Syllabus

for

Four Year B.Sc. Degree Course

in

ENVIRONMENTAL SCIENCE

(NEP-2020)

SEMESTER (I–VIII)

MIZORAM UNIVERSITY

2023

Syllabus for Four Year B.Sc. ENVIRONMENTAL SCIENCE (NEP-2020), 2023

Course Structure: B. Sc. Environmental Science								
Semester	**Paper Name**	**Paper Code**	**Components**	**Credits**	**Total credits**	**Marks**		**Total Marks**
						Continuous Assessment	**End Semester**	
I	**Major Course:** Fundamentals of Environmental Science	EVS/100	T + P	3 + 1	4	25	75 (50+25)	100
	*Environmental Education and Awareness	EVS/101	T	4	4	25	75	100
	Minor Course (*To be offered for other departments as a minor)	(* EVS/101)			4	25	75	100
	Multidisciplinary Course: Environmental Issues	EVS/102	T		3	25	75	100
	AEC				3	25	75	100
	VAC				2	25	75	100
				Total	**20**			**600**
II	**Major Course:** Natural Resources	EVS/103	T + P	3 + 1	4	25	75 (50+25)	100
	*Environmental Pollution	EVS/104	T + P	3 + 1	4	25	75 (50+25)	100
	Minor Course (*To be offered for other departments as a minor)	(*EVS/104)			4	25	75	100
	Multidisciplinary Course: Natural Resource Conservation	EVS/105	T	3	3	25	75	100
	SEC				3	25	75	100
	VAC				2	25	75	100
				Total	**20**			**600**
Exit Option with Undergraduate Certificate after securing 40 credits with additional credits of work based vocational course(s) offered during summer term with entry option to second year or third semester.								
III	**Major Course:** Environmental Monitoring and Control Technology	EVS/200	T + P	3 + 1	4	25	75 (50+25)	100
	*Biodiversity Conservation and Sustainable Development	EVS/201	T + P	3 + 1	4	25	75 (50+25)	100
	Minor Course (*To be offered for other departments as a minor)	(*EVS/201)			4	25	75	100

	Multidisciplinary Course: Waste Management	EVS/202	T	3	3	25	75	100
	SEC				3	25	75	100
	VAC				2	25	75	100
				Total	**20**			**600**
IV	**Major Course:** Environmental Assessment and Legislations	EVS/203	T + P	3 + 1	4	25	75 (50+25)	100
	*Global Environmental Issues	EVS/204	T	4	4	25	75	100
	Minor Course (*To be offered for other departments as a minor)	(* EVS/204)			4	25	75	100
	AEC				3	25	75	100
	SEC				3	25	75	100
	VAC				2	25	75	100
				Total	**20**			**600**
Exit Option with Undergraduate Diploma after securing 80 credits with additional 4 credits of skilled based vocational course(s) offered during the first or second year summer term along with entry option to third year or fifth semester.								
V	**Major Course:** Environmental Toxicology and Health	EVS/300	T + P	3 + 1	4	25	75 (50+25)	100
	Environmental Biology	EVS/301	T +P	3+1	4	25	75 (50+25)	100
	*Restoration Ecology	EVS/302	T	4	4	25	75	100
	Minor Course (*To be offered for other departments as a minor)	(* EVS/302)			4	25	75	100
	AEC				2	25	75	100
	Internship/Field Study/Practical	EVS/303	P		2	25	75	100
				Total	**20**			**600**
VI	**Major Course:** Chemistry of Environment	EVS/304	T + P	3 + 1	4	25	75 (50+25)	100
	Natural Hazards and Disaster Management	EVS/305	T + P	3 + 1	4	25	75 (50+25)	100
	Human Ecology	EVS/306	T	4	4	25	75	100
	*Environmental Ethics	EVS/307	T	4	4	25	75	100
	Minor Course (*To be offered for other departments as a minor)	(* EVS/307)			4	25	75	100
				Total	**20**			**500**
Award of 3 year Bachelor's Degree after completion of 120 credits with entry option to the 4 year Bachelor's Degree for those students who obtain a minimum CGPA of 7.5 in Bachelor's degree examination								

VII	**Major Course:** Environmental Statistics and Computer Application	EVS/400	T + P	3 + 1	4	25	75 (50+25)	100
	*Climatology	EVS/401	T + P	3 + 1	4	25	75 (50+25)	100
	*Human Wildlife Conflict and Management	EVS/402	T	4	4	25	75	100
	Minor Course (*To be offered for other departments as a minor)	(* EVS/401)			4	25	75	100
	Minor Course (*To be offered for other departments as a minor)	(* EVS/402)			4	25	75	100
				Total	**20**			**500**
Bachelor's Degree (Honours)								
VIII	**Major Course:** Research Methodology	EVS/403	T + P	3 + 1	4	25	75 (50+25)	100
	Geoinformatics	EVS/404	T + P	3 + 1	4	25	75 (50+25)	100
	Environmental Biotechnology	EVS/405	T + P	3 + 1	4	25	75 (50+25)	100
	Soil Science	EVS/406	T + P	3 + 1	4	25	75 (50+25)	100
	Environmental Management	EVS/407	T + P	3 + 1	4	25	75 (50+25)	100
				Total	**20**			**500**
Entire Programme (Semester I-VIII) Grand Total Credits					**160**			**4300**
Award of Bachelor's Degree (Honours) in relevant Discipline/Subject after completion of 160 credits without Research								
OR								
VIII	***Bachelor's Degree (Honours with Research)***							
	Major Course: Research Methodology	EVS/403	T + P	3 + 1	4	25	75 (50+25)	100
	Select any **ONE** major course from Geoinformatics; Environmental Biotechnology; Soil Science; Environmental Management	EVS/404; EVS/405; EVS/406; EVS/407	T + P	3 + 1	4	25	75 (50+25)	100
	Research Project/Dissertation	EVS/408		12	12	75	225	300
				Total	20			500
Entire Programme (Semester I-VIII) Grand Total Credits					**160**			**4300**
Award of Bachelor's Degree (Honours with Research) in relevant Discipline/Subject after completion of 160 credits with Research								

T = Theory; **P** = Practical; AEC = Ability Enhancement Courses; SEC = Skill Enhancement Courses; VAC = Value Added Courses; *Courses having both theory (3 credits) and practical (1 credit) papers will carry 50 marks and 25 marks for the end semester examination respectively.*

Minor Course (*Major to be offered for students of other allied departments opting as minor course) Environmental Science core student will opt minor course of other allied departments.

SEMESTER I

Main Course

FUNDAMENTALS OF ENVIRONMENTAL SCIENCE

Paper Code: EVS/100

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY

Total number of contact hours: 45

Unit-I: Principles of Environmental Science

Scope and importance of environmental science; Fundamental principles; Multidisciplinary nature of environmental science; Physico-chemical and biological factors in the environment; Social environment; Nature of man and environment interactions; Carrying capacity.

Unit-II: Basic Concept of Ecology and Ecosystem

Ecology and its branches; Concept and types of ecosystems, their structure, and functions; Components of an ecosystem; Energy flow within ecosystem; Food chain and food web; Ecological pyramids; Ecological succession.

Unit-III: Environment and its components

Atmosphere, lithosphere, hydrosphere and hydrological cycles, biosphere, their structure and composition; Biogeochemical and nutrient cycles- nitrogen, carbon, oxygen.

PRACTICAL

Paper Code: EVS/100 (P)

Total number of contact hours: 15 hours

1. Preparation of environmental diary.
2. Plotting of important protected areas of India.
3. Experiment to demonstrate the superiority of man over other primates by studying cranial size, dentition, versality of limbs.
4. Determination of atmospheric temperature and relative humidity.
5. Determination of pH of water sample.
6. Determination of Rainfall.

Suggested Readings:

1. Santra, S.C. 2018. Environmental Science. New Central Book Agency (P) Ltd., Kolkata.
2. Goudie, A.S. 2018. Human impact on the natural environment, Wiley and Sons, US.
3. Moseley, W.G., Perramond, E., Hapke, H.M., Laris, P. 2013. An Introduction to Human-Environment Geography: Local Dynamics and Global Processes, Wiley & Sons, US.
4. Sharma, P.D. 2018. Ecology and Environment. Rastogi Publications (13th Edition), Meerut.
5. Singh, J.S., Singh, S.P., Gupta, S.R. 2017. Ecology, Environmental Science, and Conservation, S Chand Publishers, New Delhi
6. Agarwal, K.M., Sikdar, P.K. and Deb, S.C. 2013. A text book of Environment. Macmillan Publishers India Ltd.
7. Bharucha, E. 2015. Text Book of Environmental Studies. University Press (India) Pvt. Ltd., Hyderabad.

