FOUR YEARS UNDER GRADUATE (FYUG) PROGRAMMEEUNDER

NEW EDUCATION POLICY, 2020

ENVIRONEMNETAL SCIENCE



Date of approval in Academic Council: 30th May and 21st June 2024.

Preface

The objective of the programme is to expose students to the wide knowledge base of the environment, its components and the principles operating therein. The students will also gain specialized knowledge on contemporary environmental issues and problems so as to attempt in solving them, and also will disseminate the same to the society. The programme will enable the students to develop analytical skills, investigation capabilities and hone their decision-making skills in the areas of environmental Science.

Students will also take part in practical sessions which are focused on laboratory techniques that allow them to acquire lab skills. The practical skills are critical and indispensable to effective holistic learning and will enable them to engage effectively with advanced laboratory modules and prepare them for future employment.

Programme Outcomes (POS):

Upon completion of this programme the student will be able to

1. Academic competence: Understand fundamental concepts, principles and processes underlying the field of Environmental Science, its interdisciplinary nature and create and disseminate knowledge to the students about environmental problems at local, regional and global scale and demonstrate an understanding of a wide range of Environmental techniques

2. Students will acquire knowledge, competent professionals with a strong foundation of Environmental Science and application to be suitable for vital positions in the academia, industry, government and non-government institutions as skilled manpower.

3. Personal and Professional Competence: They will become effective scientific communications /collaborators in multidisciplinary teams providing technical leadership to engage with the challenging environmental problems of local, national and global nature. Employ skills in specific areas related to Environmental Science such as industrial pollution, Green technology development, Ecological, health, agriculture and ensure multilevel commitment to health and wellbeing of the society at large.

4. Research Competence: Apply environmental data analysis methodology in order to conduct research and demonstrate appropriate skill to seek innovative solutions to problems that emerge in various fields of Environmental Science.

1st Semester

Course Code	Title of the Course	Credit			Total Contact Hours
		Theory	Practical	Total	
EVS-100	Concepts and Components of Environment (Major)	3	1	4	75
EVS-100	Concepts and Components of Environment (Minor)	3	1	4	75
MDC102119	Any of the available course as notified by the university from time to time	<u>'3</u>]	51	3	' <u>45</u> '
AEC120129	Any of the available course as notified by the university from time to time	<u>'3</u>	8	3	<u>'45</u> '
SEC- 130//139	Any of the available course as notified by the university from time to time			3	i45-90 <u>-</u>
VAC-140	Environmental Studies	3	-	3	45
				20	

2nd Semester

Course Code	Title of the Course	Credit			Total Contact Hours
		Theory	Practical	Total	
EVS-150	Population and Community Ecology (Major)	3	1	4	75
EVS-150	Population and Community Ecology (Minor)	3	1	4	75
MDC- 160169	Any of the available course as notified by the university from time to time	<u>'3</u> '		3	' <u>45</u> '
AEC-170179	Any of the available course as notified by the university from time to time	3	5	3	<u>45</u>]
SEC-130139	Any of the available course as notified by the university from time to time			3	<u>45-90</u>]
VAC-190 199	Any of the available course as notified by the university from time to time	<u>'3</u>]	ι <u>-</u> , ε_'	3	<u>[45]</u>
				20	

3rd Semester

Course Code	Title of the Course	Credit			Total Contact Hours
		Theory	Practical	Total	
EVS-200	Ecosystem and Biomes (Major)	3	1	4	75
EVS-201	Natural Resources and Management (Major)	3	1	4	75
MDC-210219	Any of the available course as notified by the university from time to time	3		3	45
AEC-220229	Any of the available course as notified by the university from time to time	2		2	30
SEC-230239	Any of the available course as notified by the university from time to time			3	45-90
VTC-240249	Any of the available course as notified by the university from time to time	1	3	4	105
				20	

4th Semester

Course Code	Title of the Course	Credit			Total Contact
		Theory	Practical	Total	
EVS-250	Energy and Mineral Resources (Major)	3	1	4	75
EVS-251	Biodiversity (Major)	3	1	4	75
EVS-252	Biodiversity Conservation and Laws (Major)	4	-	4	60
EVS-253	Wildlife Ecology and Ecotourism (Major)	4	-	4	60
VTC-240249	Any of the available course as notified by the university from time to time	1	3	4	105
				20	

5th Semester

Course Code	Title of the Course	Credit			Total Contact Hours
		Theory	Practical	Total	
EVS-300	Environmental Physics and Environmental Chemistry	4	-	4	60

	(Major)				
EVS-301	Environmental Pollution (Major)	4	-	4	60
EVS-302	Tools and techniques in Environmental Science (Major)	3	1	4	75
EVS-302	Disaster Management (Minor)	4	-	4	60
ENV-303	Internship/ Apprenticeship/ Community engagement and service/ field-based learning or minor project	-	4	4	120
				20	

6th Semester

Course Code	Title of the Course	Credit			Total Contact
		Theory	Practical	Total	liouis
EVS-350	Environmental Impact Assessment and Environmental Economics (Major)	4	-	4	60
EVS-351	Environmental laws and Contemporary Environmental Movements (Major)	3	1	4	75
EVS-352	Waste Management and Toxicology (Major)	3	1	4	75
EVS-353	Environmental Biotechnology and Environmental Microbiology (Major)	3	1	4	75
VTC-360369	Any of the available course as notified by the university from time to time	1	3	4	105
				20	

1st SEMESTER

EVS-100: CONCEPTS AND COMPONENTS OF ENVIRONMENT

Credit: 4

Total Contact Hours: 75 (45+30)

Course Objective: To introduce the concepts and components of environment, composition and structure of atmosphere, lithosphere.

Learning Outcomes: Student should be able to gain the knowledge about the environment, its components and functions.

Unit I: Environment: Definition, concept and importance; Scope of Environmental Science; Multidisciplinary nature of Environmental Science; Man - Environment Relationship; Need for environmental awareness; Applications of and Career in Environmental Science. **(Contact hours: 15 hrs.)**

Unit **II: Atmosphere:** Composition and structure; Heat budget; Lapse Rate; Inversion of Temperature. Weather and climate: Wind and pressure systems; Major climatic zones of the world; Tropical cyclones; Ocean currents; Western disturbances; El Nino and La Nina. Clouds: Formation and classification. (**Contact hours: 15 hrs.**)

Unit III: Lithosphere: Internal Structure of the earth; Earth's Crust and its composition; Plate tectonics: evidences and boundaries; Continental drift. Minerals and Rocks: Definition, types and usages; Rock Cycle. Hydrosphere: Types of water; Properties of water; Distribution of water; Hydrological cycle; Aquifer and water table. Zonation of Hydrosphere: lentic, lotic and marine. **(Contact hours: 15 hrs.)**

Unit IV: Identification of minerals and rocks; Plotting of Climograph (line & bar diagram method) and Hythergraph (G. Taylor's 12sided polygon method); Measurement of rainfall and wind speed; Estimation of moisture, temperature and conductivity of soil; Determination of transparency, temperature, pH and conductivity of water; Visits to institutions/centers of environmental significance. **(Contact hours: 30 hrs.)**

Suggested readings: (All latest edition)

Anjaneyulu, Y. Introduction to Environmental Science. BSP Books Pvt. Ltd., Hyderabad.

