Semester – II			
Environmental Studies			
Code : 21UAEV21	**Hrs/ Week : 2**	**Hrs/Sem:30**	**Credits : 2**

Course Outcomes:

Upon completion of this course, the students will be able to

1 Recognize the biotic and abiotic components of ecosystem and how they function.
2 Use natural resources more efficiently and know more sustainable ways of living.
3. Acquire an attitude of concern for the environment.
4. Participate in improvement and protection of environment.
5. Manage unpredictable disasters.
6 Create awareness about environmental issues to the public.

Unit I Environment and Ecosystem

Aim and need for Environmental Awareness - Components of Environment Ecosystem - Components of Ecosystem: Abiotic and biotic factors (Producer, Consumer and Decomposer) – Food Chain, Tropic Levels - Food Web, Energy flow and Ecological pyramids

Unit II Natural Resources:

Renewable and non-renewable resources – Water Resources: Uses and Conservation of Water – Rain Water Harvesting – Forest Resources: Importance of Forests - Conservation of Forest Energy Resources: Solar Fossil Fuel – Wind – Role of individuals in the conservation of natural resources

Unit III Environmental Pollution

Pollutants – Types of pollution: Air, Water, Noise and Plastic Pollution – Causes, effects and Control measures – Global warming and Climate Change

Unit IV **Human Population and Environment**

Effect of human population on environment – Population Explosion problems related to population explosion – Involvement of population in conservation of environment – Measures adopted by the Government to control population growth – Environment and human health

Unit V **Disaster Management**

Floods–Drought–Earthquakes– Cyclones – Landslide–Tsunami–Control measures

Semester VI			
Core XII	**Ecology and Phytogeography**		
Code;18UBOC63	**hrs/week:4**	**Hrs/semester: 60**	**Credit : 4**

Vision:

- To learn about the interconnectedness of life with the environment

Mission:

- To understand the structure and function of ecosystem
- To analyze the different types of vegetation and their distribution pattern.

Course Outcome

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	reveal the range of plant diversity in terms of structure, function and their environmental relationships.	5	Un
CO-2	describe the climatic and edaphic factors and ecological succession	5	Un
CO-3	categorize the plants based on adaptation	3	An
CO-4	address the global environment crisis and the strategies applicable for environmental problem mitigation	7	Ev
CO-5	learn the global level environmental summit organized that focused for sustainable future	7	Cr
CO-6	know the importance of remote sensing in finding the current status of global health	7	Cr
CO-7	recognize the causes of environmental problems	7	Un
CO-8	discuss ecological issues and concept	5	Re

Semester VI			
Core XII	**Ecology and Phytogeography**		
Code:18UBOC63	**hrs/week:4**	**Hrs/semester: 60**	**Credit : 4**

Unit I : Introduction. Ecological factors: Climatic factor – light, temperature, wind, precipitation and humidity. Biotic factors – Interaction between plants and animals, interaction between plants growing in a community and interaction between plants and microorganisms. Edaphic factors – soil temperature, soil nutrients and soil organisms.

Unit II : Plant adaptations – morphological, anatomical and physiological adaptations of hydrophytes, xerophytes and halophytes.

Unit III : Plat communities – Characteristic features, methods of analysis- quadrats and transect methods, units of vegetation.

Unit IV : Plant succession - types, causes, processes. Hydrosere and xerosers. Climax and its concepts.

Unit V : Geographical regions of India. Vegetational types of Tamil Nadu. Structure and distribution of evergrren and deciduous forests, mangroves, scrub jungle and grassland, Endemism.

Text Books:

1. Sharma, P.D1999.*Elements of ecology*. Rastogi Publications, Shivaji Road, Meerut.
2. Shukla, R.S. and Chandal, S.S 1991. *Plant Ecology*. S, Chandal and Co. New Delhi

Books for Reference:

1. Asthana and Meera Asthana, 2001. *Environmental problems and solutions*. S.Chand and Co. Ltd., New Delhi.
2. Balasubramanian,D; C.F.a. Bryee, K.Dharmalingam, J.Green and K. Jeyaraman, 2005. *Concepts in Biotechnology*. Universities Press.
3. Dash, M.C.2001.*Fundamentals of ecology*. Tata McGraw Hill publishing Co. Ltd., New Delhi.
4. Murugesan, A.G.and Rajakumari , 2005. *Environmental Science and Biotechnology, theory and Techniques.* M.J.P. Publishers, chennai.
5. Trivedi P.R, P.L Sharma and KN Sundarshan 1994. *Natural environment and Constitution of India*, Efficient offset printers, New Delhi.
6. Tyller Miller G., 2004. *Environment Science* Thompson Brooks/Cole. Singapore.
7. Varshney C.K 1989. *Water pollution and management*, S.P. Printers, Noida.

