

**Under- Graduate Programme
in Environmental Sciences**

Courses of Study, Schemes of Examinations & Syllabi

(Choice Based Credit System)



DEPARTMENT OF ENVIRONMENTAL SCIENCES

BISHOP HEBER COLLEGE (Autonomous)

(Reaccredited with 'A' Grade (CGPA-3.58/4.0) by the NAAC &
identified as College of Excellence by the UGC)

DST-FIST Sponsored College &

DBT Star College

TIRUCHIRAPPALLI-620017

TAMIL NAU, INDIA

2017-2018

Under – Graduate Programme in Environmental Sciences

Structure of the Curriculum

Parts of the Curriculum	No. of Courses	Credits
Part – I : Language	4	12
Part – II : English	4	12
Part – III		
Major		
Core(Theory)	10	41
Core(Practical)	4	12
Elective	3	12
Allied		
Allied (Environmental Botany)	2	10
Allied (Environmental Zoology)	2	
Allied (Environmental Chemistry)	3	9
Internship	5	10
Group Project	1	5
Part – IV		
SBEC	3	6
NMEC	2	4
VLOC	1	2
Env. Studies	1	2
SBC	1	1
Part – V		
Extension Activities	1	1
Gender Studies	1	1
Total	48	140

B.Sc. Environmental Sciences – Programme Description

(For the students admitted from the year 2017 onwards)

Sem.	Part	Course	Course Code	Course Title	Pre requisites	Hrs./ week	Credits	Marks		
								CIA	ESA	Total
I	I	Tamil I /*	U15T M1L1	செய்யுள்ஓ இலக்கிய வரலாறுஓ உரைநடைஓ மொழி பயிற்சியும் படைப்பாக்கமும்		6	3	25	75	100
	II	English I	U16EGPL1	English Communication Skills -I		6	3	40	60	100
	III	Core I	U17ES101	Physical Environment		5	4	25	75	100
		Allied I	U17ESBY1	Environmental Botany		4	3	25	75	100
		Allied Prac.I	U17ESYP1	Environmental Biology Lab		3	-	-	-	-
		PS – Internship I	U17ES1F1	Explore Your Environment		2	2	--	--	100
	IV	Env. Studies	U16EST11	Environmental Studies		2	2	25	75	100
		Val. Edu.	U15VL1:1/ U15VL1:2	Value Education (RI/MI)		2	2	25	75	100
II	I	Tamil II /*	U15TM2L2	செய்யுள், இலக்கிய வரலாறு, சிறுகதைத்திரட்டு, மொழி பயிற்சி & படைப்பாக்கம்		6	3	25	75	100
	II	English II	U16EGPL2	English Communication Skills –II		6	3	40	60	100
	III	Core II	U17ES202	Ecology		5	4	25	75	100
		Core Prac. I	U17ES2P1	Ecology Lab		4	3	40	60	100
		Allied II	U17ESZY2	Environmental Zoology		4	3	25	75	100
		Allied Prac. II	U18ESZP1	Environmental Zoology Lab		3	4	40	60	100
		PS - Internship II	U17ES2F2	Ecology and Biodiversity		2	2	--	--	100
	III	I	Tamil III/*	U15TM3L3	செய்யுள் - காப்பியங்கள், இலக்கிய வரலாறு, நாவல், மொழி பயிற்சி		6	3	25	75
II		English III	U16EGNL3/ U17EGCL3	English for Competitive Examinations/ Business Communication in English		6	3	40	60	100
III		Core III	U17ES303	Environmental Microbiology and Biotechnology		5	4	25	75	100
		Core Prac. II	U17ES3P2	Environmental Microbiology and Biotechnology Lab		3	3	40	60	100
		Allied III	U17ESCY3	Allied Chemistry– I		4	3	25	75	100
		PS - Internship III	U17ES3F3	Industrial Exposure Training (IET) and Green Initiatives		2	2	--	--	100
IV		SBEC I	U17ESPS1	Environmental Education and Awareness		2	2	40	60	100
		NMEC I	U17ES3E1	Global warming and Climate Change		2	2	25	75	100

Sem.	Part	Course	Course Code	Course Title	Pre requisites	Hrs./ week	Credits	Marks		
								CIA	ESA	Total
IV	I	Tamil IV/*	U15TM4L4	செய்யுள் - நாடகம், இலக்கிய வரலாறு, மொழி பயிற்சி		5	3	25	75	100
	II	English IV	U16EGNL4	English through Literature		5	3	40	60	100
	III	Core IV	U17ES404	Environmental Pollution		4	4	25	75	100
		Core V	U17ES405	Energy Resources and Biostatistics		4	4	25	75	100
		Allied IV	U17ESCY4	Chemistry for Environmental Sciences		3	3	25	75	100
		Allied Prac. II	U17ESCP2	Allied Chemistry Practical		3	3	40	60	100
		PS - Internship IV	U17ES4F4	Industrial Practice School		2	2	-	-	100
	IV	NMEC II	U17ES4E2	Environmental Safety, Health and Management		2	2	25	75	100
		Soft Skills	U16LFS41	Life Skills		2	1	-	-	100
V	Extension Activities	U16ETA41	NSS, NCC, Rotaract, Leo club, etc.		-	1	-	-	-	
V	III	Core VI	U17ES506	Conservation Biology	U17ES202 U17ESBY1 U17ESZY2	5	5	25	75	100
		Core VII	U17ES507	Fundamentals of Environmental Engineering		5	4	25	75	100
		Core Prac. III	U17ES5P3	Water Pollution Lab		4	3	40	60	100
		Elective I	U17ES5:1	Tools and Techniques in Environmental Sciences		5	4	25	75	100
		Elective II	U17ES5:2	Environmental Safety Health and Management		5	4	25	75	100
		PS - Internship V	U17ES5F5	Environmental Monitoring and Assessment		2	2	-	-	100
	IV	SBEC II	U17ES5S2	Ecology and Biodiversity of Birds		2	2	25	75	100
		SBEC III	U17ES5S3	Waste Management		2	2	25	75	100
VI	III	Core VIII	U17ES608	Instrumental Analysis and Methods	U17ESCY3 U17ES404	5	4	25	75	100
		Core IX	U17ES609	Sustainable Development and Environmental Legislation		5	4	25	75	100
		Core X	U17ES610	Global Warming and Climate Change		5	4	25	75	100
		Core Prac. IV	U17ES6P4	Air and Soil Pollution Lab		5	3	40	60	100
		Elective III	U17ES6:3	Ecotourism		5	4	25	75	100
		Core Project	U17ES6PJ	Project Work		5	5	-	-	100
V	Gender Studies	U16GST61	Gender Studies		-	1	-	-	100	
Total							140			4600

SBEC- Skill Based Elective Course
VLOC- Value added Life Oriented Course
CIA- Continuous Internal Assessment
PS- Practice School

NMEC- Non Major Elective Course
SBC- Skill Based Course
ESA- End Semester Assessment

* Other Languages	Hindi	Sanskrit	French		Hindi	Sanskrit	French
Semester I	U14HD1L1	U14SK1L1	U14FR1L1	Semester III	U14HD3L3	U14SK3L3	U14FR3L3
Semester II	U14HD2L2	U14SK2L2	U14FR2L2	Semester IV	U14HD4L4	U14SK4L4	U14FR4L4

NMEC offered by the Department:

1. Global Warming and Climate Change - U17ES3E1
2. Environmental Safety, Health and Management - U17ES4E2

CORE I: PHYSICAL ENVIRONMENT

Semester I
Credits: 4

Code: U17ES101
Total Hrs: 75

General objectives

- To know the physical environment encompassing atmosphere, hydrosphere, lithosphere and biosphere.
- To realize the importance of interactions among various spheres and appreciate the inter- relationships among them.

Unit I

Environment: Definition and importance; Spheres of the Earth system – atmosphere, hydrosphere, biosphere, lithosphere, anthroposphere and their interrelationships; Continents and oceans; landmasses. Earth and Sun relationship: earth in the solar system, earth's planetary motions – rotation and revolution, seasonality, solstices and equinoxes.

Unit II

Atmosphere: Composition of air- Layers of Atmosphere – Radiation balance- Horizontal distribution of temperature and pressure, Global Circulation.

Unit III

Hydrosphere: Sources of water – importance of water, hydrologic cycle - Precipitation and types of precipitation, ocean currents – generation of ocean currents, types of ocean currents; Distribution of fresh water.

Unit IV

Lithosphere: Earth's crust and its composition-Internal structure of the earth- Different types of rocks- Process of soil formation.

Unit V

Biosphere: Concept and definition; Types of Biomes and their distribution. Biogeographic zones: Phytoecographic zones, Zoogeographic zones.

References

1. Botkin, D.B. and Keller, E.A., **Environmental Science: Earth as a Living Planet**, John Wiley and Sons, New Delhi, 2011.
2. Cunningham, W. P. and Saigo, B.W., **Environmental Science – A Global Concern**, Eighth Edition. WCB/McGraw Hill, New York, 2007.
3. McKinney, M.L., Schoch, R. and Yonavjak, R.M., **Environmental Science Systems and Solutions**, Jones & Bartlett Publishing Inc., Delhi, 2007.
4. Sharma, P.D., **Ecology and Environment**, Seventh Edition, Rastogi Publication, Meerut, 2004.

5. Santra, S.C., **Environmental Science**, Second Edition, New Central Book Agency (P) Ltd., Kolkata, 2010.
6. Joseph, K. and Nagendran, R., **Essentials of Environmental Studies**, Pearson Education Publisher, Delhi, 2004.
7. Purohit, S.S., Shammi, Q.J. and Agarwal, A.K., **A Textbook of Environmental Science**, Students Edition, Jodhpur, 2004.
8. Reddy, A.M., **Textbook of Environmental Science and Technology**, BSP Books Pvt. Ltd., Hyderabad, 2005.
9. Anjaneyulu, Y., **Introduction to Environmental Science**, BSP Books Pvt. Ltd., Hyderabad, 2009.
10. Lal, D.S. **Climatology**, Sharda Pustak Bhawan, Allahabad, 2003.
11. Chapin III, F.S., Matson, P.A. and Vitousek, P.M., **Principles of Terrestrial Ecosystem Ecology**, Springer, New Delhi, 2012.
12. Bloom, A.L., **Geomorphology – A Systematic Analysis of Late Cenozoic Landforms**, Third Edition, Pearson Education, Singapore, 2003.
13. Dayal, P., **A Textbook of Geomorphology**, Shukla Book Depot, Patna, 2001.
14. Singh, S., **Environmental Geography**, Prayag Pustak Bhawan, Allahabad, 2002

ALLIED I: ENVIRONMENTAL BOTANY

Semester I

Credits: 3

Code: U17ESBY1

Total Hrs: 60

General objectives

- To know about the lower group of plants and their reproduction.
- To understand the structural and functional aspects of various tissue systems and organs in plants.
- To understand the morphology and Taxonomy flowering plants and their reproductive cycle.
- To understand the various methods of plant propagation and plant pathology.
- To understand the basic physiological mechanisms of plants.

