**

Toxic substances in the environment, their sources and entry routes, Effects of heavy metals and pesticides, Eco-system influence on the fate and transport of toxicants; Transport of toxicants by air and water; Transport through food chain - bio-transformation and bio-magnification

##### **b) Man and Environmental Toxins:**

Routes of toxicants to human body – entry through inhalation, skin absorption, indigestion and injection; Response to toxin exposures -Dose response, Frequency response and cumulative response; Lethal and sub-lethal doses; Dose-Response relationships between chemical and biological reactions. Analysis of NOEL, LD 50, LC 50 and MLD; Detoxification in human body - detoxification mechanisms, organs of detoxification

#### **Unit – 3**

**(15)**

##### **a) Occupational health hazards**

Stress, man, machine and environment, Ergonomics -Introduction, Definition, Objectives, Advantages, Occupational physiology and hazards of working environment, Occupational diseases, Personal Protective Equipment's, Respiratory

personal protective devices, Non respiratory personal protective devices: Head protection, Ear protection, Hand protection , Foot protection, Body protection.

#### **Unit-4**

**(15)**

##### **a) Sanitation and public health**

Sanitation, hygiene and human health, concept of social and public health, sanitation, practices and related problems, case studies.

##### **b) Biomedical waste Management**

Definition biomedical waste, Sources of generation, different categories, colour coding, related health hazards, Treatment and disposal methods.

#### **References:**

1. Environmental Sanitation, Ehlers, V.M., add Steel, E.W., McGraw-Hill Book Co., Inc.
2. Toxic Chemicals, health and the Environment, Lave, L.B and Upton, A.C. 1987. The HopkinsPress Ltd., London.
3. Basic Environmental Toxicology, Lorris G. Cockerham and Barbara S. Shane, CRC Press.
4. Introduction to Environmental Toxicology Wayne G.Landi Ming-Ho Yu.
5. Patty's Industrial Hygiene and Toxicology, Ed.by Lewis J.Cralley, Lester V. Cralley, James S. Bus.
6. Hazardous waste management - Charles A. Wentz, 2nd Edition, 1995, Mc Graw Hill International
7. Integrated Solid waste management - George Tchobanoglous, Hilary and Samuel A. Vigil
8. Standard handbook of hazardous waste treatment and disposal - Harry M. Freeman, Mc Graw Hill 1997.
9. Environmental Sanitation, Ehlers, V.M., add Steel, E.W., McGraw-Hill Book Co., Inc.
10. Toxicology- The Basic Science of Poisons, Louis J Casarette, John Doull. Mc Millan Publishing Co. Inc. New York.
11. Modern Toxicology, Gupta , Salunkhe, Metropolitan Book Co. Pvt. Ltd.

## **CC-401: Socioeconomic aspects of Environment**

Students are able to

**CO1:** Sensitise students about the present growth pattern and actual developmental aspects.

**CO2:** Introduce the concept of sustainable development.

**CO3:** Comprehend the environmental and developmental priorities in India, past and future.

**CO4:** Get acquainted with the aspects of people's participation and role of NGOs in environmental protection

**CO5:** Calculate the cost- benefit of developmental projects.

### **Syllabus**

#### **Unit -1**

**(15)**

##### **a) Global and national environmental movements :**

Global environmental movements and initiatives - Green Peace, IUCN, WWF, World Watch Institute, Wetland International etc. Environmental movements : Chipko, Narmada Bachao Andolan, Save Western Ghats, Silent Valley, Bhopal Gas Tragedy, Rehabilitation and resettlement issues, Government policies and social awareness for the protection of environment.

##### **b) People's participation and role of NGOs in environmental protection**

People's participation in environmental protection, history of role of women in Environmental protection in India, Role of NGOs in environmental protection, Individual efforts for environmental protection. Environmental awareness through workshops, literature, exhibitions, displays, folk songs and folk lore, street plays, games, internet etc. Involvement of social, organizations, women groups, youths nature, etc. in environmental protection action.

