Faculty of Life Sciences

JSS ACADEMY OF HIGHER EDUCATION & RESEARCH
(DEEMED TO BE UNIVERSITY) MYSURU

JSS Academy of Higher Education & Research
(Deemed to be University)
Re-Accredited "A+" Grade by NAAC
Sri Shivarathreeshwara Nagara Mysuru - 570015, Karnataka

Syllabus

M.Sc. ENVIRONMENTAL SCIENCE

As per UGC's Learning Outcome Based Curriculum Framework (LOCF) under the CBCS pattern
Implementation Year 2021-22 onwards

MSc

Syllabus

M.Sc. Environmental Science

As per UGC's Learning Outcome Based Curriculum Framework (LOCF) under the CBCS pattern Implementation Year 2021-22 onwards

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M.Sc. Environmental Science

CONTENTS

M.Sc. Environmental Science

Forward

Today best practice procedures in environment management are rapidly becoming international rather than national. Building on an unparalleled history of excellence in academic JSS University looks to provide in depth learning in environmental education, which will serve as a focus for research into local, regional and global environmental issues, management and policies in response to the urgent and increasingly complex challenges of the new century.

Significance of the Course

The prudent management of our precious water resources, environment conservation, and sustainable development are high on the agenda of global concerns. Addressing these challenges requires professionals with a high degree of specialization and interdisciplinary approach. In order to develop improved systems and practices to preserve the most precious resource of our planet, there are a great demand fort rained people. In view of the huge focus and investment made by all nations on the water sector, there is a tremendous need for specially trained manpower for supporting the institution involved in the development and management of water, at both the grass roots levels and at the institutional level. Applying knowledge gained through environmental science is the only way to solve these problems so that the environment can be preserved. The rapid urbanization of the environment needs to be studied constantly in order to avoid altering and damaging the environment significantly. Ultimately, environmental science is necessary to save the environment from destruction and all of its dependents from extinction.

M.Sc., environmental science at JSS University is intended for professional's practitioners, researchers and students from wide range of backgrounds who aim to develop their knowledge and insights pertaining to the environment. The course in designed to provide critical and practical skills to analyze, evaluate, design and implement solution and strategies with regards to water and health issues.

Career Prospects

With increasing public concern about the environment, worlds of possibilities are available for graduates in terms of employment and research opportunities. Coupled with the growth of the global economy, the need for competent graduates with knowledge in environmental science is tremendous in the international arena as well. Careers in Environmental Science are so varied it is difficult to consider them as one category. Graduates of this programme can gain employment with consulting firms, research bodies, government and non-government organizations as Environmental consultant, Environmental education officer. Environmental manager, Nature conservation officer, Recycling officer, Sustainability consultant, Waste management officer, Water quality scientist. As private companies and industries are emphasizing more on the science of sustainability, they are looking for a wide range of professionals to manage the process related to environment.

Objective & Outcomes

This course is designed to provide foundation knowledge of environmental issues and problem solving strategies at national as well as at global level. A student who successfully completes this course should be able to demonstrate the following:

- Knowledge and skills needed to measure environmental problems and other ecological concepts.
- Understanding of diversity issues as they interact with the environmental problems.
- Understanding of the use of environmental strategies and remediation techniques to solve the environmental problems.
- Understanding the basic principles of environmental pathways and phenomenon related to the environmental issues at the global level.
- Ability to apply this skill to the evaluation of the environmental problems and related disciplines at industrial and corporate sectors.

With increasing public concern about the environment, worlds of possibilities are available for graduates in terms of employment and research opportunities. Coupled with the growth of the global economy, the need for competent graduates with knowledge in Environmental Science is tremendous in the international arena as well. Careers in Environmental Science are so varied it is difficult to consider them as one category. Graduates of this programme can gain employment with consulting firms, research bodies, government and non-government organizations as Environmental consultant, Environmental education officer, Environmental manager, Nature conservation officer, Recycling officer, Sustainability consultant, Waste management officer, Water quality scientist. As private companies and industries are emphasizing more on the science of sustainability, they are looking for a wide range of professionals to manage the process related to environment.

Eligibility
Candidates who have passed the undergraduate examination/Equivalent Examination with any science subject (B.Sc/B.FSc/B.Sc in Agri./B.Sc in Geography/B.Sc in Horticulture/B.E or B.Tech in any branch/MBBS/BDS/B.Pharm) from any recognized institution/university.

CURRICULUM STRUCTURE

Sl. No.	Study Components and Code	Title of the Paper	Hrs/ Week	Examination				Total Credit
				Dur. in Hours	CIA	Theory/ Practical Exam	Max. Marks	
SEMESTER-I								
1	DSC 01	Principles of Environmental Science	4	3	30	70	100	4
2	DSC 02	Environmental Biology	4	3	30	70	100	4
3	DSC 03	Environmental Chemistry	4	3	30	70	100	4
4	AECC	Water Supply and Sanitation	2	2	-	50	50	2
5	SEC 01	Climate Change and Management	2	2	-	50	50	2
6	Practical 01	Environmental Science and Biology	4	3	15	35	50	2
7	Practical 02	Environmental Chemistry	4	3	15	35	50	2
	Total Marks and Credits						**500**	**20**
SEMESTER-II								
1	DSC 04	Environmental Economics and Management	4	3	30	70	100	4
2	DSC 05	Environmental Impact Assessment	4	3	30	70	100	4
3	DSC 06	Water Resource Management	4	3	30	70	100	4
4	DSE 01a# **OR** DSE 01b#	Bioenergy Technologies **OR** Ecotoxicology	4	3	30	70	100	4
5	DSE 2a# **OR** DSE 2b#	Catalysis for Environmental Applications **OR** Environmental Radiations and Pollution	4	3	30	70	100	4
6	SEC 02	Field/industrial visits and awareness*					50	2
7	Practical 03	Environmental Economics and Management	4	3	15	35	50	2
8	Practical 04	Environmental Impact Assessment and Water resource management	4	3	15	35	50	2
	Total Marks and Credits						**650**	**26**
SEMESTER-III								
1	DSC 07	Water and Wastewater Treatment	4	3	30	70	100	4
2	DSC 08	Environmental Pollution and Law	4	3	30	70	100	4
3	DSC 09	Environmental Data Modeling	4	3	30	70	100	4
4	DSE 03a# **OR** DSE 03b#	Waste and Biomass Energy **OR** Environmental Modeling	4	3	30	70	100	4
5	SEC 03	Environment and Sustainable Development	2	2	-	50	50	2

6	Practical 05	Water and Wastewater Treatment	4	3	15	35	50	2
7	Practical 06	Environmental Data Modeling and Pollution	4	3	15	35	50	2
8		Internship					50	2
	Total Marks and credits						**600**	**24**
SEMESTER-IV								
1	Dissertation						**300**	**12**
Total (Semester I to IV)							**2050**	**82**

Abbreviations:
DSC – Discipline Specific Core
DSE – Discipline Specific Elective
AECC – Ability Enhancement Compulsory Course
SEC – Skill Enhancement Course

*Students need to be submitted reports on field/industries visits suggested by the department and participation in the environmental awareness/education programs or environmental activities organized by the department.

#Students may choose any one elective course among the offered choice, specific to the discipline

Semester One

SEMESTER ONE

No. of hours/week	Credit
4	4

DSC 01- Principles of Environmental Science

Course Objectives:
1. This is an interdisciplinary nature that focuses on the introduction to the course of Environmental Science
2. Students will learn the major components of the environment, ecology and biomes.
3. Students will learn the conservation methods of biodiversity.