Botkin, D.B. and Keller, E.A. Environmental Science: Earth as a Living Planet. John Wiley and Sons, New Delhi.

Cunningham, W.P. and Saigo, B.W. Environmental Science – A Global Concern. WCB/McGraw Hill, New York.

Lal, D.S. Climatology. Sharda Pustak Bhawan, Allahabad.

Lal, D.S. Physical Geography. Sharda Pustak Bhawan, Allahabad.

McKinney, M. L., Schoch, R. and Yonavjak, R.M. Environmental Science Systems and Solutions. Jones & Bartlett Publishing Inc., Delhi.

Purohit, S. S., Shammi, Q.J. and Agarwal, A.K. A Textbook of Environmental Science. Students Edition, Jodhpur.

Sharma, P.D. Ecology and Environment. Rastogi Publication, Meerut.

Singh, S. Environmental Geography. Prayag Pustak Bhawan, Allahabad.

Maiti, S.K. Hand Book of Methods in Environmental Studies. Vol. I & II. ABD Publishers, Jaipur.

Michael, P. Ecological Methods for Field and Laboratory Investigation. Tata McGraw Hill, New Delhi.

Misra, R. Ecology Workbook. Oxford & IBH Publications Co., New Delhi.

VAC-140 Environmental Science

Credit: 3

Total Contact Hours: 45

Course Objective: To introduce the basic concepts of environment, natural resources, biodiversity and its conservation and concepts and components of environmental pollution and social issues.

Learning Outcomes: Student should be able to gain the knowledge about the environment, its component, natural resources, biodiversity conservation, environmental pollution and social issues pertaining to environmental pollution.

Unit I: Environment: Definition, Components of Environment; Natural resources (Renewable and Nonrenewable) their conservation and management: Forest resources, Water resources, Mineral resources, Energy resources, Land resources. Soil erosion and desertification. **(Contact hours: 15 hrs.)**

Unit II: Ecosystems: Concept, Structure and Functions. Food Chain and Food web. Energy flow in an ecosystem and biogeochemical cycle. Biodiversity: definition and concepts, biodiversity hot-spots. Conservation of biodiversity: *In-situ* and *ex-situ* conservation. **(Contact hours: 15 hrs.)**

Unit III: Environmental Pollution and Social Issues: Definition, causes, effects and control measures for Air pollution, Water pollution, Soil pollution, Noise pollution; Important issues of environmental pollution: Climate change (Greenhouse effect & Global warming), acid rain, ozone layer depletion; Environmental Legislation: Salient features of Environmental Protection Act, Air (Prevention & Control of Pollution) Act; Water (Prevention & Control of Pollution) Act; Sustainable development; Role of Information Technology in Environmental ethics and movements. (Contact hours: 15 hrs.)

Suggested Readings: (All latest edition)

Botkin, D.B. and Keller, E.A. Environmental Science: Earth as a Living Planet. John Wiley and Sons, New Delhi.

Chapin III, F.S., Matson, P.A. and Vitousek, P.M. Principles of Terrestrial Ecosystem Ecology. Springer, New Delhi.

Purohit, S.S., Shammi, Q.J. and Agarwal, A.K. A Textbook of Environmental Science. Students Edition, Jodhpur.

Sharma, P.D. Ecology and Environment. Thirteenth Edition. Rastogi Publication, Meerut.

Odum, E.P. Fundamentals of Ecology. Nataraj Publisher, DehraDun.

Rana, S.V.S. Essentials of Ecology and Environmental Science. Prentice Hall of India, New Delhi.

De, A.K. Environmental Chemistry. New Age International Pvt. Ltd., New Delhi.

Viswanatha, C.R., Hegadal, R.V. and Hegadal, S.V. Disaster Management. Himalaya Publishing House

2nd SEMESTER

EVS-150: POPULATION AND COMMUNITY ECOLOGY

Credit: 4

Total Contact Hours: 75 (45+30)

Course Objective: To give students an understanding regarding the various pollution sources in environment and their effect on environment and life.

Learning Outcomes: Students should get a clear idea regarding pollution, pollutants and their various effects on humans as well as ecosystem which will make them careful in future.

Unit I: Ecology: Definition of ecology; Division of ecology; Ecological factors: biotic and abiotic (light, temperature, precipitation, fire) factors; Shelford's law of Tolerance; Leibig's Law of minimum; Ecological amplitudes, ecotypes, ecoclines, ecological niche. **(Contact hours: 15 hrs.)**

Unit II: Population Ecology: Concept and characteristics of population: natality, mortality, age structure, population pyramids, population density, population dispersion, population growth, life table and survivorship curves; Carrying Capacity of the Earth. Population interactions: competition, predation, parasitism, symbiosis, commensalism, mutualism, and ammensalism. **(Contact hours: 15 hrs.)**

Unit III: Community Ecology: Concept of community, classification; Community structure: horizontal and vertical stratification. Community Characteristics; Analytical Characters of community: qualitative and quantitative; Methods of study of community. Ecological Succession: Concept, processes, stages and types of successions; Examples of succession; Concept of Climax; Climax communities; Climax Theories: Monoclimax and Polyclimax. **(Contact hours: 15 hrs.)**

Unit IV: Determination of requisite size and number of quadrats for vegetation analyses; Determination of frequency, density and abundance of species in a grassland community; Calculation of IVI of plant species in a grassland community; Qualitative and quantitative analyses of planktons; Determination of chlorophyll content. **(Contact hours: 30 hrs.)**

Suggested Readings: (All latest edition)

Ambhast, R.S. A Textbook of Plant Ecology. Students, Friends and Co., Varanasi. Arora, M.P..Ecology. Himalaya Publishing House, New Delhi. Chapman, J.L. and Reiss, M.J. Ecology - Principles and Applications. Cambridge University Press, Cambridge. Dakshini, K.M.M. and Foy, C.L. Principle and Practices in Plant Ecology. CRC, Boston. Misra, Dash, M.C. and Dash, S.P. Fundamentals of Ecology. Tata McGraw Hill Publishing Company Ltd., New Delhi. Miller, G.T. and Spoolman, S. Essentials of Ecology. Brooks/Cole Learning, USA. Odum, E.P. Fundamentals of Ecology. Nataraj Publisher, DehraDun. Kormondy, E.J. Concepts of Ecology. Fourth Edition. Prentice Hall of India, New Delhi. Rana, S.V.S. Essentials of Ecology and Environmental Science. Prentice Hall of India, New Delhi. Michael, P. Ecological Methods for Field and Laboratory Investigation. Tata McGraw Hill, New Delhi. Misra, R. Ecology Workbook. Oxford & IBH Publications Co., New Delhi. Sharma, P.D. Ecology and Environment. Rastogi Publications, Meerut. Tripathi, B.D. and Govil, S.R. Water Pollution (An Experimental Approach).CBS Publishers and Distributors, New Delhi.

THIRD SEMESTER

Course Code: ENV: 200

Course Title: ECOSYSTEM AND BIOMES

Total Contact Hours 75/Total Credits 4/Total Marks 100

Course Objectives: To provide an understanding about ecosystem, concepts, classification and types of ecosystems along with concepts of biomes.

Learning Outcomes: Student should be able to gain the knowledge about concepts of ecosystem, it's type and concepts of biomes and biogeography.

