UNIVERSITY OF KALYANI

PROPOSED

COURSE STRUCTURE FOR FOUR(4) YEARS (8 SEMESTERS) UNDERGRADUATE PROGRAMME IN ENVIRONMENTAL SCIENCE (HONOURS) UNDER NATIONAL CURRICULUM AND CREDIT FRAMEWORK (NEP-2020)

Semester	Major (M)	Minor (MI)	Multidis-ciplinary (MDC)	Ability Enhancement Course (AECC)	Skill Enhancement Course (SEC)	Value Added Course(VA)	Summer Course (SI)	Total Credits/ Courses
SEM - I	6	4	3	-	3	4	-	20/5
SEM - II	6	4	3	4	3	-	4	20/5
Certificate	**12**	**8**	**6**	**4**	**6**	**4**		**40**
SEM - III	6	4	3	-	3	4	-	20/5
SEM - IV	12	4	-	4	-	-	4	20/4
Diploma	**30**	**16**	**9**	**8**	**9**	**8**		**80**
SEM -V	12	8	-	-	-	-	-	20/4
SEM - VI	18	-	-	-	-	-	2 (outreach/ Internship)	20/3
UG	**60**	**24**	**9**	**8**	**9**	**8**	**2**	**120**
SEM-VII	18	8	-	-	-	-	-	26/5
SEM-VIII **(UG Honours without Research)**	24	-	-	-	-	-	-	24/5
SEM-VIII **(UG Honours with Research)**	12	-	-		-	-	12 (Research Project/ Dissertation)	24
UG Honours without Research	**102**	**32**	**9**	**8**	**9**	**8**	**2**	**170**
UG Honours with Research	**90**	**32**	**9**	**8**	**9**	**8**	**14**	**170**

COURSE STRUCTURE IN ENVIRONMENTAL SCIENCE (NEP-2020)

Semester – I

Course Code	Course Title	Nature of Course	Credits of Course	Class hour/week	Evaluation		Total
					Internal	Semester End	
ENVS-M-1 ENVS-M-1-L ENVS-M-1-P	Fundamentals of Environment and Ecology	Major Course	4+2	6	10+5	40+20	75
ENVS-MI(I)-1	Environmental Pollution	Minor Course	4	4	10	40	50
ENVS-MDC-1	Natural Resource Management	Multidisciplinary Course	3	3	10	35	45
ENVS-SEC-1	Water and Air Quality Analysis	Skill Enhancement Course	3	3	10	35	45
ENVS-VA-1	Environmental Education	Value added course	4	4	10	40	50
Total Credits/ Courses= 20/5			**20**	**20**	**55**	**210**	**265**

Semester – II

Course Code	Course Title	Nature of Course	Credits of Course	Class hour/week	Evaluation		Total
					Internal	Semester End	
ENVS-M-2 ENVS-M-2-L ENVS-M-2-P	Environmental Pollution and Mitigation	Major Course	4+2	6	10+5	40+20	75
ENVS-MI(II)-2	Society, Gender and Environment	Minor Course	4	4	10	40	50
ENVS-MDC-2	Climate Change and Global Environmental Issues	Multidisciplinary Course	3	3	10	35	45
AECC-I	Communicative English	Ability enhancement course	4	4	10	40	50
ENVS-SEC-2	Soil Quality Analysis and Noise Monitoring	Skill Enhancement Course	3	3	10	35	45
ENVS-SI-1	Summer internship (Additional for Certificate/Diploma)	Summer internship	4	4			
Total Credits/ Courses= 20/5			**20**	**20**	**55**	**210**	**265**

COURSE STRUCTURE IN ENVIRONMENTAL SCIENCE (NEP-2020)

Semester – III

Course Code	Course Title	Nature of Course	Credit of Course	Class hour/week	Evaluation		Total
					Internal	Semester End	
ENVS-M-3 ENVS-M-3-L ENVS-M-3-P	Water Resources and Wastewater Management	Major Course	4+2	6	10+5	40+20	75
ENVS-MI(I)-3	Resource and Energy Management	Minor Course	4	4	10	40	50
ENVS-MDC-3	Environment and Sustainable Development	Multidisciplinary Course	3	3	10	35	45
ENVS-SEC-3	Analytical Techniques in Environment	Skill Enhancement Course	3	3	10	35	45
ENVS-VA-3	to be selected from the pool	Value added course	4	4	10	40	50
Total Credits/ Courses= 20/5			**20**	**20**	**55**	**210**	**265**