Course Outcomes:
1. Students will be able to understand the basic concepts of environmental science.
2. Students will be able to appreciate the intricate nature of ecosystem.
3. Students will be able to explain different biomes and habitat
4. Students will be able to understand the different types of biodiversity conservation methods.

Unit I- Introduction: Definition, scope and interdisciplinary nature of environmental science, environmental factors: structure, composition of Atmosphere – structure & composition, Causes & effect of ozone depletion, Lithosphere – different layers, tectonic plates, Biosphere and Hydrosphere.

Unit II- Ecology: Definition, subdivision, ecosystem- Terrestrial, Aquatic, Grass, flow of energy, food chain, food web, trophic level, ecological pyramid – types (Numbers. Biomass, productivity), eco-tone, edge effect, Biogeochemical Cycles of major environmental elements and significance: Carbon, Nitrogen, Phosphorus, Sulphur, Hydrogen, Oxygen, Mode of energy transmission.

Unit III- Biomes and Habitat: Classification of biomes – Tundra, Taiga, Grassland, Desert, Evergreen and deciduous forests, Tropical rain forests and their characteristics, flora and fauna; Classification of Aquatic Habitats – Freshwater pond, Wetlands, Beels, Rivers – their characteristics, flora and fauna; Marine Habitats – Pelagic, Benthic, Inter-tidal Estuarine; Mangroves – their characteristics, flora and fauna

Unit IV- Conservative biology: Biodiversity conservation, Wildlife management, Ex-situ and in-situ Conservation, Protected area networks in India, important projects, Role of local community in conservation, national conservation policies: National Forest policy, biodiversity Act, Concept of Endangered, endemic and extinct species, Red data Book.

Recommended Textbooks and References:

1. Environmental Science – The natural environment and human impact (2nd Edition) (2011): A. R. W. Jackson and J. M. Jackson, Longman
2. Environmental Science (2012): S. C. Santra, New Central Book Agency (P) Ltd
3. Introduction to Environmental Science and Engineering (2nd Ed.) (2011): G. M. Masters, Pearson Education Pvt. Ltd.
4. Environmental Science (6th Edition) (2011): Jr. G. T. Miller, Wadsworth Pub. Co.
5. Fundamentals of Environmental Science (2004): G. S. Dhaliwal, G. S. Sangha and P. K. Raina,Kalyani Publication
6. General Climatology (4th Edition) (2010): Critichfield H. J.
7. Microbial Ecology (4th Edition) (2000): Atlast. R.M and Bartha,R., Addison Wesley Longman Inc.
8. Ecology Principles & Applications (2nd Edition) (2008): J. L. Chapman & M. J. Resis, Cambridge University Press.

9. Dimensions of Environmental and Ecological Economics (2009): N. C. Sahu & A. K. Choudhury (Ed), Universities Press
10. Fundamentals of Ecology (2009): Odum Eugene, Cengage Learning.
11. Cell Biology (2010) by Verma, P. S., Agarwal, V. K. S Chand and Company Ltd, New Delhi, India.
12. A text book of Environmental Science (2012) by Vidya Thakur, Scientific publisher, India.
13. Aquatic Ecosystems (2009): Kumar, A P H Publishing Corporation, India.

SEMESTER ONE

No. of hours/week	Credit
4	4

DSC 02-Environmental Biology

Course Objectives:
1. Students are expected to have the advanced learning of environmental techniques.
2. Microbiological treatment of wastewater,
3. Bioremediation and biodegradation of xenobiotics.

Course Outcomes: By the end of this course students should be able to:
1. Describe and comprehend the fundamental concepts of environmental microbiology
2. To learn about biodegradation and bioremediation process.
3. To learn about microbial treatment of wastewater
4. Assess the costs/benefits of conservation vs. remediation or technological solutions.

Unit I- Microbial interface: Interactions among microorganisms: parasitism, predation, amensalism, competition, commensalism, and mutualism. Microbial interactions with plant, animal, and human being. Microbial-Higher plant associations (Mycorrhiza, Rhizobium - Legume association), De-nitrification.

Unit II- Applied microbiology: Concept of biofertilizers, Concept of biopesticides, Microbial degradation of pesticides, Microbial enhanced oil recovery, Microorganisms as bio-indicators (lichens as air pollution indictors), Bio-mining (copper extraction), Microbial fuel cells, Biosurfactants and Biofilters.

Unit III- Environmental biotechnology: Biotechnology and environmental management, Bioremediation, In situ and Ex situ bioremediation, advantages and disadvantages. Bioremediation of ground water pollution. Phyto-remediation of soil metals, degradation of xenobiotics by microbes, Phytotechnology in wastewater treatment.

Unit IV-Environmental reclamation: Bio-composting - Aerobic composting methods such as Windrow, Static pile and In-vessel methods for composting, Vermi-technology - Biology of Earthworm, type, species and preparation. Use of microbes in improving soil fertility, Microbial treatment of oil pollution- Bio-scrubbers, and Bio-beds.

Recommended Textbooks and References:
1. Paul Edmonds (1978): Microbiology: An Environmental Perspective. Mac Millan Publishing Co. Inc. New York.
2. Dart R. K. and Stretton R.J. (1980): Microbiological aspects of Pollution Control. Elsevier Scientific Publishing Company, New York.
3. Atlas R.M. and Bartha R. (1981): Microbial Ecology Fundamentals and Applications. Addison Wesley Publishing Company, Massachusetts.
4. Alexander M. (1977): Introduction to Soil Microbiology 2nd Ed., John Wiley and Sons, New York.
5. Higgins I.J. and Bunns R.G. (1975): The Chemistry of Microbiology of Pollution. Academic Press, New York.

SEMESTER ONE

No. of hours/week	Credit
4	4

DSC 03-Environmental Chemistry

Course Objectives:
1. Toprovide the fundamental knowledge concerning the chemical-physical characteristics of the environmental components
2. Toillustrate the important chemical processes in the environment.
3. To understand the basic chemistry concepts to address environmental problems

Course Outcomes:
1. The students are acquire knowledge concerning the chemical-physical characteristics of air, water and soil
2. The students are able to understand the chemical processes and chemical mechanisms of interactions in an environment
3. The students are able to apply basic chemical concepts to analyze and solve different environmental problems
4. The students are capable of analyzing the various chemical based problems and environmental phenomena.

Unit I- Essential chemical concepts-atoms, elements, radicals; states of matter, elemental and chemical bonding, stoichiometry and chemical thermodynamics, gas law, chemical reactions (order of reaction), mass balance, classification of organic compounds, contaminants of emerging concerns

Unit II- Atmospheric chemistry-formation of earth atmosphere, structure and chemical composition of atmosphere (gases, particles, ions and radicals), chemical processes for formation of inorganic and organic particulate matters, thermochemical & photochemical reactions of oxygen and ozone, NOx, SOx, photochemical smog, green house gases and global warming, ozone depletion

Unit III-Water chemistry: properties of water (unusual properties-solvent properties of water, cohesion and adhesion, surface tension (capillary action), specific heat, heat of vaporization, density), hydrogen bonding in water and importance in biological systems, solubility of gases in water, marine water chemistry

Unit IV- Soil chemistry-constituents and properties of soils, colloids and soil solution, sorption and ion exchange processes in the soil, adsorption of contaminants in soil: adsorption isotherms and models, redox properties of soil, soil pH and acidity in soil, transport processes and importance in the soil.

