BHARATHIDASAN UNIVERSITY  **TIRUCHIRAPPALLI - 620 024.**

M.Sc. ENVIRONMENT SCIENCE: CHOICE BASED CREDIT SYSTEM - LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2022-23 onwards)

Sem.	Courses	Title	Ins. Hrs	Credit	Exams Hrs	Marks		Total
							Ext.	
I	Core Course I (CC)	Fundamentals of Ecology	6	5	3	25	75	100
	Core Course II (CC)	Environmental Microbiology and Biotechnology	6	5	3	25	75	100
	Core Choice Course I (CCC) (Any one choice)	1. Current Environmental Issues 2. Earth Science	6	5	3	25	75	100
	Core Practical I (CP)	Environmental Microbiology and Biotechnology	6	3	6	40	60	100
	Elective Course I (EC) (Any one choice)	1. Energy Resources 2. Biodiversity and Conservation	6	4	3	25	75	100
	Value Added Course I (VAC)	Vermicomposting	-	2*	3	25	75	100*
	Total		**30**	**22**	**-**	**-**	**-**	**500**
II	Core Course III (CC)	Environmental Chemistry	6	5	3	25	75	100
	Core Course IV (CC)	Environmental Remote Sensing and GIS	5	5	3	25	75	100
	Core Choice Course II (CCC) (Any one choice)	1. Energy and Green Technology 2. Eco Tourism	5	5	3	25	75	100
	Core Practical II (CP)	Environmental Chemistry	6	3	6	40	60	100
	Elective Course II (EC) (Any one choice)	1. Environmental Ethics Law and Policy 2. Bioenergy Resources	5	4	3	25	75	100
	Non-Major Elective Course I	Environment and Health	3	2	3	25	75	100
		Total	**30**	**24**	**-**	**-**	**-**	**600**

SUMMARY OF CURRICULUM STRUCTURE OF PG PROGRAMMES

Sl. No.	Types of the Courses	No. of Courses	No. of Credits	Marks
1.	Core Courses	8	40	800
2.	Core Choice Courses	3	15	300
3.	Core Practicals	3	9	300
4.	Elective Courses	3	12	300
5.	Entrepreneurship / Industry Based Course	1	5	100
6.	Project	1	5	100
7.	Non-Major Elective Courses	2	4	200
	Total	**21**	**90**	**2100**
	Value Added Courses *	2*	4*	200*

***The value added courses credit will not be included in the total CGPA.**
These courses are extra-credit courses.
Instruction hours for these courses are 30 hours.

PROGRAMME OBJECTIVES:

- To create and disseminate knowledge to the students about environmental problems at local, regional and global scale.
- To provide practical training on modern instrumentation and analytical techniques for environmental analyses.
- To sensitize students towards environmental concerns, issues, and impacts of climate change and related mitigation strategies.
- To make the students to apply their knowledge for efficient environmental decision-making, management and sustainable development.
- To prepare students for successful career in environmental departments, research institutes, industries, consultancy and NGOs, etc.

PROGRAMME OUTCOMES:

PG Graduands are **Professionally Competent** with characteristic **Knowledge-bank**, **Skill-set,Mindset** and **Pragmatic Wisdom** in their chosen fields.

- PG Graduands demonstrate the desired sense of being **Seasoned** and exhibit unequivocal Spiritedness with excellent qualities of productive contribution to **society** and **nation** in the arena Science and Technology.
- PG Graduands are mentored such that they exert **Leadership Latitude** in their chosen fields with **commitment to novelty** and **distinction**.
- PG Graduands are directed in understanding of ethical principles and responsibilities, moral and social values in day-to-day life thereby attaining **Cultural** and **Civilized** personality.
- PG Graduands of are able to **Collate** information from different kinds of sources and gain a coherent understanding of the subject.
- To understand the causes, effects and solutions for different environmental problem
- To learn various instrumentation techniques involved in environmental analysis and monitoring
- To comprehend and gain knowledge on remediation and restoration techniques for the contaminated sites

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First Year | **CORE COURSE I** | **Semester I**

FUNDAMENTALS OF ECOLOGY

Code | **(Theory)** | **Credit: 5**

COURSE OBJECTIVES:

- This course is framed in such a way that the students are exposed to the structure and function of our life-supporting environment and to understand the causes, effects and solutions for different environmental problems.

UNIT – I:

Definition, Principle, Branches and Scope of Ecology. Ecology as an inter-disciplinary science. Origin of life and speciation. Human Ecology and Settlement. Ecological Factors: Abiotic – Physical and Chemical Factors: Soil, Air, Water, Temperature, pH, Humidity, Radiation, Wind, Pressure, Precipitation. Biotic – Limiting Factors. Species Interaction: Commensalism, Amensalism, Mutualism, Competition, Parasitism, Prey–predator Relationship–Sedimentary Cycles (P, S, Fe), Gaseous Cycles (C, N, O) and Hydrological Cycle.

UNIT – II:

Population – Definition, Characteristics, Population Density, Natality, Mortality, Age Distribution, Growth Patterns, Population Fluctuation, Population Equilibrium, Biotic Potentials, Population Dispersion, meta population and Regulation of Population. Concept of 'r' and 'k' species. Keystone species - Ecological Age Pyramids. Survivorship Curves and its Types.

UNIT – III:

Community – Definition, Characteristics, Dominance, Structure, Stratification, Periodicity, Fluctuation within Community, types and interaction - predation, herbivory, parasitism and allelopathy. Biological invasions. Communal Interdependence, Eco tone, Edge Effect, Ecological Niche and Ecological Equivalents, Ecological Succession, Types, Process, Climax and Significance of Succession.

UNIT – IV:

Definition, Concept, Structure and Function of an Ecosystem: Producers, Consumers and Decomposers. Primary and Secondary Productivity. Food Chain, Food Web, Energy Flow. Ecological Pyramids – Types, Ecosystem Types: Terrestrial – Forest, Mountains, Deserts and Grassland. Aquatic – Freshwater (Lentic and lotic) and Marine (Estuary, Deep sea) – Mangroves, Corals. Ecosystem stability and factors affecting stability. Ecosystem services. Biomes: Concept, classification and distribution. Characteristics of different biomes: Tundra, Taiga, Grassland, Deciduous Forest biome, Highland Icy Alpine Biome, Chapparal, Savanna, Tropical Rain Forest.

UNIT – V:

Definition, Principle and Scope of Environmental Sciences. Earth, Man and Environment Interactions. Geographical Classification and Zones – Torrid, Temperate and Frigid Zones. Significance of Atmosphere, Lithosphere, Hydrosphere and Biosphere. Environmental Pollution: Definition and Types (Air, Water and Soil). Case Studies –

London Smog, Minamata Disease, Love Canal, Bhopal Gas Tragedy, Chernobyl Disaster. Biodiversity - Definition, Concept and Types.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Recent scenario of Air and Water pollution at national and global level – highly polluted cities. Various Ecosystems of Tamil Nadu, Threat to the coral reef, Impact of Tannery industries in and around Tiruchirappalli.

REFERENCES:

1. A Text-Book of Ecology, S. K. Dubey (2006), Dominant Publishers.
2. Ecology Principles and Applications, J. L. Chapman & M. J. Resiss (2010), Cambridge University Press.
3. Ecology, Russell (2008), Cengage Learning.
4. Elements of Ecology, Thomas M. Smith, Robert Leo Smith (2016), Pearson India Education Services.
5. Environment, Peter H. Raven, Berg, David M. Hassenzahl (2010), John Wiley & Sons.
6. Environmental Concepts, V. S. Katiyar (1997), Pointer Publishers
7. Environmental Health, Kathryn Hilgenkamp (2006), Jones & Barklet Surbury.
8. Environmental Issues and Sustainable Development, S. C.Kalwar (2002), Pointer Publishers
9. Environmental Science and Technology, Stanley E. Manahan, (2007), Lewis Publishers.
10. Environmental Science Physical Principles and Applications, Egbert Boeker & Rienkvan Grandelle (2001), John Wiley & Sons.
11. Environmental Science, Botkin, Keller (2012), John Wiley & Sons.
12. Environmental Science, G. Tyler Miller, Scott E. Spoolman (2014), Cengage Learning
13. Environmental Science, S. C. Santra (2016), New Central Book Agency Pvt. Ltd.,
14. Environmental Science, Travis Wagner & Robert Stanford (2005), John Wiley & Sons.
15. Fundamentals of Ecology, Eugene P. Odum, Gary W. Barrett (2012), Cengage Learning.
16. http://www.envfor.nic.in
17. http://www.ecology.edu

COURSE OUTCOMES:

- The learner could understand the structure and function of our life-supporting environment.
- One can understand the fundamentals of Environmental Sciences
- The student would learn the basic concepts of population and community ecology
- The student gains knowledge on the basic concepts of ecosystems and its components
- The student could have a wide knowledge regarding various types of pollution.
- One can clearly understand the concepts of food chain, food web and energy flow in an ecosystem.
- The student gets exposure regarding major case studies around the globe related to different environmental issues.
- One can clearly sum up the details regarding the causes, effects and solutions for different environmental problems.