Unit I

Plant Diversity: Structure, reproduction and life cycle of Algae - *Chlamydomonos*, Fungi - *Penicillium*,

Bryophyte -*Riccia*, Pteridophyte – *Lycopodium* and Gymnosperm -*Cycas*.

Unit II

Morphology: Root, shoot system and its modification. Inflorescence – Simple and compound and Special types – one example). Flower description. Taxonomy: Nomenclature (Binomial), Systems of Classification (Bentham and Hooker), Study of following families – Annonaceae, Apocynaceae, Lamiaceae, and Poaceae.

Unit III

Anatomy: Tissue (Meristematic and Permanent), primary structures of Dicot and Monocot Stem and Root. Embryology: Structure of Anther and Ovule; Types of Pollination, Fertilization and development of Dicot Embryo.

Unit IV

Plant physiology: Absorption of water and salts. Role of mineral elements; Transpiration. Photosynthesis, Light and Dark Reactions – C₃ Cycle, Respiration – aerobic, anaerobic, Krebs cycle.

Unit V

Plant as an ecological indicator – characteristics, type and physiological changes. Plant pathology: Detailed study of the following plant diseases, symptoms, causal agents and control measures of white rust, citrus canker and tobacco Mosaic disease.

References

1. Mathawat, G.S.P., Sharma, D. and R.K. Sahni, **A text book of Botany**, Ramesh Book depot, Jaipur, 1996.
2. Mehrotra, R.S., **Plant Pathology**, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 1991.
3. Muneeswaran, A., **Allied Botany**, Titan Nooks, Madurai, India, 2004.
4. Pandey, B.P., **Economic Botany**, S. Chand and Co., New Delhi, 1999.
5. Rao, K.N. Krishnamoorthy, K. and G.S. Rao., **Ancillary Botany**, Rajalakshmi Publication, Nagercoil, 1979.
6. Verma, V., **A text book of Economic Botany**, Emkay Publications, New Delhi, 1980.

Allied Practical I: ENVIRONMENTAL BIOLOGY LAB

Semester I
Credits: 2

Code: U18ESBP1
Total Hrs: 45

General objectives

- To know about the plant diversity (lower to higher plants).
- To expertise in plant science techniques - anatomy, embryology, plant propagation, plant pathology and physiology studies.

Unit I

Plant Biodiversity: Habit, stem, root and reproductive parts of Algae- *Chlamydomonos*; Fungi – *Penicillium*; Bryophyte - *Riccia* – habit, thallus and Capsule; Pteridophyte - *Lycopodium* – habit and stem; Gymnosperm – *Cycas*.

Unit II

Taxonomy: Annonaceae – *Polyalthialongifolia*; Apocyanacea – *Vincarosea*; Lamiaceae – *Leucasaspera*; Euphorbiaceae – Poaceae – *Chloris barbata*

Unit III

Anatomy: T. S of monocot root - monocot stem - dicot stem - dicot leaf - Embryology: T. S of mature anther - Ovule L. S – Fertilization - Globular – embryo - Cordate embryo

Unit IV

Plant physiology (Demo only): Bell Jar, Thistle funnel, TA balance, Test tube funnel, Ganong light screen and respiroscope.

Unit V

Plant specimens for the ecological indicators; Plant pathology: White rust, Citrus canker and Tobacco Mosaic disease.

References

1. Chattopadhyaya, S.B., **Principles and Procedures of Plant protection**, (3rd Ed.), Oxford and IBH Publishing Cosec2 (P) Ltd., New Delhi, 1991.
2. Edmond, J.B., Musser, A.M. and Andres, F.S., **Fundamentals of Horticulture**, McGraw Hill Book Co., New Delhi, 1957.
3. Fuller, H.J. and Tippo, O., **College Botany**, Henry Holt and Co., New York, 1967.
4. Gangully, A.K., **General Botany**, The New Book Stall Calcutta, Vol I and II. Rajalakshmi Publication., Nagerkoil, 1971.
5. Kumar, N., **Introduction to Horticulture**, Rajalakshmi Publications, Nagarkoil, India, 1997.
6. Mathawat, G.S.P., Sharma, D. and R.K. Sahni, **A text book of Botany**, Ramesh Book depot, Jaipur, 1996.
7. Mehrothra, R.S., **Plant Pathology**, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 1991.

8. Muneeswaran, A., **Allied Botany**, Titan Nooks, Madurai, India, 2004.
9. Pandey, B.P., **Economic Botany**, S. Chand and Co., New Delhi, 1999.
10. Rao, K.N. Krishnamoorthy, K. and G.S. Rao., **Ancillary Botany**, Rajalakshmi Publication, Nagercoil, 1979.
11. Verma, V., **A Text Book of Economic Botany**, Emkay Publications, New Delhi, 1980.

Practice School – Internship I: EXPLORE YOUR ENVIRONMENT

Semester I
Credits: 2

Code: U17ES1F1
Total Hrs: 30

General objectives

- To learn the environmental challenges (waste water / air pollution / noise / solid wastes etc.,) in the neighboring environment.
- To understand selected ecosystems and to learn the ecological principles.

1. Know your Campus Environment (College/School campus)

Profile of the college/school and its natural resources

Service – Learning in Environment and Health

Exploring /Mapping the campus: campus layout and preparation of thematic layers

Experiential Learning in College/School campus

Assessment of Flora and Fauna

Water and wastewater audit

Energy audit

Solid waste audit

Impacts and Mitigation

2. Know your Domestic Environment

Water and energy audit

Greenery in house

Household Carbon foot print

Solid and liquid waste management practices

3. Know your Local Environment

Profile of the ward/lowest administrative unit

Mapping the ward

Water and wastewater audit

Documenting the flora and fauna

Assessment of ecological foot print

4. Observation of Micro-Meteorological Parameters

Temperature, Humidity, pressure

Wind velocity, sunshine

Ambient noise levels

5. Documenting the State of Environment through Field Work/Study:

Need for fieldwork,

Methods,

Steps involved in field study.

Report writing methods.

Preparation of State of Environment Report.

References:

1. Canter LW, **Environmental impact assessment**, McGraw Hill Book co., New York, 1977.
2. April Smith, **Campus Ecology – A Guide to assessing Environmental Quality and Creating Strategies for change**, Living Planet, Los Angeles, 1993.

3. Rao MN and Rao HVN, **Air Pollution**, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1989.
4. Cunningham AB. **Professional ethics and ethnobotanical research**. In: Alexiades M, editor. Selected guidelines for ethnobotanical research: a field manual. Bronx: New York Botanical Garden; 1996. p. 19–51.

Core – II: ECOLOGY

Semester II
Credits: 4

Code: U17ES202
Total Hrs: 75

General objectives

- To understand the ecological principles governing the environment.
- To understand and appreciate the interrelation existing between Abiotic and Biotic environment.

Unit I

Importance and scope of ecology – Ecosystem and its components – Abiotic factors – climate – temperature – light – humidity – edaphic - wind and biotic factors including biotic interactions – inter-specific and intra-specific.

Unit II

Ecosystems – Characteristics of ecosystems- Structure of the ecosystem food chain – herbivorous and detritus food chains - trophic levels; and food web - Function of ecosystem- Energy flow in an ecosystem– productivity – biogeographic cycle in an ecosystem.

Unit III

Population Ecology: Definition, Characteristics of Population: Density- Natality – Mortality – Age distribution – Growth form-Population Equilibrium – Biotic potential – Carrying capacity – Dispersal – Dispersion – Population fluctuations – Population regulation.

Unit IV

Community Ecology: Characteristics of a Community; Physical structure – structure, stratification, Biological characteristics – Species richness, Species diversity, Abundance, Dominance, Frequency, Importance value, guild, niche, Ecotone, Edge effect, Ecological equivalents, Ecotypes, and Ecophenes; Ecological succession and ecological pyramid.

Unit V

Habitat Ecology: Aquatic- **Freshwater** – lentic, lotic; **Marine** – neritic, estuarine - mangrove, intertidal, tidal flats, seagrass bed, coral bed; oceanic – pelagic, benthic; **Terrestrial** habitat - Tundra, Forest, Desert and mountain biomes.

References

1. Agarwal, K. C., **Environmental Biology**, Agro Botanica, 1999.
2. Beck, W.S., Liem, K. F. and Simpson, G. G., **Life – Introduction to Biology**, Harper Collins Publications, 1991.
3. Chapman, J. L. Reiss, M. J., **Ecology – Principles and Applications**, Cambridge University Press, 1995.
4. Dash, M. C., **Fundamentals of Ecology**, Tata McGraw-Hill Publishing Co., 2001.
5. Kormondy, E. J., **Concepts of Ecology**, Prentice Hall of India, 1996.

6. Odum, E.P., **Fundamentals of Ecology**, W.B. Saunders Co., 1971.
7. Ricklefs, R. E. And Miller, **Ecology**, W.H. Freeman and Co., 1999.
8. Raven.P.H. and Johnson, G.B., **Biology**, Wm. C. Brown Publications, 1995.
9. Smith, T.M. and Smith, R.L., **Elements of Ecology**, Pearson Education, 2007.
10. Taylor, T.J., Green, N.P.O. and Stout, G.W., **Biological Science**, Soper, R (ed.). Cambridge University Press, 1998.
11. Wallace, R.A., **Biology-The World of Life**, Harper Collins Publications, 1990.

Core Practical – I: ECOLOGY LAB

Semester II
Credits: 3

Code: U17ES2P1
Total Hrs: 60

General objectives

- To assess the biotic and abiotic factors of the environment.
- To analyse species diversity and compute biodiversity indices.

1. Study of vegetation by Quadrature method
2. Estimation of species diversity – Density, Frequency, Frequency class, Relative Frequency, Richness, abundance, Abundance class, evenness.
3. Estimation of species diversity by Shannon - Weiner diversity index method.
4. Submission of 6 herbarium sheets
5. Tree height, girth measurement
6. Insect survey – Sweep net, Shake and light trap methods
7. Insect box preparation

References

1. Daisy, A., **Butterfly of Bishop Heber College**, Heber Au Sable Institute of Environmental Studies, Trichy, ISBN 978 – 81 – 906267 – 9 – 8. 98 pages, 2010.
2. Prema Michael, **Ecological Methods for Field and Laboratory Investigations**, Tata McGraw Hill, ISBN 0074517651, 9780074517659, 1984.
3. Relton, A., **Bird of Bishop Heber College**, Heber Au Sable Institute of Environmental Studies, Trichy, ISBN 978 – 93 – 80767 – 00 – 0, 2010.
4. Shailaja Ravindranath and Sudha Premnath, **Biomass Studies – Field Methods for Monitoring Biomass**, Centre For Environmental Education, Southern Regional Cell, Bangalore, ISBN – 81 – 2-4 – 1113 – 4, 1997.
5. Trivedy and Goel, **Practical Methods in Ecology and Environmental Science**, Karad, 1986.