Recommended Textbooks and References:

1. A. K. De, Environmental Chemistry (5th Edition) (2003): New Age International
2. B K Sharma, Environmental Chemistry (11th Edition) (2007): Krishna Prakshan media
3. Gay W vanlon&Stephen Jduffy, Environmental Chemistry (3rd Edition) (2011): OUP Oxford Publication.
4. Colin &Michael Cann, W.H, Environmental Chemistry (5rd Edition) (2012): Freeman Publication.

SEMESTER ONE

No. of hours/week	Credit
2	2

AECC- Water Supply and Sanitation

Course Objectives:
1. The students will learn about the microbes and chemical agents in spread of disease through water bodies
2. They learn about Human health impact of chemical agents
3. Students will learn about the Water Safety in Distribution Systems

Course Outcomes:
1. At the end of the course, the students have a clear understanding on the role of water bodies in spreading diseases through micro organisms and chemical agents.
2. The students will have the basic knowledge in understanding the Drinking-water Quality standards
3. At the end of the course, the students will have an understanding the Disinfection process
4. The students will have the basic knowledge in understanding the Risk assessment in water distribution systems

Unit I: Introduction to Water supply and Sanitation: Rural and Urban water supply systems, Types and classification of water supply systems, Need for a protected water supply, investigation and selection of water sources, protection of well waters, Disinfection of well water, Rural and Urban Sanitation, concept of Eco-sanitation.

Unit II: Water borne diseases and chemical agents: Waterborne diseases caused by pathogenic microorganisms, Epidemiology: Amoebiasis, Cryptosporidiosis, Giardiasis, Microsporidiosis, Schistosomiasis, Dracunculiasis, Fasciolopsiasis, Ascariasis, Botulism, Cholera, E. coli Infection, M. marinuminfection, Salmonellosis, Typhoid fever, SARS, Hepatitis A, Polyomavirus infection. Trace elements (fluoride, lead, cadmium and mercury), Acrylamide, Benzene, dichloroethane, vinyl chloride, Pesticides (Organophosphates, Carbamates, Paraquat and Endosulfan) and disease Epidemiology, Fate, Transport and effects of Contaminants.

Unit III: Water Safety in Distribution Systems: Definition and Types of Distribution System, Components of Water Transmission, hazard Identification (Physical, Chemical and Biological hazards), hazardous events (Physical integrity, Hydraulic integrity and Water quality integrity, Disinfection by-products, Chemicals from pipe materials and fittings, Water treatment chemicals, Water quality integrity.

Unit IV: Risk Assessment: Assess the risks, Semi-quantitative risk assessment, Quantitative microbial risk assessment, Validate control measures, Drinking-water Quality standards and Guidelines, Standard operating and management procedures, surveillance, audits and inspections, Capacity building.

Recommended Textbooks and References:

1. Water Safety in Distribution Systems, WHO, Geneva, Switzerland.
2. WHO (2001) Sustainable Development and Healthy Environments. Sanitation on Ships.Compendium of outbreaks of foodborne and waterborne disease and Legionnaires' disease associated with ships, 1970-2000.
3. Water borne Diseases- Epiddemiology & Ecology (1997): Paul R Hunter, Wiley and Sons Ltd.
4. Microbiology of Water Borne Diseases – Microbiological aspects and risks (2014): Steven L. Percival, Marylynn V. Yates, David Williams, Rachel Chalmers, Nicholas Gray, Elsevier Ltd.
5. Water Borne Pathogens (2Edition) AWWA Manual 2006

SEMESTER ONE

No. of hours/week	Credit
2	2

SEC 01- Climate Change and Management

Course Objectives:

1. Students are introduced with climate aspects in global scenario
2. Students are exposed to various modes and mechanisms of climate and influence of greenhouse gas.
3. Students can understand global framework and methods to reduce ill effects of control of climate change

Course Outcomes:

1. In this course, the students' study about climate change and current impacts of climate change.
2. The course also covers aspects of climate parameters, environmental quality and associated issues in the context of impact of climate change.
3. At the end of the course, the students have a clear understanding on the climate change causes, impacts and mitigation strategies including global problems associated.

Unit I- Elements Related to Climate Change: Greenhouse gases; Greenhouse effect; Total carbon dioxide emissions by energy sector – industrial, commercial, transportation, residential – Impacts – air quality, water vapour, green space – Causes of global and regional climate change – Changes in patterns of temperature, precipitation and sea level rise –

Unit II- Impacts of Climate Change: Effects of Climate Changes on living things – health effects, malnutrition, human migration, socioeconomic impacts- tourism, industry and business, vulnerability assessment- infrastructure, population and sector – Agriculture, forestry, human health, coastal areas.

Unit III- Mitigating Climate Change: IPCC Technical Guidelines for Assessing Climate Change Impact and Adaptation -Identifying adaptation options – designing and implementing adaptation measures – surface albedo environment reflective roofing and reflective paving enhancement of evapotranspiration – tree planting program – green roofing strategies – energy conservation in buildings – energy efficiencies – carbon sequestration Techniques.

Unit IV- Importance of Carbon Credits: Carbon Footprint and Carbon Offset, Carbon Tax, International Carbon Pricing Initiative, Carbon Credit in India and Developed Countries, Carbon Audit-ISO 14064, Latest developments in carbon crediting.

Recommended Textbooks and References:

1. Hardy, J.T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
2. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
3. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
4. Manahan, S.E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
5. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
6. Mathez, E.A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
7. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
8. Philander, S.G. 2012. Encyclopedia of Global Warming and Climate Change (2nd edition). Sage Publications.

SEMESTER ONE

No. of hours/week	Credit
4	2

Practical 01- Environmental Science and Biology

1. Introduction to laboratory techniques (Procedure and safety)
2. Sampling techniques
3. Microbial Techniques (Sterilization, Media preparation, Plating techniques)
4. Staining Techniques
5. Sample Preparation (Soil and Water)
6. Species and community characterization.
7. Isolation techniques: serial dilution, plating.
8. Identification of bacteria and fungi: physiological and biochemical.
9. Staining – Simple and Gram's.
10. Microscopic counting of microbes using haemocytometer.
11. Measurement of microbes using ocular and stage micrometer.
12. Estimation of coli-form bacteria in water by MPN method.
13. Study of biodiversity by field study

SEMESTER ONE

No. of hours/week	Credit
4	2

Practical 02- Environmental Chemistry

1. Qualitative and quantitative estimation of greenhouse gases in air samples
2. Qualitative and quantitative estimation of water quality parameters
   - pH
   - TDS
   - Hardness
   - DO
   - Alkalinity
   - Conductivity
   - Chloride
3. Stoichiometry and calculations
4. Determination of hydraulic properties of soil.
5. Qualitative and quantitative estimation of soil quality parameters
   - pH
   - Conductivity
   - Porosity
   - Organic and inorganic compositions
6. Rocks and minerals Identification
7. Determination of Organic Carbon in the soil sample
8. Separation of pollutant and biomolecules by thin layer chromatography
9. Determination of rate of reaction (Redox or potentiometric)
10. Demonstration of sorption process (adsorption and absorption)

Semester Two

SEMESTER TWO

No. of hours/week	Credit
4	4

DSC 04- Environmental Economics and Management

Course Objectives:
1. To provide a comprehensive introduction to interactions between the natural environment and the human economy.
2. Toprovide advance knowledge on the ecosystem-services and challenges arising due to externalities and economic activities.
2. To develop the skills needed by environmental managers to tackle environmental issues at local, regional, and global levels.