#### **Unit- 2 Sustainable Development**

**(15)**

##### **a) Concept of eco-development Vs growth :**

Concept of eco-development, Integrating economic and ecological principles, definition of physical and economic growth, cost benefit ratios, development processes and growth, Integrated approach to environment and development, Western Ghats eco-development plan, developmental models for hilly area, river basins lands, growth centres.

##### **b) Concept of sustainable Development :**

Concept, Definition of sustainable development integrating economic and ecological principles, Concept of wise use and sustainable development, integrated approach to environment and development, Planning Vs perspective planning.

### Unit-3

(15)

#### a) Green techniques for nature conservation:

Rain water harvesting, zero waste management, Concept of concept of Green roofs, Concept of Green chemistry, Phytoremediation, Construction of soak pits for domestic wastewater, Ground water recharge techniques.

#### b) Green nanotechnology:

Concepts of fullerene, carbon nanotubes, nanoparticles for environmental conservation, Solar detoxification process, Carbon adsorption, Adsorption media filters, Micro screening and other low cost treatment methods, Removal of chromium, phenol, mercury, nitrogen etc. from industrial effluents.

### Unit -4

(15)

#### a) Environmental Audit, Social Audit

Definition of environmental audit, social audit and socio-economic surveys, Social Impact Assessment (SIA) methods and steps in SIA.

#### b) Environmental economics, eco-politics and accounting

Ecology and economy, economic principles, role of environmental economics at local, regional, nation and global level, polluter pays principle, natural resource accounting, trade and environment, eco-politics - have's and have nots, north south divide, restructuring of global politics on environmental justice.

#### Reference:

1. Environmental Economics in theory and practice – Hanley, Shogren and White.
2. Cost benefit analysis and the environment – Hanley, Splash.
3. Environmental Economics- Karpagam.
4. Environmental Economics- G.N. Singh.
5. Environmental Economics- R.N. Bhattachary

## **CCS-402 Environmental Hazards and Disaster Management**

Students are able to

**CO1:** Define the concepts of hazards and disasters.

**CO2:** Introduce the various man made hazards like industrial accidents, radiation hazards, Oil spills, forest and industrial fires and control.

**CO3:** Get acquainted with the natural disasters like earthquake, volcanoes, tsunami , land slides, etc.

**CO4:** Aware the different Strategies for mitigation disaster management.

**CO5:** Relate the technological aspects like remote sensing and GIS in disaster management

### **Syllabus**

#### **Unit – 1**

**(15)**

##### **a) Introduction to Hazards and Disasters :**

Definition - Hazard, vulnerability and risk, differences between disaster and hazards, types of hazards and disasters, natural disasters and man made hazards.

##### **b) Man made hazards :**

Industrial accidents, causes and effects of hazardous waste, toxic chemical waste and their disposal control, Acid rain and its control, Ozone depletion, Green house effect, Radiation hazards, Oil spills, fire, forest and industrial fires and control, environmental degradation due to wars.

#### **Unit – 2**

**(15)**

##### **a) Earthquake :**

Causes of occurrences, consequences, measurement, distribution of earthquake in world and India , mitigation.

Volcanoes : Origin and types of volcanic activities, Volcanic belts; causes of occurrences, consequences, distribution in world and Indian subcontinent, mitigation.

Tsunami : causes of occurrences, consequences, distribution in world, mitigation.

Land slides : Causes and types, human induced; Landslide prone areas in India distribution, rock/soil type, protective measures

#### **Unit – 3**

##### **a) Cyclones and Epidemics :**

**(15)**

Cyclones – types -tropical and temperate, distribution in world and India, role in Indian subcontinent,

Storms - causes of occurrences, distribution in world, consequences, mitigation.

Epidemics - types and causes and major epidemic's in India.

**b) Floods and Droughts**

Floods – occurrences, Floodplains and Flood-Prone Areas; nature and frequency of flooding; urbanization and flooding; Flood hazard assessment - environmental effects of flooding, role of man and nature, Consequences, Mitigation.