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First Year | **CORE COURSE II** | **Semester I**

ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Code | **(Theory)** | **Credit: 5**

COURSE OBJECTIVES:

- To provide the students with an opportunity to learn about the fundamentals of microbes and environment interactions.
- To make the students to understand the biotechnological aspects of microbes in biodegradation and environmental remediation.

UNIT - I:

Structure and reproduction of microbes in general - Bacteria, Fungi, Virus, and Actinomycetes - Sterilization and microbial culture methods - Preparation of culture media - isolation and identification of microorganisms by biochemical and molecular methods - Microbial growth kinetics - Molecular methods - Nucleic acids isolation - Restriction enzymes - PCR.

UNIT - II:

Microbiology of water - Bacteriological analysis in Water - Water pollution - Eutrophication - Waterborne diseases - Sewage microbiology - Sewage treatment - Activated sludge process.

UNIT - III:

Soil Microbial Community - Microbial interactions - Biogeochemical cycles - Carbon cycle - Nitrogen cycle - Biological Nitrogen fixation, ammonification, nitrification and denitrification - Phosphorus cycle - Sulphur cycle - Role of bacteria and fungi in soil fertility.

UNIT - IV:

Biological wastewater treatment - Effluent treatment - Anaerobic digestion and biogas production - Biodegradation, Biotransformation, Mineralization, Bioremediation of Environmental Pollutants - organic pollutants and heavy metals remediation - Bio-mining.

UNIT - V:

Biodegradation and Bioconversion lignocellulose to fuels - Microbial Fuels Bioethanol, Biobutanol production, Biohydrogen production - Biodeterioration - Bio-fertilizers - Bio-pesticides, Microbial enzyme - cellulases, hemicellulases - ligninases, laccases, amylases, xylanase.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Environmental Genomics and Microbial Ecology; Genetic Exchange Gene Transfer: Replication, Transformation Transduction, Taxonomic and Functional Annotation and Quantification; Introductory Bioinformatics Data Analysis Culture Based and Culture Independent Tools Molecular Biology Tools: Cloning, Amplification, Sequencing, with a Case Study.

REFERENCES:

1. Thakur IS, (2012). Environmental Biotechnology: Basic Concepts and Applications (2nd Second Edition). I. K. International Publishing Housing, New Delhi
2. Singh DP, Singh SK and DP Dwivedi, (2005). Environmental Microbiology and Biotechnology. New Age International (P) Limited , Publishers
3. Alexander N Glazer and Hiroshi Nikaido, (2007). Microbial Biotechnology: Fundamentals of Applied Microbiology (2nd Edition)
4. Ian L Pepper, Charles P Gerba and Terry J Gentry, (2015). Environmental Microbiology (Third edition), (Eds.) C.P. Gerba, T.J. Gentry, Academic Press
5. https://en.wikipedia.org/wiki/Microbial_ecology
6. http://www.environmentalscience.org/environmental-microbiology-gis
7. http://www.greenpeace.org/australia/PageFiles/434214/GM_Fact%20Sheet_Health_%20and_Env_Impacts.pdf
8. http://enhs.umn.edu/current/5103/gm/harmful.html
9. http://igmoris.nic.in/
10. www.wastewatertreatment.co.in/index.php
11. www.microbialfuelcell.org
12. www.pollutionissues.com/A-Bo/Bioremediation.html
13. www.bioreactors.net
14. http://www.cpeo.org/techtree/ttdescript/biorec.htm
15. http://www.personal.psu.edu/jel5/biofilms/
16. www.rdp.cme.msu.edu

COURSE OUTCOMES:

- The basics of Microbiology such as the types of microbes and their classification is taught
- The identification of microbes using the basic and advanced tools is exposed to the students
- The metabolism involved in the microbial system is explained
- The remediation of pollutants by microbes is emphasized
- Steps involved in the degradation of organic compounds is also taught
- Transformation of pollutants by microbes is explained
- Application of microbes for sustainable environment is made to understand

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First Year **CORE CHOICE COURSE I** **Semester I**

1) CUREENT ENVIRONMENTAL ISSUES

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The students will be exposed to different important issues of environment and about their impact on the environment. They will be able to widen their knowledge regarding various environmental issues and could spread awareness about the same to the readers.

UNIT – I:

Water Pollution – Definition – Fresh water and Marine – Sources (Natural and Anthropogenic), Pollutants (anions, cations, microbiological, Persistant Organic Pollutants) , Effects – Control of water Pollution- Primary, secondary and Tertiary treatment – Eutrophication, Oxygen sag curve, Biomagnification - Minamata and Itai - Itai disease, Exxon Valdez and Torrey canyon oil tanker accidents.

UNIT – II:

Air Pollution – Definition, Sources (Natural and Anthropogenic), Pollutants (Particulate and gaseous) Effects – Control of Air Pollution- Electrostatic precipitator, Cyclones, Bag filter, Scrubbers – Ozone layer depletion, Acid Rain, Global warming, Greenhouse effect, Photochemical smog- Bhopal Gas Tragedy, Chernobyl Disaster.

UNIT – III:

Solid waste Pollution – Definition, Sources (Domestic, Municipal, agricultural, Commercial and Industrial), Pollutants (Organic waste, E-waste, biomedical wastes, fertilizers, pesticides) Method of disposal- Open dumping, Sanitary landfills, Incineration, Pyrolysis, Composting and Vermicomposting-Love canal episode.

UNIT – IV:

Biodiversity- Definition, types (Genetic, species) – Values of Bodiversity (Direct and indirect) loss of biodiversity –reasons, effects - Conservation of biodiversity- Insitu and exsitu, Ramsar sites in India. Forest Conservation – Chipko movement, Appiko movement, Project tiger, Project Elephant.

UNIT – V:

Thermal, Noise and Radioactive Pollution – Definition, Sources and Types of Pollutants – Effects – Fukusima Daiichi nuclear disaster,

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

United Nations SDGs – 17 goals and themes – Environmental awareness levels-1, 2, 3 and 4 – Laws and Policies for Environmental Management – EIA – Energy auditing.

REFERENCES:

1. Abbasi. S. A (1998) Environmental pollution and its control. Cogent publications (P) Limited. Delhi.
2. Andrew former (2003) Managing Environmental Pollution, Routledge Publisher, London.
3. Bhatia H.S (1998) Environmental pollution and its control, Golgotia publications (P) Limited, New Delhi.