Course Outcomes:
1. The students are able to discuss on environmental issues in relation to the theory of externalities, public goods, and welfare
2. The students can realize the importance and influence of environment on the economic development
3. The students are able to illustrate and examine economic principles concerning the pollution, economic activities and the environmental policies
4. The students are capable of analyzing and adopting sustainable environmental management strategies to solve environmental problems.

Unit I- Introduction: Environmental economics and principles; cost-benefits analysis; instrument for environmental control: regulatory policy, economic incentives (price rationing, quality rationing, liability rule), externalities, biophysical limits to economic growth: the Malthusian, neoclassical, ecological economic perspectives, law of diminishing returns, carrying capacity, net present value, circular economy and importance.

Unit II- Environmental management fundamentals and goals: approaches to environmental management; sustainable development, environmental management challenges, environmentalism, and green movement, social aspects of resource use and total economic value, environmental ethics, global environmental problems and economics, environmental accounts, environmental trade, and importance

Unit III- Environmental management systems: Environmental system principles: polluter pays principle, user pays principle (or resource pricing principle), precautionary principle, subsidiary principle, intergenerational equity principle; tools: standards, monitoring, modeling, eco-auditing, and management strategies; different environmental management systems; perspectives of environmental management policy in India, ISO systems & certification procedure

Unit IV- Environmental management approaches in business: industrial ecology, ecological engineering, Pigouvian taxes, green marketing, consumer protection bodies, eco-labeling, total quality management, covenants, life-cycle assessment, green-washing, green energy and technology, international law and sovereignty issues, international conferences (Stockholm) and agreements; participatory environmental management: education and awareness, facilitators, international bodies and NGOs

Recommended Textbooks and References:
1.Charles D Kolstad,Environmental Economics (2nd edition), Oxford Press, 2010
2. Roger Perman, YueMa, Michael Common, David Maddison, James Mcgilvray, Addison Natural Resources & Environmental Economics (4th Edition) Wiley & Sons, 2011
3. Uberoi, N K Environmental Management, New Delhi Publ. Excel Books, 2020
4. Phillip Mc Cann, Modern Urban and Regional Economics, Oxford publication, 2019

SEMESTER TWO

No. of hours/week	Credit
4	4

DSC 05- Environmental Impact Assessment

Course Objectives:
1. Identify the need to assess and evaluate the impact on environment.
2.Major principles of environmental impact assessment
3. Understand the different steps within environmental impact assessment

Course Outcomes:
After learning the course, the students should be able to:
1. Demonstrate the understanding of concept of Sustainable Development and justify the methods of achieving SD.
2. Appreciate the importance of EIA as an integral part of planning process.
3. Apply the different methodologies to predict and assess the impacts of project on various aspects of environment.
4. Enumerate the role of public participation in environmental decision-making process.
5. Characterize the environmental attributes.

Unit I-Introduction to EIA: Principles of EIA, History of EIA, Evolution of EIA in India, Environmental Impact Statement, Institutional framework and EIA, Legal framework for EIA, Environmental clearance procedure in India, Role of various actors in the EIA process, Comparison between EIA of 2006 and 1994, the drawback/limitations of EIA

Unit II-EIA process: EIA notifications, Screening, Scoping, Terms of Reference, Baseline data – air, water, soil and socioeconomic. Prediction, Impact assessment, Mitigation, EIA methodologies – Checklists, Matrix/matrices, Networks, Overlays, The Battelle Environmental Evaluation System, Public hearing.

Unit III-EIA management: Capacity building in EIA, Trends in EIA, Air quality monitoring, Environmental monitoring - Monitoring types, Environmental Management Plan - Scope and Organization, Environmental audit – Features, Benefits, Process, Report. Environmental Risk Assessment (ERA).

Unit IV-EIA case studies: 1. Highways, 2. River valleys, 3. Power plants, 4. Mining projects, 5. Irrigation activities, 6. Ports, 7. Airports and 8. Chemical industry, etc.,

Recommended Textbooks and References:
1. Marriott, B. 1997. Environmental Impact Assessment: A Practical Guide. McGraw-Hill, New York, USA.
2. Barrow, C.J. 2000. Social Impact Assessment: An Introduction. Oxford University Press.
3. Glasson, J., Therivel, R., Chadwick, A. 1994. Introduction to Environmental Impact Assessment. London, Research Press, UK.
4. Judith, P. 1999. Handbook of Environmental Impact Assessment. Blackwell Science.
5. D. P. Lawrence (2003) Environmental Impact Assessment: Practical Solutions to Recurrent Problems, John Wiley and Sons, New Delhi.

SEMESTER TWO

No. of hours/week	Credit
4	4

DSC 06- Water Resource Management

Course Objectives:
1. The students learn about precipitation, ground water hydrology.
2. They learn about water resource management and rain harvesting techniques..
3. Students will learn about the concept of Integrated water resources management (IWRM)

Course Outcomes:
1. By the end of the course, the student is well versed in the understanding of ground water resources and its management
2. The students will have the basic knowledge in understanding the flood control
3. At the end of the course, the students will have an understanding on the concept of Integrated water resources management
4. The students will have the basic knowledge in understanding the ground water hydrology

Unit I- Water resources management: concept of Integrated water resources management (IWRM) within the broader context of development – Examining the key elements of IWRM process, Economic view of water issues: economic characteristics of water good and services, Demand and supply management.

Unit II- Water for food production: 'blue' versus 'green' water debate, international and national law in the area of water management, Private sector involvement in water resources management (PPP): objectives, options, processes, experiences through case studies, Links between PPP and IWRM, Agricultural catchment management and pollution remediation techniques.

Unit III- Water Resources: Introduction of water resources, Types (Renewable and non-renewable water resources) Concept and objectives of water resources, Exploitable water resources, Concept of irrigation, development of irrigation in India, Benefits of irrigation, irrigation systems: minor and major, medium and minor irrigation projects, impact of irrigation on environment.

Unit IV- Urban Water Resource Management: Concept of Urban eco-system – Urban Water Resources – Major problems –objectives and limitations of Storm water management – Storm water policies – Feasibility consideration, Storm water management practices (Structural and Non-structural Management measures) – Water Harvesting and Conservation (Design of Small Water Harvesting Structures), Watershed Management, Urban surface runoff models, Quality models.

Recommended Textbooks and References:

1. Water Resources (2010): Shimon C Anisfeld, Island Press.
2. Water resource Engineering: Principle & Practice (2009): Satya N Challa Murthy, New Age International Publisher.
2. Principles of Water Resources: History, Development, Management, and Policy (3rd Edition) (2010): Thomas V Cech, John Wiley and Sons, Inc.
3. Hydrology & Water Resource Engineeering (2014): S. K. Garg, Khanna Publishers, Delhi.
4. Water Supply Engineering, Vol.1 (25th Edition) (2014): S. K. Garg, Khanna Publishers,

SEMESTER TWO

No. of hours/week	Credit
4	4

DSE 01a- Bioenergy Technologies

Course Objectives:

1. Students are introduced to importance of biomass in energy sector.
2. Students are introduced to various mechanisms of producing biofuels.
3. Students are also exposed to waste management and energy generations.

Course Outcomes:

1. This course highlights biomass, biogas, pyrolysis, and waste characteristics.
2. By the end of the course the student understands biogas production from waste, characteristics of biomass fuel and importance of biodiesel.