Unit I: Ecosystems: Concept, classification: terrestrial and aquatic; Structure and function of ecosystems:trophic levels, food chain, food web and ecological pyramids; Energy flow in ecosystem:energy flow models (single and double channel model).Productivity:Concept of productivity; types: primary and secondary. Biogeochemicalcycles: carbon, nitrogen andphosphorous cycle;Anthropogenic influences on biogeochemical cycles.

Unit II: Major Ecosystem types: Structure and functions of grassland ecosystem, forest ecosystem, agro-ecosystem, freshwater ecosystem: lentic and lotic, wetland ecosystem, estuarine ecosystem, and marine ecosystem.

Unit III: Biomes: Concept, types and distribution. Biogeography: Concept, Biogeographical classification of the world and India; Barriers; Continuous and discontinuous distribution; Endemism and Endemic species of India.

Unit IV: Estimation of soil organic carbon content in grassland and forest; Determination of DO in a water body; Determination of primary productivity of a pond ecosystem; Determination of primary productivity of a terrestrial ecosystem by harvest method; Identification of ecological indicators: hydrophytes, xerophytes and epiphytes; Field visit to a terrestrial or an aquatic ecosystem.

Suggested Readings: (all latest editions)

Ambhast, R.S. 2008. A Textbook of Plant Ecology. Third Edition. Students, Friends and Co., Varanasi. Arora, M.P. 2018. Ecology. Fifth Edition. Himalaya Publishing House, New Delhi.

Botkin, D.B. and Keller, E.A. 2019. Environmental Science: Earth as a Living Planet. Ninth Edition. John Wiley and Sons, New Delhi.

Chapman, J.L. and Reiss, M.J. 2006. Ecology - Principles and Applications. Second Edition. Cambridge University Press, Cambridge.

Misra, K.C. 1992. Manual of Plant Ecology. Oxford and IBH Publishing Co., New Delhi.

Dash, M.C. and Dash, S.P. 2009.Fundamentals of Ecology. Tata McGraw Hill Publishing Company Ltd., New Delhi.

Molles, M.C. 2012. Ecology: Concepts and Applications. McGraw-Hill Higher Education, UK.

Odum, E.P. 2005.Fundamentals of Ecology.Nataraj Publisher, DehraDun.

Kormondy, E.J. 2000.Concepts of Ecology.Fourth Edition.Prentice Hall of India, New Delhi.

Rana, S.V.S. 2013. Essentials of Ecology and Environmental Science. Prentice Hall of India, New Delhi.

Sharma, P.D. 2017. Ecology and Environment.Rastogi Publications, Meerut.Springer, New Delhi.

Maiti, S.K. 2011. Hand Book of Methods in Environmental Studies. Vol.I &II.ABD Publishers, Jaipur. Michael, P. 1990. Ecological Methods for Field and Laboratory Investigation.Tata McGraw Hill, New Delhi.

Course Title: NATURAL RESOURCES AND MANAGEMENT

Total Contact Hours 75/Total Credits 4/Total Marks 100

Course Objective: To make students appreciate the role of natural resources in the sustenance of life and to explain the distribution of different natural resources and their sustainable management.

Learning Outcomes: Students will develop concept of natural resources and will be able to recognize and solve environmental and social impacts of resource depletion.

Unit I: Natural Resources: Concept and classification of natural resources; Depletion and degradation of natural resources; Water as a resource; Surface and Ground water resources: importance and uses; Depletion and recharge of groundwater table; Watershed Management; Rainwater harvesting; Conservation of water resources.

Unit II: Soil Resources: Concept, formation and composition of soil; Soil profile; Types of soil; Transported and residual soil; Soil as a resource; Soil erosion: types – wind and water induced; causes and effects of soil erosion; Methods of soil conservation.

Unit III: Forest Resources: Concept, Forest as a resource; Major forest types and their distribution (World and India); Causes and consequences of deforestation; Timber and non-timber forest products; Agroforestry; Shifting Cultivation. Management and Conservation of forests: Sustainable forest management, community forestry, social forestry, joint forest management.

Unit IV: Inventorization of important local NTFPs; Study of important ethno-medicinal plants and preparation of herbarium; Determination of texture, porosity, permeability and bulk density of soil; Measurement of tree height, girth and volume; Estimation of carbon stock in selected tree species; Visit to a community forest/agroforestry system/slash and burn area.

Suggested Readings: (All latest editions)

Bhattacharya, T. and Pal, D.K. 2015. The Soil: A natural resource. In: Soil Science – An Introduction, Rattan, R.K., Katyal, B.S., Dwivedi, A.K., Bhattarcharya, T., Tarafdar, J.C. and Kukal, S.S. (eds.). ISSS, Publishers, New Delhi, pp: 39-56.

Brooks, K.N. 2003. Hydrology and Watershed Management. Iowa State Press, New York.

Ghosh, S.K. and Singh, R. 2015. Social Forestry and Forest Management. Global Vision Publication, Delhi.

Hartshorn, T.A. and Alexander, J.W. 2004. Economic Geography. Third Edition. Prentice Hall of India Pvt. Ltd., New Delhi.

Jat, B.C. and Singh, S. 2010. Water Management through Traditional Technologies.Pointer Publishers, Jaipur.

Jha, L.K. 1995. Shifting Cultivation. APH Publishing Corporation, NewDelhi.

Jha, L.K. and Sen Sarma, P.K. 2009. Forestry for the People. APH Publishing Corporation, New Delhi.

Jha, L.K. 2009. Advances in Agroforestry. APH Publication Corporation, NewDelhi.

Majumdar, D.N. 1994. Shifting cultivation in North East India.Om Sons Publications, New Delhi.

Mukherjee, B. 2000.Environmental Management.Vikas Publishing House Pvt. Ltd.,Noida.

Singh, B.K. 2004. Conservation and Management. Mangal Deep Publication, Jaipur.

Singh, O.P. 2006. Environment and Natural Resources.Regency Publications, NewDelhi. Tripathi, R.P. and Singh, H.P. 2008.Soil Erosion and Conservation. Wiley Eastern Limited, New York. Ghosh, S.K. and Singh, R. 2003. Social Forestry and Forest Management. Global Vision Publication, Delhi.

Haab, T. and McConnell, K.E. 2003. Valuing Environmental and Natural Resources. Edward Elgar Publishing Ltd., Cheltenham.

FORTH SEMESTER

Course Code: ENV: 250

Course Title: ENERGY AND MINERAL RESOURCES

Total Contact Hours 75/Total Credits 4/Total Marks 100

Course Objectivse: To give students an understanding about energy and mineral resources, their environmental consequences and remedial measures.

Learning Outcomes: Student will be able to gain the knowledge about various energy and mineral resources, their importance in the economic development.

Unit I: Energy Resources: Definition and introduction; Classification of energy resources: Conventional and Non-conventional, Renewable and Non-renewable. Concept of emerging energy resources. Concept of carbon footprint and ecological footprint.

Unit II: Conventional and non-conventional energy resources: Fossil fuels, Hydro-electric power, Nuclear energy, Solar energy, Wind energy, Geothermal energy, Biogas and Bio-diesel.

Unit III: Mineral Resources: Classification and its importance; Distribution of major minerals in India; Processes of formation of Economic Mineral Deposit; Endogenic and Exogenic mineralization. Ocean as a source of mineral resources.