Practical Hrs per week: 2

- Determination of soil pH (at least 3 types of soil)
- Determination of soil texture.
- Determination of soil moisture.
- Determination of soil bulk density.
- Determination of soil porosity.
- Determination of soil organic matter content.
- Estimation of dissolved O_2 in water samples.
- Estimation of BOD in water samples.
- Estimation of COD in water samples.
- Adaptation of plants- hydrophytes, xerophytes and halophytes,

Submission - Record Note Book

Books for Reference : Murugesan A.G. and Rajakumari 2005.Environmental Science andBiotechnology and Biotechnology, Theory and Techniques, MJP Publishers

SEMESTER - III			
Core XII Ecology and Conservation Biology			
Course Code: 21PBOC34	**Hrs / Week:5**	**Hrs / Semester: 75**	**Credits:4**

Objectives:

- To explore the natural capital asset, ecosystem services provided by the biodiversity and their biogeochemical intersection that shape the environment.
- To realize the current ecological threat associated with biodiversity and learn about global / national level action taken to address the issues of biodiversity.
- To understand the characteristics of community, community dynamics and development of community forest.

Course Outcomes:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	reveal the range of plant diversity in terms of structure, function and their environmental relationships.	5	Un
CO-2	describe the climatic and edaphic factors and ecological succession	5	Un
CO-3	categorize the plants based on adaptation	3	An
CO-4	address the global environment crisis and the strategies applicable for environmental problem mitigation	7	Ev
CO-5	learn the global level environmental summit organized that focused for sustainable future	7	Cr
CO-6	know the importance of remote sensing in finding the current status of global health	7	Cr
CO-7	recognize the causes of environmental problems	7	Un
CO-8	manage and conserve the biological resources	7	Cr

SEMESTER - III			
Core XII	**Ecology and Conservation Biology**		
Course Code: 21PBOC34	**Hrs / Week:5**	**Hrs / Semester: 75**	**Credits:4**

UNIT I: Plant and the environment: climatic factors - air, water and temperature; Edaphic factors - types based on texture and colour. Components of soil- soil air, soil water, pH, mineral matter, organic matter, soil profile - soil organisms - reclamation of soil erosions and conservation. Biotic Factors, positive and negative interactions. Structure and function of major ecosystems - terrestrial (Grassland, forest and desert) aquatic (pond).

UNIT II: Population structure and dynamics: Basic concepts - characteristics of population, size and density, dispersion, age structure, natality, mortality, biotic potential and life table. Population dynamics - theory of population growth, Plant population dynamics, Regulation of population growth, Evolution among population and population interaction. Ecological succession - Causes of succession, Kinds ofsuccession and process of succession. Climax concept – mono climax and poly climax theories. Adaptation of plants- hydrophytes and xerophytes

UNIT III: Environmental Management Plan (EMP), ecological indicators. Bioremediation – *in situ* and *ex situ* bioremediation: Bioremediation of - hydrocarbon, dyes, heavy metals and xenobiotics. Bio- augmentation – principles and use of enzymes. Bio-filtration – biofilters, microorganisms used and mechanism. Bioleaching - microorganisms used, leaching process, examples of bioleaching. Ecology in national affairs- carbon trading, carbon sequestration, blue carbon, climate conference, convention and summit.

UNIT IV: Conservation of biodiversity *In situ* conservation – National park, wild life sanctuaries and Biosphere reserve, afforestation, social forestry, agro forestry. *Ex situ* conservation - field gene bank, seed bank, pollen bank, tissue culture, DNA bank and cryopreservation methods. Species based approaches, Social approaches- sacred groves and sthalaviriksha. Green movements – Chipko movement and Silent valley movement.

UNIT V: Organizations associated with biodiversity management, IUCN, WWF, UNEP, NBPGR, ICAR, WHF. Biodiversity legislations – GATT, TRIPS, CITES, Wild life preservation Act (1972), Rio Summit – Agenda- 21, Convention on biological Diversity, Biodiversity**,** Act (2002). Role of indigenous people in conservation. Biopiracy, sustainable development and management of biodiversity.