4. Cunningham, W.P. and W.B. Saigo (2005) Environmental Science, McGraw Hill, New York.
5. Dara SS (1998) Textbook of Environmental Chemistry and pollution control, Chanthan company
6. De A.K (1987) Environmental Chemistry, Wiley Eastern Ltd,New Delhi.
7. Dr.Suresh K. Dhamaja(2005)Environmental Science andEngineering
8. Geethalakshmi V, Jagannathan R, Thavaprakash N (2007) Agroclimoitic approach to water management, Coimbatore.
9. Kannan K (1991) Fundamentals of Environmental Pollution S Chand Co, New Delhi.
10. Manahan (2000) Environmental chemistry, CRC press, U.S
11. Rao M.N and H.V.N Rao (1989) Air Pollution. Tata Mcgraw Hill Publishing Co. Ltd, New Delhi.
12. Sawyer C.N., Mc Carty P.L., and Parkin,G.F (2003) Chemistry for Environmental Engineering and Science, Tata McGraw-HillPublishing Company Ltd., New Delhi.
13. Sharma, B.K. and H.Kaur (1994) Soil and Noise Pollution, GoelPublishing House.
14. Sharma, B.K. and H.Kaur (1994) Water Pollution, Goel Publishing House.
15. https://books.google.co.in/books/about/Environmental_ Pollution.html?id= GQftLn7u8igC&redirges =y
16. https://books.google.co.in/books/about/Air_Pollution. Html?id=hDoN0SPgLksC
17. http://www.naturefirstusa.org/environmental pollution/ Environmental Pollution – Health and Toxicology – Google Books.htm#PPR11,M1
18. https://authors.library.caltech.edu/25069/1/AirPollution88.pdf
19. http://payesh.saba.org.ir/saba_content/media/image/2016/11/ 8706_orig.pdf

COURSE OUTCOMES:

On completion of this course the student will be able to

- Describe the sources and effects of various pollutants with respect to water including both fresh water and marine water.
- Review the established methods employed for controlling different types of pollution
- Assess the environmental impacts of noise, thermal and also radioactive pollution.
- Evaluate the scientific basis underlying in controlling of allpollutants and to take suitable measures for all pollution control
- Improve the knowledge on the case studies, which could highlight the real danger of pollution.
- Propose ideas to control environmental pollution with respects professionalism, ethics and moral
- Would get an awareness regarding various pollution and understand about their ill effects.
- Can really come out with research ideas to facilitate sustainability

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First Year | **CORE CHOICE COURSE I** | **Semester I**

2) EARTH SCENCE

Code | **(Theory)** | **Credit: 5**

COURSE OBJECTIVES:

This course is designed to introduce students to the "stuff" the Earth is made of (minerals, rocks and associated materials), the significance of these materials to the understanding of the internal and external processes that shape the face of our highly dynamic planet, the many ways Earth's processes and materials affect the lives of humans and major changes that have occurred in the Earth system

UNIT – I:

Milky Way and the solar system. Modern theories on the origin of the Earth and other planetary bodies. Earths orbital parameters, Kepler's laws of planetary motion, Geological Time Scale; Space and time scales of processes in the solid Earth, atmosphere and oceans. Radioactive isotopes and their applications. Meteorites Chemical composition and the Primary differentiation of the earth.

UNIT – II:

Gross composition and physical properties of important minerals and rocks; properties and processes responsible for mineral concentrations; nature and distribution of rocks and minerals. Physiography of the Earth; weathering, erosion, transportation and deposition of Earth's material; formation of soil, sediments and sedimentary rocks; energy balance of the Earth's surface processes; physiographic features and river basins in India

UNIT – III:

Basic concepts of seismology and internal structure of the Earth. Physico-chemical and seismic properties of Earth's interior. Concepts of stress and strain.Behaviour of rocks under stress; Folds, joints and faults. Earthquakes – their causes and measurement. Interplate and intraplate seismicity.Pale magnetism, sea floor spreading and plate tectonics.

UNIT – IV:

Hypsography of the continents and ocean floor –continental shelf, slope, rise and abyssal plains. Physical and chemical properties of sea water and their spatial variations. Residence times of elements in sea water. Ocean currents, waves and tides, important current systems, thermohaline circulation and the oceanic conveyor belt. Major water masses of the world's oceans. Biological productivity in the oceans.

UNIT – V:

Properties of water; hydrological cycle; water resources and management. Energy resources, uses, degradation, alternatives and management; Ecology and biodiversity.Impact of use of energy and land on the environment.Exploitation and conservation of mineral and other natural resources.Natural hazards. Elements of Remote Sensing

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Nurture the Nature, Ecological footprints and the future of humankind, deforestation, air and water pollution, the struggle to feed a planet of billions, Melting glaciers, Earth Age.

COURSE OUTCOMES:

- Student understanding of the planet on which they live. The Earth's vital role in their lives, its contribution of a complex and in some ways fragile places that needs, first their understanding and second their care resulting from that understanding.
- Student awareness of the interconnectedness of the various topics considered during the course as systems that interact with each other to create the Earth as a system.
- Student appreciation of the contributions of science to the human knowledgebase about the Earth and its place in the cosmos.
- Student ability to apply scientific methods and skills to discover new perspectives on the Earth.

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First Year **CORE PRACTICAL I** **Semester I**

ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Code **(Practical)** **Credit: 3**

COURSE OBJECTIVES:

- To provide practical knowledge on basic environmental chemistry.
- To develop experimental skills of the students in handling microbes.
- To develop experimental skills of the students in production of microbial products for environmental applications.

EXPERIMENTS:

1. Isolation of bacterial DNA and gel electrophoresis.
2. PCR amplification of 16S Rrna gene, sequencing and identification of Bacteria.
3. Introduction to General Microbiology: Laboratory Rules, Microscopy, Sterilization, Preparation of Culture Media, Isolation of BacteriafromSoil, Isolation of fungifromSoil, Ubiquitous nature of Microorganisms.
4. Types of staining techniques: Simple staining, Gram staining, Capsularstaining and Endospore staining.
5. Demonstration of motility for bacteria by hanging drop technique
6. List of Biochemical Test: Indole production, Methyl Red, Voges Proskaeur, Citrate Utilization, Triple sugar-Iron agar, Catalase and Oxidase Test
7. Antibioticsensitivity test: Disc diffusion method
8. Enzymatic test of Milk by Methylenebluereductase.
9. Most Probable Number (MPN): Presumptive, Confirmatory and complete test
10. Identification of Fungi: Lactophenolcottonblue test
11. Molecular identification of unknownbacteria: Isolation of genomic DNA, PCR amplification of 16S Rrna and Phylogeneticanalysis of 16S r RNA.
12. Molecular identification of unknown fungi: Isolation of genomic DNA, PCR amplification of 18S Rrna and Phylogenetic analysis of 18S r RNA.

COURSE OUTCOMES:

- The students are introduced to the diversity of microbial populations in the environment
- The practical provides knowledge to the students to learn the role of microbes in the environmental processes
- The role of microbial activities in sustaining the natural ecosystem and environmental quality is also understood from the practical
- Techniques for characterizing microorganisms and investigating microbial processes is also provided.

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First Year **ELECTIVE COURSE I** **Semester I**

1) ENERGY RESOURCES

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The students will be exposed to different types of energy resources and also the global energy budget. Also, they will be able to widen their knowledge in different types of wastes material from which energy can be derived and the energy patterns in India and world.

UNIT - I:

Sources and Categories, Current Status of Exploitation viz. Coal, Petroleum, Natural Gas, Nuclear Fuel with Reference to India and global scenario – Fossil Fuel Uses – Energy Production Consequence on Environment – Hubbert's Peak curve

UNIT - II:

Sun as Source of Energy, Nature of its Radiation, Heat Budget of Earth, Earth's Temperature and Atmosphere Current Status of Usage viz. Introduction to Solar energy harnessing systems – Flat plate collectors – thermal and Photovoltaic – Wind- Wind Power, Harnessing of Wind Energy, Power Generation – Wind Mills, Wind Energy Potential in India.

UNIT - III:

Tidal – OTEC – Geothermal – Sources – Crust, High Temperature Aquifers, Low Temperature Aquifers, Reserves; Harnessing of Geothermal Energy – Problems and Prospects; Geothermal Energy Prospect in India – Hydel Energy – Principles of Generation of Hydroelectric Power – micro-Hydel Power Plants

UNIT - IV:

Biomass Composition and Types; Conversion Processes – Pyrolysis, Gasification and Liquefaction; Energy Plantation; Biogas – Production and Uses – Types of Biogas Plants – Environmental Constraints; Microbial fuel cells.

UNIT - V:

Energy Use Pattern in India and in Different Parts of the World– Conventional (Coal, Oil and Natural Gas) and Non-conventional Energy Resources (Solar, Wind, Geothermal, Hydel) and their Impacts on Environment.