Unit I- Introduction to Biomass energy: Biomass definition, photosynthesis and biomass, biomass types, composition, and analysis of biomass (heating value, ultimate and proximate analyses). Modes of biomass utilization for energy, biomass conversion processes, sewage sludge and its utilization.

Unit II- Biogas: Biogas production, types of substrates, operational Problems, biogas process, types of biogas plants, use of biogas and digestate, advantages and limitations of biogas. Ethanol production processes, biodiesel Preparation and its applications.

Unit III- Thermochemical techniques of Biomass: Biomass combustion systems and wood stoves, Densification and its techniques, Pyrolysis, Slow and fast pyrolysis, Biomass gasification, Type of Gasifiers, fluidized bed combustion systems, application of biomass combustion system.

Unit IV- Waste to Energy: Waste and its characteristics, waste generation, composition, collection, separation, treatment and storage, Environmental and health impacts of waste, solid waste management, waste disposal methods: sanitary landfill, incineration, composting, policy and economics of waste. Energy from sewage treatment.

Recommended Textbooks and References:

1. Gerhard Knothe, Jon Van Gerpen and Jurgen Krahl (2005), The Biodiesel Handbook.
2. Bioenergy Options for a Cleaner Environment: in Developed and Developing (2004) : Ralph E.H. Sims, Elsevier.
3. Sustainable Bioenergy Production - An Integrated Approach (2013) : Hans Ruppert, Martin Kappas, Jens , Springer.
4. Anaerobic Biotechnology for Bioenergy Production Principles and Applications(2011): Samir Khanal, Wiley Publishing.
5. Bioenergy Economy: A Methodological Study on Bioenergy-Based Therapies (2010): Farzad Goli, Xilbris Corporation.
6. Bioenergy: Opportunities and Challenges (2015): R. Navanietha Krishnaraj, Jong-Sung Yu, CRC Press

SEMESTER TWO

No. of hours/week	Credit
4	4

DSE 01b- Ecotoxicology

Course Objectives:
1. To know about the basics of toxicology.
2. To know about the metabolism of the toxic substances.
3. To know about the various bioassay methods.

Course Outcomes:
1. The students will learn about the various toxicological aspects.
2. They will learn about the various modes of action of toxic substances.
3. They will learn about the various bioassay methods of toxicity.
4. They will learn about the various carcinogenic and mutagenic substances.

Unit I- Basics of toxicology: Definitions and Toxicological terms, Concept, Importance-History of Toxicology-Dose–Response Relationship, Dose–Response Curves (LD_{50} and LC_{50}). Sub divisions of Toxicology- epidemiology-history- Types of Epidemiologic Studies: Advantages and Disadvantages.

Unit II- Toxicology and safety: Absorption and distribution of toxicants-Transfer across Membrane Barriers, Absorption, Distribution, and Elimination of Toxic Agents, Sites of Biotransformation, Biotransformation Reactions.

Unit III- Concepts of Bioassay: types, characteristics, importance and significance of bioassay, field based microbial bioassay for toxicity testing, Immunotoxicity, histotoxicity, cell toxicity, Bio-sensors and Bio-markers: Concept and approach, advantages and disadvantages. Metal Toxicity-toxicology of Selected Metals-Fe, Hg, Pb, Ar, Cr.

Unit IV- Environmental Carcinogens and Mutagens: Chemicals (VOC, Pesticides): DNA Damage and Mutagenesis- Human Cancer- Causes, Incidence, and Mortality Rates - Occupational Carcinogens.

Recommended Textbooks and References:

1. Environmental biology and Toxicology, by Sharma P.D. Rastogi and Lamporary., 1994.
2. Environmental pollution and Toxicology by Meera Asthana and Astana D.K., Alka printers, 1990.
3. Toxicology, by A.Sood, Sarup and sons New Delhi, 1999
4. Text book of Preventive and Social Medicine, by Park J.E. and Park K., Banosidas Bharat Publishers, Jabalpur, 1985
5. Environmental Epidemiology, by Anisa Basheer, Rawat Publication Jaipur, New Delhi 1995.

SEMESTER TWO

No. of hours/week	Credit
4	4

DSE 02a- Catalysis for Environmental Applications

Course Objectives:
1. To understand about the advanced catalysis and catalysts
2. To get advance knowledge on catalysis processes in environment and environmental applications.
3. To get advance knowledge on designing, characterization and fictionalization of catalytic materials

Course Outcomes:
1. Students are able to understand the important catalysis and related catalytic materials
2. Students are able to application of catalysis for various environmental applications
3. Students are able employ catalytic processes for pollution remediation and energy production
4. The students can have the ability to design and apply a new catalyst for environmental application

Unit I - Introduction: Definition of catalyst and catalysis, history and classification of catalysis, homogeneous and heterogeneous catalysis, biocatalyst, heterogeneously catalyzed reactions (adsorption and desorption), catalysis and green chemistry, significance of catalysis.

Unit II – Component of solid-state catalysts: important catalysts-active components, supports, promoters, metals, semiconductors-oxides and sulfides, insulators- oxides and sulfides, carbon and carbonaceous matrix, factors affect on catalysis-size and dimension (0D, 1D, 2D, 3D), shape, surface area and morphology, crystalline.

Unit III – Synthesis and characterization: Preparation methods-top down approach (mechanical grinding and lithography) and bottom up approach (physical techniques-physical vapor deposit, chemical techniques-chemical vapor deposit, sol-gel, hydrothermal, electro-spinning), nucleation and growth processes, Properties- optical properties, electrical properties, mechanical properties, magnetic properties, Characterization techniques-XRD, FTIR, SEM, TEM, DLS, XPS, BET-surface area.

Unit IV – Environmental Applications: Pollution detection, catalyst based advanced oxidation for removal of pollutants from water and air, photocatalysis for water treatment, catalyst based disinfection and self-cleaning processes, carbon sequestration and CO_2 conversion, microbial fuel cells, energy production (solar cells, fuel cells, waste to energy, etc).

Recommended Textbooks and References:

1. Environanotechnology by Mao Hong fan, Chin-pao Huang, Alan E Bland, Z Honglin
2. Nick Kanello Poulos. CRC press, 2011.
3. Inorganic Nanoparticles: Synthesis, Application and Perspectives. Edited by Claudia Altavilla and Enrico Ciliberto. CRC Press, 2011.
4. Nanostructured conductive polymers. Edited by Ali Eftekhari. Wiley, 2010.
5. Adsorption and diffusion in nanoporous material by Rolando M.A. Raque Malherbe. CRC press, 2007.
6. Introduction to Nanoscience by Gabor L. Hornyak, Joyde.

SEMESTER TWO

No. of hours/week	Credit
4	4

DSE 02b- Environmental Radiations and Pollution

Course Objectives:
1. To understand about the Radiation
2. Students will learn about Radiation pollution in the environment.
3. Students will learn about the Radiation protection and control measures

Course Outcomes:
1. Through this course, the students learn the natural and anthropogenic sources of radioactivity
2. The students will have the basic knowledge of Disposal of Radioactive Waste
3. At the end of the course, the students will have an understanding on the Monitoring and preventive measures.
4. The students will have the knowledge of the various type of environmental radiation

Unit I- Introduction to radiation: Effect of Radiation , cosmic radiation; natural and anthropogenic sources of radioactivity and distribution in environment- rocks and soils, uranium and thorium ores, the atmosphere, water, food and building construction materials, Effect of radiation on plant and animal:

Unit II- Ionizing Radiation: radioactive decay, Interaction of radiation with matter. Biological effects of radiation with matters. Health hazards associated with radiations. Units of health hazards associated with radiations. Units of radioactivity and radiation dose.