Allied – II: ENVIRONMENTAL ZOOLOGY

Semester II
Credits: 3

Code: U17ESZY2
Total Hrs: 60

General objectives

- To understand animal diversity, adaptation, organization and taxonomic status of invertebrates and chordates.
- To analyze the behavior of various animals.

Unit I

Kingdom Animalia: Salient features - levels of organization: cellular, tissue, organ and organ system; Classification of major Invertebrata Phyla and Phylum Chordata up to classes - General characters and diversity of Major Invertebrata Phyla and Phylum Chordata with suitable examples.

Unit II

Detailed study: Earthworm- Cockroach – Lamellidens – Starfish.

Economic importance of beneficial insects - Brief study of Vermiculture: vermicomposting and its applications.

Parasitology-Vector borne diseases –Malaria, Dengue.

Unit III

Biological significance of Migratory animals: Fishes, Birds and Mammals. Flight adaptations in vertebrates - Aquatic adaptations in birds and mammals; embryonic adaptation: Extra embryonic membrane structure in Reptiles and Birds. Adaptive radiations in chordates: Aquatic, terrestrial and arboreal. Bioindicators-microbes.

Unit IV

Animal Behaviour: Stereotyped behaviour- instincts and motivation; Acquired behaviour: Pavlovian learning, trial and error learning, reasoning and imprinting; Pheromones and behaviour: types, significance – Pheromones with reference to insects and rodents.

Unit V

Social behaviour: Birds, primates. Biological rhythms: circadian, tidal, lunar, circannual rhythms. Types of communication in animals: visual, olfactory, tactile, verbal and non-verbal- Communication in bees and birds, mimicry and animal colorations

References

1. Ayyar E.K. Ananthkrishnan, T.N., **Outlines of Zoology: Invertebrata**, Vol-I and Vol-II Viswanathan Pvt. Ltd.1993.
2. Hoshang. S, Gundevia and Hare Govind Singh, **A textbook of Animal Behaviour**, Chand & Co., 1997.
3. Shukla G.S and Upadhay V.B., **Economic Zoology**, Rastogi Publications, 2004.
4. Jordan, E.L. and Verma P.S., **Invertebrate Zoology**, 12thedn. S.Chand & Co., 1995.

5. Kotpal, R.L., Agarwal, R.P.R., Khertarpa. I., **Modern Text Book of Zoology**, Rastogi Publications, 1989.
6. Dhami, D.S and Dhami, J.K.R., **Chordate Zoology**, Chand & Co., 1978.
7. Ismail,S.A., **Vermicology: The Biology of Earthworm**, Orient Longman, London,1970.

Allied Practical – II: ENVIRONMENTAL ZOOLOGY LAB

Semester II
Credits: 2

Code: U18ESZP1
Total Hrs: 45

General objectives

- To expertise in dissection of digestive system and nervous system of Arthropoda and Annelida.
- To identify the macro and micro organisms.

1. Virtual Dissections

- Cockroach : Digestive system and Nervous system
- Earthworm : Digestive system and Nervous system

2. Mountings

- Mosquito : Mouth parts
- House fly : Mouth parts
- Earthworm : Body setae
- Shark : Placoid scale

3. Spotters

- Amoeba, Paramecium, Obelia colony, Tapeworm, Ascaris, Leech, Millipede, Centipede, Freshwater mussel, Starfish, Shark, Calotes, Pigeon, Rabbit,
- *Eudriluseugeniae*, vermicasts,
- Biological rhythms and communication in bee.

References

1. Shukla G.S and Upadhyay V.B., **Economic Zoology**, Rastogi Publications, 2004.
2. Jordan, E.L and Verma P.S., **Invertebrate Zoology**, 12thedn. S. Chand & Co., 1995

Practice School – INTERNSHIP II : ECOLOGY AND BIODIVERSITY

Semester II
Credits: 2

Code: U17ES2F2
Total Hrs:30

General objectives:

- a. To document the biodiversity, landscape, and types of forests, natural vegetation
- b. To learn the conservation practices in natural parks and sanctuaries
- c. To prepare reports on flora & fauna
- d. To identify the environmental impacts and to suggest mitigation measures

1. Ecosystem Biodiversity of India

Moist Tropical:

Wet evergreen

Semi-evergreen

Moist-deciduous

Littoral Swamp

Dry – Tropical forests

Dry deciduous

Thorn forest

Dry evergreen

2. Conservation of Biodiversity

In-situ conservation

- National Parks and Sanctuaries
- Biosphere Reserves
- Nature Reserves
- Reserved and Protected forests

Ex-situ Conservation

- Botanical gardens
- Zoological parks

3. Crop Production

Plantation Crops: Arecanut, Cocoa, Coffee, Tea and Rubber

Commercial Crops: Cotton, Sugarcane, Tobacco, Jute and allied fibres

Forest Plantation: Conifers (Pine), Wattle, Eucalyptus, Acacias and Teak

Food crops: Paddy, Wheat, Maize and Potatoes

4. Biodiversity Register

Peoples' Biodiversity register : Functions and processes

People and Natural resource links : Ecosystem Goods and Services

Peoplescape : Inventory practices, User groups and associated activities

Mapping the landscape: Participatory mapping and landscape elements types

Sketching the lifescape

Wetlands – Watersheds – Lotic and lentic, types and water harvesting.

5. Preparation of Ecology and Biodiversity report

Flora – Listing of species as Agricultural, commercial crops, Natural vegetation, Medicinal and Economically important plants

Fauna – Listing of species – Invertebrates and Vertebrates (Phylum-wise) with their Status as per International Union for Conservation of Nature (IUCN), Wildlife Protection Act (WPA) 1972, Convention on International Trade in Endangered Species (CITES)/ Conservation Status of Migratory Birds (CMS).

Identification of Environmental impacts and
Environmental Management Plan

References

- Chapman JL and Reiss MJ, **Ecology-Principles and applications**, Cambridge University Press (Low price edition), 1995.
- Gadgil M, **Peoples Biodiversity Register: A Record of India's Wealth**, Amruth Spl. Suppl., 1-16. (1996).
- MadhavGadgil, **Ecology is for the People – A Methodology Manual for People's BiodiversityRegister**, Centre for Ecological Sciences, Bangalore, 2005.

Core – III : ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY

Semester III
Credits: 4

Code: U17ES303
Total Hrs:75

General objectives

- To understand the harmful and useful role of the microbes in Sanitary Environment.
- To apply the Microbial Biotechnology as a tool for Bioremediation.

Unit I

Environmental Microbiology: History and discovery of microorganisms - Spontaneous generation - Germ Theory of disease, Immunity – chemotherapy. Prokaryotic and Eukaryotic cell structure of bacteria, virus, fungi, yeast and algae, Growth and reproduction of bacteria and virus.

Unit II

Sterilization-physical and chemical methods; Culture Techniques- Types of media; Environmental Determinants; Temperature, Radiation, Pressure, Salinity, pH and Water Activity; Microorganisms in Industry – Production of lactic acid, Amino acid, Alcohol fermentation, Penicillin Production. Microorganisms in food: milk, fruits, egg and Fish-Principles of food spoilage and food preservation; Microorganisms in sanitation.

Unit III

Microorganism in Air: Air borne Infections – Causative Microbes - Control Measures; Sick Building Syndrome; Droplet infection.

Aquatic Microbiology: Water-borne Diseases Disinfection of water for potable purposes.

Soil Microbiology: Rhizosphere and Rhizoplane Microflora – Composting

Unit IV

Environmental Biotechnology: Concept and scope of environmental biotechnology; Biofertilizers–use of Rhizobium, Azolla, Mycorrhiza; Vermiculture.

Unit V

Principles of various biotechnological methods: plasmid isolation; restriction digestion; PCR; RAPD; RFLP. Genetically Modified Crops; Genetically Engineered species and pest control; salient features of Guidelines and policy of GMOs in India

References

1. Atlas, R. M. and Bartha, R., **Microbial Ecology – Fundamentals and Applications**, Benjamin/Cummings Science Publishing, 1998.
2. Baker, K. H. and Herson, D. S., **Bioremediation**, McGraw-Hill Inc., 1994.

3. Bitton, G., **Wastewater Microbiology**, Wiley-Liss Inc., 1994.
4. Mitchel, R., (ed.) **Environmental Microbiology**, Wiley-Liss Inc., 1992.
5. Pelczar, M. J., Chan, E. C. S. and Krieg, N. R., **Microbiology – Concepts and Applications**, McGraw-Hill Book Co., 1993.
6. Murugesan, A.G. and Rajakumari, C., **Environmental Science and Biotechnology**, MJP Publishers, Chennai, 2006.
7. Scrogg, A., **Environmental Biotechnology**, Second edition, Oxford University Press, New York, 2005.
8. Gupta, P.K., **Elements of Biotechnology**, Rastogi Publications, Meerut, 2007.
9. Abbasi, S.A. and Ramasami, E., **Biotechnological Methods of Pollution Control**, University Press, Hyderabad, 1999.
10. Gupta, H.C.L., Siddiqui, A.U. and Parihar, A., **Biopest Management (Entomopathogenic Nematodes, Microbes & Bioagents)**, Agrotech Publishing Academy, Udaipur, 2010.
11. Somani, L.L., Shilpkar, P. And Shilpkar, D., **Biofertilizers – Commercial Production Technology & Quality Control**, Agrotech Publishing Academy, Udaipur, 2011.
12. Jemba, P.K., **Environmental Microbiology**, Science Publishers, New Hampshire, 2004.
13. Srivastava, M.L., **Basic Environmental Microbiology**, Manohar Books, New Delhi, 2003.
14. Raina, M., Pepper, I. and Gerba, C., **Environmental Microbiology**, Academic Press, New York, 2006.

Core Practical – III : ENVIRONMENTAL MICROBIOLOGY AND BIOTECHNOLOGY LAB

Semester III
Credits: 3

Code: U17ES3P2
Total Hrs:45

General objectives

- To learn to prepare the microbiological cultures – techniques.
 - To apply the Bioremediation and Recombinant DNA Technique in Biotechnology.
1. To show the presence of microorganisms around us
 2. Demonstration of Microscope
 3. Gram staining of bacteria
 4. Methylene blue reductase test
 5. Identification of Fungi – Lactophenol Cotton Blue Staining.
 6. Isolation of Fungi from Soils – Pour Plate method.
 7. Preparation of culture media for microorganism
 8. Isolation of Bacteria from Water/Wastewater – Serial Dilution Technique.
 9. Estimation of Coliform Group of Bacteria – MPN Technique.
 10. Demonstration of Gel Electrophoresis and PCR,

References

1. Aneja, K. R., **Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation**, Wishwa Prakashan, 1996.
2. Benson, H. J., **Microbiological Applications – Laboratory Manual in General Microbiology**, McGraw-Hill Publications, 1998.
3. Bhattacharyya, B. N., **Experiments with Microorganisms**, Emkay Publications, 1993.
4. APHA, **Standard Method for Examination of Water and Wastewater**, APHA- AWWA, WPCF, 1989.
5. APHA, **Standard Method for Examination of Water and Wastewater**, APHA –AWW, WEF, 1998.