8. Das, R.C. and Behera, D.K. 2008. Environmental Science: Principle and Practice. PHI Learning Private Limited, New Delhi.
9. Gupta, A., Dey, M. and Bhattacharjee, P.R. 2001. Our Environment. Assam University, Silchar.
10. William P Cunningham, Mary Ann Cunningham. 2006. Principles of Environmental Science: Inquiry and Applications (English) 4th Edition. McGraw Hill Education (India) Private Limited
11. Rai, P.K. 2015. Ecology and Environmental Science. Today & Tomorrow Printers & Publishers, New Delhi.
12. Daniel, D.C. 2014. Environmental Science (Tenth Edition). Jones and Bartlett Publishers, London.
13. Joshi, P.C. & Joshi, N. 2012. A Text Book of Environmental Science. APH Publishing Corporation. New Delhi.
14. Maiti, S.K. 2016. Handbook of Methods in Environmental Studies. Oxford Book Company, New Delhi.
15. Gupta, P.K. 2011. Methods in Environmental Analysis: Water, Soil, Air (2nd Edition). Vatsal Enterprises, New Delhi.

SEMESTER I
Main Course
ENVIRONMENTAL EDUCATION AND AWARENESS
Paper Code: EVS/101

Full Marks- [75+25]
Credits: 4 [Theory]

Total number of contact hours: 60

Unit-I: Fundamentals of Environmental Education

Environmental education: Background and definition, Methods of EE- Formal and Non-formal education, Goals and objectives of Environmental education; International norms guiding EE, Current scenario of EE in India and the world, Major challenges and the possible way-outs.

Unit-II: Environmental Ethics

Environmental ethics – concept, Eco-philosophy: eco-centric and anthropocentric world views, Environmental ethics and sustainable development; Ethical principles in moral reasoning about the environment; Imbibing lessons from religions, cultures and human values, Relevance of Environmental ethics in the present day society.

Unit-III: Environmental Awareness

Environmental Awareness: definitions and concepts, role of Government, NGOs and media; People's initiatives to save the environment in the western world; Gandhian, Marxism and Indian environmentalism; Environment awareness programme in Northeast India with special emphasis on Mizoram.

Unit-IV: Environmental Movement for Environmental Conservation

Global and National environmental Organizations and agencies; UNEP, MAB, IUCN, UNFCCC (COP); Environmental Movements in India- Chipko movement; Silent Valley project movement; Appiko movement; Narmada Bacchao Andolan movement; Tehri Dam

Movement. Initiatives for Environment Conservation in India- government initiative, institutional initiative, role of voluntary organizations in environmental conservation, initiatives taken by educational institutions, green warriors.

Suggested readings:

1. Senapati, T. and Sahoo, R.K. (2009). Environmental Education and Pollution Control, Mittal Publications, Daryaganj, New Delhi.
2. Vromans, K. et al., 2012. Environmental Ethics- An Introduction and Learning Guide. Atlantic Publishers and distributors.
3. Kothari Dr. Milind, 2005. Environmental Education – Universal Publication, Agra.
4. Thaddeus C. et al., 2001. World Directory of Environmental Organizations. International Center for the Environment and Public Policy, California Institute of Public Affaires.
5. Sahgal, A., 2010. CCE Awareness Environmental Studies-5. S. Chand Publishing
6. Bharucha, E. 2015. Text Book of Environmental Studies. University Press (India) Pvt. Ltd., Hyderabad.
7. Vij J. Nornam and Axelrod. 1999. The Global Environment, Institutions, Law and Policy, Earthscan Publishers Ltd, UK.
8. Mishra, S. 2010. Green Warriors: conserving Local Biodiversity through Community Conservation Initatives in Orissa, India. Policy Matters, 17, 143-149.

SEMESTER-I
Multidisciplinary Course

ENVIRONMENTAL ISSUES
Paper Code: EVS/102

Full Marks-[75+25]
Credits: 3

Total number of contact hours: 45

UNIT-I: Environmental Issues-I

Environmental Pollution; Types, Causes, effects, and control measures (Air, Water, Soil pollution); Population Explosion, causes and effects.

UNIT-II: Environmental Issues-II

Natural resource depletion; Causes and consequences of biodiversity loss, conservation of biodiversity; Deforestation, wildlife depletion, desertification.

UNIT-III: Environmental Issues-III

Green house effects; Global warming, Climate change and its impacts; Stratospheric Ozone depletion, El-Nino and La Nina, Acid rain

Suggested Readings:

1. Bharucha, E. 2021. Text Book of Environmental Studies. University Press (India) Pvt. Ltd.,
2. Mcconnell, M.C and Abel, Daniel, C. 2012. Environmental issues: Looking Towards a Sustainable Future (Fourth edition). Pearson Custom Publication.
3. Rangarajan, M. 2011. Environmental Issues in India. Pearson Education.
4. Balliett, J.F. 2010. Environmental Issues (Global Perspectives). Routledge.

SEMESTER II

Main Course

NATURAL RESOURCES

Paper Code: EVS/103

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY

Total number of contact hours: 45

Unit-I: Introduction and Energy Resources

Natural resources-Classification and types of resources- renewable and non-renewable resources; Concept of conventional and non-conventional sources of energy; Fossil fuels- coal, crude oils and natural gas; Solar energy; Wind energy; Biomass energy; Geothermal energy; Tidal energy; Nuclear energy; Waste-to-energy; Hydrogen-fuel cell

Unit-II: Forest and Mineral Resources

Importance of forest; Productive functions, protective and ameliorative functions, recreation, educational and developmental functions; Non-timber forest products. Major forest types in India. Mineral resources and its classification; conservation of mineral resources.

Unit-III: Water and Land Resources

Water resources on the earth- distribution and sources; Consumptive & non-consumptive uses of water; Water resource scenario in India; Water characteristics; Freshwater- surface and groundwater. Land resources in India, land use pattern in India; Major types of soils in India; Soil profile, Soil properties, Soil Erosion,

PRACTICAL

Paper Code: EVS/103 (P)

Total Number of Contact Hours: 15 Hours

1. Identification of some minerals and rocks samples.
2. Plotting of important natural resources of India.
3. Determination of pH of soil sample.
4. Determination of electrical conductivity of water sample.
5. Determination of temperature of water and soil sample.
6. To visit and make a list of forest and non-forest products in the market.

Suggested Readings:

1. Rogoff, M., Screve, F. 2019. Waste-to-Energy, Elsevier, Amsterdam
2. Singh, M.P, Rallan,B.R. and Vivek Kumar. 2012. Natural Resources Management. Emkay Publishing House.
3. Odum, E.P. and Barrett, G.W. 2008. Fundamentals of Ecology (5thEdition). Thomson Brooks Australia and Affiliated to East West Press Pvt. Ltd., New Delhi.
4. Kanagasabai, T. 2010. Environmental Studies. PHI Learning Private Limited, New Delhi.
5. Sharma, P.D. 2018. Ecology and Environment. Rastogi Publication, Meerut.

6. Joseph, K. and Nagendran, R. 2004. Essentials of Environmental Studies. Pearson Education, New Delhi.
7. Santra, S.C. 2010. Fundamentals of Ecology and Environmental Science. NCBA, Kolkata.
8. Colin, R.T., John, L.H. and Michael, B. 2006. Essentials of Ecology. Blackwell Publishing (Indian Edition).
9. Koteswar Rao, 2006. Energy Resources: Conventional and Non-Conventional. B S Publications Hyderabad.
10. Abbasi, T. and Abbasi, S.A. 2011. Renewable Energy Sources: Their Impact on Global Warming and Pollution. PHI Learning Private Limited, New Delhi.
11. Maiti, S.K. 2016. Handbook of Methods in Environmental Studies. Oxford Book Company, New Delhi.
12. Trivedy, R.K., Goel, P.K. and Trisal, C.L. 1987. Practical Methods in Ecology and Environmental Science. Enviro Media Publications, Karad (India).

SEMESTER II
Main Course
ENVIRONMENTAL POLLUTION
Paper Code: EVS/104

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY
Total Number of Contact Hours: 45

Unit-I: Air and Noise Pollution
Sources and types of air pollution, sink of air pollutants; Air pollutants in the atmosphere-gaseous, particulate matter, aerosol, photochemical smog; Effects of air pollutants on the environment. Sources of noise pollution; intensity of noise and its measurements; hazardous effect of noise pollution.

Unit-II: Water and Thermal Pollution
Introduction; Sources and types of water pollution; Surface and groundwater pollution; Effects of water pollution; Organic waste and water pollution; Concepts of DO and BOD; Problems of pesticides and chemical fertilizers; Eutrophication; Indicators of water pollution; Thermal pollution, Silt pollution. Industrial pollution.

Unit-III: Soil and Radioactive Pollution
Sources of soil pollution; Effects of soil pollution on environment; Vegetation and other life forms; Remedial measures for soil pollution; Saline, alkaline and acidic soils. Radioactive pollution- sources of exposure to radiation; Effects of radioactive pollution.

PRACTICAL
Paper Code: EVS/104 (P)

Total Number of Contact Hours: 15

1. Determination of turbidity of water sample.
2. Determination of soil porosity and bulk density.
3. Determination of dissolved carbon dioxide (CO_2) of water sample.
4. Determination of total hardness of water sample.
5. Determination of noise level of a particular area.
6. Determination of sulphur dioxide (SO_2) content in air.