Text Books:

1. Sharma, P.D. *Elements of ecology*. Meerut: Rastogi Publications. 1999.
2. Shukla, R.S. and Chandal, S.S. *Plant Ecology*. New Delhi: S. Chandal and Co.1991.

Books for Reference:

1. Asthana and Meera Asthana. *Environmental problems and solutions.* New Delhi: S.Chand and Co. Ltd., 2001.
2. Balasubramania, D., Bryee C.F.,Dharmalingam, K., Green J. and Jeyaraman K. *Concepts in Biotechnology*. Universities Press.2005.
3. Dash M. C. *Fundamentals of ecology*. New Delhi: Tata McGraw Hill publishing Co. Ltd.2001.
4. Murugesan, A.G. and Rajakumari *Environmental Science and Biotechnology, theory and Techniques.* Chennai: M.J.P. Publishers, 2005.
5. Sharma, P.D. *Elements of ecology*. Meerut: Rastogi Publications. 1999.
6. Trivedi P.R, Sharma, P.L. and Sundarshan, K. N..*Natural environment and Constitution of India.* New Delhi: Efficient offset printers. 1994.
7. Tyller Miller G. *Environment Science.* Singapore: Thompson Brooks / Cole. 2004.
8. Varshney C. K. *Water pollution and management*. Noida: S.P. Printers.1989.

Practical Hrs/week: 2

- Determination of soil pH (at least 3 types of soil)
- Determination of soil texture.
- Determination of soil moisture.
- Determination of soil bulk density.
- Determination of soil porosity.
- Determination of soil organic matter content.

- Estimation of calcium.
- Estimation of magnesium.
- Estimation of sodium.
- Estimation of potassium.
- Estimation of nitrogen.
- Adaptation of plants- hydrophytes, xerophytes and halophytes,
- India map showing grass land, forest and desert.
- India map showing hotspots
- India map showing Biosphere reserves.
- Endangered / Endemic plants lists and photos (any2).

Scientific visits: Visit to any nearby place to observe the ecosystem their communities and their succession.

Submission - Record note book.

Book for Reference:

1. Murugesan A.G. and Rajakumari *Environmental Science and Biotechnology Theory and Techniques.* Chennai: MJP Publishers.2005.

SEMESTER I			
Elective I : Environmental Biology and Resource Management			
Code: 17PZOE11	**Hrs / Week:6**	**Hrs/Sem :90**	**Credits : 5**

Objectives

- To create environmental awareness among students.
- To inculcate knowledge about the natural resources, their conservation and efforts towards their sustainability.
- To generate concepts of prediction, prospecting, promotion, preservation and vision about restoration and resuscitation of dwindling natural resources.

Unit I **Environment and Social Issues**

From unsustainable to sustainable development - environmental ethics, issues - possible solutions – urban problems related to energy - consumerism and waste products - climate change - global warming – ozone depletion - acid rain.

Unit II **Human Population & Environment**

Population growth – population explosion – family welfare programmes - environment and human health – human rights – value education – women and child welfare – Role of IT in environmental and human health.

Unit III **Natural Resources**

a. Forest resources: Use and over exploitation- deforestation- timber extraction- mining- dams and forests – tribes.

b. Water resources: Use and over exploitation of ground water – surface water – conflicts over water- dams - benefits and problems -Conservation of water.

c. Land resources: Land as a resource- land degradation- soil erosion and desertification -Conservation of soil

d. Energy resources: Growing energy needs – renewable and non-renewable energy sources – use of alternate energy source.

Unit IV **Biodiversity and Conservation**

Biodiversity – values of biodiversity - threats to biodiversity, *in-situ* conservation, *ex –situ* conservation- role of individual in conservation of natural resources - role of organizations - NB PGR, BSI, ZSI, WWF, IUCN and Convention on Biological diversity - Ramsar Convention, National Action Plan on Conservation of Biodiversity. Environmental Protection Act (1986) – Forest Conservation Act (1980).

Unit V **Disaster Management**

Flood warning system - earthquakes, droughts, famines and heat waves – cyclone - wild fires – land slide – Disaster Management Information System (DMIS) – A guideline for disaster management.