Allied – III: ALLIED CHEMISTRY

Semester III
Credits: 3

Code: U18ESCY3
Total Hrs:60

General Objectives

1. To understand the basics of organic and inorganic chemistry.
2. To be aware of the different parameters involved in bonding and its types.
3. To understand the chemistry of hydrocarbons.

Unit – I Chemical Bonding

- 1.1 Ionic bond- Nature of Ionic bond – structure of NaCl, KCl & CsCl- Factors influencing the formation of ionic bond.
- 1.2. Covalent bond- nature of covalent bond –VSEPR theory - shapes of BeCl₂, BF₃, CH₄, PCl₅, IF₇, NH₃ & H₂O.
- 1.3 Coordinate Bond – Nature of coordinate bond, Werners' theory and structure of some complexes Ni(CO)₄, [Co(NH₃)₆]Cl₃, K₄[Fe(CN)₆]
- 1.4. Hydrogen bonding-Theory of Hydrogen bonding- one example for inter and intra molecular hydrogen bonding- consequences of hydrogen bonding.
- 1.5 van der Waals and London Dispersive forces in simple molecules.

Unit- II Chemistry of Hydrocarbons

- 2.1 Hydrocarbons: Classification- aliphatic, aromatic, saturated, unsaturated cyclic, acyclic compounds
- 2.2 Alkanes- nomenclature, isomerism, preparation, properties (halogenation, nitration, sulphonation, oxidation) and uses Alkenes-nomenclature, isomerism, preparation, properties (hydrogenation, halogenation, hydroxylation) and uses. Alkynes - nomenclature-preparation, properties (hydrogenation, halogenation, polymerization) and uses
- 2.3 Chemistry of benzene: Preparation, properties (nitration, sulphonation, oxidation , Friedel- Crafts alkylation & acylation) and uses any two methods of preparation).

Unit- III Solutions (12 hours)

- 3.1 **Mole Concept -Normality – Molarity – parts per million** - Simple problems on concentration terms
- 3.2 Primary and secondary standards and preparation of standard solutions and **simple problems**.
- 3.3 Acids and bases: Arrhenius, Lowry- Bronsted, Lewis concepts- strong and weak acids and Bases.- pH , pK_a ,pK_b, buffer solutions. Henderson – Hasselbalch equation.

Unit- IV Chemical Kinetics and Catalysis

- 4.1 Chemical kinetics: rate of reaction, order, molecularity, first order rate law, half life period and derivation of the first order equation
- 4.2 Catalysis – homogeneous and heterogeneous catalysis, intermediate complex and adsorption theories of catalysis, promoters and poisons, applications.

Unit- V Colloids

- 5.1 Colloids – Types with examples – classification based on affinity (Lyophilic & Lyophobic)

5.2 Optical and Kinetic properties of colloids – electrophoresis- electroosmosis – peptization – Coagulation
5.3 Applications of colloids

Reference Books

1. B.K. Sharma, Industrial Chemistry, Goel Publishing Co., 1997 **(Unit- III, IV, V)**
2. Puri B.R., Sharma L. R., Kalia K.K, Principles of inorganic Chemistry- (23rd edition), New Delhi, Shoban Lal Nagin Chand & Co., 1993**(Unit- I)**
3. Bahl B. S and Arun Bahl, Organic Chemistry, 12th edition, New Delhi, Sultan Chand and Co., 1997 **(Unit- II)**
4. B.R.Puri, L.R.Sharma and Madan. S. Pathania, Principles of Physical Chemistry-42nd Edition, Vishal Publishing Co., Jalandhar, 2007 **(Unit I-V)**
5. B.S. Bhal G.D. Tuli and Arun Bhal, Essentials of Physical Chemistry, S. Chand & Co., New Delhi, 2004 **(Unit- I, II)**
6. R.T. Morrison & R.N.Boyd, Study Guide to Organic Chemistry, Prentice Hall, New Delhi, 2000
7. R.L. Madan and G.D. Tuli, Inorganic Chemistry, S. Chand Co., Ltd., New Delhi,2003
8. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House, Meerut, 2000

Practice School – INTERNSHIP III: INDUSTRIAL EXPOSURE TRAINING (IET) AND GREEN INITIATIVES

Semester III
Credits: 2

Code: U17ES3F3
Total Hrs:30

General objectives:

- To enable students to have a smooth transition from academics to professional world.
- To enhance interpersonal skills, communication skills, leadership qualities etc.
- To provide a platform to learn the manufacturing processes and pollution control in various industries
- To observe the functioning of selected common treatment facilities
- To gain hands on experience in environmental monitoring.

1. Industrial Exposure Training

Apparel Industries: Tannery and Textiles units

Agro Industries

Sugar, Distillery

Pulp and Paper

Edible oil

Dairy Sago units

Cement and Thermal Power Plants

Mining activity – Limestone mining

2. Common Waste management facility – Visit/Observation

Biomedical waste, Municipal Solid waste

Sewage Treatment Plants, Effluent Treatment Plant

E Waste Management facility

Treatment processes, Recycling, Reuse and up cycling practices

3. Green Energy technologies and Green Buildings:

Sources of energy in the anthrosphere.

Green technology and energy conversion efficiency.

Energy conservation and renewable energy sources (list of sources only).

Green Composites for buildings: Concepts of Green Composites.

Water Utilization in Buildings and Low Energy Approaches to Water Management.

Management of Solid Wastes, sewage and sullage

Urban Environment and Green Buildings. Green Cover and Built Environment.

4. Environmental Monitoring Laboratories in Regulatory agencies and Industries

Pollution control Board/King Institute/ISI laboratories

Laboratory facility in industries to monitor Air (ambient and Stack), Water and wastewater and noise parameters

NABL Accredited Laboratories

References

1. Austin GT, Shreves, **Chemical processes in industries**, McGraw Hill Book Co., New York, 1977.
2. Mahajan SP, **Pollution Control in process industries**, Tata McGraw Hill Co. Ltd., New Delhi, 1986.
3. Rao MN and Datta, **Wastewater treatment**, Oxford and IBH, 1982.
4. Patnaik, P, **Handbook of Environmental Analysis – Chemical Pollutants in Air; Water; Soil and Solid wastes** –Lewis publishers, Boca Raton, 1997
5. APHA Standard Methods for the Examination of Water and Wastewater, American Water Works

- Association, 21st Edition. ISBN 0875530478, 9780875530475 APHA Publisher, 2005.
6. Saxena MM, **Environmental Analysis Water, Soil and Air**, Agro Botanical Publishers, India.
ISBN: 81-85031-22-3, 1987.

SBEC I : ENVIRONMENTAL EDUCATION AND AWARENESS

Semester III
Credits: 2

Code: U17ES3S1
Total Hrs:30

General objectives

- To understand the importance, need and methodologies of environmental education.
- To acquire skills to conduct environmental awareness programs.

Unit I

Theory: Basics of Environmental Education: Concepts, Principles and Characters of Environmental Education; Importance and history of Environmental Education; Global (UNEP, WII, CSE, IPCC, IUCN) and National (WWF- I, CPR Environmental Education Centre, Centre for Environmental Education, BVIEER) Environmental organizations – objectives and activities, Major Environmental Activism Movements – Bishnoi, Chipko & Silent Valley.

Unit II

Theory: Methodology of Environmental Education: Forms of Environmental Education – Formal, non formal; Guidelines of contents for early childhood, higher education, adult and general public; Current practices in India.

Unit III

Practice: Planning, preparation, Implementation and Evaluation of Environmental Awareness for rural school children

Unit IV

Practice: Planning, preparation, Implementation and Evaluation of Environmental Awareness for urban school / college community

Unit V

Practice: Planning, preparation, Implementation and Evaluation of Environmental Awareness for general public

References

1. Early Childhood Environmental Education Programs: Guidelines for Excellence, North American Association for Environmental Education, 2000, USA, www.naaee.org
www.eelink.net.
2. <http://envfor.nic.in/division/environmental-education-awareness-and-training-eeat>
3. http://www.moef.nic.in/sites/default/files/chap5_0.pdf
4. <http://www.yourarticlelibrary.com/environment/environmental-education-objectives-aims-and-principles-of-environmental-education/39724/>
5. <http://www.yourarticlelibrary.com/environment/organizing-environmental-education-system-formal-and-non-formal-education/28153/>

6. <http://www.yourarticlelibrary.com/essay/environment-essay/how-environmental-awareness-can-be-achieved/39725/>
7. <http://www.yourarticlelibrary.com/speech/importance-of-public-awareness-for-conservation-of-environment-in-india/30187/>
8. Joyce Meredith, **A Project of Ohio**, EE 2000: A Strategic Plan for Environmental Education in Ohio. Published by: Environmental Education Council of Ohio P.O. Box 2911 Akron, OH 44309-2911, 2000.
9. Ministry of Environment & Forests Government of India Paryavaran Bhawan Cgo Complex Lodhi Road New Delhi, 110003 National Environment Awareness Campaign. 2011-2012.
10. Nonformal Environmental Education Programs: Guidelines for Excellence. North American Association for Environmental Education. 2000 P Street, NW - Suite 540 Washington, DC 20036, USA. www.naaee.org www.eelink.net.
11. UNEP, Public Environmental Awareness and Education, 2007. [http://www.unep.org/dec/onlinemanual/Enforcement/InstitutionalFrameworks/PublicAwareness Education/tabid/99/Default.aspx?page=](http://www.unep.org/dec/onlinemanual/Enforcement/InstitutionalFrameworks/PublicAwarenessEducation/tabid/99/Default.aspx?page=)

Core IV: ENVIRONMENTAL POLLUTION

Semester IV
Credits: 4

Code: U17ES404
Total Hrs:60

General objective

- To understand the various forms of pollution their causes, effects and control.
- To acquire the knowledge of chemical reactions taking places in the environment

Unit I

Air pollution – Introduction – structure and composition of atmosphere; classification of air pollutants – primary and secondary, particulate and gaseous; Sources of air pollution - vehicular pollution; Effects of air pollution on – Man – Plants and Materials; green house effect – global warming – ozone depletion; Bhopal Gas disaster; acid rain.

Unit II

Water Pollution: Introduction – sources – point and non- point ; Oxygen demanding waste, industrial effluents and domestic sewage and its effects ; Eutrophication, Bioaccumulation, Bio- magnification Ground water – Surface water – lake water – sea water; Causes of waterborne diseases; Water Quality standards; Water treatment (Theory only) – physical, chemical and biological;

Unit III

Soil pollution: Soil texture, structure, physical, chemical and biological properties; Sources of soil pollution - Effects of soil pollution; Pesticides in soil environment and their effects; Sediments; Biological magnification, pollution through mining; Control of soil pollution.