Suggested Readings:

1. Narayanan, P. 2018. Environmental Pollution. CBS Publishers & Distributers. New Delhi.
2. Purohit, S.S. 2011. Environmental Pollution: Causes, Effects and Control. Vatsal Enterprises, New Delhi.
3. Santra, S.C. 2017. Environmental Science. New Central Book Agency (P) Ltd., Kolkata.
4. Anjaneyulu and Narasimha, R. 2009. Introduction to Environmental Science. B.S. Publications, Hyderabad.
5. Katyal, T. and Satake, M. 2005. Environmental Pollution. Anmol Publication, New Delhi.
6. Kannan, K. 2006. Fundamentals of Environmental Pollution. S. Chand and Company, New Delhi.
7. Smith, R.L. and Smith, T.M. 2008. Elements of Ecology. Pearson Higher Education. New Delhi
8. Daniel, D.C. 2014. Environmental Science. Jones and Bartlett Publishers, London.
9. Singh, J.S., Singh. S.P., Gupta. and S.R. 2010. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.
10. Trivedi R. K. and P.K. Goel, 2003. Introduction to air pollution, ABD Publishers.
11. APHA. 2005. Standard Method for Examination of Water and Waste Water (21st Edition). American Public Health Association, Washington DC. USA.
12. Gopal, K. 2007. Water and Waste Water. APH Publishing Corporation, New Delhi.
13. Manivasakam, N. 2003. Physico-chemical Examination of Water Sewage and Industrial Effluents. Pragati Prakashan Publication, Meerut.
14. Maity, S.K. 2014. Handbook of Methods in Environmental Studies Vol-I & II. Oxford Book Company, New Delhi.
15. Trivedy, R.K. and Goel, P.K. 1984. Chemical and Biological Methods of Water Pollution Studies. Enviro Media, Karad (India).

SEMESTER-II
Multidisciplinary Course
NATURAL RESOURCE COSERVATION
Paper Code: EVS/105

Full Marks-[75+25]
Credits: 3

Total number of contact hours: 45

Unit-I: Causes for Depletion of Natural resources

Major causes for depletion of natural resources; Population growth and population explosion, Deforestation and shifting cultivation, Depletion of Soil fertility and soil erosion, Industrialisation and aviation technology, Construction of Dam, roads, railways, and urban encroachment, Excess Extraction of natural resources.

Unit-II: Conservation of Natural resources

Mass Awareness for conservation of natural resources, Judicial use of natural resources;, Reduction, recycle and reused, substitution and use of waste, Promotion of Afforestation programmes, Soil conservation strategies practice, Soil stabilization and restoration of soil fertility.

Unit-III: Basics of Conservation Biology

Definition, objectives of conservation; Extinction of species; Types and causes of extinction; Invasive alien species; Characteristics and impact of invasive species, prevention and mitigation of alien species; Keystone species.

Suggested Readings:

1. Rogoff, M., Screve, F. 2019. Waste-to-Energy, Elsevier, Amsterdam
2. Singh, M.P, Rallan,B.R. and Vivek Kumar. 2012. Natural Resources Management. Emkay Publishing House.
3. Odum, E.P. and Barrett, G.W. 2008. Fundamentals of Ecology (5thEdition). Thomson Brooks Australia and Affiliated to East West Press Pvt. Ltd., New Delhi.
4. Kanagasabai, T. 2010. Environmental Studies. PHI Learning Private Limited, New Delhi.
5. Sharma, P.D. 2018. Ecology and Environment. Rastogi Publication, Meerut.
6. Joseph, K. and Nagendran, R. 2004. Essentials of Environmental Studies. Pearson Education, New Delhi.
7. Santra, S.C. 2010. Fundamentals of Ecology and Environmental Science. NCBA, Kolkata.
8. Colin, R.T., John, L.H. and Michael, B. 2006. Essentials of Ecology. Blackwell Publishing (Indian Edition).
9. Koteswar Rao, 2006. Energy Resources: Conventional and Non-Conventional. B S Publications Hyderabad.
10. Abbasi, T. and Abbasi, S.A. 2011. Renewable Energy Sources: Their Impact on Global Warming and Pollution. PHI Learning Private Limited, New Delhi.

SEMESTER III

Main Course

ENVIRONMENTAL MONITORING AND CONTROL TECHNOLOGY

Paper Code: EVS/200

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY

Total number of contact hours: 45

Unit-I: Air Pollution Monitoring and Mitigation

Air pollution sampling and monitoring; Air quality standards (NAAQS); Air quality index (AQI); Air pollution control- Electrostatic precipitators, scrubbers, incineration, bag filters, adsorption; Automobile emission control measures.

Unit-II: Water Pollution Monitoring and Mitigation

Water quality parameters; Water sampling; Physico-chemical analysis of water; Purification process and standards for drinking water; Waste water treatment process; Conservation and management of water.

Unit-III: Soil Pollution Monitoring and Mitigation

Soil sampling; Soil fertility; Soil quality monitoring; Soil quality parameters- physical, chemical and biological parameters; Concept of organic farming; Compost; Vermicomposting; Soil microorganism and their functions.

PRACTICAL

Paper Code: EVS/200 (P)

Total number of contact hours: 15

1. Analysis of soil moisture content by oven dry method.
2. Determination of electrical conductivity of soil sample.
3. Determination of total alkalinity of water sample.
4. Determination of chloride content of water sample.
5. Determination of physical composition and characteristics of municipal solid waste.
6. Analysis of nitrogen dioxide (NO_2) and suspended particulate matter (SPM) in air.

Suggested readings:

1. APHA. 2005. Standard Method for Examination of Water and Waste Water (21st Edition). American Public Health Association, Washington DC. USA.
2. Gupta, P.K. 2011. Methods in Environmental Analysis: Water, Soil, Air (2nd Edition) Vatsal Enterprises, New Delhi
3. Maity, S.K. 2014. Handbook of Methods in Environmental Studies Vol-I & II. Oxford Book Company, New Delhi

4. Rana, S.V.S. 2010. Essentials of Ecology and Environmental Science. PHI Learning Pvt Limited, New Delhi.
5. Rao, C.S. 2006. Environmental Pollution Control Engineering. New Age International.
6. Trivedy, R.N. 2002. A Text Book of Environmental Pollution and Control. Anmol Publication, New Delhi.
7. Khopkar, S. M.2007. Environmental pollution control and monitoring. Newage International Pvt. Ltd. Mumbai.
8. Ibrahim Mirsal. 2010. Soil pollution: Origin, Monitoring and Remediation. Springer
9. Trivedi, P.C. 2010. Environmental pollution: Causes, mitigation and recycling. Aaviskar Publishers.
10. Rao, M.N., Sultana, R., Kota, S.H. 2016. Solid and Hazardous Waste Management, Elsevier, Amsterdam
11. Singh, K., Nath, G., Shukla, R.C., Bhartiya, D.K. 2014. A Textbook of Vermicompost: Vermiwash and Biopesticide, Biotech Books, New Delhi
12. Henry, J.G. and Heinke, G.W. 2011. Environmental Science and Engineering (2nd Edition). PHI Learning Private Limited, New Delhi.
13. Dara, S.S. 2004. A Text Book of Environmental Studies and Pollution Control.S. Chand and Company, New Delhi.

SEMESTER III
Main Course
BIODIVERSITY CONSERVATION AND SUSTAINABLE DEVELOPMENT
Paper Code: EVS/201

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY
Total number of contact hours: 45

Unit-I: Concept of biodiversity
Biodiversity- levels of biodiversity; biodiversity patterns- spatial and temporal pattern; Importance and value of biodiversity; Biodiversity hotspots; Hotspots in India; Biogeographical classification of India; Causes and consequences of biodiversity loss; Biodiversity conservation methods- In-situ and Ex-situ conservation; Concept of community conserved areas and afforestation

Unit-II: Plant, animal and microbial biodiversity
Floristic regions of India; Important rare, threatened and endemic plant species in India with special reference to Northeast region. Zoological realms of India; Rare, endemic and threatened faunal species of India with special reference to Northeast India; rehabilitation of animals; Major five types of microbial diversity: Viruses, Bacteria, Archaea, Fungi, and Protists; BSI & ZSI: its role in biodiversity conservation.

Unit-III: Sustainable development
Sustainable development- Important fundamentals concerning sustainable development; Stockholm conference; World commission on environment and development; Sustainable water and energy solution.

PRACTICAL

Paper Code: EVS/201 (P)

Total number of contact hours: 15

1. Determination of minimum size of quadrat by "Species area curve" method.
2. Estimation of frequency, density, abundance of species in a forest ecosystem by quadrat method.
3. Study of vegetation changes in shady and light exposed area by belt transect method
4. Estimation of biomass of a grassland ecosystem by total harvest method.
5. Collection of flora found in a local area (college campus etc.) by herbarium method
6. Vegetation studies by line transect method to determine the frequency of individual species.