UNIT - VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Biomass conversion technologies – energy from waste – Briquetting – Pedal power devices – Urjagram – Energy Villages

REFERENCE BOOKS:

1. Advances in Solar Energy Technology, Garg, H.P.(1990), D. Reid Publishing Company, Tokyo.
2. Alternative liquid fuels, Desai, A.V. (1990), New Age International (p) Ltd.,
3. Biomass for Energy in the Developing Countries, Current Roles, Potential, Problems, Prospects, D.O. Hall, G.W. Barnard, and P.A. Moss (1982), Pergamon Press Ltd.,
4. Biomass- Regenerable Energy, D.O. Hall & R.P. Overend (1987), John Wiley.
5. Biotechnology and Oother Alternative Technologies, Chakraverty, A. (1998.). Oxford and IBH Publishing Co. Pvt. Ltd.,
6. Critical Reflections on Nuclear and Renewable Energy, Way Kuo (2014), Scrivener Publishers Wiley.
7. Non-Conventional Energy Sources, Rai, G.D. (2001), Khanna Publishers, New Delhi.
8. Renewable Energy Sources & Conversion Technology, Bansal
9. N. K., Kleemann M. & Michael, Meliss., (1990), Tata Mc Graw Hill Publishing Company.
10. Renewable Energy Sources, Mathur A. N. &Rathore N. S (1992), Bohra Ganesh Publications.
11. Solar Energy, Sukhatme, S.P. (1996), Tata Mc Graw Hill Publishing Company.
12. Wind Energy Conversion Systems, FrerisL. L. (1990) Prentice Hall.
13. http://www.ener-supply.eu/downloads/ENER_handbook_ en.pdf
14. http://bieap.gov.in/Pdf/Nonconventionalenergysourses.pdf

COURSE OUTCOMES:

- The course content introduces the concept of non-renewable energy resources and its scenario in India and at global level
- The concept of Renewable energy resources and in particular about the solar and wind power is explained.
- The course explains the other sources of energy.
- The biogas generation and the biogas plants involved were explained clearly
- Various Microbial fuel cells were also explained.
- The energy usage pattern of the world and India was highlighted in a planned manner
- The student would understand the importance of Energy resources in a systematic way.

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First Year **ELECTIVE COURSE I** **Semester I**

2) BIODIVERSITY AND CONSERVATION

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

This course deals with biodiversity conservation which is a major domain of Environmental Science. The student further learns about the different aspects of diversified ecosystem, its deterioration, conservation and management strategies to be adopted in changingglobal scenario.

UNIT - I:

Definition and scope of biodiversity–Composition and Scales of Biodiversity: Types of Biodiversity: Genetic Diversity, Species Diversity, Ecosystem Diversity, Landscape/ Pattern Diversity, Agricultural biodiversity and Urban Biodiversity.

UNIT - II:

Biogeographical Classification in India. Status of Biodiversity – Global, National and Local Status. Species Inventory, Hot-spots of Biodiversity. Endangered and Threatened Species. Bioprospecting,IUCN Categories – Red Data Book.

UNIT - III:

Indirect/ Non-consumptive use value -Tangible Benefits- Food, Fiber, Fodder, Timber, Rattans and Canes, Ornamentals, Medicines and Construction Material. Intangibles- Pollination, Pest Control, Soil Development and Maintenance of Soil Fertility, Soil and Water Conservation, Biogeochemical cycles- Anthropocentrism, Biocentrism, Ecocentrism and Religions; Intellectual Values. Uses of Microbes

UNIT - IV:

Habitat Alteration, Invasive Species, Pollution, Population Explosion, and Overexploitation of Bioresources- Factors causing loss of Genetic diversity- loss of Species diversity- Processes Responsible for Species Extinction Current and Future Extinction Rates, IUCN Threatened Categories, Sixth Extinction/Biological Crisis. Loss of Ecosystem diversity- Factors affecting ecosystem diversity, Loss diversity of major ecosystem of the world-Loss of Agrobiodiversity-Projected scenario for biodiversity.

UNIT - V:

Conservation and Management, Protection of Natural Habitats, National and International Protected Area, Current Practices in Conservation - In *Situ* Conservation and *Ex Situ* Conservation of Threatened Species - Cryopreservation, Gene Banks, Gene Pool and Species Conservation. National Parks and Sanctuaries. Top-down and bottom-up protocols for Conservation, The Biological Diversity Act, 2002, Biological Diversity Rules, 2004 – Patent Act - Intellectual Property Rights (IPR). Biodiversity Bill 2002, Agenda 21, Multilateral Treaties, Biodiversity Conventions.

UNIT - VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

For an assessment of biodiversity, a field visit to BDU campus. Field visit to Butterfly Conservation Park. An observation visits to Pachamalai area, Trichy. To study about marine bio-resources (MFR) Mukum.

REFERENCES:

1. Biodiversity and Human Health, Aguirre, A. Alonso (2009), Eco Health, 6 (1), 153-156.
2. Ecology: from Individuals to Ecosystems, Begon M, Townsend CR & Harper JL (2006), John Wiley and Sons.
3. Ecology, Environmental and Resource Conservation, Singh JS, Singh SP and SR Gupta (2008), Anamaya Publishers, India
4. Ecology and Field Biology, Smith R and Smith RM (2000), 6^{th} ed., Prentice Hall.
5. Global Biodiversity – Status of the Earths Living Resources, Brian Groombridge (1992) Chapman & Hall, London.
6. Ecology of Natural Resources, Ferancois Ramade (1991), John Wiley.
7. Biodiversity, Science and Development, Francesco dicastri (1996), Backhuys Publishers, The Netherlands.
8. The Biology of Biodiversity, Kato, M (1999), Springer Verlag, Tokyo.
9. Biodiversity Conservation – In Managed Forest and Protected Areas, Kotwal, P.C. and S. Banerjee (2002). Agrobios, India.
10. Global Biodiversity, Sinha, R. K (1997), INA Shree Publishers, Jaipur.
11. Mega diversity Conservation, Flora, Fauna and Medicinal Plants of India's Hot Spots, Chaudhuri, A. B. and D. D. Sarkar (2003), Daya Publishing House, Delhi.
12. Conservation of Biodiversity and Natural Resources. Singh, M.P., B.S. Singh and Soma S. Dey (2004), Daya Publishing House, Delhi.
13. Biodiversity – Strategies for Conservation, Dadhich L. K. and A.P. Sharma (2002), APH Publishing Corporation, New Delhi.
14. Global Biodiversity – Conservation Measure, Khan, T. I and Dhari N Al Ajmi (1999), Pointer Publishers, Jaipur.
15. An Advanced Textbook on Biodiversity – Principles and Practice, Krishnamurthy, K.V (2003). Oxford and IBH Publishing, New Delhi.
16. Fundamentals of Conservation Biology, Malcolm L. Hunter, Jr. (2002), Blackwell Science.
17. Biodiversity and Ecosystem functioning, Michael Lotaceer, Shaheed Naeen& P. Inchausti (2002). Oxford Press.
18. Environmental Biodiversity, P. R. Yadhav, Shudrata. R. Mishra (2004), Discovery Publishers.
19. Valuation and Conservation of Biodiverstiy, M. Markassen, R. Buse& H. Garrelts (2005), Springer.
20. Biodiverstiy, Supriyo Chakraburty (2007), Pointer Publishers.
21. Global Biodiversity and Environmental Conservation, T. I. Khanz (2000) Oxford Press.
22. www.biodiversityofindia.org
23. www.edu.green.teri.res.in
24. www.intelwl.org
25. www.glems.com

COURSE OUTCOMES:

On completion of this course the student will be able to

- Understand the types of biodiversity
- Interpret the economic values of biodiversity
- Obtain the knowledge of sustainable ecosystem
- Understand the various rules at National and International level for Biodiversity Conservation
- List out the threats available to Biodiversity
- Know about the importance and significance of hot spots
- List down the endemic, endangered, Extinct species

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First Year	VALUE ADDED COURSE I VERMICOMPOSTING	Semester I
Code	(Theory)	Credit: 2

COURSE OBJECTIVES:

The main scope of this course is to introduce the different types of earthworms and their features. The types, advantages and limitations of the vermicomposting technology is also elaborated. Further the learner could understand the process which could be done at different scales.