Semester – IV

Course Code	Course Title	Nature of Course	Credit of Course	Class hour/week	Evaluation		Total
					Internal	Semester End	
ENVS-M-4 ENVS-M-4-L ENVS-M-4-P	Environmental Chemistry and Environmental Physics	Major Course	4+2	6	10+5	40+20	75
ENVS-M-5 ENVS-M-5-L ENVS-M-5-P	Environmental Toxicology and Health	Major Course	4+2	6	10+5	40+20	75
ENVS-MI(II)-3	Basics of Biodiversity	Minor Course	4	4	10	40	50
AECC-II	MIL	Ability enhancement course	4	4	10	40	50
ENVS-SI-2	Summer Internship (Additional for Certificate/Diploma)	Summer internship	4	4			
Total Credits/ Courses= 20/4			**20**	**20**	**50**	**200**	**250**

COURSE STRUCTURE IN ENVIRONMENTAL SCIENCE (NEP-2020)

Semester – V

Course Code	Course Title	Nature of Course	Credit of Course	Class hour/week	Evaluation		Total
					Internal	Semester End	
ENVS-M-6 ENVS-M-6-L ENVS-M-6-P	Environmental Geoscience	Major Course	4+2	6	10+5	40+20	75
ENVS-M-7 ENVS-M-7-L ENVS-M-7-P	Biodiversity Management	Major Course	4+2	6	10+5	40+20	75
ENVS-MI(I)-4-a **OR** **ENVS-MI(I)-4-b** (Any one)	(a) Land Resource Management (b) Water Resource Management	Minor Course	4	4	10	40	50
ENVS-MI(II)-4-a **OR** **ENVS-MI(II)-4-b** (Any one)	(a) Wildlife Management (b) Sustainable Tourism	Minor Course	4	4	10	40	50
Total Credits/ Courses= 20/4			**20**	**20**	**50**	**200**	**250**

Semester – VI

Course Code	Course Title	Nature of Course	Credit of Course	Class hour/week	Evaluation		Total
					Internal	Semester End	
ENVS-M-8 ENVS-M-8-L ENVS-M-8-P	Environmental Microbiology and Environmental Biotechnology	Major Course	4+2	6	10+5	40+20	75
ENVS-M-9 ENVS-M-9-L ENVS-M-9-P	Green Chemistry and Green Technology	Major Course	4+2	6	10+5	40+20	75
ENVS-M-10 ENVS-M-10-L ENVS-M-10-P	Environmental Impact and Risk Assessment	Major Course	4+2	6	10+5	40+20	75
ENVS-SI-3	Outreach/Internship	Outreach/Internship	2	2	-	-	-
Total Credits/ Courses+ Internship= 20/3			**20**	**20**			

COURSE STRUCTURE IN ENVIRONMENTAL SCIENCE (NEP-2020)

Semester – VII

Course Code	Course Title	Nature of Course	Credit of Course	Class hour/week	Evaluation		Total
					Internal	Semester End	
ENVS-M-11 ENVS-M-11-L ENVS-M-11-P	Solid and Hazardous Waste Management	Major Course	4+2	6	10+5	40+20	75
ENVS-M-12 ENVS-M-12-L ENVS-M-12-P	Occupational Health and Safety	Major Course	4+2	6	10+5	40+20	75
ENVS-M-13 ENVS-M-13-L ENVS-M-13-P	Environmental Legislation and Policy	Major Course	4+2	6	10+5	40+20	75
ENVS-MI(I)-5-a **OR** **ENVS-MI(I)-5-b** (Any one)	(a) Occupational Health and Safety	Minor Course	4	4	10	40	50
	(b) Disaster management						
ENVS-MI(I)-6-a **OR** **ENVS-MI(I)-6-b** (Any one)	(a) Environmental Quality Monitoring	Minor Course	4	4	10	40	50
	(b) Introductory Geospatial Technology						
Total Credits/ Courses= 26/5			**26**	**26**	**65**	**260**	**325**