Suggested readings:

1. Sodhi, N. S., Gibson, L. & Raven, P. H. 2013. Conservation Biology: Voices from the Tropics.Wiley-Blackwell, Oxford, UK.
2. Gaston, K.J. 2004. Biodiversity: An introduction. Atlantic Publishers Distributors New Delhi.
3. Badola, R., Bardwaj, A.K., Mishra, K. and Rathore, BMS. 2002. Eco-development Planning for Biodiversity Conservation. Wildlife Institute of India, Dehradun.
4. Joshi, N. and Joshi, P.C. 2009. Biodiversity and Conservation. APH Publishing Company.
5. Magurran, A.E. 2004. Measuring Biological Diversity. Blackwell Publishing Company.
6. Maiti, P.K. and Maiti, P. 2011. Conservation of Biodiversity and Natural Resources: Perception, Peril and Preservation. PHI Learning Private Limited, New Delhi.
7. Mishra, K.C. 1992. Manual of Plant Ecology (3rd Edition). Oxford and IBH Publishing Company, New Delhi.
8. Ramakrishnan, P.S. 2002. Sustainable Development. UNESCO, New Delhi.
9. Shiva, M.P. and Verma, S.K. 2002. Approaches to Sustainable Forest Management and Biodiversity Conservation. International Book Distributors, Dehradun.
10. Singh, M.P., Dey, S. and Singh, B.S. 2004. Conservation of Biodiversity and Natural Resource. Daya Publishing House, New Delhi

SEMESTER-III
Multidisciplinary Course
WASTE MANAGEMENT
Paper Code: EVS/202

Full Marks-[75+25]
Credits: 3

Total number of contact hours: 45

UNIT – I: Concept of Solid waste management
Types of solid wastes; sources of solid wastes; properties of solid wastes; solid waste generation; on-site handling, storage and processing; collection of solid wastes; transfer and transport; processing, techniques; ultimate disposal; Integrated SW Management concepts

UNIT-II: Logistics in waste collection and disposal
Importance, methods of logistics, human components, technological components- waste handling equipment and technology; steps in waste management logistics; environmental aspects of waste collection; role of public authority and private sector in waste collection; recycling of solid waste

Unit-III: Waste processing technologies
Mechanical treatment and resource recovery; types of material recovery facilities; Thermal treatment of solid waste: incineration, pyrolysis, gasification, residues and its utilization, Biological treatment: Composting, bio-methanation, bio-gas, bio-diesel

Suggested readings:

1. Hand Book of Solid Waste Management, Tchobanoglous G., Frank Kreith., (2002)., 2nd Ed., McGraw Hill, USA
2. Solid Waste Technology & Management, Thomas Christensen, (2011)., John wiley & sons, USA
3. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel (2014)., 2nd Ed., CRC Press, USA.
4. Solid Waste Management - Present and Future Challenges, Jagbir Singh, Ramanathan, AL., (2019)., I.K. International publishing House Pvt.Ltd., India
5. Manual on Municipal Solid Waste Management, CPHEEO (2016)., Ministry of Urban Development, India

SEMESTER IV

Main Course

ENVIRONMENTAL ASSESSMENT AND LEGISLATIONS

Paper Code: EVS/203

Full Marks-[{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY

Total number of contact hours: 45

Unit-I: Introduction to EIA

Concept of environmental impact assessment (EIA); Process & Steps of EIA, Design and different methods of EIA; Review procedure of EIA & EIS. Guidelines of EIA; EIA of big dams, hydro-electric projects and highways.

Unit-II: Environmental Economics, Planning and Auditing

Environmental Economics: cost benefit analysis; Environmental accounting; Green Marketing; Concept of environmental planning: urban and rural planning; Development indices; Concepts of environmental audit; Carbon credit; Emission trading.

Unit-III: Basics on Environmental Laws and Legislations

Basic features of Indian constitution and environmental provisions in the constitution; Some of existing environmental laws and legislations: Environmental Protection Act 1986; Forest (Conservation) Act, 1980; Water (Prevention and Control of Pollution) Act 1974; Air (Prevention and Control of Pollution) Act 1981; National Biodiversity Act, 2002.

PRACTICAL

Paper Code: EVS/203 (P)

Total number of contact hours: 15

1. To study environmental impact assessment (EIA) of an urban area.
2. To conduct community base awareness programme on protection and conservation of wildlife.
3. To conduct community base awareness programme on protection and conservation of environment.
4. To conduct awareness programme on environmental issues in Schools.
5. To carry out awareness programmes on environmental issues in NGOs.
6. Field visit to a protected area (Biosphere Reserves/National Parks/Wildlife Sanctuary) and submit an EIA report on it.

Suggested readings:

1. Nandimath, O.V. 2008. Handbook of Environmental Decision Making in India: An EIA Model. Oxford University Press, India.
2. Prabhakar, V.K. 2003. Environmental Impact Assessment. Anmol Publications, New Delhi.
3. Anjaneyulu, Y. 2004. Environmental Impact Assessment Methodologies. BS Publication, Hyderabad.
4. Chriswood. 2007. Environmental Impact Assessment. Pearson Higher Education.

5. Desta, T.S. 2010. Environmental Impact Assessment. VDM Verlag.
6. Venkat, A. 2012. Environmental Law and Policy. PHI Learning Private Limited, New Delhi.
7. Sengar, D.S. 2014. Environmental Law. PHI Learning Private Limited, New Delhi.
8. Jadhav, H. and Bhosale, V.M. 1995. Environmental Protection and Laws. Himalaya Publishing House

SEMESTER IV
Main Course
GLOBAL ENVIRONMENTAL ISSUES
Paper Code: EVS/204

Full Marks- [75+25]
Credits: 4 [Theory]

THEORY
Total number of contact hours: 60

Unit-I: Global environmental issues related to atmosphere
Fundamentals, causes, effects and mitigation strategies of – Global Warming, Depletion of Stratospheric Ozone Layer and Acid Rain; El-Nino and La Nina.

Unit-II: Global environmental issue related to forests
Basic concepts, causes, consequences and control of – Deforestation, wildlife depletion, desertification, changing land-use pattern, population explosion and rapid urbanization.

Unit-III: Global environmental issues related to water
Degradation of wetlands, depletion of water resources, global water crisis; international transboundary water disputes, ocean acidification, ocean oil spill.

Unit-IV: Global environmental issue related to urban environment
Causes and consequences of- global climate change, classical smog- London smog, photochemical Smog, urban heat island, nuclear meltdowns and disasters; global energy crisis.

Suggested readings:

1. Harris, F. 2004. Global Environmental Issues. Wiley-Blackwell
2. Singh, S. 2015. Environmental Geography. Pravalika Publications
3. Buckingfham, S., Turner, M. 2012. Understanding Environmental Issues. Sage Publications
4. Runyan, C., D'Odorico. 2016. Global deforestation. Cambridge University Press
5. Ray, S.P.S. 2019. Ground Water Development - Issues and Sustainable Solutions. Springer-Verlag
6. Kateja, A., Jain, R. 2021. Urban Growth and Environmental Issues in India. Springer-Verlag
7. Sánchez-Carrillo, S., Angeler, D.G. 2010. Ecology of Threatened Semi-Arid Wetlands. Springer-Verlag
8. Berner, E.K., Berner, R.A. 2012. Global Environment: Water, Air, and Geochemical Cycles. Princeton University Press
9. Newton, D.E. 2016. The Global Water Crisis: A Reference Handbook. Greenwood Press

SEMESTER V

Main Course

ENVIRONMENTAL TOXICOLOGY AND HEALTH

Paper Code: EVS/300

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY

Total number of contact hours: 45

Unit-I: Basics of Toxicology

Introduction to toxicants, routes of exposure, exposure assessment; Absorption and translocation of toxicants; Biomagnification; Acute and chronic toxicity- LC50, LD50; Environmental Carcinogens. effects of Toxicants; Radiation sources in the environment- natural and man-made, biological effects of radiation; Pesticides-classifications; Heavy metals- health effects of lead and cadmium.

Unit-II: Concept of Environmental Health

Definition, historical perspectives; Human environment status in urban and rural India; Water and sanitation in urban and rural context; WHO and other bodies and their role in public health projects developments; Public awareness of sanitation and hygiene issues.

Unit-III: Environmental Health Management

Principles of environmental control, environmental quality, eradication programmes and their efficacy; Environmental risk assessment; Advanced treatment methods- ultra filtration and reverse osmosis; Environmental Health Impact Assessment.