Unit IV: Identification of economic minerals; Mapping of important mineral ores of India; Demonstration of solar photovoltaic panel and its working in series combination and parallel combination; Preparation of station based wind rose for an area; Energy audit for a room/house/institute.

Suggested Readings: (all latest editions)

Banerjee, B.P. 2005. Handbook of Energy and the Environment in India. Oxford University Press, New Delhi.

Dar, I.A. and Dar, M.A. 2011. Earth and Environmental.Science.In-Tech (onlinepublisher), Delhi.

Keller, E.A. 2011.Introduction to Environmental Geology.Fifth Edition.Pearson PrenticeHall.

Kesler, P. 2002. Mineral resources: Economics and Environment. CBS Publishers & Distributors,New Delhi.

Leeder, M., Arlucea, M.P. 2006. Physical Processes in Earth and Environmental Sciences. Blackwell Publishing.

Mukherjee, B. 2000. Environmental Management. Vikas Publishing House Pvt. Ltd., Noida.

Negi, B.S. 2002. Geography of Resources.KedarNath Ram Nath, New Delhi andMeerut.

Sastri, M.N. 1994. Energy Sources, Resources and Options. Saujanya Books, NewDelhi.

Singh, B.K. 2004.Conservation and Management.Mangal Deep Publication,Jaipur. Singh, O.P. 2006. Environment and Natural Resources.Regency Publications, NewDelhi. Tiwari, G.N. 2016.Solar Energy.Narosa Publishing, NewDelhi.

Course Code: ENV: 251

Course Title: BIODIVERSITY

Total Contact Hours 75/Total Credits 4/Total Marks 100

Course Objectives: To give students an understanding regarding the biodiversity at various levels, its conservation strategies, ecosystem services and their role in maintaining sustainable ecosystems.

Learning Outcomes: Students will be able to understand different types of biodiversity, its importance and conservation strategies in maintaining healthy ecosystem.

Unit I: Biodiversity: Concept, types and importance of biodiversity; Levels of biodiversity; Megadiversity countries;Globalbiodiversityhotspots;Biodiversity hotspots of India; Direct and indirect valuesofbiodiversity; Bioprospecting: examples and impacts.

Unit II: Ethno-biology and traditional practices: Concept and definition of Ethnobiology; Disciplines of Ethnobiology: Ethnobotany and Ethnozoology; Traditional practices and uses of plants and animals, Concept and importance of sacred groves.

Unit III: Biodiversity Loss: Factors causing loss of biodiversity; Extinction of species; Threatened species; IUCN Red List and Red List Index; CITES, TRAFFIC; Human-wildlife conflict and its management.

Unit IV: Determination of Similarity and dissimilarity by Bray Curtis method; Determination of Shannon Weiner index and Simpson Diversity Index in a forest and grassland ecosystem; Market survey of wild edibles; Study of soil fauna using modified tullgren apparatus; Identification and documentation of bird species in an area; Visit to a place/area promoting biodiversity conservation and preparation of field report.

Suggested Readings: (All latest editions)

Chiras, D.D. and Reganold, J.P. 2009. Natural Resource Conservation: Management for a Sustainable Future. Tenth Edition Addison Wesley, Boston.

Cunningham, W.P. and Cunningham, M. 2011. Environmental Science: A Global Concern. McGraw-Hill, Boston.

Ghosh, A. 2009. Biodiversity Conservation. APH Publications, New Delhi.

Jain, S.K. (ed) 1981. Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi.

Jain, S.K. 2004. Manual of Ethnobotany. Scientific Publishers, Jodhpur.

Khan, I.A. 2000.Environmental Law.Central Law Agency, Allahabad.

Kumar, A. 2005. Biodiversity and Conservation. Saujanya Books, New Delhi.

Murugesan, A.G. and Rajakumari, C. 2006. Environmental Science and Biotechnology.MJP Publishers, Chennai.

Pandey, H.N. 2010. Sacred Forests – Their Ecology and Diversity. Regency Publications, Delhi.

Thapar, S.D. 1975. India's Forest Resources. Macmillan India, NewDelhi. Tiwari,B.K.,Barik,S.K. and Tripathi,R.S.1999.Sacred forests of Meghalaya:biological and cultural diversity. Regional Centre: NAEB, North-Eastern Hill University, Shillong. Zafar, R. 2009. Medicinal plants of India. CBS Publishers & Distributers Pvt. Ltd, New Delhi.

Course Code: ENV: 252

Course Title: BIODIVERSITY CONSERVATION AND LAWS

Total Contact Hours 60/Total Credits 4/Total Marks 100

Course Objectives: To give students an understanding about biodiversity conservation strategies at various level, traditional knowledge system, and biodiversity laws.

Learning Outcomes: It will motivate students to appreciate that they are an integral stakeholder in conservation and management of Biodiversity.

Unit I: Biodiversity Conservation: *Ex-Situ* and *In-Situ* conservation measures: Protected area network (wildlife sanctuaries, national parks, biosphere reserves, community reserves, conservation reserves), botanical gardens, germ-plasm bank; Wildlife corridors; Keystone species, Umbrella species, Sentinel species, Exotic and invasive species.

Unit II: Biodiversity Conservation in India: Concept of Man and Biosphere; Conservation of Endangered Species: Project Tiger, Project Elephant, Project Crocodile; Wet land Conservation of India, Ramsar sites.

Unit III: Biodiversity and traditional knowledge: Concept and importance of traditional practices pertaining to bioresource conservation; Intellectual Property Rights – Concept, types and its application to Protection of biodiversity and related Traditional knowledge in India.

Unit IV: Biodiversity Laws: Convention on Biological Diversity, Wildlife Protection Act 1972, Forest Conservation Act 1980, Biodiversity Act 2002, Biodiversity management levels: National Biodiversity Authority, State Biodiversity Board and Biodiversity Management Committees; Peoples biodiversity register.

Suggested Readings: (all latest editions)

Chiras, D.D. and Reganold, J.P. 2009. Natural Resource Conservation: Management for a Sustainable Future. Tenth Edition Addison Wesley, Boston.

Cunningham, W.P. and Cunningham, M. 2011. Environmental Science: A Global Concern. McGraw-Hill, Boston.

Ghosh, A. 2009. Biodiversity Conservation. APH Publications, New Delhi.

Jain, S.K. (ed) 1981. Glimpses of Indian Ethnobotany. Oxford and IBH, New Delhi.

Jain, S.K. 2004. Manual of Ethnobotany. Scientific Publishers, Jodhpur.

Khan, I.A. 2000.Environmental Law.Central Law Agency, Allahabad.

Krishnamurthy, V.K. 2003. Text Book of Biodiversity. Science Publisher, Chennai.

Kumar, A. 2005. Biodiversity and Conservation. Saujanya Books, New Delhi.

Negi, S.S. 2000. Forest Law (with explanations). Oscar Publications, Delhi.

Pandey, H.N. 2010. Sacred Forests – Their Ecology and Diversity. Regency Publications, Delhi.

Raina, M., Pepper, I. and Gerba, C. 2006. Environmental Microbiology. Academic Press, New York.

Sands, P. 2003. Principles of International Environment Laws. Cambridge University Press, London.