Books for Reference

1. DhulasiBrindha, V. 2004. Environmental Studies. Allied Publishers Pvt. Ltd., New Delhi.
2. Veer BalaRastogi and M.S. Jayaraj. 2009. Animal Ecology and Distribution of Animals KedarnathRamnath, Meerut – Delhi.
3. Agarwal, A.C. 1999. Environmental Biology, Agro Botanical, Bikaner.
4. Anjaneyalu, Y.B. 2004. Introduction to Environmental Science, SPBS. Publications. Hyderabad.
5. Kormondy Edward J. 1994. Concepts of Ecology - Prentice Hall of India, Pvt. Ltd.
6. Odum, E.P. 1983. Basic Ecology - CBS College Publishing, Saunder.
7. Anubhakaushik and C.P. Kaushik. 2007. Environmental Science & Engineering, Newage International (p) Publishers. New Delhi.
8. Ravikrishnan, A. 2010. Environmental Science & Engineering. Sri Krishna Publications, Chennai.
9. Saha, T.K. 2008. Ecology & Environmental Biology, Books and Allied (P) Ltd.

SEMESTER – IV			
Core – XIII- Environmental Microbiology			
Course Code :21PMIC41	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 4**

Objectives:

1. To provide the learners with the best learning experience in Microbiology by providing standard education and enabling the students to become entrepreneurs and socially responsible.
2. Developing young students with active and creative minds in the field of microbiology enabling the students to become entrepreneur by applying the microbial technology.
3. Motivating learners to contribute to sustainable development of nation through environmental protection and social responsibility.

Course Outcome:

CO.No	**Upon completion of this course, students will be able to**	**PSO addressed**	**CL**
CO-1	recall the ecological groups of microbes	1	Re,
CO -2	have knowledge about the interaction between microbes and organisms at other tropic level.	1,2	Un, An
CO-3	interpret the microbiology of sewage and its treatment	2,3	Co
CO-4	explain about aero microbiology and microbial ecology	2	Un, An
CO-5	acquire basic knowledge about water purification	2	Ap
CO-6	gets knowledge about biogeochemical cycles	2,4	Co
CO-7	understanding about biodegradation.	2	Sy
CO-8	develop the application of biodegradation and bioremediation.	5	Ap, Cr

SEMESTER – IV			
Core – XIII- Environmental Microbiology			
Course Code :21PMIC41	**Hrs/ Week: 4**	**Hrs/ Sem: 60**	**Credit: 4**

Unit I: Microbial Ecology

Interaction between abiotic and biotic factors in an ecosystem, ecological niche, limiting factor, concept of community, fluctuation and succession. Basic concept of food chain, food web and energy flow. Microbial symbiosis: commensalism, mutualism, parasitism and predation with examples.

Unit II: Biogeochemical cycles

Types of biogeochemical cycles: Water cycle, gaseous cycle (Oxygen, Carbon & Nitrogen), and sedimentary cycles (Sulphur & Phosphorus). Biogeochemical cycles of micronutrients.

Unit III: Aerobiology

Air space in different layers of atmosphere, bioaerosol, assessment of air quality - sedimentation, impaction impingement, suction, and filtration. Brief account of transmission of airborne microbes (Bacteria, Virus & Fungi). Microbiology of indoor and outdoor. Allergy: causes and tests for detection of allergy.

Unit IV: Aquatic Microbiology

The aquatic ecosystem (Pond)– factors governing micro flora and their distribution in natural water. Water pollution and its sources. Role of organic pollutants in water, concepts of C-BOD, N-BOD & COD. Treatment of waste water by aerobic and anaerobic processes (like trickling filter, activated sludge, oxidative pond, anaerobic digestion and chemical disinfection).

Unit V: Advancement in Bioremediation

Concept, principle and mechanism of bioremediation, factors affecting bioremediation, types of bioremediation. Bioremediation of metals with examples. Biodegradation and biotransformation of xenbiotics including pesticides, chlorinated and nitrated aromatic compounds, phenolic compounds and polycyclic aromatic compounds.