Draught - reason of occurrences, draught prone areas in India and world, consequences, mitigation

**Unit – 4****(15)****a) Disaster management**

Strategies for mitigation – warning system, forecasting, Emergency Preparedness, Education and Training Activities, planning for Rescue and Relief works, National and state level planning for hazards mitigation, Engineered structure /structural strengthening techniques- Hazard zonation and mapping- Risk Reduction Measures.

**b)** Use of remote sensing in disaster management, Disaster management plan, Social and economic impacts of disasters.

**References:**

1. Environmental Hazards: Assessing Risk and Reducing Disaster Smith, Keith, Routledge Publication
2. Environmental Geology, K. Valdia, Tata McGraw Hill Publishing House
3. Lal D.S. ,Climatology, Parag Pustak Bhavan, Allahabad
4. Hillary , Sir Edmand , Ecology,2000, The changing face of Earth, Multimedia Publication,1984 disaster



## **CCS-403 Environmental Planning and Management**

**CO1:** Understand the objectives and principals of environmental management with its importance.

**CO2:** Recognise the need for environmental planning with demographic considerations.

**CO3:** Introduce the concept of Total Quality Management.

**CO4:** Bring in to light the procedure of Environmental Impact Assessment for various category projects

**CO5:** Aware the importance of Environmental Audit with its procedure.

### **Unit -1 Environmental Impact Assessment: (15)**

a) Introduction of Environmental Impact Assessment process, objectives of EIA, Terminology, and Hierarchy in EIA, Historical Review of EIA, and concepts of EIA, Basic data collection for EIA.

b) Legislation and Procedures: National Environmental Policy Act and Implementation, EIA legislative requirements and administrative procedures in India/Indian States, EIA notification 2006 and its amendments.

### **Unit -2 (15)**

#### **a) Techniques and Methodology of EIA :**

Description of the environmental setting, Environmental Impact Assessment techniques-Ad-hoc method, checklist method, overlay mapping method, network method, simulation and modeling technique, matrix method, system diagram technique, Environmental risk assessment, baseline data collection for EIA

#### **b) Public Participation, Prediction and impacts and case studies of EIA:**

Public Participation in environmental decision making, regulatory requirement, techniques, advantages and disadvantages of public participation, Preparation and writing of EIA report

Prediction and Assessment of Impacts on Air, Water, Noise, Biological, Cultural and socio-economic Environment, Mining, blasting.

Case studies of EIA for Industries like Oil, Petrochemical, iron and steel,

Fertilizer, sugar and distillery, projects of road/dams and housing etc.

### **Unit -3 Environmental Audit:**

#### **a) Environmental Audit:**

Definition of Environment Audit and its importance for industries. Types of audits, General audit methodology and basic structure of audit, Elements of an audit process and its importance.

**b) Types of Audits:**

Definitions of Signatory, a. Consumption Audit, b. Pollution audit, c. Hazardous audit, d. Solid waste audit, e. Disposal audit, f. Cost audit, g. Investment audit, h. Voluntary social audit and socio-economic surveys, Social Impact Assessment (SIA).

**Unit -4****(15)****a) Environmental Management system:**

a) EMS benefits and costs, benefits to an industry, ISO 14000-Background, the ISO 14000 series, business and standards, voluntary standards and GATT/WTO, ISO 14001 & elements of EMS-environmental policy, planning, implementation and operation checking & correction action and management review–Case study Principles and elements, OSHAS – 18000.

**b) Life Cycle Assessment :**Components of LCA, measuring environmental impact (lifecycle stages of product, boundaries, functional unit, issues at each life-cycle stage, benefits of LCA), strategic framework for LCA and LCA-a tool for sustainability-Case study.

**c) Fair environmental practices in trade, commerce and industry:**

Total Quality Management (TQM) and business ecosystems, business ethics and environmental principals, traditional trade and commerce practices, fair environmental practices, Quality management and its impact of human society in India.