Tiwari, B.K., Barik, S.K. and Tripathi,R.S.1999.Sacred forests of Meghalaya: biological and cultural diversity. Regional Centre: NAEB, North-Eastern Hill University, Shillong. Trivedi, R.K. 2009.Handbook of Environmental Laws, Acts, Guidelines, Compliance and Standards (Vol.I and II).Third Edition.B.S. Publications, Hyderabad.

Zafar, R. 2009. Medicinal plants of India. CBS Publishers & Distributers Pvt. Ltd, New Delhi.

Course Code: ENV: 253

Course Title: WILDLIFE ECOLOGY AND ECOTOURISM

Total Contact Hours 60/Total Credits 4/Total Marks 100

Course Objectives: To build up scientific knowledge on wildlife ecology, concepts of wildlife management and wildlife tourism and ecotourism concepts and practices.

Learning Outcomes: The students will be able to apply knowledge to solve problems related to wildlife conservation, management, wildlife tourism and ecotourism.

Unit I: Wildlife ecology: Concept, scope and importance of wildlife; Wildlife values; Concept and importance of population in wildlife studies; Animal-habitat interactions; Effects of intra- and inter- specific competition on wildlife; Prey-predator relationship.

Unit II: Wildlife Management: Concept and importance of wildlife management; Construction and importance of life-tables in wildlife management; Habitat manipulation: food, water, shade improvement; Making observations and records: field notes, datasheets; Wildlife photography: types of camera, camera traps; Field equipments: altimeter, pedometer, field compass, binoculars, radio collaring.

Unit III: Wildlife tourism: Basic concepts, importance and scope; Sustainable development in wildlife tourism; Negative impact of wildlife tourism: Disruption of breeding behaviour, disruption of parent-offspring bonds, increased mortality, vanity hunts and poaching, increased vulnerability, disruption feeding behaviour; Positive impacts: Habitat restoration by eco-lodges and other tourism operations, conservation breeding, quality interpretation, culling and population maintenance, conservation hunting/harvest, anti-poaching practices and tools.

Unit IV: Ecotourism practices: Evolution and concept; importance and types of ecotourism; Components and principles of ecotourism; Impacts of ecotourism; Ecotourism criteria; Ecotourists: types and code of ethics; Quebec Declaration on Ecotourism; GI Tourism;Ecotourism practices; Community based tourism-transportation, facilities and services.

Suggested Readings: (All latest editions)

Balakrishnan, M. 2016. Wildlife Ecology and Conservation.Scientific Publishers, Jodhpur, India.
Black, R. and Crabtree, A. 2007.Quality Assurance and Certification in Ecotourism.CABI Publishing.
Buckley, R. 2009 Ecotourism: Principles and Practices.
Buckley, R. 2009 Ecotourism: Principles and Practices.
Buckley, R. 2009 Ecotourism: Principles and Practices.
Buckley, R. 2004 Ecotourism: Principles and Practices.
Buckley, R.C. 2004 Environmental Impacts of Ecotourism.CABI Publishing.4.Buckley, R.C. 2009.
Ecotourism: Principles and Practices. CAB International.
Fennell, D.A. 2020. Ecotourism: An Introduction. Fifth edition. Routledge, London.

Gangte, M.T.C. 2012. Eco-tourism Development in Northeast India: Sustainable Alternative: In Search of a Road to Peace, Development and Sustainability. LAP Lambert Academic Publishing.

Giles, R.H. Jr. 2000.Wildlife Management Techniques.Third edition.The Wildlife Society, Washington, D.C. Nataraj Publishers, Dehra Dun, India.

Ranga, M.M. 2012. Wildlife Management and Conservation. Agrobios (India).

Seba, J. 2011. Ecotourism and Sustainable Tourism: New Perspectives and Studies. Apple Academic Press, New Jersey.

Sharma, B.D. 1999. Indian Wildlife Resources Ecology and Development. Daya Publishing House, New Delhi.

Sinclair, A.R.E., Fryxell, J.M. and Caughly, G. 2006. Wildlife Ecology, Conservation and Management. Blackwell Publishing, U.S.A.

Singh, J. 2010. Ecotourism. I.K. International Publication, New Delhi.

Singh, R. 2003. Ecotourism and Sustainable Development. Abhijeet Publications, Delhi.

Tyagi. R. 2010. Understanding Wildlife. Discovery Publishing House Pvt. Ltd., New Delhi.

Wearing, S. and Neil, J. 2009. Ecotourism: Impacts, potentials and possibilities. Second edition. Elsevier, UK.

Wheelan, T. 1991. Nature tourism. Managing the Environment. Island press, Washington D.C.

FIFTH SEMESTER

Course Code: ENV: 300

Course Title: ENVIRONMENTAL PHYSICS AND ENVIRONMENTAL CHEMISTRY

Total Contact Hours 60/Total Credits 4/Total Marks 100

Course Objectives: To give students an understanding about basic concepts of physics, chemistry applicable in the field of environmental science.

Learning Outcomes: Student will be able to gain the knowledge about various concepts of physics and chemistry applicable in environmental science.

Unit I: Environmental Physics: Basic concept of light and matter; Relation between energy, wavelength and frequency; Black body radiation; Kirchhoff's Law of radiation; Boltzmann equation; Spectroscopic concept: introduction to concept of absorption and transmission of light, Beer-Lambert law, Photovoltiac cells; Scattering of light.

Unit II: Environmental Chemistry: Concept and scope of Environmental Chemistry; Classification and distribution of elements in the earth; Ions, particles and radicals in the atmosphere; Principles of chemical reactions: dissociation in solutions, concept of pH, acids and bases, buffer solutions.

Unit III: Atmospheric Chemistry: Composition of atmosphere; photochemical reactions in atmosphere; smog formation, types of smog (sulphur smog and photochemical smog), aerosols; chemistry of acid rain; reactions of NO₂and SO₂; free radicals and ozone layer depletion, role of CFCs in ozone depletion. Movement of pollutants in environment: Diffusion and dispersion, pollutant dispersal; Gaussian plume model, mixing heights.

Unit IV: Soil Chemistry:Soil properties: soil porosity, soil permeability, soil texture and soil water; Inorganic and organic components in soil; cation and anion exchange reactions in soil; Nitrogen, phosphorus and potassium in soil. Pesticides: Concept, classification and mode of action; organo-chlorine insecticides, cyclodine insecticides, organophosphates and carbamates.

Suggested Readings: (All latest editions)

Bahl, A and Bahl, B.S. 2014. A textbook of Organic Chemistry. S.Chand & Company, New Delhi. Dara, S.S. and Mishra, D.D. 2014. A Textbook of Environmental Chemistry and Pollution Control. S. Chand & Company, Ltd., New Delhi.

De, A.K. 2014.Environmental Chemistry.Seventh Edition. New Age International Pvt. Ltd., New Delhi. Gupta, P.K. 2010.Modern Toxicology Vol. I-III. Metropolitan Book Co. Pvt. Ltd., Delhi.

Hayes, W.A. 2014.Principles and Methods of Toxicology. Sixth Edition.CRC Press, New York. Klaassen, C.D and Watkins, J.B. 2015.Essentials of Toxicology.Third Edition. McGraw-Hill Professional, New Delhi.