Books for Reference:

1. Atlas,R.M and Bartha.M. *Microbial Ecology –Fundamentals and applications.* California: *Benjamin – Cummings*, Mento Park, 2003.
2. SubbaRao, N.S. *Soil Microorganisms and Plant growth*. NewDelhi Oxford and IBH Publishing Co, Pvt. Ltd, 3rdEdition, 1995.
3. Gupta,S.K. *Approaches and trends in plant disease management*. India: Scientificpublishers.Jodhpur, 5th Edition, 2014.
4. Jammaluddin et al. . *Microbes and sustainable plant productivity* India*:* Jodhpur: Scientific Publishers,. 3rdEdition, 2013.
5. G.Purohit, S.S.Kothari,P.R.andMathur. *Basic and Agricultural Biotechnology*, India: Agrobotanical Publishers Bikaner. 1993.
6. Prescott, L.M., Harley, J.P. and Helin, D.A.. *Microbiology*, , New York. McGraw Hill, 5th Edition, 2008.
7. Schlegal, H.G.. *General Microbiology*, Cambridge: Cambridge Univeristy. 7th edition, 1995.
8. Prabhakaran, G. *Introduction to Soil and Agricultural Microbiology, New Delhi:* Himalaya Publishing House. 2004.
9. George N. Agrios.. *Plant Pathology*. Academic Press. 5th Edition. 2005
10. Raina M. Maier, Ian A. Pepper and Charles Gerba. *Environmental Microbiology*. Academic Press. 2nd edition. 2009.
11. Dubey, R.C. and Maheswari, D.K.. *A text book of Microbiology*, NewDelhi: S. Chand and Company Ltd, 2013.
12. Shiva Aithal, C. *Mordern approaches in Soil,Agricultural and Environmental Microbiology*. NewDelhi: Himalaya Publishers. 2010.
13. Madigan, M.T., Martinka, M., Parker, J. and Brock, T.D.. *Biology Microorganisms*, NewDelhi: Prentice Hall, 12th Edition, 2000.
14. Pelczar, M.J., Schan, E.C. and Kreig, N.R. *Microbiology – An application based approach*, NewDelhi: Tata McGraw Hill Publishing Company Limited, 5th Edition, 2010.

SEMESTER- III			
CORE – VII AGRICULTURAL AND ENVIRONMENTAL MICROBIOLOGY			
Code:17PMIC31	**HRS/WEEK: 6**	**HRS/SEM: 90**	**CREDITS: 5**

OBJECTIVES

1. To inculcate the knowledge on interaction between microbes and environment.
2. To impart advanced information in Agricultural Microbiology.

UNIT I :

Based on oxygen requirement, nutrition, temperature, habitat (soil, water & air). Physio-chemical properties of soil -Rhizosphere and rhizoplane organisms. Mineralization and Immobilization. Biogeochemical cycling: Carbon, Nitrogen, Phosphorus & Sulphur.

UNIT II :

Microbial analysis of drinking water: Tests for coliforms (presumptive, confirmed and completed tests). Purification of water: Sedimentation, Filtration (slow and rapid sand filters) and Disinfection. Aeromicrobiology – Phylloplane microflora (morphological, physiological characters: nutrition, radiation, relative humidity and temperature) – Air Pollution – aerosol, droplet nuclei and infectious dust. Examination of air microflora.

UNIT III :

Nature of sewage and its composition. Physical, chemical and biological properties of sewage (BOD, COD etc). Sewage systems and types. Sewage Treatment: Single Dwelling Unit, municipal sewage treatment – primary, secondary and tertiary treatments (Trickling filters, Activated sludge process, Oxidation lagoons and Imhoff tank).

UNIT – IV

Biological Nitrogen fixation- The range of nitrogen fixing organisms- mechanism of nitrogen fixation (biochemistry of nitrogenase) - genetics of nitrogen-fixation - Rhizobium-Legume Association - N_2 fixation by non-leguminous plants.

UNIT – V

Microbial products and plant health: PGPR (plant growth promoting rhizobacteria) - significance of mycorrhizae - Role of biofertilizers and biopesticides- Biofertilizers- (*Rhizobium*, *Azospirillum*, *Azotobacter*, *Cyanobacteria*, *Phosphobacteria and Azolla*)- Inoculants, mass production and method of application and its Quality Control (BIS specification).

REFERENCE BOOKS:

1. Shiva Aithal, C. (2010). Mordern approaches in Soil,Agricultural and Environmental Microbiology. Himalaya Publishers, New Delhi.
2. Atlas,R.M., and Bartha.M. (2003). Microbial Ecology –Fundamentals and applications. Benjamin – Cummings, Mento Park, California.
3. Martin Alexander (1983).Introduction to Soil Microbiology, Wiley eastern Ltd., NewDelhi.
4. SubbaRao,N.S.(1997). Biofertilizers in Agriculture and Forestry III Ed,Oxford and IBH Publishing Co, Pvt. Ltd, NewDelhi.