UNIT – I:

Earthworms – classification, ecological types, internal and external features, life cycle, Morphology, Physiology, Reproduction, breeding.

UNIT – II:

Physical, chemical and biological properties of soil ecosystem– Nutrient cycling – Ecological function of soil biota – Population, influence of environmental factors, indicators of soil quality. Soil biodiversity.

UNIT – III:

Vermiculture, principle, vermicomposting process – Physical and chemical factors, types (Windrows – batch, continuous flow – wedge system – bed and bin system – reactor system) Enzyme activity. Advantages & limitations.

UNIT – IV:

Composting and Vermicomposting of different wastes – Animal waste, industrial waste, municipal solid waste, aquatic weed, sewage sludge, agricultural waste. Small Scale Earthworm farming for home gardens – Earthworm compost for home gardens. Conventional commercial composting – Earthworm Composting larger scale – Earthworm Farming (Vermiculture), vermicomposting harvest and processing.

UNIT – V:

Micro and macro nutrients – Vermiwash – Organic agriculture – Cultivation of vegetables, cereals, fruits – Economics – World & Indian scenario.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Organic agriculture – benefits – panchakavya and Jeevamirtham – Manural value of vermicompost.

REFERENCE BOOKS:

1. A text book of soil analysis. Baruah, T.C and Barthakur, H.P, (1997). Vikas publishing house Pvt. New Delhi.
2. Earthworm vermiculture and vermicomposting. Bhatnagar, R.K and Palta.R, (1996). Kalyani Publishers, Ludhiana, India.
3. Role of Earthworms in Agriculture, Bhatt J.V. & S.R. Khambata (1959). Indian Council of Agricultural Research, New Delhi

4. Vermins and Vermicomposting. Dash, M.C., B.K. Senapati, P.C. Mishra (1980) Proceedings of the National Seminar on Organic Waste Utilization and Vermicomposting Dec. 5-8, 1984, (Part B), School of Life Sciences, Sambalpur University, JyotiVihar, Orissa.
5. Biology and ecology of earthworms. Edwards C.A, and Bohlen, P.J. (1996). Chapman and Hall, London.
6. Vermicology – biology of earthworm. Ismail S.A (1997).Orient Longman Ltd. Chennai, India.
7. Earthworm for Gardeners and Fisherman Kevin, A and K.E. Lee, (1989). (CSIRO, Australia, Division of Soils)
8. Earthworms: Their ecology and Relationship with Soils and Land Use, Lee, K.E. (1985). Academic Press, Sydney.
9. Earthworm Biology, Wallwork, J.A. (1983). Edward Arnold (Publishers) Ltd. London.
10. https://byjus.com/biology/vermicomposting/
11. https://www.vedantu.com/biology/what-is-vermicomposting
12. https://gardeningtips.in/vermicomposting-process-steps-pit-method-bed-method-diagram-and-pdf
13. https://static.vikaspedia.in/media/files_en/agriculture/farm-based-enterprises/vermicompost-production-and-practices.pdf

COURSE OUTCOMES:

- Students residing in cities can produce vermicompost in small scale for garden/household plants.
- They can get the jobs in educational institutes as vermicompost/vermiculture technician.
- The candidate can generate income by supplying verms, vermiwash, & vermicompost.

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First Year	CORE COURSE III ENVIRONMENTAL CHEMISTRY	Semester II
Code	(Theory)	Credit: 5

COURSE OBJECTIVES:

Environmental Chemistry is important to study the chemicals and chemical processes within the air, water, and soil ecosystems. It also involves the source, route, transformation and the effects of the chemicals on various ecosystems.

UNIT – I:

Concept and Scope of Environmental Chemistry, Elements and compounds – Atomic structure, their properties, electronic configuration, types of chemical bonds (ionic, covalent, coordinate and hydrogen bonds). Formation of Molecules, Molecular Weight, Equivalent Weight, Strength of the Solution – Molality, Molarity, Normality, Valency and Oxidation State, Oxidation and Reduction Reactions, Metals and Nonmetals, Aromatic and Aliphatic Compounds, Saturated and Unsaturated Hydrocarbons, Radio nuclides, polarity of the functional groups.

UNIT – II:

Stochiometry, Chemical equilibrium, Gibbs energy, Chemical Potential, Acids, bases & salts, Acid-Base Reactions, Ph & Poh, Ionic Product of Water, Common Ion Effect, Buffer Solutions, solutes & solvents; Solubility& Solubility Product, Hydrolysis, Oxidation & Reduction, Chemical Speciation. Exothermic & endothermic reactions, spontaneous & nonspontaneous reactions.

UNIT – III:

Chemistry of water, Water Quality Parameters – Physical, Chemical and Biological Properties of Water and their Environmental Significance, Distribution of Chemical Species in Water; Gases, Organic Matter and Humic Matter in Water. Heavy metals, metal solubility, Complexation and chelation in Natural and Waste Water, Role of Microorganisms in Aquatic Chemical Reactions. Water Resources, Hydrological Cycle, drinking water quality standards; Water pollution; Classification of water pollutants, Groundwater pollution, Sources and sinks, Eutrophication.

UNIT – IV:

Structure and Composition of Atmosphere, Classification of Elements, Particulate Matter, Ions and Radicals in the Atmosphere. Chemical and Photochemical Reactions in the Atmosphere – Formation of Smog, PAN, aerosols; chemistry of Acid Rain, reactions of NO2 and SO2. Oxygen and Ozone Chemistry, ozone layer depletion, role of CFCs in ozone depletion, Green House Gases and Global Warming. Temperature Inversion – Climatic Factors, Topographic Factors, Meteorological Parameters – Humidity, Wind Direction, Wind Speed and Temperature.

UNIT – V:

Soil Profile, Soil Horizons, Physical, Chemical and Biological Characteristics of soil, Nature of Soil, Soil Structure and Texture. Soil Macro and Micro Nutrients, Soil Water, Soil Air, Soil Temperature, Soil Organic Matter. Soil Colloids, Ion Exchange Capacity. Inorganic& organic components of soil, anion &cation exchange reactions in soil, nitrogen pathways & NPK in soils.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Ocean microplastics contamination, Arsenic sensing & removal strategies, Toxins in fracking fluid.

REFERENCE BOOKS:

1. Basic Concept of Environmental Chemistry, Des W. Connell (2005), Taylor & Francis
2. Chemisity for Environmental Engineering, C. N. Sawyer & P.
3. L. McCarty (1990), McGraw Hill Kogakusha Ltd.
4. Environmental Chemistry with Green Chemistry. Asim K. Das & Mahua Das (2012), Books & Allied Pvt. Ltd.
5. Environmental Chemistry, A.K. De (2010), New Age International Pvt. Ltd.
6. Environmental Chemistry, B.K. Sharma & H.Kaur (1995), Goel Publishing House
7. Environmental Chemistry, Colin Baird & Michael Cann (2008),
8. W.H. Freman & Co.
9. EnvironmentalChemistry,PeterO'Neil,(2004),BlackieAcademic&Professional
10. EnvironmentalChemistry,StanleyE.Manahan(1999),CRCPress
11. EnvironmentalScience&Technology,StanleyE.Manahan(2007), Tailor&Francis,CRCPress
12. http://base.dnsgb.com.ua/files/book/Agriculture/Soil/The-Chemistry-of-Soils.pdf
13. http://www.ncert.nic.in/ncerts/l/kech101.pdf
14. https://www.khanacademy.org/science/chemistry
15. https://ocw.mit.edu/courses/chemistry/5-60-thermodynamics-kinetics-spring-2008/lecture-notes/
16. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-84j-atmospheric-chemistry-fall-2013/lecture-notes/
17. https://ocw.mit.edu/courses/civil-and-environmental-engineering/1-89-environmental-microbiology-fall-2004/lecture-notes/

COURSE OUTCOMES:

On successful completion of the course the student will be able to:

- Understand and apply fundamental concepts of chemistry
- Demonstrate knowledge of chemical principles of various fundamental environmental phenomena and processes in land,water, and air
- Gain understanding of chemical methods employed for environmental problem solving
- Discuss local and global environmental issues based on the knowledge gained
- Accurately portray, explain and interpret data calculation and present environmental scientific ideas and practices in writing
- Effectively understand and convey scientific material from peer-reviewed sources
- Conduct an individual research project within the university or at other appropriate setting
- Acquire broad knowledge of the field of environmental chemistry

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First Year **CORE COURSE IV** **Semester II**

ENVIRONMENTAL REMOTE SENSING AND GIS

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

This course provides an immense introduction regarding remote sensing and GIS along with the scope to explore, identify, and analyse the natural resources and present environment. It also helps to document the changes in natural environment such as land, soil, water, forests, mountainside.