Guthrie, F.E. and Perry, G. 1980. Introduction to Environmental Toxicology. Elsevier, Amsterdam. Walker, C.H., Sibly R.M., Hopkin, S.P., and Peakall, D.B. 2012.Principles of Ecotoxicology.Fourth Edition. CRC Press, NewYork.

Wright, D.A. and Welbourn, P. 2002. Environmental Toxicology. Cambridge UniversityPress, London.

Course Title: ENVIRONMENTAL POLLUTION

Total Contact Hours 60/Total Credits 4/Total Marks 100

Course Objectives: To give students an understanding about various pollution sources in environment and their effect on environment and life.

Learning Outcomes: Students will get a clear idea regarding pollution, pollutants and their various effects on humans and ecosystem which will make them careful in future.

Unit I: Pollution / Air Pollution: Concept and definition; Pollutants: classification: primary and secondary, biodegradable and non-biodegradable, point and non-point sources of pollution; Biological indicators of environmental pollution. Air Pollution: Sources of air pollutants, Gaseous pollutant: oxides of nitrogen, sulphur and carbon, hydrocarbons and CFCs; Particulate pollutants: total suspended particulate matter (TSPM), respirable suspended particulate matter (RSPM), aerosols; Consequences of air pollution; Greenhouse effect and Global warming; Bhopal Gas Tragedy; Methods of mitigating and controlling air pollution.

Unit II: Water Pollution: Concept and definition; Types and sources of water pollutants; Domestic effluents and industrial effluents; Surface water and ground water pollution; Marine pollution; Oil spills; Agriculture discharge: pesticides, fertilizers; Eutrophication; Bioaccumulation and Biomagnification; Minamata disease; Primary and Secondary treatment of wastewater; Methods of mitigating and controlling water pollution.

Unit III: Soil Pollution: Sources of soil pollution: domestic, industrial, agricultural practices and mining; Chemical and biological agents and their effects on soil; Salination of soil; Methods of mitigating and controlling soil pollution. Radioactive Pollution: Radioactivity; Units of measurement of radiation; Half-life period; Kinds and sources of radiation; Effects of ionizing and non-ionizing radiation; Fukushima nuclear accident; Prevention and remedial measures;

Unit IV: Noise Pollution: Sources of noise pollution; Measurement of noise pollution; Effects of noise pollution of human health: auditory and non-auditory; Shock waves; Silence zone; Abatement of noise pollution.

Suggested Readings: (All latest editions)

Finlayson-Pitts, B.J. and Finlayson Jr., J.N. 1986. Atmospheric Chemistry: Fundamentals and experimental techniques. John Wiley, New York.

Asthana, D K. and Asthana, M. 2006. Environment - Problems and Solutions.Second Edition. S. Chand and Co. Ltd., New Delhi.

Cheremisinoff, N.P.1996.Biotechnology for Waste and Wastewater Treatment.First Edition.William Andrew Publishing, New York.

Cunningham, W.P. and Saigo, W.B. 2007. Environmental Science.Ninth edition. McGraw Hill Higher Education, New York.

Fellenberg, G. 2003. 3rd Edition.Chemistry of Pollution.John Wiley and Sons Ltd, Chichester, UK. Khitoliya, R.K. 2014. Environmental Pollution Management and Control for Sustainable Development. Second Edition. S. Chand & Co. Ltd., New Delhi.

Rao, M.N. and Sultana, R. 2011. Solid and Hazardous Waste Management. BPS Books Pvt. Ltd, Hyderabad.

Reddy, P.J. 2011.Pollution and Global Warming. First Edition BSP Books Pvt. Ltd, Hyderabad. Sharma, B.K. 2015.Water Pollution.Fourth Edition.GOEL Publishing House, Meerut.

Sharma, B.K. and Kaur, H. 2001. An Introduction to Environmental Pollution.GOEL Publishing House, Meerut.

Tirvedi, R.K. and Geol, P.K. 2010. An Introduction to Air Pollution. Second Edition, DVS Publication, New Delhi.

Tripathi, B.D. and Govil, S.R. 2001. Water Pollution (An Experimental Approach). CBS Publishers and Distributors, New Delhi.

Uma Devi, P., Nagarathnam, A. and Satish Rao, B.S. 2000. Introduction to Radiation Biology. B.I. Churchill Livingstone Pvt. Ltd., New Delhi.

Course Code: ENV: 302

Course Title: TOOL AND TECHNIQUES IN ENVIRONMENTAL SCIENCE

Total Contact Hours 75/Total Credits 4/Total Marks 100

Course Objectives: To give students an understanding of statistical techniques, techniques used in air, water quality monitoring, basic concepts of remote sensing.

Learning Outcomes: Students are expected to have knowledge of statistical tools, sampling and analytical methods applied environmental monitoring.

Unit I: Statistics: Types of data: primary and secondary; Methods of collection of environmental data; Classification and tabulation of data; Frequency distribution; Measures of central tendency; Measures of dispersion; Correlation and Regression. Remote Sensing and GIS: Basics of Remote Sensing and GIS; Use of remote sensing and GIS in resource survey and land use mapping.

Unit II: Air quality Monitoring: Ambient air quality monitoring; Meteorological measurements; Measurement of suspended particulate matter (PM_{2.5}, PM₁₀),carbon monoxide; oxides of nitrogen; oxides of sulphur.

Unit III: Water quality monitoring: Water quality parameters; Water sampling techniques; Principles and procedures for measurement of pH, conductivity, total solids, hardness, chloride, dissolved oxygen, phosphate, nitrate, heavy metals (Atomic Absorption Spectrophotometry method) and total coliform count.

Unit IV: Computation of mean, median, mode and variance of a given environmental dataset; Demonstration on the use of GPS and determination of coordinates and altitude using GPS; Study of meteorological parameters: light intensity, ambient temperature and relative humidity; Determination of RSPM in atmosphere (roadside and classroom); Determination of total suspended solids (TSS) and total dissolved solids (TDS) in water samples; Determination of total hardness, chloride, calcium and magnesium content of water samples; Monitoring of noise level in public area (campus and roadside).

Suggested Readings: (All latest editions)

Adhikari, K. and Bhattacharjee, D. 2003. Statistics – Theory and Applications (including fundamentals of Computer). Bibhu Ranjan Paul, Silchar.

Arora, P.N. and Malhan, P.K. 2012.Biostatistics.Himalaya Publishing House, Pvt. Ltd, Nagpur. Barrett, E.C. and Curtis, L.F. 2016.Introduction to Environmental Remote Sensing.Tenth Edition.Routledge, Taylor and Francis, NewYork.

Bhatta, B. 2011.Remote Sensing and GIS.Second Edition. Oxford University Press, NewYork.

Dara, S.S. 2004. Environmental Chemistry and Pollution Control.Seventh Edition. S. Chand, NewDelhi.

Jensen, J. R. 2007. Remote Sensing of the Environment: An Earth Resource Perspective. Second Edition.Pearson Education India.

Leon, A. and Leon, M. 2009. Fundamentals of Information Technology.Second Edition. Leon Press, Chennai.

Lillesand, T.M. and Kiefer, R.W. 2014. Remote Sensing and Image Interpretation. Seventh Edition. John Wiley, Cambridge.

Rajaraman, V. 2014.Fundamentals of Computers.Sixth Edition.Prentice-Hall of India Pvt. Ltd., New Delhi.