5. SubbaRao,N.S.(1995). Soil Microorganisms and Plant growth. Ed,Oxford and IBH Publishing Co, Pvt. Ltd, NewDelhi
6. Wheeler, B.E. (1976). An introduction to Plant disease. ELBS and John Wiley and sons, Ltd.
7. Rangaswamy.g., and Bagyaraj.D.J. (1996). Agricultural Microbiology. Prentice-Hall of India Pvt Ltd., New Delhi.
8. Dirk, J. Elasas, V., Trevors,.T., and Wellington, E.M.H. (1997). Modern Soil Mirobiology. Marcel Dekker INC, New York, HongKong.
9. Dubey R.C. (2001).A Text Book of Biotechnology. S Chand & Co. New Delhi.
10. Gupta,S.K.(2014).Approaches and trends in plant disease management. Scientific publishers.Jodhpur,India.
11. Jammaluddin et al (2013). Microbes and sustainable plant productivity. Scientific Publishers Jodhpur,India,G.
12. Purohit, S.S.Kothari,P.R.andMathur (1993). Basic and Agricultural Biotechnology, Agrobotanical Publishers (India).Bikaner.

Semester – IV			
Core - XVII	**ENVIRONMENTAL ECONOMICS**		
Course Code: 21PECC 42	**Hrs/Week: 6**	**Hrs/ Semester: 90**	**Credits: 4**

Objectives:

- To understand the role of economics in environmental issues and in the formation of environmental policy.
- To express an informed view on the role, contribution, and limitations of economic tools in providing policy guidance on environmental issues.
- To provide the students with a thorough knowledge and understanding of the foundations of environment economics.

Course Outcome:

CO. No	Upon Completion of this course, students will be Able to	PSO addressed	CL
CO - 1	apply microeconomic theory to the study of environmental issues.	2	Ap
CO - 2	identify and critically evaluate alternative environmental policy instruments.	3	Kn
CO - 3	develop written and verbal skills in communicating an environmental economic perspective.	5	Le
CO - 4	enhance the student's ability to conduct professional economic research and to develop and present professional proposals, papers, and presentations	4	Le
CO - 5	increase the student's ability to analyze environmental policies through a deeper understanding of economic behavior and incentives	8	Un
CO - 6	analyze the environmental policy practices in the real world using economics methods and tools.	5	Kn
CO - 7	demonstrate the ability to model environmental policy issues using fundamental environmental and economics skills.	6	Un
CO - 8	engage in self-directed research and learning about environmental economics.	7	Kn

Semester – IV			
Core -XVII	**ENVIRONMENTAL ECONOMICS**		
Course Code: 21PECC42	**Hrs/Week: 6**	**Hrs/ Semester: 90**	**Credits: 4**

.

UNIT-I: Introduction **20Hrs**

Meaning of Environment - Environmental Economics - Nature & Scope - significance - fundamentals of Environmental Economics - Importance of Environmental Economics-Functions and Objectives-Role of economic environment-Environmental economics issues

UNIT-II: Theory of Environmental Economics **15Hrs**

Basic theory of Environmental Economics - Environmental quality as a public good - forms of environmental quality-– Environmental issues- Natural Resource of Environmental Economics -Conservation of Natural Resources.

UNIT-III: Environmental Education **15Hrs**

Environmental Education -Environmental awareness - Education through Environmental movements - Environmental Education and Training Program-Environmental education grants – Environmental Internships and fellowships-Environmental education awards

UNIT-IV: Environmental Pollution **20Hrs**

Environmental Pollution –Types of Pollution (Air, Water, *Land*, Noise, Indoor and Nuclear) - Forest and Environmental quality - urbanization and its impact on environment - population and environmental quality - pollution control and Environmental protection- Environmental Problems.

UNIT-V: Economics of Solid Waste Management **20Hrs**

Define Solid Waste Management – Types and impacts- - Solid Waste Disposal and Management- Methods of Solid Waste Disposal and Management- Methods of Solid Waste Management- Categories of Waste- recycling and reuse of solid waste management.