UNIT – I:

Definition and Fundamental Concepts of Remote Sensing-A Historic Perspective – Indian Remote Sensing Programme-Sun and Atmospheric Source of EM Radiations for RS – Physics of Remote Sensing–Electromagnetic Radiation and its Interaction with Atmosphere –Spectral Reflectance of Earth Materials and Vegetations–Concepts of Signature.

UNIT – II:

Remote Sensing Platforms-Aerial Photographs – Classification of Remote Sensors: Active and Passive Sensors – Selection of Sensor Parameter – Spatial Resolution – Spectral Resolution –Radiometric Resolution – Temporal Resolution – Data Products – formats – Various Satellites in Orbits and their Sensors – Types of Orbits – Orbital Perturbations–The Space Craft.

UNIT-III:

Types of Maps – Map Reading and Scale – Map Projection – Basics and Fundamentals of Satellite Image Interpretation – Types of Image interpretation – Techniques of visual and digital image interpretation Techniques – Image Rectification and Restoration – Multispectral data analysis – Overview of image processing and image classification methods for feature extraction – Classification Accuracy Assessment.

UNIT-IV:

Introduction of GIS – definition – Concept and components of GIS – Fundamental operations – An overview of existing GIS software's –Global positioning system and its applications**.** Types of data representation – Data input and output – Data model – Data entry – Data analysis and modeling – spatial data infrastructure – Coordinate geometry procedure – Manual digitizing – Scanning – Raster and vector data conversion – File management – Spatial data analysis – Data manipulations – Integrated analysis of spatial, spectral and attribute data.

UNIT-V:

Ecosystem Studies – Environmental Impact Assessment – Land Use / Land Cover Change detection – Climate change its impact – Natural resource Management – Pollution Mapping- forest management – Prevention of forest fire – Disaster mitigation and management. Site selection for industrial location – Waste disposal

– Dumping site selection – Composting yard – hazardous, biomedical and radioactive waste disposal / dumping sites – Health Management – Wet land management – Coastal zone management.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Discussion about Indian History of remote sensing. Web visualization practice of NASA and its activities. Specific discussion on climate for-casting sensors. Mini project on identification of polluted zones/ oxas.

REFERENCE BOOKS:

1. Principles of Geographical Information System, Burrough P.H and Mc Donnelli (1998), Oxford University Press.
2. Fundamentals of Remote Sensing (2nd edition), George Joseph (2008), Universities press, Hyderabad.
3. Remote Sensing and Image Interpretation, Lillie's T. M. and Kiefer R.W (2003), John Wiley and Sons.
4. Physical Principles of Remote sensing (3rd edition), Rees W.G (2013), Scott polar, Research Institute, University of Cambridge, New York.
5. Geographic Information Systems, David Martin (2013), Routledge.
6. GIS for Natural Resources and Disaster Management, Kumaraswamy K (2009) ,Dept. of Geography, Bharathidasan University,
7. Remote Sensing of Environment, Liws.J.Simornet (1994),Addison Wesley Publishing, Company.
8. Geographic information Systems – A Management Perspective,Stan Aronoff (1989) ,WDL Publications.
9. Fundamentals of Geographic Information Systems (3rd edition), Michael N. Demers (2008) , John Wiley & Sons.
10. www.isro.org
11. www.nrsc.gov.in
12. www.sac.gov.in
13. www.esri.com
14. www.erdas.com
15. www.ittvis.com
16. www.terraseer.com

COURSE OUTCOMES:

On completion of course, students will be able to

- Understand the concept of remote sensing technique
- Obtain knowledge about functional analysis of remote sensingtechnology
- Understand the data integration in GIS platform
- Identify the value and truthfulness of remote sensing data
- Elaborate the need of remote sensing for sustainable development by proper planning

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First Year **CORE COURSE CHOICE II** **Semester II**

1) ENERGY AND GREEN TECHNOLOGY

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To study the energy and its effects.
- To understand the concepts of green technology composite on environment.
- To study ecological economics and green energy management.

UNIT – I:

Types of energy: oil, natural gas, coal, solar, wind, their merits and demerits, (effect of price controls, cost benefit) and environmental perspectives – Renewable and non-renewable energy – The McCkelvey classification of energy resources. Commercial and non-commercial energy economic issues

UNIT – II:

New Energy Materials: Carbon nano-tubes (CNTs) and multiwall carbon nanotubes (MWCNTs) methods of production, properties and its utility in energy devices. Recent advances in new energy materials, concepts of Green Composites: Low Energy Approaches to Water Management. Management of Solid Wastes and Sewage.Urban Environment and Green Buildings.

UNIT – III:

Approaches from ecological economics; indicators of sustainability; ecosystem services and their sustainable use; bio-diversity; Indian perspective; alternate theories. Environmental reporting and ISO 14001; climate change business and ISO 14064; green financing; financial initiative by UNEP; green techniques and methods, green energy management.

UNIT – IV:

Criteria for choosing appropriate green energy technologies, life cycle cost; the emerging trends –process/product innovation; Eco/green technologies for addressing the problems of water, energy, health, agriculture and biodiversity- WEHAB (eco-restoration/ phyto-remediation, ecological sanitation, renewable energy technologies, industrial ecology, agro ecology and other appropriate green technologies); design for sustainability (4Ds).

UNIT – V:

The inseparable linkages of life supporting systems, biodiversity and ecosystem services and their implications for sustainable development; future energy Systems- clean/green energy technologies; International agreements/conventions on energy and sustainability – United Nations Framework Convention on Climate Change (UNFCCC).

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Technology transfers from lab to land-Patenting, Marketing, Promoting and Sustaining-Case studies**.**

REFERENCES:

1. Climate Responsive Architecture, (2001). Tata Mc Graw Hill
2. Loulou Richard, Waaub Jean-Philippe, Zaccour Georges, (2005), Energy and Environment Set: Mathematics of Decision Making, XVIII, 282 p. ISBN: 978-0-387-25351-0
3. EH Thorndike, (2000). Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 8 [4] Energy & Environment: A Primer for Scientists and Engineers, Addison-Wesley Publishing Company.
4. Ristinen, Robert A Kraushaar, Jack JA Kraushaar, Jack P Ristinen, Robert A, (2006). Energy and the Environment, 2nd Edition, John Wiley, ISBN:9780471172482; Publisher: Wiley, Location: New York
5. Markus TA and Morris EN, (1980). Buildings Climate and Energy. Pitman, London, ArvindKishan et al (Ed)
6. Michael F, (2009). Ashby Materials and the Environment, Elsevier
7. Nick Hanely, Jason F Shogren and Ben White, (2001). "Introduction to Environmental Economics", Oxford University Press.Chapter 14
8. Osman Attmann, (2010). Green Architecture Advanced Technologies and Materials. McGraw Hill
9. Parry C Field, (2001). Natural Resource Economics, Mcraw Hill. Chapters 10 & 11
10. Wilson, R. & Jones, W. J., Energy, Ecology and the Environment, Academic Press Inc.

COURSE OUTCOMES:

- Students to gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centers and various agencies.
- The knowledge pertaining to management should also help students to be able to build up a strongest work within the industry

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First Year **CORE COURSE CHOICE II** **Semester II**

2) ECO TOURISM

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

This course introduces the students to the economic, cultural and environmental impacts of ecotourism. The students will also be aware of the different Eco tourist spots and its activities. They will be also prepared to analyse and understand ecotourism as a significant aspect of tourism in future.

UNIT – I:

Concepts of Tourism – Classification of Tourism – Religious – Cultural – Heritage – Monumental – Adventure – Mass – Sustainable – Consumptive and Non-Consumptive Tourism. Introduction to Ecotourism – Concepts, History and Origin, Objectives and Benefits of Ecotourism – Factors affecting Ecotourism.