Unit IV

Thermal pollution – Introduction; sources of thermal pollution – Nuclear power plants, Hydro electrical power plants, coal power plants; Effects of thermal pollution.

Oil pollution – sources and effects – oil pollution and marine biota; Microbial degradation of oil in the sea; flora and fauna – bio indicators to oil spill

Unit V

Noise pollution: Sources – natural and manmade; Characteristics of sound – frequency, intensity, time of exposure, Intermittence; Effects of noise pollution – Man and materials; Control of noise pollution.

References

1. De, A. K., **Environmental Chemistry**, Wiley Eastern Ltd., New Delhi, 1987.
2. Kannan, K., **Fundamentals of Environmental Pollution**, S. Chand and Co., Delhi, 1991.
3. Rao, M. N and Rao, H.V.N., **Air Pollution**, Tata McGraw HillPublishing Co. Ltd., New Delhi, 1989.
4. Sharma, B,K and Kaur, H., **Soil and Noise Pollution**, Goel Publishing House, Meerut, 1994.
5. Sharma, B,K and Kaur, H., **Water Pollution**, Goyal Publishing House, Meerut, 1994.
6. Brady, N.C. **The nature and properties of Soils**, Tenth Edition. Mac Millan Publishing Co., New York, 1990.

Core V : ENERGY RESOURCES AND BIOSTATISTICS

Semester IV
Credits: 4

Code: U17ES405
Total Hrs: 60

General objectives

- To understand the sustainable use of energy
- To know the basics of energy resources and their application
- To apply Biostatistical tools in environmental problems.

Unit I

Energy Resources: Introduction - Natural Resources – types and classifications (primary/ secondary)- Fundamentals of energy and measurements: Classification –Conventional, Non- conventional energy – Renewable, Non – renewable energy - fossil fuels :coal, oil, natural gas,– Non-fossil fuels: nuclear energy : cosmic origin - isotope of Uranium called U-235 - Indian Energy Scenario – supply, consumption and demand.

Unit II

Renewable Energy sources: Introduction - Alternative Energy Resources -Availability of Resources - Solar energy: radiation measuring instrument - Principle of photovoltaic conversion of solar energy - Application of solar energy - Wind energy: characteristics and measurement -Wind energy conversion principles -Types and classification of WECS - Biomass Energy: Classification of biomass - Physicochemical characteristics of biomass as fuel- Biomass conversion routes - Hydropower: Overview of micro,mini and small hydro system - types of hydro turbine - Ocean Energy: Principle of ocean thermal energy conversion system - Principles of Wave and Tidal energy conversion - Geothermal energy: Origin of geothermal resources - type of geothermal energy deposits - Hydrogen as a source of energy - types of fuel cell - fuel cell system.

Unit III

Statistics: Definition – Functions and Limitations of Statistics – Diagrammatic Representation of Data: Bar diagram – Pie diagram, Graphical representation of Data: Histogram, Frequency Polygon, Frequency Curve, Ogives.

Unit IV

Measures of Central Tendency: Types of Averages – Arithmetic mean, median, mode, Geometric mean. Measures of Dispersion: Range, Standard Deviation and coefficient of variation. Correlation: Karl Pearson coefficient of correlation – Spearman's Rank correlation coefficient

Unit V

Introduction - Testing of hypothesis – Standard error, Difference between standard deviation and standard error - Tests of significance for attributes (Test for number of successes and test for proportion of successes) Tests of significance for large samples - Testing the difference between means of two samples - Tests of significance for small samples– Student's t distribution – (Test of hypothesis about the population mean and Test of hypothesis about the difference between two means)

References

1. G.D. Rai, **Non Conventional Energy Sources**, Khanna Publishers, New Delhi, 1999.
2. R.K. Rajput, **Non Conventional Energy Sources and Utilisation**, S.Chand & Company Ltd., 2012.
3. Twidell, J.W. and Weir, A., **Renewable Energy Sources**, EFNSpon Ltd., 1986.
4. B.H.Khan, **Non-Conventional Energy Resources**, Tata McGraw Hill, 2nd Edn, 2009.
5. Bent Sørensen, **Renewable Energy Conversion, Transmission and Storage**, Elsevier Inc, 2007.
6. Demirel and Yaşar, **Energy-Production, Conversion, Storage, Conservation, and Coupling**, Springer Link, 2012.
7. S. P. Gupta, **Statistical Methods**, Sultan Chand & sons, 2009.

Allied - IV: CHEMISTRY FOR ENVIRONMENTAL SCIENCES

Semester IV
Credits: 3

Code: U17ESCY4
Total Hrs.: 45

General Objectives

1. To understand the chemistry of air and water
2. To learn the elementary concepts of chemical analysis
3. To learn the principles of analytical techniques like chromatography and colorimetry.

Unit– I Chemistry of Atmosphere

- 1.1 Chemical constituents of the atmosphere; oxygen in the atmosphere-atomic oxygen, molecular oxygen and ozone and their chemical reactions in atmosphere, Ozone-oxygen cycle in stratosphere-photochemical reactions in ozone layer.
- 1.2 Nitrogen and its compound in atmosphere - their sources and reactions, Photochemical reaction, O₃ in troposphere,
- 1.3 Inorganic carbon compounds- CO, CO₂ and their sources and reactions, Hydrocarbons in Atmosphere, Water vapor – hydroxyl radical formation and their reactions.

Unit–II Chemistry of Water

- 2.1 Water as a universal solvent – hardness of water- permanent and temporary hardness, disadvantage of hard water- DO, BOD and COD -definition, determination (any one method).
- 2.2 Water Softening methods - zeolite process, reverse osmosis
- 2.3 Preparation of Deionised water- Distilled water – Double Distilled water – Packaged drinking water.

Unit–III Basics of Quantitative Analysis

- 3.1 Error analysis: accuracy, precision, determinate and indeterminate errors, relative error, absolute error,
- 3.2 Quantitative analysis: titrimetry- principle, acid-base titrations and redox titrations with examples - End point and equivalence points.
- 3.3 Theory of Indicators- Types of indicators - Quinonoid theory

Unit-IV Analytical Techniques

- 4.1 Chromatography-introduction-principle, sampling and applications of paper, thin layer and column chromatography.
- 4.2 Colorimetry: Beer-Lambert's Law, components of a colorimeter(Block diagram), application (estimation of iron).

Unit- V Types of Reactions

- 5.1 Types of chemical reactions –substitution (one example for Nucleophilic and electrophilic with mechanism) – Addition(Addition of HBr on alkenes) – Elimination(Dehalogenation of alkyl halides) – Condensation (formation of ester) – Polymerisation (Formation of Poly vinyl Chloride) – Reduction reaction (Hydrogenation of oil)- Oxidation (KMnO₄ for conversion of benzaldehyde

to benzoic acid) .

5.2 Types of intermediates- Electrophiles – nucleophiles – free radicals

Reference Books

1. Tiwari K.S., Melhotra S.N., Vishnoi N.K, A Text book of Organic Chemistry, Vikas Publishing House Pvt. Ltd., New Delhi, 2006 **(Unit-I, V)**
2. R. Gopalan, P. S. Subramanian and K. Rengarajan, Elements of Analytical Chemistry, Sultan Chand and Sons, New Delhi, 1997**(Unit- IV)**
3. Puri B.R., Sharma L. R., Kalia K.K, Principles of Inorganic Chemistry-23rd edition, New Delhi, Shoban Lal Nagin Chand & Co, 1993**(Unit- I, III)**
4. Puri B.R., Sharma L. R., Kalia K.K, Principles of physical Chemistry, 23rd edition, New Delhi, Shoban Lal Nagin Chand & Co, 1993**(Unit-II)**
5. R.T. Morrison & R.N.Boyd, Study Guide to Organic Chemistry, Prentice Hall, New Delhi, 2000
6. R.L. Madan and G.D.Tuli, Inorganic Chemistry, S. Chand Co., Ltd., New Delhi, 2003
7. Gurdeep Raj, Advanced Physical Chemistry, Goel Publishing House, Meerut, 2000

**Allied Practical III : ALLIED CHEMISTRY PRACTICAL
VOLUMETRIC AND ORGANIC ANALYSIS**

**Semester IV
Credits: 3**

**Code: U17ESCP2
Total Hrs: 45**

General Objectives

1. To understand the basic principles and types of volumetric analysis.
2. To gain skills in identifying organic compounds.
3. To appreciate the importance qualitative and quantitative analysis

I. Volumetric Analysis

- a) Acidimetry and Alkalimetry
 - i) Estimation of hydrochloric acid
 - ii) Estimation of sodium hydroxide
- b) Permanganometry
 - iii) Estimation of oxalic acid using KMnO_4
 - iv) Estimation of ferrous sulphate using KMnO_4
- c) **Demonstrative Experiments**
 - i) Estimation of acid content in citrus fruits
 - ii) Determination of total hardness of water
 - iii) Determination of calcium in commercial milk powder by EDTA method
 - iv) Determination of dissolved oxygen in water (Winkler's Method)

II. ORGANIC ANALYSIS

- a) Analysis of organic compounds with the following
 - i) tests for Aromatic/ Aliphatic,
 - ii) saturated/ unsaturated
 - iii) solubility in common solvents, and
 - iv) presence of nitrogen

Test for Functional groups

- i) Carbohydrate
- ii) Diamide
- iii) Aldehyde
- iv) Ketone
- v) Acid
- vi) Amine

b) Demonstration

- i) Preparation of Buffer solution
- ii) Determination of pH using pH meter
- iii) Preparation of standard solution (Molar, ppm & Normal)

Reference Books

1. V.Venkateswaran, R.Veerasingam, A.R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons, New Delhi, 1997

Practice School – INTERNSHIP IV : INDUSTRIAL PRACTICE SCHOOL

Semester IV
Credits: 2

Code: U17ES4F4
Total Hrs:30

General objectives:

- To learn the processes in various industries, environmental organizations and biodiversity conservation centres
- To understand the pollution control in various industries

Duration: (Minimum duration of 15 days in any one of the IPS stations mentioned below).

1. Industrial Practice School (IPS): Types of IPS – Stations

Textile processing, Dyeing and Bleaching units

Drinking water applications: Water softening/DM plants

Common Waste Management Facility: Wastewater/Solid waste/Biomedical waste

Environmental Consultant Organizations: GOs/ NGOs

Ecology and Biodiversity Centres

2. Profile of the IPS stations

Organizational setup/Administrative structure

Environmental setting of the station

Material production and processing in Industries/waste management facilities

3. Environmental Management System in IPS stations

Environmental Management Policy of the organization

Environmental Compliance

ISO 14001 and 18001 Certification

Environmental Resource Auditing in industries

Waste management practices: Wastewater and Solid waste

4. Occupational health and safety in industries

Occupational Health and Safety: Occupational health and hazards – physical –chemical – biological hazards, Occupational diseases-prevention and control,

Health protection measures for workers – health education – medical first-aid. Management of medical emergencies, Personal protective equipments

OSHAS compliance,

5. IPS Report: The Narrative should contain information on the following topics:

ACTIVITY DESCRIPTION

What projects were you assigned?