Unit III- Radiation pollution: Hazards of radio-active wastes; Radio isotopes and their applications: food; agriculture; medicine, Radiochemical Methods of monitoring air and effluent. Methods for monitoring air emission, Radiation Protection, Principles and Techniques.

Unit IV- Radioactivity: radioactive elements; unit of radiation: Radiation detection and dosimetry. Application of stable nuclides, radionuclides isotopes; Nuclear energy and nuclear fuel cycle, effect of nuclear cycle on environment

Recommended Textbooks and References:

1. Environmental Physics by Sood D.D
2. Murugeshan, R. Modern Physics. S. Chand & company, Ltd
3. Miller, G.T. Environmental Science-An Introduction, Wadsworth Publishing Company, California
4. Kopkar, S. M. Environmental Pollution – Monitoring and Control. New Age, International Ltd, New Delhi
5. Chandler, S. D. Radioactive waste control and controversies. Vol-3. Gordon and Bleach Science Publishers,
6. Environmental Radioactivity from Natural, Industrial and Miltry sources, Merril Eisenbud and Thomas Gessell Academic Press, London

SEMESTER TWO

No. of hours/week	Credit
2	2

Practical 03- Environmental Economics and Management

1. Cost-benefit analysis
2. Law of diminishing returns and problems
3. Carrying capacity
4. Net present value.
5. Designing of environmental management approaches to solve the environmental problems
6. Eco-auditing and problem solving
7. Life-cycle assessment
8. Environmental standards and monitoring practices
9. Carbon auditing
10. Green Certificates
11. Green technology and sustainable management
    - Carbon sequestration techniques
    - Resource mining from waste (biological, physical and chemical techniques)

SEMESTER TWO

No. of hours/week	Credit
2	2

Practical 04- Environmental Impact Assessment and Water Resource Management

1. Preparation of Activity-processes Flow diagrams.
2. Preparation/drafting of EIA Report (Chemical Industry, Fertilizer Industry, hydropower station).
3. Case study Analysis of Environmental Audit of a major industry.
4. Preparation of Environmental Impact Statement.
5. Application of Matrices Method.
6. Cost-benefit Analysis for Resource Allocations: Transportation Method.
7. Visit to understand Institutional arrangements and functioning of Pollution Control Boards.
8. Visit to understand the Environmental Management system of an Industry.
9. Visit and report submission on eco-development society activity
10. Socio-economic Questionnaire Survey in minimum five villages
11. Economic view of water issues
12. Demand and supply management
13. Urban water resource and conservation strategies
14. Underground water resource and recharge points
15. Rainwater harvesting and models
16. Watershed models

Semester Three

SEMESTER THREE

No. of hours/week	Credit
4	4

DSC 07- Water and Wastewater Treatment

Course Objectives:
1. To provide the fundamental knowledge concerning the water and wastewater treatment techniques
2. To illustrate the importance water and wastewater treatment.
3. To understand the concepts of advanced water treatment techniques

Course Outcomes:
1. The students are acquire knowledge concerning the water and wastewater treatment
2. The students are able to understand the various types of water and wastewater treatment techniques
3. The students are able to apply water and wastewater treatment skills at different industries.
4. The students are capable of employ appropriate treatment techniques to treat diversified wastewater.

Unit I- Physico-chemical Treatment: Principles of primary and preliminary treatment process of water & wastewater: Physical treatments-screening, grit removal; Chemical treatments- coagulation, flocculation, and sedimentation, Dissolved air flotation (DAF), Iron removal.

Unit II- Biological Treatment: Principle of biological treatment, microbial growth and their kinetics for substrate removal, Aerobic Process: Activated sludge, Oxidation ponds, Trickling filter, Bio-towers, Rotating discs and Rotating drums, Oxidation ditch; Anaerobic Process: Anaerobic digestion, Anaerobic filters, Up-flow anaerobic sludge blanket reactors (UASB), Bioreactors for wastewater treatments: Reactor types and design

Unit III- Advance Treatment: Disinfections (UV, Ozonization), water softening, Demineralization, Reverse osmosis, Color & odor removal by activated carbon, Application of Nanotechnology: Applications and emerging opportunities, Nanofibers and Nanobiocides, Nanozymes for biofilm removal, Nanofiltration and nanomembranes, Nanomaterials and nanocatalyst in water and waste water treatment applications, Potential risks of using nanotechnology in water treatment.

Unit IV- Industrial waste water treatment: Selection of appropriate unit operations for the treatment and flow chart of wastewater treatment plant for Dairy and food, Pulp & Paper, Electroplating, Textile, Distillery, Hospitals

Recommended Textbooks and References:

1. Water and waste Engineering, Vol. I and II, Fair, G.M. Geyer T.C. and Okun. D.A. (1984): John Wiley and Sons.
2. Waste water treatment processes, Metcalf and Eddy Inc. Academic Press, New York. (2003 & 1979)
3. Standard Methods for Examination of Water and Waste Water American Public Health Association (5th Ed) (1980)
4. Water and waste water Engineering, Vol.I and II, Fair, G.M. Geyer T.C. and Okun. D.A. (1984): John Wiley and Sons.
5. WastewaterTreatment Plants: Planning, Design & Operation (2nd Edition) (1999): Syed R Qasim, CRC Press.

6. Wastewater Treatment(3rd Edition) (2002): M Henze, Springer.
7. Water & Wastewater Treatment- A guide for non eng. Professional (2001): Jonnae E Drinan, CRC Press.
8. Wastewater Treatment- Advanced Processesd & Technologies (2013): D.G. Rao, R. Senthil Kumar, J Anthony Byrne,S. Feroz, IWA Publishing, CRC Press.
9. Industrial Wastewater Treatment (Eastern Economy Edition) (2008): A.D Patwardhan, Prentice hall of India Private Limited.
10. Wastewater Microbiology (3rd Edition) (2005): Cabriel Bitton, John Wiley & Sons.
11. Physial – Chemical Treatment of Water & Wastewater(2003): Arcadio P Sincero & Gregoria A Sincero, IWA Publishing, CRC Press.
12. Wasteawter Engineering (2 Edition) (2005) : B.C. Punmia, Ashok Jain,Laxmi publications Ltd.
13. Advances in Membrane Technology for Water Treatment (2015): Angelo Basile, Alfredo Cassano, Navin K Rastog, Elsevier Limited.
14. Nanotechnology for Water Treatment & Purification (2014) : Anming Hu & allen Apblett, Springer International Publishing.
15. Green Nanotechnology (2011): Geoffrey B. Smith, Claes-Goran S. Granqvis, CRC Press.

SEMESTER THREE

No. of hours/week	Credit
4	4

DSC 08- Environmental Pollution and Law

Course Objectives:
1. To understand about air, water and soil pollution
2. Students will learn about Climate change, health, and environment.
3. Students will learn about the various kinds of pollution that occur in the environment

Course Outcomes:
1. Through this course, the students learn the importance of environment and methods to minimize the pollution
2. This course prepares the students to be responsible citizens
3. At the end of the course, the students will have an understanding on the pollution measures
4. The students will have the basic knowledge in understanding the Climate change and health

Unit I-Noise Pollution: Types, sources, noise exposure levels and standards, consequences, prevention and control of noise pollution. Noise Pollution (Regulation and Control) Rules, 2000. Radio-active Pollution: Radiation, types, sources, biological effects and control measures. The atomic energy (Radiation Protection) Rules, 2004. Thermal Pollution: Definition, sources and consequences, pollution control measurement.