UNIT – II:

Places of interests of Ecotourism – Ecocircuit of the Eastern and Western Ghats (India) – Infrastructural Facilities for Ecotourism – Maintenance of Ecological Centers – Important Biosphere Reserves. Target group of Ecotourism

UNIT – III:

Types of Ecotourism – Rain forest – Mountain, Polar, Islands and Coasts – Wilderness – Total Quality Management (TQM) of Ecotourism Resorts, Knowledge, skills, attitude and commitment of ecotourism service providers. Biodiversity Conservation and Sustainable Ecotourism, Community Based Tourism for Conservation and Development. Conservation – *In situ* and *Ex situ* (Sanctuaries, National Parks, Gene Banks, Seed Banks, Ova Bank).

UNIT – IV:

Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities – Socio-cultural Impacts – Ecotourism related organization – Ecotourism Research- Disasters and Ecotourism – Role of ethics in ecotourism – Advantages and Limitations of Ecotourism – Eco-branding, Green washing and Eco-labeling of Ecotourism Products – Marketing of Ecotourism, Ecotourism and Sustainable Development – Management Issues in Ecotourism, Ecotourism based/related employment, Scope and areas of employment.

UNIT – V:

Case Study – Parambikulam Tiger Reserve, Kaziranga National Park, Ecotourism spots in Tamil Nadu (Ooty, Kodaikanal, Elagiri, Yerkaud). A World Heritage Site in Assam,Ecotourism in Bagalkot District, Karnataka, The Kabini River Lodge. Gender and Sustainable Development in Mountains in Garhwal Himalaya, Fambonglho Wildlife Sanctuary, Sikkim– Ecotourism Potential in Tripura, North East India.Role of NGO's in Ecotourism and capacity building.Ecotourism and Community Development: Case Studies from Hainan, China.

UNIT-VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Virtual ecotourism, *Leishmaniasis* transmission in an ecotourism area of Brazil. SWOT analysis of Ecotourism.

REFERENCES:

1. Case studies in ecotourism, Buckley, R. (2003), Cambridge: CABI.
2. Ecotourism and sustainable Development, N. Mukherjee (2008). Cybetech Publications
3. Ecotourism Impacts, Potentials and Possibilities, Wearing and Neil (2000), Oxford: Butterworth & Heinemann.
4. Ecotourism, Page, S.J. and R.K. Dowling. (2002). New York: Prentice Hall.
5. Ecotourism, Weaver, D. (2001). Milton: John Wiley & Sons
6. Ecotourism. An Introduction, Fennell A David. (2003), Routledge, London and New York.
7. Ecotourism: a guide for planners and managers, Lindberg, K. and D.E. Hawkins. (eds). (1993), North Benninton: The Ecotourism Society.
8. Ecotourism: Management and Assessment, Diamantis, D. (2004), London: Thomson.
9. Encyclopedia of Ecotourism, Volume I, II and III, Sinha, P.C (2003), Anmol Publications Pvt. Ltd.,
10. Environmental impacts of ecotourism, Buckley, R. ed. (2004), Oxfordshire: CABI.
11. Facing the wild: ecotourism, conservation, and animal encounters, Bulbeck, C. (2005), London: Earthscan.
12. Global Ecotourism, Prabhas Chandra (2003), Kaniskha Publishers
13. The Encyclopedia of Ecotourism, Weaver, D. B. (2001), CABI.
14. Tourism, ecotourism, and protected areas. Ceballos Lascurain,
15. H. (1996), Gland: IUCN
16. http://www.vecotourism.org/news/category/internet-technology/
17. https://parasitesandvectors.biomedcentral.com/articles/10.1186/ 1756-3305-6-325
18. http://media.unwto.org/press-release/2013-01-03/un-general- assembly-ecotourism-key-eradicating-poverty-and-protecting- envir
19. http://sdt.unwto.org/content/ecotourism-and-protected-areas
20. http://tourism.gov.in/eco-tourism

COURSE OUTCOMES:

The student studying this course would be able to

- Understand the basic principles and practices of eco-tourism
- Understand the importance of ecotourism.
- Describe the link between ecotourism and reduction in poverty levels.
- Explain the human factors that have an impact on ecotourism.
- Describe how environmental protection can lead to poverty reduction.
- Share this topic with other people to get them involved, and to be aware of the benefits of ecotourism
- Participate in a discussion on ecotourism.
- Explain how the environmental programs can have a positive impact on tourist spots.

First Year **CORE PRACTICAL II** **Semester II**

ENVIRONMENTAL CHEMISTRY

Code **(Practical)** **Credit: 3**

COURSE OBJECTIVES:

The course enables the students to know the basic concepts of Environmental chemistry in terms of Strength of the solution, Standardization, Primary and Secondary standards. This course also enables the students to learn the importance and influenceof abiotic and biotic factors on the living organisms.

EXPERIMENTS:

1. Preparation of Normal Solutions, Molar Solutions, Primary Standard Solutions and Secondary Standard Solutions
2. Titrimetric analysis:
   - (i) Conductometric titration:
     - a) Strong acid Vs Strong base – HCl Vs NaOH
     - b) Weak acid Vs Strong Base – CH3COOH Vs NaOH
   - (ii) Complexometric titration:
     - a) Standardization of EDTA solution
     - b) Estimation of total hardness
   - (iii) Volumetric titration:
     - a) Standardization of Sodium thiosulphate solution
     - b) Estimation of Dissolved Oxygen
3. Determination of heavy metal by colorimetric method
   - a) Development of standard solution and preparation of standard graph:
     - (ii) Cr6+ (ii) Fe3+

COURSE OUTCOMES:

On completion of the course, the students will be able to

- Understand and apply fundamental concepts of chemistry
- Display technical competence in basic chemistry; specifically collect, accurately record, interpret and draw conclusions from scientific data
- Design and carry out scientific experiments as well as accurately record and analyze the results of such experiments

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First Year **ELECTIVE COURSE II** **Semester II**

1) ENVIRONMENTAL ETHICS LAW AND POLICY

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To learn the basic concepts of constitutional frame work of India with emphasis to Environmental protection
- To understand the pollution control laws in India with respect air, water soil, wildlife and biodiversity
- To develop and understanding about the powers of Government and Judiciary in Environmental Protection

UNIT – I:

Environment and Constitution of India – Environmental Legislature Machinery – Constitutional Status of Environment – Duty to Protect Environment – Role of Public Interest Litigation in Environmental Protection – Constitutional Justification – Ethics - Concepts - Ethical theories - consequential theory - deontological theory - virtue ethics - situation ethics - feminist ethics.

UNIT – II:

Laws on Water Pollution Control – Powers of Central and State Pollution Control Boards – Prevention and Control of Water Pollution – Judicial Restraint Order – Closure or Stoppage of Water and Electricity Supply – Citizen Suit Provision – Power of Central Government to Supersede the Central Board – Power of State Government to Supersede the State Board.

UNIT – III:

Laws on Air Pollution Control – Powers and Functions of Boards – Air Pollution Control Areas –Prohibition of Emissions of Air Pollutants – Judicial Restraint Order – Citizen Suit Provision – Offenses and Penalties.

UNIT – IV:

Legal Protection of Forests and Wild Life – The Forest Act 1927 – Constitutional Status – The Forest (Conservation) Act 1980 Application of Act to Union Territories – Hunting of Wild Animals – Sanctuaries or National Parks – Prohibition of Trade or Commerce in Wild Animals, Animal Articles – Offences and Penalties. Biodiversity Act and Rules.