PRACTICAL

Paper Code: EVS/300 (P)

Total number of contact hours: 15

1. To determine the human blood group.
2. To determine the blood pressure of human
3. To determine the body temperature of human
4. To detect the presence of Bilirubin (bile) in urine by Hay's test
5. To detect the presence of blood in urine.
6. To study the sanitation/hygiene of a local area

Suggested readings:

1. Bhattarcharjee, S. 2011. Environmental Toxicology. Books and Allied (P) Ltd. Kolkota.
2. Gupta P.K. Fundamentals of Toxicology: Essential Concepts and Applications 2016. Academic Press.
3. Guyton and Hall 2015. Textbook of Medical Physiology (13th Edition). Relx India Pvt. Ltd
4. Rana, S.V.S. 2011. Environmental Pollution: Health and Toxicology.Alpha Science International Ltd; 2nd revised edition edition.
5. Joshi, B.D., Joshi, P.C., & Joshi, Namita. 2008. Environmental Pollution & Toxicology. APH Publishing Corporation, New Delhi.
6. Wright, D.A. and Welbourn, P. 2002. Environmental Toxicology. Cambridge University Press.

7. Wayne, G.L. and Yu, Ming-Ho. 2004. Introduction to Environmental Toxicology. Lewis Publishers.
8. Yu, Ming-Ho. 2005. Environmental Toxicology: Biological & Health Effects. CRC Press.
9. Satake and Tagauchi. 2003. Environmental Toxicology. Discovery Publishing House.
10. Morgan, M.T. 2002. Environmental Health (3rd Edition). Brooks Cole Inc, Publishers

SEMESTER V
Main Course
ENVIRONMENTAL BIOLOGY
Paper Code: EVS/301

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY
Total number of contact hours: 45

Unit-I: Introduction to Environmental Biology
Principle and scope of environmental biology; Environmental adaptations, evolution and classification of organisms; Environmental factors and species interactions.

Unit-II: Population Ecology
Basic concepts; Population characteristics; Population density, natality, mortality; Age distribution; Biotic potential of population; Growth form of population; Population dispersal; Population factors.

Unit-III: Community Ecology
Characteristics of a community; Community structure; Community stratification; Community metabolism; Different methods for study of communities; Qualitative, quantitative and synthetic attributes of communities.

PRACTICAL

Paper Code: EVS/301 (P)
Total number of contact hours: 15

1. To draw and prepare a list of environmental adaptation of plants and animals.
2. To draw and prepare a geological timescale on the basis of evolution of organisms.
3. To study the abiotic factors in a terrestrial ecosystem.
4. To estimate the population size from population chart by quadrat method (plant).
5. To estimate the population size by capture-recapture method (animal).
6. To study the zooplankton/ macro consumer community of fresh water system.

Suggested Readings:

1. Saha, T.K. 2013. Ecology and Environmental Biology. Books & Allied (P) Ltd. Kolkata.
2. Sharma, P.D. 2011. Ecology and Environment (10th Revised Edition). Rastogi Publication, Meerut.
3. Primack, R. B. 2014. Essentials of Conservation Biology. Oxford University Press, US.

4. Verma, P.S. 2008. Environmental Biology. (Principles of Ecology). S. Chand and Company Ltd., New Delhi.
5. Kormondy, E.J. 2009. Concepts of Ecology (4th Edition). PHI Learning Private Limited, New Delhi.
6. Malcolm, L.H. and Gibbs, J. 2009. Fundamentals of Conservation Biology. Blackwell Publishing Company.
7. Singh, J.S., Singh, S.P. & Gupta, S.R. 2010. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.
8. Maiti,P.K. & Maiti, P. 2011. Biodiversity: Perception, Peril and Preservation. Phi Learning Private Limited.
9. Chatterjee.A.K. 2011. Introduction to Environmental Biotechnology *(3rd edition)*. PHI Learning Private Limited, New Delhi.
10. Ambasht, R.S. and Ambasht, N.K. 2006. A Text Book of Plant Ecology. CBS Publishers and Distributors.
11. Verma, P.S. 2008. Environmental Biology. (Principles of Ecology). S. Chand and Company Ltd., New Delhi.
12. Gupta, P.K. 2011. Methods in Environmental Analysis: Water, Soil, Air (2nd Edition) Vatsal Enterprises, New Delhi.
13. Michael, P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw Hill, New Delhi.
14. Trivedi, R.K., Goel, P.K. and Trisal, C.L. 1987. Practical Methods in Ecology and Environmental Science. Enviro Media Publication, Karad (India)

SEMESTER V
Main Course
RESTORATION ECOLOGY
Paper Code: EVS/302

Full Marks- [75+25]
Credits: 4

Total number of contact hours: 60

Unit-I: Introduction
Definition and scope of restoration ecology; Concept, causes and consequences Environmental Degradation; Myths, planning and strategies of restoration.

Unit-II: Restoration of Degraded Ecosystems
Concept of degraded ecosystems; restoration of degraded ecosystems: fore.st lands, mined areas, shifting cultivated areas, wetlands.

Unit-III: Reclamation of Wasteland and Agricultural land
Concept, causes of wasteland formation, and reclamation of wasteland; restoration of agricultural lands (Acid soils, Salt affected soil, Saline soil, Alkali soil) Waterlogged soil.

Unit-IV: Basics of Bioremediation
Concept, Definition and scope of bioremediation; Types of bioremediations; Concept and types of phytoremediation, Microbial remediation; Application of Bioremediation, Bioindicator and Biomonitoring.

Suggested Readings:

1. Henry, J.G. and Heinke, G.W. 2011. *Environmental Science and Engineering* (2nd Edition). PHI Learning Private Limited, New Delhi.
2. Smith, R.L. and Smith, T.M. 2008. *Elements of Ecology*. Pearson Higher Education. New Delhi
3. Dara, S.S. 2004. *A Text Book of Environmental Studies and Pollution Control*. S. Chand and Company, New Delhi.

SEMESTER V
Internship/Field Study/Practical
Paper Code: EVSC/V/303

Full Marks- [75+25]
Credits: 2

Total number of contact hours: 30

1. To conduct EIA of the biological components of a particular area.
2. To assess the water quality of a particular locality.
3. To assess the soil quality of a particular area.
4. To assess the solid waste generation in a local area.

SEMESTER VI
Main Course
CHEMISTRY OF ENVIRONMENT
Paper Code: EVS/304

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY
Total number of contact hours: 45

Unit-I: Fundamentals of Environmental Chemistry
Concept of environmental chemistry; Chemical equilibrium, Conductance; Oxidation and reduction; Sedimentation; Acid, bases and salts; Solubility product; Chemistry of various organic and inorganic compounds; Types of chemical bonds, Radionuclides; Surfactants

Unit-II: 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 NO2 and SO2; free radicals and ozone layer depletion, role of CFCs in ozone depletion.

Unit-III: Water and Soil Chemistry
Properties of water; alkalinity and hardness of water, dissolved oxygen (DO), biological oxygen demand (BOD) and chemical oxygen demand (COD), colloidal particles; heavy metals in water. Soil composition, relation between organic carbon and organic matter, inorganic and organic

components in soil; soil humus; cation and anion exchange reactions in soil; nitrogen, phosphorous and potassium in soil; phenolic compounds in soil.

PRACTICAL

Paper Code: EVS/304 (P)

Total number of contact hours: 15

1. Analysis of water holding capacity of soil.
2. Analysis of particle size of soil by hydrometer method.
3. Determination of dissolved oxygen (DO) of water sample.
4. Determination of organic carbon and organic matter content of soil sample.
5. Determination of calcium and magnesium content of water sample.
6. Determination of biological oxygen demand (BOD) of water sample.

Suggested Readings:

1. Kaur, H. 2018. Environmental Chemistry. Pragati Prakashan, Meerut
2. De, A.K. 2017. Environmental Chemistry. New Age International Publications, New Delhi.
3. Banerjee, S.K. 2009. Environmental Chemistry. PHI Leraning Private Limited, New Delhi.
4. Manahan. S.E. 2010. Environmental Chemistry, CRC Press.
5. Girard J. 2014. Principles of Environmental Chemistry, Jones Bartlett Learning.
6. Pani, Balram. 2007. A text book of Environmental Chemistry. I.K. International Publishing House.
7. Sharma, B.K. and Kaur, H. 2007. Environmental Chemistry. Goel Publishing House, Meerut.
8. Stanley, M.E. 2001. Fundamentals of Environmental Chemistry. Lewis Publishers, London.
9. Maiti, S.K. 2016. Handbook of Methods in Environmental Studies. Oxford Book Company, New Delhi.
10. Gopalan, R., Anand, A & Sugumar, R.W. 2008. A laboratory manual for Environmental Chemistry. I.K. International Publishing House.
11. APHA. 2005. Standard Method for Examination of Water and Waste Water (21st Edition). American Public Health Association, Washington DC. USA.
12. Michael, P. 1984. Ecological Methods for Field and Laboratory Investigations. Tata McGraw Hill, New Delhi.
13. Saxena, M.M. 1987. Environmental Analysis: Water, Soil and Air. Agro Botanical Publishers (India).
14. Trivedi, R.K., Goel, P.K. and Trisal, C.L. 1987. Practical Methods in Ecology and Environmental Science. Enviro Media Publication, Karad (India)

SEMESTER VI
Main Course
NATURAL HAZARDS AND DISASTER MANAGEMENT
Paper Code: EVS/305

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY
Total number of contact hours: 45

Unit-II: Natural Hazards
Natural hazards: hydrological, atmospheric & geological hazards; earthquake, seismic waves, epicenter; volcanoes; flood; landslides: causes and types of landslides, drought, cyclone & hurricanes; tsunamis: coastal erosion, sea level changes and its impact on coastal areas and coastal zone management.