Semester – VIII

Course Code	Course Title	Nature of Course	Credit of Course	Class hour/week	Evaluation		Total
					Internal	Semester End	
ENVS-M-14	Environmental Geoinformatics	Major Course	4	4	10	40	50
ENVS-M-15	Disaster Management	Major Course	4	4	10	40	50
ENVS-M-16	Environmental Statistics	Major Course	4	4	10	40	50
UG Honours without Research: Two Additional Major courses							
ENVS-M-17 ENVS-M-17-L ENVS-M-17-P	Environmental Economics	Major Course	4+2	6	10+5	40+20	75
ENVS-M-18 ENVS-M-18-L ENVS-M-18-P	Environmental Management	Major Course	4+2	6	10+5	40+20	75
Total Credits/ Courses= 24/5			**24**	**24**	**60**	**240**	**300**
			170				
UG Honours with Research: One Summer Internship							
ENVS-SI-4	Research Project/ Dissertation		12	12			
Total = 03+Research Project			**24**	**24**			

Semester - I

Major Course:

Course Code: ENVS-M-1
Course Title: FUNDAMENTALS OF ENVIRONMENT AND ECOLOGY
Full marks: 75, Credits: 4(L) +2(P) = 06

Preamble: This paper will introduce to the students the basic understanding of environment and ecology. It will explore the interconnectedness among all the biotic and abiotic components of environment and the dynamic nature of the ecological processes in maintaining equilibrium in nature.

ENVS-M-1-L

Credits: 4, Full Marks: 40+10

Unit 1: Life and Environment: Origin of earth, its environment and life (with special reference to Big Bang, chemical and biochemical evolution); Gaia hypothesis and life-environment interactions.

Unit 2: Environmental Systems and Subsystems: Basic concepts of atmosphere; hydrosphere; lithosphere; biosphere; anthro(po)sphere; circulation systems; catchment basin system; weathering system; slope system; fluvial system; glacial system; aeolian system; coastal system; ecosystem; landscape; biomes.

Unit 3: Ecology of Individuals: Ecological amplitude; Limiting factors; Liebig's law of the minimum; Shelford's law of tolerance; phenotypic plasticity; ecotypes; ecoclines; ecological niche (types of niche: Eltonian niche, Hutchinsonian niche, fundamental niche, realized niche; niche breadth; niche partitioning; niche differentiation); thermoregulation; strategies of adaptation in plants and animals.

Unit 4: Population Ecology: Concept of population and meta-population; r-and K-selection; characteristics of population (density, dispersion, natality, mortality, life tables, survivorship curves, age structure); population growth: geometric, exponential, logistic, density-dependent; limits of population growth; deterministic and stochastic models of population dynamics; rudreal, competitive and stress-tolerance strategies.

Unit 5: Community Ecology: Discrete versus continuum community view; community structure and organization: physiognomy, sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; interspecies interactions (mutualism, symbiotic relationships, commensalism, amensalism, proto-cooperation, predation, competition, parasitism, mimicry, herbivory); ecological succession: types, processes and models.

Unit 6: Ecosystem Ecology: Ecosystem structure and functions; abiotic and biotic components of ecosystem; ecosystem metabolism; primary production; secondary production and trophic efficiency; ecosystem connections: food chain, food web; models of energy flow; ecological efficiencies; ecological pyramids; ecosystem homeostasis (resistance and resilience stability); ecosystem services; Some model ecosystems: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands.

Unit 7: Biogeochemical cycles and nutrient cycling: Concepts of pools, flux, turnover time; types of biogeochemical cycles; carbon cycle; nitrogen cycle; phosphorus cycle; sulphur cycle; hydrological cycle; impact of anthropogenic activities on the nutrient cycles; nutrient conservation strategies.

ENVS-M-1-P **Credits: 2 Full Marks: 20+5**

Practical:

- Determination of dissolved oxygen, free carbon dioxide, and primary productivity of water samples collected from aquatic ecosystems.
- Qualitative and quantitative analysis of planktons of aquatic systems.
- Determination of species, dominance and frequency using quadrate/ plot method.
- Ecological field visit: pond/forest/river/wetland or other ecosystem.