Siddiqui, M. A. 2005.Introduction to Geographical Information System. ShardaPustakBhawan, Allahabad.

Singhal, M. 2016. Elements of Statistics (Theory and Practice). Eight Edition. Lakshmi Narain Agarwal, Educational Publishers, Agra.

Wing, M.G. and Bettinger, P. 2008. Geographic Information Systems: Applications in Natural Resource Management. Second Edition. Oxford University Press, New York.

Course Code: ENV: 302

Course Title: DISASTER MANAGEMENT

Total Contact Hours 60/Total Credits 4/Total Marks 100

Course Objectives:To help students to get a basic understanding about disasters and how to deal with disasters.

Learning Outcomes: Students should be able to assess the result of an environmental activity and should know how the effect can be assessed, mitigated and managed.

Unit I: Disasters: Introduction, definition; Hazards and disasters, risk and vulnerability in disaster; Natural and Manmade disasters; Earthquake, flood, drought, landslide, land subsidence, cyclone, tsunami, volcanoes; Man Made Disasters: gas and radiation leaks, toxic waste disposal, oil spills, forest fires.

Unit II: Study of important disasters: Earthquake: types, intensity, magnitude; Seismic zones of India; Major fault systems of India plate; Flood: types and its management; Drought: types and its management; Landslide and its management; Case studies of disaster in Meghalaya: earthquake and flood.

Unit III: Socio-economic and environmental impacts of disaster; Disaster Management Cycle; Basic principles of Disaster Management; National and state bodies for Disaster Management; Early warning systems: cyclone, tsunami, volcano.

Unit IV: Training, Awareness Program and Project on Disaster management: Training and drill for Disaster preparedness; Awareness generation programme; Usage of GIS and Remote Sensing Techniques in Disaster Management.

Suggested Readings: (All latest editions)

Carter, W.N. 2008. Disaster Management: A disaster manager's Handbook. Asian Development Bank. Dandapat, K. 2020. Flood Hazards Management: A Community Approach-Natural Hazards and Disaster Management. Notion Press Media Pvt. Ltd.

Handmer, J. and Dovers, S. 2007. Handbook of Disaster and Emergency Policies and Institutions.Earthscan, London, Sterling, VA.

Hyndman, D. and Hyndman, D. 2007. Natural Hazards and Disasters.Second Edition. Wadsworth Publishing Co. Inc.

Kumar, N. 2013. Textbook of Disaster Management. Satish Serial Publishing House.

Kumar, S. 2023. Landslide, Disaster and Management. Shashwat Publication.

Paul, R. 2021. Geographical Information System and IT in Disaster Management. Academic Aspirations Rosales, J. 2018. Disaster Management of Earthquakes and Volcanoes. Delve Publishers, Arcler Education Inc.

Singh, R.B. 2006.Natural Hazards and Disaster Management - vulnerability and mitigation. Reprint Edition. Rawat Publications.

Subramanian, R. 2018. Disaster Management. Vikas Publishing.

Viswanatha, C.R., Hegadal, R.V. and Hegadal, S.V. 2019.Disaster Management.Himalaya Publishing House.

Course Code: ENV: 303

Course Title: Internship/ Apprenticeship/Community engagement and service/ field based learning or minor project

Total Contact Hours 120/Total Credits 4/Total Marks 100

SIXTH SEMESTER

Course Code: ENV: 350

Course Title: ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL ECOMONICS

Total Contact Hours 60/Total Credits 4/Total Marks 100

Course Objectives: To make students understand how the impacts of a developmental activity can be assessed and adverse effects can be mitigated along with concepts of environmental economics.

Learning Outcomes: It will enhance the foundation on the concept and components of environmental impact assessment, environmental audit and develop the skill to write and design the draft of EIA report and risk assessment.

Unit I: Environmental Impact Assessment: Concept; Principles of EIA; Necessity ofEIA; EIA as a decision-making tool; EIA notification of 1994 and 2006; Procedure of environmental clearance; Case studies: River valley projects, Mining, Thermal power plants.

Unit II: Steps of EIA: screening, scoping, project description, baseline data, impact prediction and analysis and mitigation measures. EMP (Environment Management Plan): concept, components, and importance of EMP.

Unit III: Environmental Economics: Concept of Environmental Economics; Natural Resource Accounting: concept and methods of NRA; Cost Benefit Analysis:cost effectiveness, market-based incentives and disincentives.

Unit IV: Environmental Audit:Concept of Environmental Audit; Process and implementation of Environmental Audit; Life Cycle Assessment and Environmental Management System; Ecomark and ISO certification.

Suggested Readings: (All latest editions)

Anjaneyulu, Y. and Manickam, W. 2011.Environmental Impact Assessment Methodologies. Second Edition BSP Books Pvt. Ltd., Hyderabad.

Botkin, D.B. and Keller, E.A. 2011. Environmental Science: Earth as a Living Planet. John Wiley and Sons, New Delhi.

Charles, P. and Vincent, J.R. 2003. Natural Resource Accounting and Economic Development: Theory and Practice. Edward Elgar Publishing Ltd., Cheltenham.

Eccleston, C.H. 2011. Environmental Impact Assessment. CRC Press, New York.

Haab, T. and McConnell, K.E. 2003. Valuing Environmental and Natural Resources. Edward Elgar Publishing Ltd., Cheltenham.

Lawrence, D.P. 2003. Environmental Impact Assessment: Practical Solutions to Recurrent Problems. John Wiley and Sons, New Delhi.

Markandya, A., Harou, P., Bellu, L. and Cistulli, V. 2006.Environmental Accounting and Sustainability. Edward Elgar Publishing Ltd., Cheltenham.

Morris, P. and Therivel, R. 2001. Methods of Environmental Impact Assessment. Spoon Press, Prague. Srivastava, D.C.2005. Readings in Environmental Ethics: Multidisciplinary Perspectives. Rawat Publications, Jaipur.

Course Title: ENVIRONMENTAL LAWS AND CONTEMPORARY ENVIRONMENAL MOVEMENTS

Total Contact Hours 75/Total Credits 4/Total Marks 100

Course Objective: To impact knowledge about concepts of environmental policies, legislation pertaining to protection and prevention of air and water pollution, international conventions and environmental movements for protection of environment.

Learning Outcomes:Learning about the significance of developments in international environmental law and the fundamental principles that have emerged, comprehending the statutory and regulatory mechanisms pertaining to environment in India and Knowing about importance of public participation in environmental protection.

Unit I: Environmental Policies and Laws: Concept, importance and challenges of environmental laws; Salient features of: Conventionon Combating Desertification; Convention on Climatic Change; Kyoto Protocol; Paris Agreement of 2015.

Unit II: Environmental Legislation in India: The Air (Prevention and Control of Pollution) Act 1981; The Water (Prevention and Control of Pollution) Act 1974; Environmental Protection Act 1986; National Environmental Policy 2006.

Unit III: Environmental Movements and Environmental ethics: Origin of environmental movements; Environmental Movements in India: Silent Valley, Narmada BachaoAndolan, Chipko Movement, Bishnoi Movement.Environmental Organizations: National: ATREE, Kalpavriksh; International: Greenpeace, WWF, IUCN. Prominent environmentalists of India: Sunderlal Bahugana, Salim Ali, Amrita Devi; Environmental ethics.