Text book:

S. Sankaran. *Environmental Economics.* Chennai: Margham Publications, 2nd edition 2013

Reference Books :

1. M. Karpagam.*Environmental Economics.* New Delhi : Sung Publication Pvt.Ltd,2nd edition2011
2. T. Eugene.*Environmental Economics.*New Delhi:Virinda Publication Pvt. Ltd, 2010
3. Dorfman, Robert and Nancy Dorfman.*Economics of Environment*. Bombay:W.W.NortoCompany 2nd edition 2000

Semester – II			
Elective II A	**Energy and Environmental Chemistry**		
Code : 19PCHE21	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Vision:

To protect and improve the environment as a valuable asset against hazardous chemicals and energy resources.

Mission:

- To learn the various types of sonochemical reactions.
- To summarise renewable and non renewable energy resources.
- To gain knowledge about Environment and its problem solving techniques.

Course outcome:

CO No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO - 1	compare heterogeneous liquid- liquid and heterogeneous solid- liquid reactions	2	An
CO - 2	distinguish between renewable and non- renewable energy resources.	5,6	An
CO - 3	explain the construction, working and applications of primary and secondary batteries.	4,8	Ap
CO - 4	classify and compare the fuels based on their appearance such as solid, liquid and gas.	7	Cr
CO - 5	demonstrate the Orsat process for flue gas analysis.	8	Ap
CO - 6	identify a catalyst used in fine chemical synthesis.	4,6	Un
CO - 7	sketch the natural cycles of environment such as the hydrological, oxygen and nitrogen cycles.	6	Cr
CO - 8	differentiate chemical and photochemical reactions occurs in atmosphere.	1,5	An

Semester – II			
Elective II A	**Energy and Environmental Chemistry**		
Code : 19PCHE21	**Hrs / Week : 4**	**Hrs / Sem : 60**	**Credits : 4**

Unit I Sonochemistry

Introduction Instrumentation (Whistle reactor, Ultrasonic cleaning bath, Direct Immersion Sonic horn, The Cup horn) Types of Sonochemical reactions - Homogeneous reaction(Strecker, Solvolysis and Hydrolysis) - Heterogeneous liquid-liquid reactions (Hydrolysis, Solvolysis, Saponification and Esterification), Heteogeneous solid-liquid reactions, Induced Organic reactions (Bouveault reactions, Cannizzaro reaction, Strecker Synthesis, Reformatsky reaction, Barbier reaction of carbonyl compounds, Dickmann reaction)

Unit II Energy resources

Introduction - classification of energy resources - Renewable - Solar energy (Solar cells, Solar batteries, Solar heat collector and Solar water heater), Wind energy (Wind mills and Wind farms), Ocean energy (Tidal energy, Ocean thermal energy and geothermal energy) and Bio mass energy (Bio fuel and Hydrogen fuel).

Non Renewable - Batteries- Construction, Working and Applications: Primary battery - Leclanche Cell, Alkaline battery, Lithium ion; Secondary battery - NICAD, Lead Acid , Nickel metal hydride cell - Fuel cell - Use of alternate energy sources – Energy Conversion process: Anaerobic digestion and bio gas.

Unit III Fuels and combustion

Introduction - Classification of fuels - Calorific values - Solid fuel - Classification of coal by rank - Metallurgical coke and its manufacture (Otto Hoffmans method) - Liquid fuel - Petroleum - synthetic petrol and its manufacture (Bergius process) - Knocking - Octane number and Cetane number. Gaseous fuel - Liquid Petroleum gas, Natural gas, Compressed natural gas - Ignition temperature - Explosive range - Analysis of flue gas (Orsat process).

Unit IV Recent developments in catalysis

Introduction - Reactions over Solid - Acid catalyst (Alkylation, Cracking & Hydrocracking, Isomerisation), Catalyst in Fine Chemical synthesis (Halogenation, Amination, Condensation, selective Oxidation reactions), Photocatalyst - Introduction - Semiconductor as photocatalyst - Water splitting by Semiconductor Particle - Photocatalysis in the removal of Organic and Inorganic pollutants - Photocatalytic reduction of Dinitrogen, Photocatalysis of Organic reactions.

Unit V Environmental chemistry

Environmental Segments - The natural cycles of environment: the hydrological, oxygen and nitrogen cycles - Chemical and Photochemical reactions in atmosphere: SO_2, O_2 and O_3

chemistry, nitrogen oxides and organic compounds - Greenhouse effect - Ozone hole - El Nino phenomenon.

Microorganisms - the catalysts of aquatic chemical reactions - Acid-base and ion exchange reactions in soil - Nitrogen pathways and NPK in soil - Waste classification and disposal - Solid waste management.