What were the objectives of these projects?

What were your project responsibilities?

What problems did you encounter?

How did you solve these problems?

What did you do to complete your responsibilities?

ANALYSIS

What did you learn?

How did the projects and responsibilities relate to theory learned in the classroom?

How will this assignment help in achieving your long-term career goals?

5.2.4. How might you have improved your performance?

References:

1. Austin GT, Shreves, **Chemical processes in industries**, McGraw Hill Book Co., New York, 1977.
 2. Mahajan SP, **Pollution Control in process industries**, Tata McGraw Hill Co. Ltd., New Delhi, 1986.
 3. Diberardinis LJ, **Handbook of Occupational Safety and Health**, John Wiley, New York, 1998.
 4. Peterson RD and Cohen JJ, **The complete guide to OSHA Compliance**, Lewis publishers, New York, 1997.
-

Core VI : CONSERVATION BIOLOGY

Semester V
Credits: 5

Code: U17ES506
Total Hrs:75

General objectives

- To understand the significance of biodiversity.
- To conserve natural resources and maintaining the integrity of the indigenous culture.

Unit I

Biodiversity: Introduction, Concept and definition, Levels of biodiversity - genetic – species - ecosystem biodiversity; Biodiversity at Global, National and local levels; the mega-diversity countries of the world; Hot spots of biodiversity; Bio geographical classification of India.

Unit II

Importance and value of biodiversity: consumptive use - productive use – social- ethical -aesthetic and option values; Threats to biodiversity-Habitat loss, Invasive species, population pollution and poaching of wild life; IUCN categories - Red Data Book; Endangered and endemic species of India.

Unit III

Strategies of Conservation: In-situ conservation–protected areas-National parks, Wildlife sanctuaries, Biosphere reserves, Strategic Species approach - key stone species, indicator species, flagship species, umbrella species

Ex-situ conservation-Botanical gardens, zoos, aquaria, Gene banks, Seed banks, Arboretum, Inter specific pregnancy

Unit IV

Policies and Laws pertaining to Biodiversity conservation: Salient features of – National Forest Policy 1988; Wildlife Protection Act 1972; Forest Conservation Act, 1980, Biodiversity Act 2002; Convention on Biological Diversity (CBD). Concept and importance of traditional knowledge and sacred groves

Unit V

Measurement of Biodiversity: Quantitative Sampling methods in Ecology: Vegetation sampling - Transect, Quadrat, point; Sampling phytoplankton, Sampling animal populations – True census, Sampling Estimates, Indices.

Diversity indices: Species diversity - Density, Frequency, Relative Frequency, Richness, Abundance, Evenness - Simpson Index- Shannon Wiener Index- Alpha, Beta and Gamma Diversity.

References

1. Misra S.P, Pandey S.N, **Essential Environmental Studies**, Ane Books Pvt. Ltd, Chennai, 2009.
2. Erach Bharucha, **Text Book of Environmental Studies**, Orient Longman Pvt. Ltd., Ernakulam, 2005.
3. Sharma, P.D, **Ecology and Environment**, Rastogi Publications, New Delhi, 1998.
4. Purohit, S.S, Shammi, .J, and Agarwal, A.K, **Environmental Science: A new approach**, Jodhpur Agrobios Publisher, Jodhpur, 2012.
5. Asthana D. K. and Meera Asthana, **A Text Book of Environmental Studies**, S. Chand & Co, New Delhi, 2004.
6. Chapman J. L. and Reiss M., **Ecology: Principles and Applications**, Cambridge University Press, U.K.1993.
7. Maiti, S.K, **Handbook of Methods in Environmental Studies**, Vol. 1 & 2, Oxford Book Company Publishers, Jaipur, 2011.
8. Trivedy R. K. and Goel P.K., **Practical Methods in Ecology and Environmental Science**, Enviro Media Publications, 1987.
9. Brian Groombridge and Martin D. J, **World Atlas of Biodiversity Earth's Living Resources in the 21st Century**, University of California Press, Los Angeles, US, 2010.
10. Sabbins, F.F, **Remote Sensing: Principles and Interpretation**, 2nd edition, Freeman and Company, New York, 1987.
11. Verma, P.S and Agarwal, V.K, **Environmental Biology**, S. Chand Publishing, New Delhi.2012.
12. Menon, A.R.R, **Remote Sensing and GIS**, KFRI Publications, KFRI, Peechi, Thrissur, 2006.

Core VII: FUNDAMENTALS OF ENVIRONMENTAL ENGINEERING

Semester V
Credits: 4

Code: U17ES507
Total Hrs:75

Objectives:

- To identify the sources and quantity of surface and ground water bodies and their demand for the public distribution and also to study the quality of water and their treatment techniques.
- To impart knowledge on characteristics of sewage, primary and secondary treatment of sewage as well as disposal of sludge and treated wastewater.

Unit I (Description with Diagram only)

Water supply Schemes and Water requirement: Objectives of public water supply schemes – planning – Quantity of water – water requirements – continuous and intermittent supply – water demand – variations in rate of demand- its effect on design – design period – population growth and forecast – estimating the quantity of water required, Water distribution systems.

Unit II (Description with Diagram only)

Purification of Water – Natural and Engineered systems of water purification: Treatment of water- working principles of all the unit process of water treatment, Purpose and its design – screening – plain sedimentation – coagulation sedimentation – filtration – disinfection – water softening and Desalination– Operation & Maintenance aspects of all the unit process.

Unit III (Description with Diagram only)

Wastewater treatment and disposal: Wastewater sources and flow rates; analysis of constituent mass loading, calculation of mass loading. Mass balance analysis - Principles, design and applications of unit operations and processes – Physical, chemical and biological. Lay out of Wastewater treatment plants.

Unit IV (Description with Diagram only)

Air pollution control: Control of particulates, Settling chamber, Cyclone, Fabric filter, Scrubber.

Unit V (Description with Diagram only)

Air pollution control: Control of gaseous contaminants – Adsorption and absorption techniques, Condensation and combustion techniques.

Textbooks

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2001
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 1998.
3. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 1991.
4. Duggal. K.N., "Elememts of public Health Engineering", S.Chand and Company Ltd, New Delhi, 1998.
5. Mark J. Hammer & Mark J. Hammer Jr., "Water and Waste Water Technology", Prentice Hall of India Pvt. Ltd., New Delhi, 2008.

References

1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.

Core Practical III: WATER POLLUTION LAB

Semester V
Credits: 3

Code: U17ES5P3
Total Hrs:60

General objectives

- To collect, handle and preserve the environmental samples.
 - To analyze the water quality parameters
1. Estimation of pH - pH metric method
 2. Estimation of EC - Conductivity method
 3. Estimation of Turbidity -Nephelometric method
 4. Estimation of Total Dissolved Solids (TDS)- Gravimetric and Filtration method
 5. Estimation of Dissolved Oxygen- (DO) - Winkler's method
 6. Estimation of Biological Oxygen Demand- (BOD)
 7. Estimation of Chemical Oxygen Demand – (COD)
 8. Estimation of Carbonates-bicarbonates
 9. Estimation of Total Hardness
 10. Estimation of Chloride
 11. Estimation of Fluoride
 12. Estimation of Phosphorous
 13. Estimation of Nitrite
 14. Estimation of Nitrate
 15. Pollution Indicators – (Plants, Planktons and microbes)

References

1. Sawyer, C.N. and Mc Carty, P. L, **Chemistry for Environmental Engineering**, McGraw Hill International, 1978.
2. Standard Method for Examination of Water and Wastewater, APHA –AWWA – WPCF, 1989.
3. Standard Method for Examination of Water and Wastewater, APHA –AWWA – WEF, 1998.

Elective I : TOOLS AND TECHNIQUES IN ENVIRONMENTAL SCIENCES

Semester V
Credits: 4

Code: U17ES5:1
Total Hrs:75

General objective:

- To analyse the environmental data with computers.

Unit I

Geo-informatics: Remote Sensing - Definition – principles – EMR - platforms – sensors – resolution. GIS: Components – Hardware and software. Maps: Types. Use of RS and GIS in Environmental Sciences.

Unit II

Air Quality Monitoring: Ambient air quality monitoring; Meteorological measurements; Measurement of SPM; CO; NO_x; SO_x.

Unit III

Water quality monitoring: Water sampling techniques; Principles and procedures for measurement of pH, conductivity, Total Solids, hardness, chloride, Dissolved Oxygen, phosphorous, nitrogen, heavy metals (Atomic Absorption Spectrophotometry method) and total Coliform count.

Unit IV

Soil quality: Morphological, Physical, Chemical and Biological attributes; sustainable soil use and management: Best agricultural practices

Unit V

Sound quality parameters- Signal level- Frequency response-Distortions- Noise- Wow and Flutter

References

1. Singhal, M, **Elements of Statistics (Theory and Practice)**, Fourth Edition, Lakshmi Narain Agarwal, Educational Publishers, Agra, 2009.
2. Adhikari, K. and Bhattacharjee, D, **Statistics – Theory and Applications (including fundamentals of Computer)**, Bibhu Ranjan Paul, Silchar, 2003.
3. Asthana, B.N, **Elements of Statistics (Part One)**, Tenth Edition, Chaitanya Publishing House, Allahabad, 1996.
4. Pal, S.K, **Statistics for Geo-Scientists – Techniques and Applications**, Concept, New Delhi, 1999.
5. Alvi, Z, **Statistical Geography – Methods of Application**, Oxford University Press, New Delhi, 2005.
6. Rajaraman, V, **Fundamentals of Computers**, Third Edition, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.
7. Leon, A. and Leon, M, **Fundamentals of Information Technology**, Second Edition, Leon Press, Chennai, 2009.

8. Lilles and, T.M. and Kiefer, R.W, **Remote Sensing and Image Interpretation**, Fifth Edition, John Wiley, Cambridge, 2004.
9. Barrett, E.C. and Curtis, L.F, **Introduction to Environmental Remote Sensing**, Routledge, Taylor and Francis, New York, 1999.
10. Bhatta, B, **Remote Sensing and GIS**, Oxford University Press, New York, 2011.
11. Siddiqui, M.A, **Introduction to Geographical Information System**, Sharda Pustak Bhawan, Allahabad, 2005.
12. Wing, M.G. and Bettinger, P, **Geographic Information Systems: Applications in Natural Resource Management**, Oxford University Press, New York, 2008.
13. Masters, G.M. and Wendell, E, **Introduction to Environmental Engineering and Science**, Third Edition, Prentice-Hall India Pvt. Ltd., New Delhi, 2008.
14. Dara, S.S, **Environmental Chemistry and Pollution Control**, S. Chand, New Delhi, 2003.
15. Chapman, J.L. and Reiss, M.J, **Ecology – Principles and Applications**, Cambridge University Press, Cambridge, 2005.