Unit IV: Project Work: Project work will be assigned in V Semester and will be evaluated in VI Semester. Each student will be required to submit a project based on field survey to be conducted under the guidance of a faculty member. The report shall be evaluated by the examiners during the practical examination.

Suggested Readings: (All latest editions)

Khan, I.A. 2000.Environmental Law.Central Law Agency, Allahabad.

Leelakrishnan, P. 2010. Environmental Law in India. Third Edition. Lexis Nexis Butterworths, Nagpur.

Sands, P. 2003. Principles of International Environment Laws. Cambridge University Press, London.

Sands, P. 2012. Principles of International Environmental Laws. Third Edition. Cambridge University Press, London.

Shanthakumar, S. 2008. Introduction to Environmental Law.Second Edition. Wadhwa and Company, Nagpur.

Trivedi, R.K. 2009. Handbook of Environmental Laws, Acts, Guidelines, Compliance and Standards (Vol. I and II). Third Edition. B.S. Publications, Hyderabad.

Trivedi, R.K. 2010. Handbook of Environmental Laws, Acts, Guidelines, Compliance and Standards: Vol I and II. B.S. Publications, Hyderabad.

Course Title: WASTE MANAGEMENT AND TOXICOLOGY

Total Contact Hours 75/Total Credits 4/Total Marks 100

Course Objective: To give students an understanding about concepts of toxic chemicals and toxic waste, E-waste, and solid waster managements.

Learing Outcomes: Students should get a clear idea regarding toxic and hazardous chemicals and wastes, E-waste and its various effects on environment which will make them careful in future.

Unit I: Toxic chemicals:Concept of toxic chemicals and toxicology; Toxic chemicals in air, soil, water and waste water;Chemistryandimpacts of Acid mine Drainage; Toxic Metals: Biochemical effects of heavy metals (arsenic, lead, mercury); Chemical Speciation: Concept and importance; Chemical speciation of lead andmercury.

Unit II: E-waste: Concept, sources and composition; Disposal methods: recycling and resource recovery, scientific disposal methods; E-waste (Management) Rules, 2022. Hazardous waste: Concept, sources and classification;Effects and disposal methods of hazardous wastes; Hazardous Waste (Management) Rules, 2016.

Unit **III: Solid waste Management**: Concept, origin, classification and characteristics of solid waste; Segregation, collection, transportation and disposal of solid waste; Solid waste treatment and disposal: composting, open dumping, sanitary landfill, incineration, recycling and recovery; Solid Waste (Management) Rules, 2016.

Unit IV: Determination of acidity and alkalinity of water samples; Determination of heavy metal toxicity by germination and seedling growth tests; Determination of effectiveness of alum as a coagulant; Determination of turbidity of water; Determination of phosphate, nitrate and sulphate of water samples; Visits to institutions/industries/waste disposal sites.

Suggested Readings: (All new editions)

Bhatia, S.C. 2007. Solid and Hazardous Waste Management. Atlantic Publishers and Distributors (P) Ltd. New Delhi.

Butter, G.C. (ed). 1978. Principles of Ecotoxicology. Scope 12. John Wiley & Sons, New York.

Gupta, P.K. 2010. Modern Toxicology Vol. I-III. Metropolitan Book Co. Pvt. Ltd., Delhi.

Hayes, W.A. 2014.Principles and Methods of Toxicology. Sixth Edition.CRC Press, New York. Klaassen, C.D and Watkins, J.B. 2015.Essentials of Toxicology.Third Edition. McGraw-Hill Professional, New Delhi.

Guthrie, F.E. and Perry, G. 1980. Introduction to Environmental Toxicology. Elsevier, Amsterdam. Walker, C.H., Sibly R.M., Hopkin, S.P., and Peakall, D.B. 2012.Principles of Ecotoxicology.Fourth Edition. CRC Press, NewYork.

Wright, D.A. and Welbourn, P. 2002. Environmental Toxicology. Cambridge UniversityPress, London. Jacobson-Kram, D. 2006.Toxicological Testing Handbook: Principles, Applications and Data Interpretation. Taylor & Francis, NewYork.

Maiti, S.K. 2011. Hand Book of Methods in Environmental Studies, Vol. I and II.ABD Publishers, Jaipur. Tripathi, B.D. and Govil, S.R. 2001.Water Pollution (An Experimental Approach).CBS Publishers and Distributors, New Delhi.

Course Title: ENIVORNMENTAL BIOTECHNOLOGY AND ENVIRONMENTAL MICROBIOLOGY

Total Contact Hours 75/Total Credits 4/Total Marks 100

Couse Objectives: To make students aware of the role of microbiology, biotechnology and toxicology in the sustenance of environment and application of concepts of microbiology and biotechnology in Environmental Sciences.

Learning Outcomes:Student should be able to comprehend the activities and roles of microbes in the environment and acquaint themselves with their applications.

Unit I: Environmental Biotechnology: Concept and scope of environmental biotechnology; Basics of gene cloning; Recombinant DNA technology; Applications of biotechnology in environment: Vermicomposting technology; Geneticallymodified organisms; Biopesticidesand Biofertilisers: types, uses and relevance to the environment; Degradation of lingo-cellulosic waste; Biogas production.

Unit II: Bioremediation: Concept and definition; *In-Situ* and *Ex-Situ* bioremediation techniques; Phytoremediation; Mycoremediation; Microbial remediation; Organisms involved in bioremediation processes; Super bugs in bioremediation.

Unit III: Environmental Microbiology: Microbial diversity and scope of microbiology; microbes in soil, air and water; Role of microorganisms in nutrient cycling: Nitrogen Cycle and Phosphorus Cycle; Role of microorganisms in waste treatment: Anaerobic (methanogenesis) and aerobic (trickling filter, activated sludge, oxidation pond) treatment of wastewater; Microbial Biosensors: Types and application.

Unit IV: Determination of Coliform count in natural waters; Determination of BOD in water samples; Preparation of vermicompost; Study of Mycorrhizal association; Study of root nodules of a nitrogen fixing plant; Media preparation and isolation of bacteria from soil.

Suggested Readings: (All latest edition)

Abbasi, S.A. and Ramasami, E. 1999.Biotechnological Methods of Pollution Control. University Press, Hyderabad.

Gupta, H.C.L., Siddiqui, A.U. and Parihar, A. 2010. Biopest Management (Entomopathogenic Nematodes, Microbes & Bioagents). Agrotech Publishing Academy, Udaipur.

Gupta, P.K. 2007. Elements of Biotechnology. Rastogi Publications, Meerut.

Jemba, P.K. 2004.Environmental Microbiology.Science Publishers, New Hampshire.Srivastava, M.L. 2003.Basic Environmental Microbiology.Manohar Books, New Delhi.

Pelczar, Jr. M.J, Chan, E.C.S. and Krieg, N.R. 2009. Microbiology. Fifth Edition. Tata McGraw-Hill, New Delhi.

Scrogg, A. 2005.Environmental Biotechnology.Second edition, Oxford University Press, New York. Somani, L.L., Shilpkar, P. And Shilpkar, D. 2011. Biofertilizers – Commercial Production Technology & Quality Control.Agrotech Publishing Academy, Udaipur.

Trivedi, P.C. 2010. Bioremediation of wastes and Environmental Laws. Aavishkar Publishers, Distributors, Jaipur.