Text Books:

1. Ahluwalia V.K & Varma R.S, Alternate Energy Process in Chemical Synthesis,1st Edition,Narosa Publishing House, Delhi, 2008.
2. Jain P.C and Monika Jain, Engineering Chemistry, 15th edition, Dhanpat Rai Publishingcompany Pvt. Ltd, New Delhi, 2011.

Books for Reference:

1. B.Viswanathan, S.Sivasanker, A.V.Ramaswamy, Catalysis-Principles and Applications,Fourth edition, Narosa Publishing House, Delhi, 2011.
2. Harish Kumar Chopra, Anupama Parmar, A textbook of Engineering Chemistry, NarosaPublishing House, 1st edition, New Delhi, 2008.
3. Dr.A.Ravikrishnan, Environmental Science & Engineering, Sri Krishna High tech Publishing Company Pvt. Ltd, Eleventh edition, 2015.
4. A.K.DE, Environmental Chemistry, New age international publishers, 6th edition, 2006.

SEMESTER- IV			
Core Practical -VII – Laboratory in Environmental Microbiology, Soil and Agricultural Microbiology			
Course Code : 21PMICR7	**Hrs/week: 6**	**Hrs/Sem:90**	**Credits: 3**

Objectives:

1) To impart skill on isolation of various microbes from Environment, soil and plant.

2) To enhance advanced level laboratory training in Soil and Agricultural Microbiology and Environmental microbiology.

Course Outcome:

CO. No	Upon completion of this course, students will be able to	PSO addressed	CL
CO -1	test for isolation of various soil microbes	5	An
CO- 2	infer quantitative assay of microbes from air borne.	5	Ap
CO -3	interpret the preparation of bio fertilizer and its assay	4	Un
CO -4	experiment with isolation of microbes from various agro samples.	2	Un
CO- 5	interpret staining of VAM	5	Un
CO -6	analyse antagonism between microorganisms	2	An
CO -7	demonstrate the isolation of phosphate solubilizing bacteria and fungi	5	Un
CO- 8	identify nitrogen fixing bacteria	5	Ap

SEMESTER- IV			
Core Practical -VII – Laboratory in Environmental Microbiology, Soil and Agricultural Microbiology			
Course Code : 21PMICR7	**Hrs/week: 6**	**Hrs/Sem:90**	**Credits: 3**

1. Testing antagonistic activity of soil microorganisms.
2. Estimation of soil mineral contents a) pH b) nitrate c) nitrite d) sulphate e) phosphate.
3. Effect of high salt concentration on microbial growth.
4. Quantitative assay of microbes in Rhizosphere and phyllosphere.
5. Isolation of air borne bio-particles.
6. Determination of biological oxygen demand.
7. Determination of chemical oxygen demand.
8. Determination of Soil pH and temperature.
9. Isolation of Phosphate solubilizing bacteria & fungi
10. MPN Technique.
11. Isolation of *Rhizobium sp* from root nodules of leguminous plants.
12. Isolation of *Azotobacter sp* from soil.
13. Isolation of *Azospirillum sp* from soil.
14. Identification of Cyanobacteria from soil. (*Anabaena* and *Nostoc*).
15. Assay of bio fertilizer (Seed treatment, Seedling treatment, Soil inoculation, Measurement of root and shoot system.

Books for Reference:

1. Jyoti Saxena, Mamta Baunthiyal, Indu Ravi. *Laboratory manual for Microbiology, Biochemistry and Molecular Biology*. India: Scientific Publishers, 2012.
2. Gunasekaran. P. *Laboratory Manual in Microbiology*. New Delhi: New Age International Ltd., Publishers, 1 st edition. 2005.
3. Dubey, R.C. and Maheswari,D.K. *Practical Microbiology*. India: Chand and Company Ltd., 2 ndedition. 2002.
4. Aneja K.R. *Experiments in Microbiology, Plant Pathology and Biotechnology.* New Delhi: New Age International Publishers, 4th edition. 1993.
5. Harold J. Benson, Alfred E. Brown - *Benson's Microbiologicalapplications: Laboratory manual in General Microbiology.* International Edition, McGraw Hill Higher Education. 2006.
6. Plummer. D.T. *An Introduction to Practical Biochemistry*. NewDelhi: Tata McGraw Hill, 1998.