Elective II : ENVIRONMENTAL SAFETY, HEALTH AND MANAGEMENT

Semester V
Credits: 4

Code: U17ES5:2
Total Hrs:75

General objectives

- To understand the significance of occupational health and industrial safety.
- To learn about the safety management system.

Unit I

Definition- need for good health- factors affecting health. Types of diseases (deficiency, infection, pollution diseases); Personal hygiene food (balanced diet): Food habits & cleanliness, food adulterants, avoiding smoking, drugs & alcohols.

Unit II

Public health: communicable diseases, mode of transmission (epidemic and endemic diseases). Management of hygiene in public places (railway stations, bus stands and other public places).

Unit III

Occupational health and safety: Occupational health and hazards-physical-chemical and biological; Occupational diseases- prevention and control.

Unit IV

Industrial safety and management techniques: Industrial safety standards and regulations; Accidents-definitions-prevention and control.

Unit V

Safety management system: concepts of safety management systems- EMS ISO 14000 and 14001 OSHA, PUBLIC LIABILITY INSURANCE ACT.

References

1. Scoot, R. M, **Basic concepts of industrial hygiene**, Lewis Publisher, New York, 1997.
2. Diberardins L.J, **Hand book of occupational safety and health**, John Willey, New York, 1998.
3. Park J.E. and Park, **Preventive and social medicine**, BHANOT Publisher, 2015.
4. Schilling R.S.E, **Occupational health practice**, **Buffer Worth**, London, 1973.
5. Khan M.A.O., John. P, Bederka. S, **Survival in Toxic Environment**, Academic Press, New York, 1974.

PRACTICE SCHOOL- INTERNSHIP V : ENVIRONMENTAL MONITORING AND ASSESSMENT

Semester V
Credits: 2

Code: U17ES5F5
Total Hrs:30

General objective:

- To observe monitoring of micro-meteorological, air, noise, water and land environment parameters
- To assess the environmental setting of a developmental activity

1. Environmental Monitoring of Micro-Meteorological parameters

Temperature, humidity, Atmospheric pressure, wind velocity, wind direction, sunshine.

Ambient Air:

Particulates PM_{2.5}, PM₁₀,

Gaseous contaminants: SO₂, H₂S, NO_x, CO, CO₂

Ambient Noise levels

National standards for air quality and noise

2. Water Quality Monitoring Protocol 2006 and

Sampling techniques of water

Preservation of water samples for the analysis of various parameters.

Standard methods for the Examination of water and wastewater

Water quality standards

3. Impact of developmental activity: Category A and B projects as per EIA Notification, 2006 (Assessment based on EIA reports of projects cleared by MoEFCC and SEIAA)

Mining extraction of natural resources and Power generation

Primary processing units

Material production

Material processing

Manufacturing/Fabrication

Service Sectors

Physical Infrastructure including services

Construction – Township/Commercial complexes/Housing

4. Environmental / Baseline / Setting,

Identification of impacts,

Prediction of impacts and

Preparation of Environmental Impact Statement

5. Environmental Management Plan:

Air

Water

Land

Socio-economic

Ecology and Biodiversity

References

1. Murty JVS, **Watershed Management in India**, Wiley Eastern Ltd., New Delhi, 1994.
2. TNPCB, **Pollution control legislations - TamilNadu pollution control Board**, Vol-I and II, Chennai, 1999.
3. Austin GT, Shreves, **Chemical processes in industries**, McGraw Hill Book Co., New York,

- 1977.
4. Mahajan SP, **Pollution Control in process industries**, Tata McGraw Hill Co. Ltd., New Delhi, 1986.
 5. Trivedy, B.K, **Pollution control in industries**, Enviro Media Publishing Co., Karad, 1991.
 6. Canter LW, **Environmental impact assessment**, McGraw Hill Book co., New York, 1977.

SBEC II : ECOLOGY AND BIODIVERSITY OF BIRDS

Semester V
Credits: 2

Code: U17ES5S2
Total Hrs:30

General objective

- To understand the importance of the local ecology, culture, history and economic development balanced with a social responsibility.

Unit I

Introduction to birds –morphology of birds

Unit II

Key to Identification of birds and methods of bird count

Unit III

Study of Species diversity of birds in an urban college
Quiz on bird identification

Unit IV

Field observation of birds in an urban area
Quiz on bird identification

Unit V

Field visit to a bird sanctuary and counting of birds
Group project: Report of bird count

References

1. Relton A, **Bird of Bishop Heber College**, Heber Au Sable Institute of Environmental Studies, Trich, ISBN 978 – 93 – 80767 – 00 – 0. 81 pages, 2010.
2. Grimmett Richard, Tim Inskipps, **Birds of India, Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives**, Second Edition, Princeton Field Guides, 2012 .

SBEC III : WASTE MANAGEMENT

Semester V
Credits: 2

Code: U17ES5S3
Total Hrs:30

General objectives

- To study various types of waste and its management
- To develop skills in establishing waste management unit

Unit-I

Introduction to waste

Wastes-Introduction, Sources, Characteristics, Composition, Classification - Global Scenario of waste – Indian Scenario of waste – Waste Collection, Storage and segregation – Transportation and Disposal Methods – Sanitary Land filling Techniques.

Unit-II

Municipal Solid Waste

Definition – Sources and types of solid waste – Composition and Its determinants of solid waste – Factors influencing generation – Quantity assessment of Solid Wastes – Methods of sampling and characterization.

Unit-III

Collection and Transfer

Collection – Collection of solid waste – collection system, equipments – Time and frequency of collection – Labour requirements – Factors affecting collection, Analysis of collection system, Need for transfer operation – Transfer Stations – Location of Transport Stations – Selection of Location, types and design requirements, operation and maintenance.

Unit IV

Solid waste Disposal

Landfilling - Types, Environmental problems, Aerobic composting - Windrow composting and Vermicomposting

Anaerobic Treatment: Bio - gas production

Unit V

Hazardous Waste Management

Hazardous waste – Introduction, Characteristics – Classification of hazardous waste (Industrial, Hospital and Domestic) - Handling of hazardous solid wastes (Segregation, Recovery of hazardous waste substance) – Hazardous waste disposal Techniques – Radioactive wastes: Sources, Pollution, types of radioactive waste and its control and management

References:

1. Chandrappa R and Das DB, **Solid waste Management Principles and Practice**, Springer, Verlag-Heidelberg, 2012.
2. Gupta VK and Tuohy MG, **Biofuel Technologies: Recent Developments**, Springer, London, 2013.
3. James Saling, **Radioactive waste management**, CRC Press, FL, USA, 2001.
4. Lagrega, M.D., Buckingham PL and Evans JC, **Hazardous Waste Management**, II Ed. Mc Graw Hill, 2001.
5. Lic DHF and Liptak BG, **Hazardous wastes and solid wastes**, Lewis Publishers, New York, 2000.
6. Subash Anand, **Solid waste management**, Mittal Publications, New Delhi, 2010.
7. SC Santra, **Environmental Sciences**, NBCA, Kolkata, India, 2016.
8. Young GC (2010) **Municipal Solid Waste to Energy Conversion Process- Economic, Technical and Renewable Comparisons**, John Wiley and sons Inc. NJ, USA, 2010.

Web References

1. www.satavic.org/vermicomposting.htm
2. www.encapafrika.org/EGSSAA/solidwaste.pdf

Core VIII : INSTRUMENTAL ANALYSIS AND METHODS

Semester V
Credits: 4

Code: U17ES608
Total Hrs:75

General objectives

- To study various forms of pollution and contaminants of the environment – their sources / causes and effects.
- To comprehend the chemical reactions /processes taking place in the environment.

Unit I

Environmental analysis: Water sampling; Sampling stations - Collection of water samples - Handling and Preservation.

Water analysis - Physical parameters: Colour -Temperature-Transparency-Turbidity.

Unit II

Water Analysis: Chemical parameters: pH - Electrical conductivity-Total solids-Total suspended solids-Dissolved oxygen - Carbonates-bicarbonates -Hardness - Calcium - Magnesium - Total alkalinity – Fluoride – Iron - Nitrate -nitrite – Phosphate Biochemical Oxygen Demand (BOD) -Chemical Oxygen Demand (COD).

Biological Parameters: Macrophytes – Phytoplankton – Zooplankton -Primary Productivity Bacteriological measurements-Standard Plate count method-MPN (Most Probable number).

Unit III

Soil /Sediment Analysis - Physical parameters: Density-Specific gravity -Texture

Chemical Parameters: pH - Electrical conductivity - Total Alkalinity –Chloride – Nitrates – Phosphate – Iron - organic matter

Biological parameters: Animal population – Benthos - Bacteria.

Unit IV

Air Analysis - Physical parameters: Wind velocity - Atmospheric pressure – Temperature - Humidity

Chemical Parameters: Carbon dioxide - Carbon monoxide - Sulphur dioxide - Nitrogen oxide.

Unit V

Remote sensing: Principle – Types - GIS-Components - Types of maps –Digitizer – Scanner - Scale of measurements

References

1. Chhatwal,G,R, M.C. Mishra, M. Satake, T. Katyal, M.Katyal and T.Nagahiro, **Environmental Analysis: Air, Water and Soil**, Anmol Publication, New Delhi, 1989 .
2. Rao,C.S, **Environmental Pollution Control Engineering**, Wiley Eastern Limited New Age International Limited, New Delhi, pp427.
3. Saxena, M.M, **Environmental analysis - Water, Soil and Air**, Agro Botanical Publishers, India, 1987.

Core IX : SUSTAINABLE DEVELOPMENT AND ENVIRONMENTAL LEGISLATION

Semester VI
Credits: 4

Code: U17ES609
Total Hrs:75

General objectives

- To understand the concepts of sustainable development.
- To know the global issues and initiatives taken for sustainable development.

Unit I

Sustainable Development: Definitions and Goals, global energy policies and resources; Green movements; Green and Eco philosophy; Ecological-footprints; corporate response to sustainable development - Brundtland Commission; Human Development Index; Living Plant Index

Unit II

National policy statement of environment and development; National Environment Policy 2006: an overview; Legislative framework of environmental protection, historical perspectives and Indian constitutional provisions.

Unit III

Environmental Acts and rules - Water (Prevention and control of Pollution Act, 1974), Air (Prevention and control of Pollution Act, 1981), Environment (protection) Act 1986, International treaties on Environmental protection: Ramsar Convention, Montreal protocol, Kyoto protocol, Convention on International trade of endangered species.

Unit IV

Sanction and enforcement bodies of environmental laws: role of high court (green bench), supreme court, State and Central Pollution Control Boards. National Environmental Movement: Silent valley movement, Chipko movement, Narmada movement, Appiko movement, Almatti dispute and Tehri dam movement.