Unit II-Air Pollution: Concept of air pollution, sources, types of air pollutants, air quality standards, air pollution indices, effects of air pollution on organisms, materials and environment. Formation of smog, acid rain, ozone layer depletion and climate change. Indoor air pollution. Pollution control by technological (catalytic converters, scrubbers, electrostatic precipitators, cyclonic separators, settling chambers) and legislation aspects (The Air (Prevention and Control of Pollution) Act 1981.

Unit III- Water and Soil Pollution: Types (ground water, surface water and marine water), sources (point and non-point source), types of water pollutants and consequences (eutrophication, bio-magnification), water quality standards, pollution control by technological (waste water treatment methods, INM and IPM) and legislation aspects (The Water (Prevention and Control of Pollution) Act, 1974). **Soil Pollution:** Sources, consequences, pollution control measures and soil reclamation and soil erosion.

Unit IV-Environmental laws and policies in India: Introduction, importance, Constitutional and statutory laws in India: Environmental (protection) Act, and rules (1986), The Forest (conservation) Act, 1980, Wildlife protection Act, 1972, The National Environment Tribunal Act, 1995, The Public Liability Insurance Act, 1991, Role of CPCB and SPCB in pollution control, Ministry of environment and Forest, Environmental Clearance (EIA notification 2006), National Green Tribunal and international environmental laws.

Recommended Textbooks and References:

1. Environmental radioactivity (1997): M. Eisendbud, Academic press.
2. Energy, Waste and the Environment: A Geochemical Perspective (2004): R. Gieré, Peter Stille, Geological Society of London
3. Understanding Environmental Pollution(3rd Edition) (2010) : Marquita K. Hill, Cambridge University
4. Air Pollution: Health And Environmental Impacts (2010): Bhola R. Gurjar, Luisa T. Molina, C.S. P. Ojha, CRC Press.
5. Air Pollution (26th Reprint) (2007): M N Rao & H V N Rao, Tata Mc Graw Hill Publication.
6. Environment Pollution & Management (2003): A. Kumar, C Bohra. L.K. Singh, APH Publishing Corporation.
7. Environmental Pollution Monitoring and Control (2004):S. M. Khopkar, New Age International Publisher.
8. Handbook of Environmental Law (2009): P.B Sahasranaman, Oxford University Press.
9. Water Pollution: Causes, Effects and Control (2006): P. K. Goel, New Age International Publisher.

SEMESTER THREE

No. of hours/week	Credit
4	4

DSC 09- Environmental Data Modeling

Course Objectives:
1. This subject gives an introduction about the various concepts of data analysis.
2. The subject describes the different components of mathematics & statistics
3. The subject describes different statistical testing methods.

Course Outcomes:
1. The student will be able to understand various sampling methods.
2. The students will be able to describe and analyze data.
3. The student will be able to explain laws of probability.
4. The student will be able to do the data hypothesis testing.

Unit I-Sampling Methods: Collection of Data, Census Method, Concept of Population, Sample, Sampling, Sample Size, Sampling Error, Advantages and Disadvantages of Sampling Method, Necessity of Sampling, Types of Sampling Methods, Types of Random Sampling Methods – SRS, Stratified Random Sampling, Systematic Random Sampling and Cluster Sampling.

Unit II- Data Analysis: Data Types: Qualitative Data, Quantitative Data, Graphical Representation Methods (Histogram, Bar Charts, Pie Charts), Measures of Center Tendency (Mean, Median, Mode,) and Dispersion (Standard Deviation, Variance) Advantages and Disadvantages, Co-Efficient of Variance.

Unit III- Probability: Basic Terminology, Definition of Probability, Basic Laws of Probability, Types of Probability, Additional Rule of Probability and Multiplication Rule of Probability, Probability Distribution- Bernoulli Distribution, Binomial Distribution, Poisson distribution and Normal Distribution- Simple Problems.

Unit IV- Analysis Hypothesis Testing: Hypothesis, Types of Hypotheses, Level of Significance, Type I and Type II Error, Standard Error, Degrees Of Freedom, Chi Square Test, Student's t Test: One Sample t Test, Paired t Test, Analysis of variance (ANOVA), Regression analysis.

Recommended Textbooks and References:
1. Fundamentals of Biostatistics: Veer Bala Rastogi,
2. Fundamentals of Mathematical Statistics: S.C. Gupta and V. K. Kapoor
3. Fundamentals of Statistics: S.C. Gupta
4. Biostatistics, Snedger and Gohrran.
5. Introductory Statistics for Biology 2nd Edition, R. E. Parker.

SEMESTER TWO

No. of hours/week	Credit
4	4

DSE 03a- Waste and Biomass Energy

Course Objectives:

1. Students are introduced to importance of biomass in energy sector.
2. Students are introduced to various mechanisms of producing biofuels.
3. Students are also exposed to waste management and energy generations.

Course Outcomes:

1. This course highlights biomass, biogas, pyrolysis, and waste characteristics.
2. By the end of the course the student understands biogas production from waste, characteristics of biomass fuel and importance of biodiesel.

Unit I- Technologies for Waste to Energy: Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation, Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies.

Unit II- Waste to Energy Options: Landfill gas, collection, and recovery. Refuse Derived Fuel (RDF) – fluff, briquettes, pellets. Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants and Industrial boilers. Conversion of wastes to fuel resources for other useful energy applications. Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery. Energy Recovery from wastes and optimization of its use, benchmarking and standardization. Energy Analysis

Unit III- Biomass Gasification: Chemical reaction in gasification, Producer gas & the constituents, Types of gasifiers. Fixed bed gasifiers, Fluidized bed gasifiers. Liquefaction: Liquefaction through pyrolysis & Methanol synthesis, application of producer gas in I C Engines.

Unit IV- Bio Power Plants: Bio Power generation routes, Basic Thermodynamic cycles in Bio power generation; Brayton cycle, Sterling cycle, Rankine cycle, Co-generation cycle. Biomass based steam power plant.

Recommended Textbooks and References:

1. G. N. Tiwari and M. K. Ghosal, Fundamentals of Renewable Energy Sources, Narosa Publishing House, 2007
2. Kishore V V N, Renewable Energy Engineering and Technology, Principles and Practice, The Energy and Resources Institute (TERI), 2009
3. Nijaguna, B.T., Biogas Technology, New Age International publishers (P) Ltd., 2002
4. Samir Kumar Khana, Bioenergy and Biofuel from Biowastes and Biomass, ASCE Publications, 2010

SEMESTER TWO

No. of hours/week	Credit
4	4

DSE 03b- Environmental Modeling

Course Objectives:
1. To provide basic knowledge on mathematical model construction and analyze environmental problems mathematically
2. Subject explains the issues and principles of Design of Experiments (DOE).
3. Subject explains the key historical figures in DOE.

Course Outcomes:
1. The students understand the idea, methodology and basic tools of environmental modeling.
2. Student will be able to understand the different modeling approaches, their scope and limitations
3. Student will be able to Understand the fate and transport of pollutants
4. Student will be able to understand the wide range of applications of modelling in environmental management & decision making.

Unit I- Introduction: Water Quality, Development of Mathematical Models, Reaction Kinetics, Mass Balance, Steady state solutions, Types of loadings, Types of Reactors, incompletely mixed systems, Advection, Diffusion, Dispersion, Distributed systems (steady state and Time variable), Control Volume approach (Steady state solutions).