Unit-II: Anthropogenic Hazards
Impacts of anthropogenic activities such as urbanization, deforestation, mangroves destruction; large scale developmental projects like dams and nuclear reactors; nature and impact of wildfires and biophysical hazards; Case studies of Bhopal gas tragedy, Minamata and Chernobyl disasters.

Unit-III: Disaster Management
Concept of hazards and disaster; Classification of disaster; Disaster management cycle; Concept of mitigation; types of mitigation: structural and non-structural mitigation; concept of preparedness; public awareness; National Disaster Management Framework, national response mechanism.

PRACTICAL

Paper Code: EVS/305 (P)

Total number of contact hours: 15

1. Plotting of Earthquake prone areas in topographic map of India.
2. Plotting of Flood prone areas in topographic map of India.
3. To prepare a list of location of earthquake's epicenter from seismogram.
4. To study on distribution of major wind patterns on the world map.
5. To study on impacts of wildfires/landslides prone areas in NE India.
6. Field base assignments and tutorials.

Suggested Readings:

1. Pine, J.C. 2009. *Natural Hazards Analysis: Reducing the Impact of Disasters*. CRC Press, Taylor and Francis Group.
2. Schneid, T.D. & Collins, L. 2001. *Disaster Management and Preparedness*. Lewis

Publishers, New York, NY.
3. Smith, K. 2001. *Environmental Hazards: Assessing Risk and Reducing Disaster*. Routledge Press.
4. Coppola, D.P. 2007. *Introduction to International Disaster Management*. Butterworth Heinemann.
5. Cutter, S.L. 2012. *Hazards Vulnerability and Environmental Justice*. EarthScan, Routledge Press.
6. Keller, E.A. 1996. *Introduction to Environmental Geology*. Prentice Hall, Upper Saddle River, New Jersey.
7. Wallace, J.M. & Hobbs, P.V. 1977. *Atmospheric Science: An Introductory Survey*. Academic Press, New York.

SEMESTER-VI
Main Course
HUMAN ECOLOGY
Paper Code: EVS/306

Full Marks- [75+25]
Credits: 4 [Theory]

THEORY
Total number of contact hours: 60

Unit I: Man, and Environmental History
Interrelations of man and nature; built environment; human diseases from environmental degradation; role of genetics and environment in human development; cultural evolution of man; impact of human beliefs on environment; human consumerism and environmental impact; man and climate change

Unit II: Human Ecosystem
Concept of global ecosystem balance and human population; basics of urban and rural human ecosystems; human colonization and biodiversity; habitat fragmentation and its impact on ecology of forest dwellers; shift in agriculture and food supply patterns; global water crisis; environmental health; sustainable development goals

Unit III: Concept of Ethnobiology
Introduction to ethnobiology; bioresources of India; medicinal plants of India and their traditional usage; indigenous traditional knowledge (ITK); concept of ethnoecology; traditional ways of environmental protection; traditional environmental management and its contribution in forest, soil, and water conservation

Unit IV: Environmental Economics and Politics
History, development and objective of environmental economics; sustainable scale, fair distribution and efficient allocation; natural capital; ecological services; cost-benefit assessment; ecological status of developed, developing and under-developed nations; ecopolitics related to global partitioning and consumption of natural resources; eco-fund for environmental cleaning

Suggested readings:

1. Human Ecology: Basic Concepts for Sustainable Development, Marten, G.G., (2001), Routledge, UK
2. Understanding Human Ecology: Knowledge, Ethics and Politics, Geetha Devi, T.K., (2019), Taylor and Francis, UK

3. Fundamentals of Human Ecology, Kormondy, E.J., Brown, D.E, (1998), Prentice Hall, USA
4. Ecosystems and Human Well-Being: Synthesis, Millennium Ecosystem Assessment, (2005), Island Press, USA
5. The Structure and Dynamics of Human Ecosystems: Toward a Model for Understanding and Action, Burch, W.R., Machlis, G.E., Force, J.E., (2017), Yale University Press, USA
6. Ethnobiology, Anderson, E.N., Pearsall, D., Hunn, E., Turner, N., (2011), Wiley-Blackwell, USA
7. Indigenous Knowledge on Ethnobotany, Ghosh, A.K., (2012), Daya Publication House, India
8. Environmental Economics, Nayak, A., (2022), VK Global Publications, India

SEMESTER-VI
Major Course
ENVIRONMENTAL ETHICS
Paper Code: EVS/307

Full Marks- [75+25]
Credits: 4

Unit – I: Basic Concepts

Environmental Ethics- Concepts, types and principles; Nature of Environmental Ethics; Ethical Theories and the environment –Anthropocentrism, eco-centrism, biocentrism, Holism, Gaia-Centrism; Relation between Natural and Moral Order; Human stewardship of Nature.

Unit –II: Science, Society and Environment

Energy resources, Impact on Environment and Ethical problems; Environmental ethics and its effects on man; Technology and Environment; Clean environment as a Fundamental right; Dilemmas of sustainable development in India; Moral status of Non-Human World.

Unit –III: Issues in Environmental Ethics

Approaches to Environmental Ethics- Conservation approach, Libertarian Approach, Ecological Approach; Environmental Degradation and Economic Development; Law and Environmental Ethics; Economics and the Environment; Education and Environmental ethics;

Unit- IV: Ethics of Climate Change

Concept; Issues and principles of equity; carbon budget and its implications; Global Issues in Science and technology; Individual and collective responsibilities; Global warming-sustainability and responsibility to the future.

Suggested Readings:

1. Wong, P.H. 2016. 'Consenting to Geoengineering'. Philosophy & Technology 29(2): 173-188.
2. Butt, D. 2013. 'The Polluter Pays? Backward-looking Principles of Intergenerational Justice and the Environment', in Spheres of Global Justice, ed. Merle, 757-774. Springer.
3. Karnein, A. 2015. 'Climate Change and Justice Between Nonoverlapping Generations'. Global Justice: Theory, Practice, Rhetoric 8(2): 43-65.
4. Gardiner, S. 2004. Ethics and Global Climate Change, Ethics 114 (2004): 555-600.
5. Gardiner, S.2010 , "Ethics and climate change: an introduction." WIREs Climate Change, Volume 1, January/February

6. Riley, T. (Guardian, 2017), "Just 100 companies responsible for 71% of global emissions study says" Link: https://www.theguardian.com/sustainable-business/2017/jul/10/100-fossil-fuel-companies-investors-responsible-71-global-emissions-cdp-study-climate-change.
7. Sachs, J. D. 2015. The Age of Sustainable Development. New York: Columbia University Press.
8. Brennan, A & Yeuk-Sze Lo. 2016. "Environmental Ethics." Stanford Encyclopedia of Philosophy. https://plato.stanford.edu/archives/win2016/entries/ethic s-environmental/.
9. Attfield, R. 2018. Environmental Ethics: A Very Short Introduction. Oxford: Oxford University Press
10. Misra, R.P. 1995. Environmental Ethics- A dialogue of Cultures. Concept Publishing Company, New Delhi.
11. Attfield, R. 2014. Environmental Ethics: An overview for the twenty first century. Polity Press, Cambridge.
12. Srivastava, D. C. 2005. Readings in Environmental Ethics- Multidisciplinary Perspectives. Rawat Publications, Jaipur.
13. Alfonso, S. 2014. Peace Education in Early Childhood Education." In Factis Pax 8(2): 167-188
14. Mochizuki, Y & Bryan, A . 2015. "Climate Change Education in the Context of Education for Sustainable Development: Rationale and Principles." Journal of Education for Sustainable Development 9 (1): 4–26

SEMESTER VII

Major Course

ENVIRONMENTAL STATISTICS AND COMPUTER APPLICATION

Paper Code: EVS/400

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY

Total number of contact hours: 45

Unit-I: Basics of Statistics

Importance and scope of statistical method; Frequency distribution table; Diagrammatic representation: Line diagram, bar diagram, histogram, pie diagram. Measures of central tendencies- mean, median and mode; Standard deviation.

Unit-II: Methods of Statistical Analysis

Measures of Dispersions; Correlation; Regression; Student's t- test; Chi Square (X^2) test, Analysis of variance (ANOVA); Principal component analysis; Introduction to SPSS.

Unit-III: Computer Application

General awareness of computers; Computer types; Basic organization of a computer; Input output devices; Memory units; Hardware and software. Units of measurement in computing; Application software; Computer networks- Local Area Network (LAN), Wide Area Networks (WAN); Internet; Microsoft- MS Word, MS Power Point, MS Excel.