Unit V

Disaster Management: Introduction –Natural disaster: Cyclone – Tsunami – flood – Landslides – earth quake; Environmental Disaster: Assessment, Planning – mitigation program – preparedness – resettlement rehabilitation – role of NGOs, GOs.

References

1. Nick Hanley, Jainsan F. Shorgen and Ben White, **Environmental Economics – In Theory and Practice**, Macmillan India Ltd, New Delhi, 1999.
2. Roger Perman, Yue Ma and James McGilvray, **Natural Resources and Environmental Economics**, II Edition, Addison Waley Longman Ltd, Singapore, 1997.

3. John Bowers, **Sustainability and Environmental Economics**, Addison Weley Longman Ltd, Singapore, 1997.
4. David W. Pearce and Kerry R Turner, **Economics of Natural Resources and The Environment**, The Johns Hopkins University Press, Baltimore, 1999.
5. Uberoi, N. K, **Environmental Management**, Excel Book, New Delhi, 2004.
6. Kerry R. Turner, David W. Pearce and Ian Bateman, **Environmental Economics – An Elementary Introduction**, The Johns Hopkins University Press, Baltimore, 1993.

Core X : GLOBAL WARMING AND CLIMATE CHANGE

Semester VI
Credits: 4

Code: U17ES610
Total Hrs:75

General objective

- To understand the concept of global warming and climate change and mitigation strategies.

Unit I

Introduction to Climate; Role of ozone in environment and its depletion; Green House Effect and global warming - role of fossil fuels

Unit II

Global warming – Trends in temperature changes and in CO₂ and other GHGs. GWP of of GHGs. Effects of Global Warming – melting polar ice, sea level rise, positive feedback

Unit III

Climate change and its socioeconomic and environmental implications (environment, biodiversity, agriculture, land use etc..)

Unit IV

International Initiatives in combating global warming – UN Conferences formation of UNEP, IPCC and UNFCCC, Kyoto Protocol; Indian Government's commitment and initiatives – role of Ministry of Environment, Forest and Climate Change.

Unit V

Kyoto Mechanisms: Emission trading, Clean Development Mechanism, Joint Implementation. Annex I, Annex II and Annex B countries and their commitments / role; Basket of gases; Lima Call for Climate Action

References

1. Annon, **Climate change 1995: Adaptation and mitigation of climate change - Scientific Technical Analysis**, Cambridge University Press, Cambridge, 1996.
2. Annon, **Intergovernmental Panel on Climate Change (IPCC) Climate Change 2001. Third Assessment Report (Volume I)**, Cambridge University Press, Cambridge, 2001.
3. Annon, **World Health Organization, Climate and Health**, Fact sheet, July, 2005.
4. Gosain, A.K. and Rao,S, **Climate change and India: Vulnerability Assessment and Adaptation**, Eds. Shukla, P.R. Universities Press Pvt. Ltd., Hyderabad, 2003.
5. Houghton, J, **Global warming: The Complete Briefing**, Cambridge University Press, Cambridge, 2005.
6. Saha, T.K, **Ecology and Environmental Biology**, Books and Allied (P) Ltd. Kolkata, 2008.
7. Lakshmipathy, M., S.R.Ramanan, R.Sathyathan and J.S.Sudarsahn, **Proceedings of the National Conference on Effect of climate change and sustainable resource management**, SRM University, Kattankallathur, 2009.

Core Practical IV : AIR AND SOIL POLLUTION LAB

Semester VI
Credits: 3

Code: U17ES6P4
Total Hrs:75

General objectives

- To collect, handle and preserve the environmental samples.
- To analyze the air pollutants and soil quality parameters

Air Analysis

1. Estimation of PM₁₀ in the ambient air
2. Estimation of SO₂ in the ambient air
3. Estimation NO_x in the ambient air
4. Measurement of ambient noise level

Soil Analysis

1. Estimation of pH - pH metric method
2. Estimation of EC - Conductivity method
3. Estimation of Alkalinity
4. Estimation of Total Organic Matter
5. Estimation of Phosphorous
6. Estimation of Sodium and Potassium

References

1. Trivedy R K, Goel PK and Trisal L, Practical Methods in ecology and Environmental Sciences, Environmental Publications, Karad, 1987.
2. Margesin R and Schinner, Manual of Soil Analysis – Monitoring and Assessing Bioremediation, Springer –Verlag Berlin Heidelberg, 2005.
3. James P. Lodge, Methods of Air Sampling and Analysis, Inter Society Committee Publication, 1988.
4. Howard S. Peavy, Donald R. Rowe and George Tchobanoglous, Environmental Engineering, 2017
5. Sawyer, C.N. and Mc Carty, P. L., **Chemistry for Environmental Engineering**, McGraw Hill International, 1978.
6. Standard Method for Examination of Water and Wastewater, APHA –AWWA – WPCF, 1989.
7. Standard Method for Examination of Water and Wastewater, APHA –AWWA – WEF, 1998.

Elective III: ECOTOURISM

Semester VI
Credits: 4

Code: U17ES6:3
Total Hrs:75

General objective

- To understand the principles and importance of ecotourism
- To learn the impacts and management practices of ecotourism

Unit I

Scope and definitions; Objectives of tourism; Significance of Tourism – Classification – Religious tourism – Cultural tourism – Heritage tourism – Monumental tourism – Adventure tourism – Mass tourism – Sustainable tourism – Consumptive & non consumptive tourism; implications of tourism.

Unit II

Ecotourism – definition and characteristics features - Ecosystem & biodiversity support to local economy, conservation of biosphere, learning experience; Goals - social, economical and environmental.

Unit III

Principles of Ecotourism: Types of Ecotourism – Objectives of Ecotourism – benefits of Ecotourism – trends affecting ecotourism.

Unit IV

Impact of Ecotourism: Economic impacts (fiscal impacts) – Types and degree of impacts from Ecotourism activities – Socio cultural impacts – Environmental impact

Unit V

Ecotourism in India – India a land of pluralism: land, people, flora and fauna and climatic variations – Ecotourism in India – Different ecotourism spots - contrast from tropics to snow – ocean to mountain – desert to forest – Critical analysis of ecotourism in India with a case study.

References

1. Agarwal, A. N, **Indian Agriculture**, Vikas publishing House, New Delhi, 1980.
2. Weaver, D. B, **The Encyclopedia of Ecotourism**, CABI, Publishing, U.K, 2001.
3. Sinha, P. C, **Encyclopedia of Ecotourism**, Vol – I, II & III, Anmol publications Pvt. Ltd, New Delhi, 2003.
4. Bhatia, A. K, **Tourism in India**, Sterling Publishers, New Delhi, 1978.

CORE PROJECT

Semester VI
Credits: 5

Code: U17ES6PJ
Total Hrs:75

General objectives

- To demonstrate the ability to carry out and write up an independent piece of work on a topic that is relevant to the course.
- To demonstrate the ability to think critically and develop original ideas.
- To analyse data or literature and form conclusions based on the analysis.
- To demonstrate independent research skills.

PROJECT WORK

Each Student admitted in the programme of study should take up a project work. The Head of the Department shall assign a project supervisor, who in turn will monitor the project work of the student. The report of the study should be submitted at the end of the semester, certified by the supervisor and duly forwarded by the Head of the Department.

NMEC offered by the Department

NMEC I : GLOBAL WARMING AND CLIMATE CHANGE

Semester III
Credits: 2

Code: U17ES3E1
Total Hrs:30

General objective

- To understand the concept of global warming and climate change and mitigation strategies.

Unit I

Introduction to Climate - Role of ozone in environment and its depletion - Green House Effect and global warming - role of fossil fuels

Unit II

Global warming – Trends in temperature changes and in CO₂ and other GHGs. GWP of of GHGs. Effects of Global Warming – melting polar ice, sea level rise, positive feedback

Unit III

Climate change and its socioeconomic and environmental implications (environment, biodiversity, agriculture, land use etc.,)

Unit IV

International Initiatives in combating global warming – UN Conferences formation of UNEP, IPCC and UNFCCC, Kyoto Protocol; Indian Government's commitment and initiatives – role of Ministry of Environment, Forest and Climate Change.

Unit V

Kyoto Mechanisms: Emission trading, Clean Development Mechanism, Joint Implementation. Annex I, Annex II and Annex B countries and their commitments / role; Basket of gases; Lima Call for Climate Action

References

1. Annon, **Climate change 1995: Adaptation and mitigation of climate change-Scientific Technical Analysis**, Cambridge University Press, Cambridge, 1996.
2. Annon, **Intergovernmental Panel on Climate Change (IPCC) Climate Change 2001, Third Assessment Report (Volume I)**, Cambridge University Press, Cambridge, 2001.
3. Annon, **World Health Organization, Climate and Health**, Fact sheet, July, 2005.
4. Gosain, A.K. and Rao, S, **Climate change and India: Vulnerability Assessment and Adaptation**, Eds. Shukla, P.R., Universities Press Pvt. Ltd., Hyderabad, 2003.

5. Houghton, J, **Global Warming: The Complete Briefing**, Cambridge University Press, Cambridge, 2005.
6. Saha, T.K, **Ecology and Environmental Biology**, Books and Allied (P) Ltd. Kolkata, 2008.
7. Lakshmipathy, M., S.R.Ramanan, R.Sathyathan and J.S.Sudarsahn, **Proceedings of the National Conference on Effect of climate change and sustainable resource management**, SRM University, Kattankallathur, 2009.

NMEC II : ENVIRONMENTAL SAFETY, HEALTH AND MANAGEMENT

Semester IV
Credits: 2

Code: U17ES4E2
Total Hrs:30

General objectives

- To understand the significance of occupational health and industrial safety.
- To learn about the safety management system.

Unit I

Definition- need for good health- factors affecting health, Types of diseases (deficiency, infection, pollution diseases).

Unit II

Personal hygiene food (balanced diet): Food habits & cleanliness, food adulterants, avoiding smoking, drugs & alcohols.

Unit III

Public health: communicable diseases, mode of transmission (epidemic and endemic diseases). Management of hygiene in public places (railway stations, bus stands and other public places).

Unit IV

Occupational health and safety: Occupational health and hazards-physical-chemical and biological; Occupational diseases - prevention and control.

Unit V

Industrial safety and management techniques: Industrial safety standards and regulations; Accidents-definitions-prevention and control.

References

1. Scoot, R. M, **Basic concepts of industrial hygiene**, Lewis Publisher, New York,1997
2. Diberardins L.J, **Hand book of occupational safety and health**, John Willey, New York, 1998.
3. Park J.E. and Park, **Preventive and social medicine**, BHANOT Publisher, 2005.
4. Schilling R.S.E, **Occupational health practice**, **Buffer Worth**, London, 1973
5. Khan M.A.O., John. P, Bederka. S., **Survival in toxic environment**, Academic Press, New York, 1974.