**References:**

1. Environmental Impact Assessment, Canter, L.W., 1977, McGraw Hills, New York.
2. Environmental Impact Assessment, Peter Wathern, Unwin Hywin, London
3. Environmental Impact Assessment, P. R. Triwedi, APH Publishing Corporation, New Delhi
4. A Handbook of EIA, V.S. Kulkarni, S.N. Kaul and R. K. Trivedi, Scientific Publication (India).

## **DSE-404 Environmental Biotechnology**

Students are able to

**CO1:** Introduce the role of biotechnology in Environmental Science.

**CO2:** Aware about the innovative practices bioleaching, bio-absorption and bioremediation.

**CO3:** Get aware with use of biotechnology in agro-industry and forestry.

**CO4:** Familiarise with use of biotechnology for industrial pollution control.

**CO5:** Understand the applications of genetic concept in environment management

### **Syllabus**

#### **Unit -1**

**(15)**

##### **a) Role of biotechnology in environmental science**

Introduction to biotechnology, concept of environmental biotechnology, public perception of biotechnology.

##### **b) Applications of some important technologies**

Genetic engineering, Genetic concept in environment management, Concept of bio-safety, Fate of GEM'S in the environment, Role of biotechnology in conservation of species.

#### **Unit- 2**

**(15)**

##### **a) Use of biotechnology in innovative practices**

**Concept of bio-leaching**, methods of bioleaching, microorganisms involved, advantages and disadvantages of bioleaching.

**Concept of bio-absorption**, factors affecting bio absorption, mechanism of bacterial metal resistance, limitations of bio absorption.

**Concept of bioremediation**, microorganisms involved, bioremediation processes and technologies, landfill technologies

Cell immobilization as a tool in waste treatment, Techniques of cell immobilization, Advantages of cell immobilization, Environmental applications of immobilized cells.

#### **Unit -3**

**(15)**

##### **a) Use of different technologies**

Aerobic Vs anaerobic degradation, testing of biodegradability, Bio-oxidation of phenolic compounds, Bio-degradation of specific hazardous wastes, biodegradation of hydrocarbons.

**b) Biotechnology in agro-industry and forestry**

Plant biotechnology, Biological control, Organic farming, Bio-fertilizers - types and production technology, Fermentation technology, Tissue culture, Animal biotechnology, Applications of biotechnology in forestry, Concept of biofuel, advantages, production. Animal Biotechnology and its application, Vermi-technology.

**Unit- 4**

**(15)**

**a) Microbial degradation of chemical pesticides.**

Important micro-organisms in degradation of chemical pesticides mechanism of degradation of chemical pesticides and herbicides, concept and types of bio-pesticides and their significance.

**b) Biotechnology for industrial pollution control**

Application of biotechnology in wastewater treatment - Tanning industry, Distilleries, Dairies, Dye industries, Pulp and paper industry, sugar industry.

**References**

1. Introduction to Environmental Biotechnology, A. K. Chatterji, Prentice Hall of India Pvt. Ltd, New Delhi
2. Environmental Biotechnology-Basic Concepts and Applications Indu Shekhar Thakur, I.K. International Pvt. Ltd. New Delhi.
3. Environmental Biotechnology S.K. Agawal, APH Publishing Corp., New Delhi.
4. Elements of Biotechnology, P. K. Gupta, Rastogi Publishing House, New Delhi.
5. Environmental Biotechnology, Jogdand S.N., Himalaya Publishing House, New Delhi.
6. Biotechnology, B.D. Singh, Kalyani Publishers , New Delhi
7. Molecular Biotechnology- Principles and Applications of Recombinant DNA, Glick and Pasternak. Panima Publishing Corporation, New Delhi
8. A Text Book of Biotechnology, R.C. Dubey, S. Chand and Company Ltd., New Delhi.

## **GE-407 Vermicomposting**

- Introduction to Vermicomposting
- Requirements for Vermicomposting
- Factors affecting vermicomposting
- Earthworms , types, structure
- Vermicomposting Methods:
  1. Vermicomposting of wastes in field pits.
  2. Vermicomposting of wastes on ground heaps
- Worms, Food , bedding, optimization of compost ecosystem

Setting up of vermicomposting system and harvesting    Trouble shooting