PRACTICAL

Paper Code: EVS/400 (P)

Total number of contact hours: 15

1. Calculation of Mean and Standard deviation from sampled data.
2. Diagrammatic representation using Line, Bar and Pie diagram.
3. Calculation of correlation coefficient from field data.
4. Calculation of regression from field data.
5. Calculation of t-Test and Chi-Square (X^2) from sampled data.
6. Analysis of variance of data using SPSS.

Suggested Readings:

1. Khan, IA and Khanum, A. 2018. Fundamentals of Biostatistics. Ukaaz Publications. Hyderabad.
2. Kothari, C.R and Garg, G. 2019. Research Methodology: Methods and Techniques. New Age International.
3. Forsyth D, 2018. Probability and Statistics for Computer Science, Springer
4. Spiegel M, Stephens LJ. 2011. Schaum's Outline of Statistics, McGraw Hill
5. Sundar Rao, P.S.S. and Richard, J. 2012. Introduction to Biostatistics and Research Methods. PHI Learning Private Limited, New Delhi
6. Dutta, K.R.N. 2004. Fundamental of Biostatistics: Practical Approach. Kaniskha Publishers, New Delhi.
7. Freund, R.J. and Wilson, W.J. 2003. Statistical Methods. Academic Press.
8. Datta, A.K. 2007. Basic Biostatistics and Its Applications. NCBA Pvt. Ltd.
9. Satguru, P. 2012. Fundamentals of Biostatistics. Emkay Publication, New Delhi.
10. Goel, Anita. 2010. Computer Fundamentals. Pearson.
11. Dutta, N.K.R.2004. Fundamental of Biostatistics: Practical Approach. Kaniskha Publishers, New Delhi.

SEMESTER-VII
Major Course
BASICS OF CLIMATOLOGY
Paper Code: EVS/401

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY

Total number of contact hours: 45

Unit – I: Introduction and Climatic elements

Nature, scope and sub-divisions of climatology; Structure and composition of the atmosphere, Lapse rate, Climatic regions of the world. Temperature, Pressure, Wind, Humidity, Precipitation, Clouds, Sunshine; Climatic control.

Unit – II: Temperature and heat balance of the Earth

Earth-Sun relationship, Insolation and Solar radiation, Distribution of solar radiation, Solstice and Equinoxes, Seasons; Albedo; Heat balance of the Earth.

Unit – III Global atmospheric circulation
Scales of atmospheric motion; Pressure and wind systems; Coriolis force; El Nino and Indian Monsoons; Cyclones, Anti-cyclones and tornadoes.

PRACTICAL
Paper Code: EVS/401 (P)
Total number of contact hours: 15

1. To study the principles and working stations of a meteorological observatories
2. To measure the sunshine intensity using sunshine recorder.
3. To measure the light intensity using lux meter.
4. To study the principles and working of rain gauges
5. To study the principles and working of mercury barometer
6. To study the wind speed, direction and wind roses

Suggested Readings:

1. Frederick K. Lutgens, Edward J. Tarbuck, Dennis G. Tasa (2015) The Atmosphere: An Introduction to Meteorology, Pearson Education
2. Barry R. G. and Carleton A. M. (2001) Synoptic and Dynamic Climatology, Routledge, UK.
3. Barry R. G. and Corley R. J. (2003) Atmosphere, Weather and Climate, Routledge, New York.
4. Critchfield H. J. (1987) General Climatology, Prentice-Hall of India, New Delhi
5. Lutgens F. K., Tarbuck E. J. and Tasa D. (2009) The Atmosphere: An Introduction to Meteorology
6. Oliver J. E. and Hidore J.J. (2002) Climatology: An Atmospheric Science, Pearson

SEMESTER VII
Main Course
HUMAN WILDLIFE CONFLICT AND MANAGEMENT
Paper Code: EVS/402

Full Marks- [75+25]
Credits: 4 [Theory]

THEORY
Total number of contact hours: 60

Unit-I: Introduction to wildlife management
Need of environmental management; wildlife conservation: moral obligations, philosophy of wildlife management; human and wildlife conflicts, role of government, wildlife biologists and social scientists in wild life conflict management; concept of deep and shallow ecology.

Unit-II: Wildlife conservation Initiatives
Protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage Sites; concept of core and buffer area in a protected range, Wildlife Protection Act, 1972, Project Tiger, Project Elephant.

Unit-III: Wildlife conflicts

Causes of human-wildlife conflict; Impacts of human-wildlife conflict; Mitigation strategies; Major human-wildlife conflicts; Keoladeo National Park conflict of Bharatpur, Human and elephant conflicts in India. Fisherman and tiger conflict of Sundarbans.

Unit-IV: Human wildlife coexistence

Symbiotic relationship between tribals and forest, community participation in forest management, Case study of Chipko movement, Man and Biosphere Programmes; concept of conservation reserves and community reserves, importance of wildlife corridors in minimizing the conflicts and conservation.

Suggested Readings:

1. Conover, M. 2001. *Resolving Humam Wildlife Conflicts.* CRC Press
2. Dickman, A.J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human-wildlife conflict. *Animal Conservation* 13:458-466.
3. Messmer, T.A. 2000. The emergence of human-wildlife conflict management: Turning challenges into opportunities. *International Biodeterioration & Biodegradation.* 45:97-102.
4. Paty, C. 2007. *Forest, Government and Tribe*. Concept Publishing Company.
5. Treves, A., & Karanth, K.U. 2003. Human-carnivore conflict and perspectives on carnivore management worldwide. *Conservation Biology.* 17:1491-1499.
6. Woodroffe, R. 2005. *People and Wildlife: Conflict and Coexistance* . Cambridge.
7. Woodorffe, R., Thirgood, S. & Rabinowitz, A. 2005. *People and Wildlife, Conflict or Coexistance?* (N0.9). Cambridge University Press.

SEMESTER VIII

Main Course
RESEARCH METHODOLOGY
Paper Code – EVS/403

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY

Total number of contact hours: 45

Unit I: Introduction

Definition of research; objectives of research; Characteristics of research; steps in research; applications and types of research; Methods of research; Research ethics, significance of research; Plagiarism- Concept and significance of plagiarism; Basics of Intellectual property rights

Unit-II: Research design

Research problem; selecting and defining a research problem; Hypothesis- Meaning, function and types of hypotheses; Null/Alternative hypothesis; Variables- Meaning and types; Research design: Types of research design- exploratory, descriptive, diagnostic and experimental; Problems Encountered by Researchers in India

Unit-III: Data Collection and report writing

Primary and secondary data collection procedures, spatial and non-spatial data, Sampling-Meaning and types of sampling; Probability and Non-Probability; Research reports: Writing preliminaries, main body of research, references and bibliography; Meaning and importance of workshop, seminar, conference, symposium etc. in research

PRACTICAL

Paper Code – EVS/403 (P)

Total number of contact hours: 15

1. To write a research article/paper
2. Literature review of scientific papers
3. Bibliographic arrangement of references and citations
4. To write a Field Report.
5. To write a synopsis of master/research thesis
6. Seminar on different topics relating to research methodology

Suggested Readings

1. Krishna Swamy K.N., Siva Kumar A.I., Mathirajan M., "Management Research Methodology (2006), Pearson Education, New Delhi.
2. Kothari C.R., "Research Methodology, Methods and Techniques, Second edition, (2008), New Age International Publication.
3. Ranjit Kumar : Research Methodology, A step by step guide for beginners, Pearson Education, Sixth Edition 2009.
4. Mark Saunders, Philip Lewis, Adrain Thornhiu:Research Methods for Business Students, Pearson Education.
5. Ram Ahuja, "Research Methods", (2001), Rawat Publications, New Delhi.
6. Cooper D., Schindler P., Business research methods", (2003) Tata Mc-Graw Hill, New Delhi.

7.

SEMESTER-VIII

Main Course
GEOINFORMATICS
Paper Code – EVS/404

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY

Total number of contact hours: 45

Unit-I: Introduction to Geosciences

Concept of environmental geology; Evolution, origin and age of earth, internal structure of the earth. Formation of continents, oceans, lakes and rivers.

Unit-II: Introduction to Geoinformatics

Concept and application of Geoinformatics, Concept of Cartography & Photogrammetry, Concept of Environmental Geography; Introduction and application of GPS & GNSS.

Unit-III: Basics to Remote Sensing & GIS

Concept, components & types of Remote Sensing; Concept, elements, types, models, and principles of geographic information system (GIS); Application of RS & GIS in Environmental Science.

PRACTICAL

Paper Code – EVS/404 (P)

Total number of contact hours: 15

1. To study the evolution of planet earth through the ages.
2. To study the diagrammatic figures of earth structure.
3. To measure latitude and longitude of a study area using GPS.
4. To interpret the physical features of a topographic map
5. To identify the physical features on single vertical aerial photograph.
6. To calculate the map distance and surface distance using map scale.