Unit II-: River Quality modeling: Streeter Phelps model, Fate and transport of pollutants in rivers and streams, Pulse and step inputs, transport in estuaries, Fate and transport of pollutants in lakes, step and pulse input models, Fate and transport of pollutants in subsurface systems, Step and pulse input models

Unit III- Design of experiments: Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments. Factorial Experiments: Terminology: factors, levels, interactions, treatment combination, randomization,

Unit IV- Response Surface Methodology: Two-level experimental designs for two factors and three factors. Three-level experimental designs for two factors and three factors, Factor effects, Factor interactions, Fractional factorial design, Saturated Designs, Central composite designs. Illustration through Numerical examples.

Recommended Textbooks and References:
1. Chapra S.C. (1997) Surface Water-Quality Modelling, McGraw-Hill International Edition.
2. Nirmalkhandan N. (2001) Modeling Tools for Environmental Engineers and Scientists, CRC Press, Boca Raton, Florida.
3. Schnelle K.B. and Dey P.R. (1999) Atmospheric Dispersion Modelling Compliance Guide, McGraw-Hill. 4. Thomann R.V. and Mueller J.A. (1987) Principles of Surface Water Quality Modelling and Control, Harper & Row, New York.
5. Dunnivant F.M. and Anders E. (2006) A Basic Introduction to Pollutant Fate and Transport, John Wiley & Sons, Inc., New Jersey.
6. Ramaswami A., Milford J.B. and Small M.J. (2005) Integrated Environmental Modelling, John Wiley and Sons, Inc., New Jersey.

SEMESTER THREE

No. of hours/week	Credit
2	2

SEC 03- Environment and Sustainable Development

Course Objectives:
1. Students will learn about the concepts of Sustainable Development
2. They learn about sustainable agriculture practices.
3. Students will learn about the sustainable earth economy

Course Outcomes:
1. Through this course, the students learn the importance of sustainable agriculture practices
2. The students will have the basic knowledge in understanding the influence of sustainable development processes on preparation, planning and policy implementation;
3. At the end of the course, the students will have an understanding the ethics and sustainability
4. The students will have understanding the effective management strategies of the sustainability issues.

Unit I- Sustainable Development: Definition and concepts of sustainable development – Brundtland Commission - sustainable agriculture, Economic and Ecologic aspects of sustainable development, sustainable forests and forestry, sustainable fisheries, sustainable earth economy, environmental worldviews, ethics and sustainability.

Unit II- Sustainable management: Components of Sustainability, Complexity of growth and equity, principles and practices, Sustainable management of resources**,** effective management strategies of the sustainability issues, United Nations Sustainable development goals (SDGs) and UNEP.

Unit III- Sustainable Development and International Contribution: International Summits, Conventions, Agreements, Transboundary issues, Action plan for implementing sustainable development, Global Sustainable Development, Moral obligations and Operational guidelines, sustainable development processes on preparation and planning.

Unit IV- Sustainable Development Systems on socio-economic aspect: Socio-economic policies for sustainable development, Strategies for implementing eco-development programs, Economic growth, Sustainable development through trade, Economic growth, Carrying Capacity, Public participation.

Recommended Textbooks and References:

1. Martha Honey 1999. Ecotourism and sustainable development, Island Press, Washington DC
2. Martin Mowforth and Ian Munt 1998. Tourism and sustainability, Routledge, U.K
3. Robert U Ayres, Paul M Weaver. Ecorestructuring: Implications for sustainable development. IN-05457.
4. Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF,2011.
5. R.B. Jain. Environmental Stewardship and Sustainable Development IN-04021.
6. The Sustainability Revolution: Portrait of a Paradigm Shift by Edwards, Andres R., New Society Publishers, 2005.
7. Mays, L.W. 2006. Water Resources Sustainability. The McGraw-Hill Publications

SEMESTER THREE

No. of hours/week	Credit
4	2

Practical 05- Water and Wastewater Treatment

1. Estimation of phenolic compound in the given sample
2. Determination of chloride in given water sample
3. Determination of dissolved oxygen in given water sample
4. Determination of chemical oxygen demand in given water sample
5. Determination of sulphate in given water sample
6. Determination of phosphate in given water sample
7. Determination of iron in given water sample
8. Determination of Kjeldal Nitrogen in given sample
9. Determination of oil and grease in given water sample
10. Determination of BOD in given water sample
11. Determination of sodium and potassium in given sample using flame photometer
12. Determination of residual chlorine in given sample
13. Demonstration of advanced oxidation based water treatment
14. Removal of color and odor by activated carbon
15. Removal of organic pollutants by adsorption and adsorption isotherm study

SEMESTER THREE

No. of hours/week	Credit
4	2

Practical 06- Environmental Data Modeling and Environmental Pollution

1. Sampling techniques
2. Type I & Type II Error and Standard Error
3. Chi Square Test
4. Student's t Test
5. Analysis of variance (ANOVA)
6. Regression analysis
7. Risk assessment and hazard characterization
8. Removal of colour by adsorption technique
9. Life cycle of water borne diseases
10. Simulation and water treatment techniques
11. Study on bioindicator and biosensor
12. Bio-monitoring techniques for environmental pollution
13. Soil pollution and recovery techniques
14. Noise pollution measurements
15. Air sampling and analysis of major pollutants
16. Air pollution remediation technology
    Catalytic converters
    Scrubbers
    Electrostatic precipitators
    Cyclonic separators
    Settling chambers

Semester Four

Accepts of method validation: observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with static package (Sigma STAT, SPSS for student t-test, ANOVA, etc.), hypothesis testing.

DISSERTATION

Course Type	Marks	Credits	L	T	P	C
Project	300					12

The student shall carryout, a semester long project work under the supervision/mentorship of identified guide (internal or external or both). The project work shall be compiled and submitted in the form of dissertation as per the format. The project work shall be original research work related to the programme or case studies that provide an analysis of specific research questions/socio-economic issues, etc. leading to a dissertation as partial fulfilment of the degree.

Question Paper Pattern

MODEL QUESTION PAPER **QP CODE:**

JSS Academy of Higher Education & Research, Mysuru
(Deemed to be University)
First Semester M.Sc., (Program) (RS-1) Examination - Year
Subject:

Note: *Draw neat, labeled diagrams wherever necessary.*
Your answers should be specific to the questions asked.

Time: 03 Hours **Max Marks: 70**

I. LONG ESSAYS (Answer any TWO of the following) **2x15=30 Marks**

1.
2.
3.

II. SHORT ESSAYS (Answer any FIVE of the following) **5x6=30 Marks**

4.
5.
6.
7.
8.
9.
10.

III. SHORT ANSWERS (Answer all the following) **5x2=10 Marks**

11.
12.
13.
14.
15.

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MODEL QUESTION PAPER **QP CODE:**

JSS Academy of Higher Education & Research, Mysuru

(Deemed to be University)

First Semester M.Sc., (Program) (RS-1) Examination - Year

Subject:

Note: *Draw neat, labeled diagrams wherever necessary.*

Your answers should be specific to the questions asked.

Time: 02 Hours **Max Marks: 50**

I LONG ESSAYS (Answer any TWO of the following) **2x10=20 Marks**

1.
2.
3.

II SHORT ESSAYS (Answer any FIVE of the following) **5x4=20 Marks**

4.
5.
6.
7.
8.
9.
10.

III SHORT ANSWERS (Answer all the following) **5x2=10 Marks**

11.
12.
13.
14.
15.

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