UNIT – V:

Environment (Protection) Act 1986 – Powers of Central Government – Legal Regulation of Hazardous Substances – Hazardous Wastes (Management and Handling) Rules 1989 – The Natural Environment Tribunal Act 1995 – Legal Measures to Control Noise Pollution. EIA 1994 and 2006.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Discussion of prevention control and abatement of Environmental pollution, Brain storming on natural resources conservation and the Judicial response towards Environmental Protection

REFERENCES:

1. Gurdip Singh, (2005). Environmental law in India, Macmillan India Ltd, New Delhi
2. Mohammad Naseem (2011) Environmental Law in India. Wolters Kluwer, The Netherlands
3. Shyam Divan and Armin Rosencranz (2001) Environmental Law and Policy in India: Cases, Materials, and Statutes , Oxford University Press
4. Singh RB and Mishra (1996) Environmental law in India – Issues and Responses Concept Publishing, New, Delhi
5. Tiwar AK (2006) Environmental law in India, Deep & Deep Publishing, New, Delhi
6. https://www.coursera.org/learn/environmental-law
7. https://www.esf.edu
8. https://indianlegalsolution.com
9. https://www.mondaq.com
10. http://www.envis.harayana.gov.in

COURSE OUTCOMES:

- Be familiar with the laws, policies in the field of Environment
- Require the skills needed for interpreting laws, policies and judicial decisions in a holistic approach
- Acquire the ability to evaluate the role of laws and policies in conservation and Management of natural resources and prevention of pollution
- Students will be able to understand the ethical values and to follow it in the practices

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First Year **ELECTIVE COURSE II** **Semester II**

2) BIOENERGY RESOURSES

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The students will be exposed to different types of energy resources and also the global energy budget. Also they will be able to widen their knowledge in different types of wastes material from which energy can be derived and the energy patterns in India and world.

UNIT - I:

Energy needs of India-Classification of energy resources-Definition of Bioenergy-sources- types of bio energy- properties of bio energy- traditional and modern methods of preparing bio fuel- bio energy consumption patterns - Use of bio energy sector wise in developing countries especially India.

UNIT - II:

Fuel wood- charcoal- bio ethanol- MSW-biodiesel- oil seeds- algae- molasses-bagasse- pellets- liquid bio fuels- Bio-mass and bio-gas: principles of bio-conversion, bio-gas digesters types, gas yield, and combustion characteristics, fermentation and wet processes, applications-utilization for cooking

UNIT - III:

Technologies used in the preparation of biofuel -Traditional biomass - modern biomass - advanced biofuel - biomass storage - bio energy supply

UNIT - IV:

Pollution and Environmental impacts of bio energy-land - water- air-climate benefits- ecosystem services -Energy balance and life- cycle analysis of biofuel production- merits and demerits of bio energy consumption

UNIT - V:

Bio fuel application- alternative energies- restriction on the use of bio fuel due to human health and concern of environment- basic economics of bio fuels conversion- socio economic impacts of bio energy -government initiatives and role to improve the use of bioenergy.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Improved Biomass Energy Technologies – Benefits and Challenges – The Kenya Ceramic Jiko – Smokeless chulhas – Bagasse-based co-generation

REFERENCE BOOKS:

1. Twidell J, Weir T (2015); Renewable Energy Resources, Routledge

2. Sorensen B. (2010); Renewable Energy, Fourth Edition, Academic press
3. Introduction to Bioenergy (Energy and the Environment) by Vaughn C. Nelson (Author), Kenneth L. Starcher (Author)
4. Biomass to Biofuels by Anju Dahiya
5. Principles and Applications by Yebo Li and Samir Kumar Khanal
6. Bioenergy by Judy D. Wall and Caroline S. Harwood
7. Bioenergy: Sustainable Perspectives by Ted Weyland
8. Monica EK; Goran Gellerstedt; Gunnar Henriksson 2007 Wood Chemistry and Wood Biotechnology.
9. Anaerobic Biotechnology for Bioenergy Production: Principles and Applications. Samir K. Khanal. Wiley-Blackwell Publishing (2008).
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11. Energy and the Environment, 2nd Edition, John Wiley, 2006, ISBN: 9780471172482; Authors: Ristinen, Robert A. Kraushaar, Jack J. A Kraushaar, Jack P. Ristinen, Robert A., Publisher: Wiley, New York, 2006.
12. Energy and the Challenge of Sustainability, World Energy assessment, UNDP, N York, 2000.
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COURSE OUTCOMES:

- On completion of the course the student will be able to:
- List and generally explain the main sources of energy and their primary applications in the developing countries.
- Describe the challenges and problems associated with the use of various bio energy sources, with regard to future supply and the environment.
- Discuss remedies/potential solutions to the supply and environmental issues associated with bio energy resources.
- List and describe the primary bio renewable energy resources and technologies.
- Understand energy demands and make comparisons among bio energy uses, resources, and technologies.
- Collect and organize information on renewable energy technologies as a basis for further analysis and evaluation.

First Year **NON-MAJOR ELECTIVE COURSE I** **Semester II**

ENVIRONMENT AND HEALTH

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

- This course focuses on the protection of human health from biological, chemical, and physical hazards in the environment.
- Its graduates are scientists, professionals, and leaders capable of identifying and measuring stressors of environmental concern; evaluating the health, environmental, and all other impacts of such stressors; developing means for their effective management; and evaluating alternative policies directed at improving and protecting health and the environment.

UNIT - I:

Ecosystems and natural balance – biodiversity, importance and threats – Population and Growth trends- Urbanization - Carrying capacity - Animal and Human Population - Food insecurity and Famine – Health related issues - Environmental risk evaluation and evaluation and management: an overview.

UNIT – II:

Indoor air pollution – Out door air pollution- Toxic chemicals in air: SO_2, NO_x, H_2S, CO, Particulate matter, Ozone, Hydrocarbons, Dioxins and Heavy metals (Pb) – effect on human health – Breathing impairment – lung damage – COPD – and Industrial technologies (use of non-biodegradable materials like plastics, aerosols, refrigerants, pesticides); Burning of Fossil fuels, automobile emissions and Acid rain.

UNIT - III

Persistent organic pollutants (POP's)- Water borne infections (Salmonellosis, Cholera, Shigellosis) heavy metal related diseases (Cd-Itai-Itai, Hg-Minamata, Pb-Neurotoxin) – organochlorines (DDT, BHC, Endosulphan) – Bioaccumulation of DDT in food chain – organophosphates (Malathion) – Radioactive materials – cancer

UNIT – IV:

Environmental factors – Malaria, Chikungunya, Dengue fever, Lymphatic filariasis, schistosomiasis, leishmaniasis, Ascarisis, Guinea worm disease, Natural disasters – Increase in the incidence of diseases – Climate Change and Implications on Health.

Unit – V:

Occupational environment-Physical, Chemical and Biological hazards; Occupational Pneumoconiosis: Asbestosis, Anthracosis, Bagassosis, Byssinosis, Silicosis – Preventive measures – Occupational Health and Safety Management Systems (OHSAS 18001)

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment Only):

Food Protection and Safety, Occupational Health, Principles of Environmental Health Administration, Case study topic: Mercury and Public Health, Case Study topic: Radiation from Cell Phones and Brain Cancer.

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3. Botkin and Keller, (1998) Environmental Science: Earth as a Living Planet. John Wiley & Sons
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7. Newman, M.C, Lawrence, C.A., and Unger. M.A., (2002) Ecotoxicology: Fundamentals of Ecotoxicology, 2nd Ed., CRC Press. Boca Raton. Florida.
8. Park and Park, (1985). Social and preventive medicine. East west publications. New Delhi
9. Robert H.Friis.(2007). Essentials of Environmental Health. Jones and Bartlett Pub. London.
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11. Walker, C.H., Hopkin, S.P., Sibly, R.M., and Peakall, D.B. (2001) Principles of Ecotoxicology. 2nd Ed. Taylor & Francis, London. 36
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14. https://books.google.co.in/books?id=HB_7xIPYx9YC&printsec=frontcover#v=onepage&
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COURSE OUTCOMES:

On completion of the course the learner could be able to:

- Acquire knowledge regarding the major public health issues of populations on a social, community and global Scale.
- Understand the public health issues and concern needed to deal with the same
- Acquire knowledge about the lifestyle behaviours that promote individual and population health and well-being
- Learn about the multidisciplinary strategies and interventions in addressing public health issues.
- Acquire knowledge of planning and management in public health programs
- Understand the importance of Integrating and applying knowledge, skills, and principles for health improvement.
- Learn about the occupation-based diseases and health issues
- Acquire knowledge the vector borne diseases which is of higher importance in the present scenario

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