Suggested Readings:

1. Anjaneyulu and Narasimha, R. 2009. Introduction to Environmental Science. B.S. Publications, Hyderabad.
2. Daniel, D. C. 2014. Environmental Science. Jones and Bartlett Publishers, London.
3. Sahni, P., Dhameja, A. and Medury, U. 2011. Disaster Mitigation: Experiences and Reflections. PHI Learning Private Limited, New Delhi.
4. Datta, A. K. 2010. Introduction to Physical Geology. Kalyani Publishers, New Delhi.
5. Mahapatra, G. B. 2013. Text book of Physical Geology. CBS Publishers & Distributers Pvt. Ltd. New Delhi.

6. Panda, B. C. 2011. Remote Sensing Principles and Applications. Viva Books Pvt. Ltd, New Delhi.
7. Singh, J.S. Singh, S.P. and Gupta, S.R. 2010. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.
8. Demers, M.N. 2005. Fundamentals of Geographical Information Systems (2nd Edition). Wiley and Sons.
9. Montgomery, C. (2005) Environmental Geology. McGraw-Hill.
10. Gleick, H.P. 1993. Water in crisis, Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute Oxford Univ. Press.

SEMESTER-VIII
Main Course
ENVIRONMENTAL BIOTECHNOLOGY
Paper Code: EVS/405

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY
Total number of contact hours: 45

UNIT – I Introduction
Issues and scope of environmental biotechnology; application of biotechnology to environmental problems; role of biotechnology in biodiversity conservation- gene banks, germplasm conservation and cryopreservation.

UNIT- II Biotechnological Approach for pollution abatement
Bioremediation: In-situ bioremediation, Ex-situ bioremediation, bioremediation of-hydrocarbons, industrial wastes, xenobiotics; phytoremediation; bioaugmentation; biofiltration; biofertilizers; biopesticides; biosensors.

UNIT-III Biotechnological Approach in Energy Management
Role of biotechnology in energy production; Biomass energy production- energy plantations, petroleum plants-hydrocarbon from higher plants, algal hydrocarbons; bioethanol, biogas production: anaerobic digestion; biogas production from different feedstocks.

PRACTICAL
Paper Code: EVS/405 (P)
Total number of contact hours: 15

1. To write the assignment of selected topic
2. To prepare a blueprint of a modal project adopting biotechnological approach.
3. To prepare a list of biofertilizers and biopesticides used by local farmers by field visit.
4. To explore the biogas production feasible areas in your state.
5. To prepare and explore the initiatives of biotechnological approach for pollution abatement in your state.
6. Seminar presentation on different areas of environmental biotechnology

Suggested Readings:

1. Evans, G.M. and Furlong J.C. 2003. Environmental Biotechnology: Theory and Application. John Wiley and Sons.

2. Thomas, J.A. and Fuchs, R. 2002. Biotechnology and Safety Assessment. Academic Press.
3. Bimal Bhattachraya and Ritu Banerjee 2007. Environmental Biotechnology. Oxford University Press
4. Jogdand, S.N. 2015. Environmental Biotechnology. Himalaya Publishing House
5. Pradipta Kumar Mohapatra 2020. Environmental Biotechnology Dreamtech Press
6. Dubey, R.C. 2014. A textbook of Biotechnology. S. Chand
7. Pranav Kumar and Usha Mina 2015. Biotechnology: A problem approach. Pathfinder Publication
8. Rana, S.V.S. 2014. Environmental Biotechnology. Rastogi Publication

SEMESTER-VIII
Main Course
SOIL SCIENCE
Paper Code: EVS/406

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY
Total number of contact hours: 45

Unit I: Soil structure, origin, formation and classification
Soil origin; factors and processes of soil formation; concept of soil individual; soil morphology and micromorphology; soil profile; soil texture; soil mineralogy; soil taxonomy and soil classification; soil series; types of soil surveys; usefulness of soil maps; major soil groups of India

Unit II: Soil physics and chemistry
Soil physical environment and soil fertility relationship; consistence, swelling, shrinkage, dispersion and workability of soil compaction process, soil-water behavior; soil air; concepts of chemical equilibrium soil; soil colloids; zeta potential, stability, coagulation/flocculation, electrometric properties, sorption properties of soil colloids; clay-organic matter interactions

Unit III: Basics of Soil biology
Soil biota; types of organisms in different soils; soil microbial biomass; microbial interactions in soil; phyllosphere; bio-fertilizers; soil enzymes activities and importance; bio chemical composition and biodegradation of soil organic matter and crop residues; organic wastes and of production of manures, biotic factors in soil development

PRACTICAL
Paper Code: EVS/406 (P)
Total number of contact hours: 15

1. Determination of soil pH and electrical conductivity
2. Determination of soil texture by particle size distribution method
3. Determination of soil porosity and bulk density
4. Determination of water holding capacity of soil
5. Determination of soil organic matter
6. Determination of phosphorous content in soil

Suggested readings:

1. The Nature and Properties of Soils, Brady, N.C., Weil, R.R., (2002), 13th Ed. Pearson Edu., USA
2. Fundamentals of Soil Science, Indian Society of Soil Science, (2002) ISSS, New Delhi
3. Pedology - Concepts and Applications, Sehgal J., (2002), Kalyani Publishers, India
4. Principles of Soil Physics, Lal, R., Shukla, M.K., (2019), Routledge, UK
5. Textbook of Soil Chemistry, Sanyal, S.K., (2020), Daya Publishing House, India
6. Soil Microbiology Ecology and Biochemistry, Paul, E.A., (2008), Elsevier, USA
7. Principles and Applications of Soil Microbiology, Sylvia, D.N., (2005), Pearson Edu, USA
8. Irrigation water management – principles and practice, Majumdar, D.K., (2004), Prentice
   Hall of India, New Delhi.
9. Fundamentals of Soil Ecology, Coleman, D.C., Crossley, D.A., Hendrix, P.F., (2004), Academic Press, USA

SEMESTER-VIII
Main Course
ENVIRONMENTAL MANAGEMENT
Paper Code: EVS/407

Full Marks- [{75(50+25)} +25]
Credits: 4 [Theory-3 and Practical-1]

THEORY
Total number of contact hours: 45

Unit-I: Fundamentals of Environmental Management
Scope, importance, need and nature of environmental management; reasons for implementing an environmental management system (EMS); key features and appropriate content of an effective EMS based on the requirements of ISO 14001; benefits and limitations of introducing a formal EMS into the workplace; key members of the ISO 14000 family of standards and their purpose.

Unit-II: International efforts for environmental management
Global Conventions like Stockholm Conference, Rio Submit, Rio+10, Brundtland Commission, Rio+20, Montreal Protocol, Kyoto Protocol, Copenhagen Summit; Global Organizations like IPCC, UNEP, IUCN, WWF, FAO, WHO; Environmental labelling; Intellectual Property Rights, Eco-mark.

Unit-III: National efforts for Environmental management
National Organizations like ATREE, BNHS, BSI, CEE, CSE, NEERI, NCF, PETA, SACON, TERI, WII, ZSI (objectives, salient features, major activities and achievements only); Ganga Action Plan, NEAC, National River Conservation Plan, National Wildlife Action Plan, National Wetland Conservation Programme etc.

PRACTICAL
Paper Code: EVS/407 (P)
Total number of contact hours: 15

1. To draw a flow chart of key elements of environmental management system.
2. To draw and prepare the environment related signs and symbol.
3. To prepare a list of international conventions on Environment.
4. To draw and prepare a list of global organizations on Environment with their logos.
5. To draw and prepare a list of eco label and symbol.
6. To draw and prepare a list of national organizations of India with their logos.

Suggested Readings

1. Nath, B. Hens, I., Compton, P. And Devuyst, D. (1998). Environmental Management in Practice, Vol. I, Routledge, London and New York.
2. Cascio, J (1996). The ISO 14000 Handbook: The New International Environmental Management Standards, McGraw Hill Professional.
3. ISO 14001 - Environmental management systems: Specifications with guidance for use (ISO 14001: 1996b (E), International Organization for standardization – Switzerland.
4. Pallister, J. 2017. Environmental Management. Oxford University Press, London
5. Negi, S.S. 2008. A Hand Book of Environmental Science. M/S Bishen Singh Mahendra Pal Singh, Dehradun.
6. Krishnamoorty, B. 2017. Environmental Management: Text and Cases, Prentice Hall of India, New Delhi.
7. Sankar, A. 2015. Environmental Management. Oxford University Press, New Delhi.
8. Kubba, S. 2010. LEED Practices, Certification, and Accreditation Handbook, Elsevier, Amsterdam.
9. Whitelaw, K. 2004. ISO 14001 Environmental Systems Handbook, Elsevier, Amsterdam
10. Krishnamoorthy, B. 2010. Environmental. Management: Text and Cases (2nd Edition). PHI Learning Private Limited, New Delhi.
11. Chaudhari, B.N. 2004. Introduction to Environmental Management. New Delhi.

SEMESTER-VIII

RESEARCH PROJECT/DISSERTATION

Paper Code: EVS/408

Credits- 12

- Each student will carry out a research project related to Environmental Science.
- The research project report has to be submitted to the university.

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