Suggested Readings:

1. Odum, E. P. & Barrett, G. W. 2006. Fundamentals of Ecology (Cengage).
2. Molles, M. C. Ecology. 2009, McGraw Hill.
3. Beeby, A. Applied Ecology. Chapman and Hall.
4. Begon, M. Harper, J. L & Townsend, C. R. 2006. Ecology (Blackwell).
5. Smith R. L & Smith, T. M. Ecology and Field Biology. Benjamin Cummings/Addition Wesley.
6. Loreau, M. & Inchausti, P. 2002. Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
7. Dash, M. C. & S. P. Dash, Fundamental of Ecology. Tata McGraw Hill Publication.
8. Singh, J. S., Singh, S. P. & Gupta, S. R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications.
9. Santra, S. C. 2010. Fundamentals of Ecology and Environmental Biology, New Central Book Agency.

Minor Course:

Course Code: ENVS-MI(I)-1
Course Title: ENVIRONMENTAL POLLUTION

Credits: 4, Full Marks: 40+10

Preamble: To impart students the different types of pollution, causes and mitigation strategies. The students will be aware of the types of pollutants, sources, impacts and mitigation practices.

Unit 1: Air pollution: Natural and anthropogenic sources of air pollution; Primary and secondary air pollutants; Air quality standards; control of air pollution; Effects of air pollutants (SOx, NOx, CO, SPM) on humans, plants, animals; Automobile pollution; Acid Rain; Photochemical smog; Global Warming; Ozone layer depletion.

Unit 2: Water pollution: Sources of pollutants; causes and consequences of water pollution; water quality parameters and water quality standards; sewage and wastewater treatment; surface and ground water pollution; control strategies; thermal pollution.

Unit 3: Soil pollution: Sources, causes and consequences of soil pollution; control strategies; concept of soil quality.

Unit 4: Solid and hazardous waste: Sources and generation of solid waste; different methods of disposal and management of solid wastes (plastic, biomedical, electrical and electronic and other hazardous wastes); waste management hierarchy; minimization technologies: recycling and recovery of resources from wastes.

Unit 5: Noise pollution: Sources of noise pollution; measurement of noise and noise indices; noise exposure levels and standards; noise pollution control strategies; impact of noise on human health.

Unit 6: Marine pollution: Sources, causes and consequences of marine pollution and control strategies.

Unit 7: Radioactive pollution: Ionizing and non-ionizing radiation and their effects; radioactive waste and its management.

Suggested Readings:

1. Rieuwerts, J, 2015, The Elements of Environmental Pollution, Routledge Taylor & Francis Group, UK.
2. Hill, M.K. 2010 Understanding Environmental Pollution, Cambridge University Press, UK.
3. Vesilind, P.A J. Jeffrey Peirce, J.J, Weiner R.F, 1990, Environmental Pollution and Control, 3rd Edition, Elsevier Publication.
4. Rana, S. V. S. 2011. Environmental Pollution: Health and Toxicology. Alpha Science International Limited.
5. Brusseau, M, Pepper, I, Gerba, Charles 2019. Environmental and Pollution Science, 3rd Edition, Elsevier Publication.

Multidisciplinary Course:

Course Code: ENVS-MDC-1
Course Title: NATURAL RESOURCE MANAGEMENT

Credits: 3, Full Marks: 35+10

Preamble: This paper aims to provide an idea of the nature of Earth's resources, their generation, extraction, degradation and a critical insight of the major sustainability issues. The students are expected to understand effective natural resource management strategies from this course.

Unit 1: Introduction to natural resource: Concept and significance; types of natural resources; renewable and non-renewable resources; resource degradation; resource conservation.

Unit 2: Water resources management: Concept**,** world water balance; lakes, dams and reservoirs, coastal and marine water resources; conservation of water resources; integrated water resource management; rainwater harvesting; watershed management, wetland conservation and management.

Unit 3: Soil and land resources management: Concept**,** soil types, soil degradation and soil erosion; integrated strategies for soil conservation and regeneration; land resources: land use pattern and planning.

Unit 4: Mineral resources: Concept and types; environmental effects of extracting and using mineral resources.

Unit 5: Bioresource Management: Concept and categories, management of human and animal resources; biodiversity and its conservation; forest management; wildlife conservation and management.

Unit 6: Forest resources: Concept and types; use and over-exploitation, deforestation; impact of mining, dams on forest, mitigation strategies and tribal people.

Unit 7: Energy resources: Concept, types, conventional and non-conventional, non-renewable and renewable, fossil fuel, nuclear, geothermal, solar, wind, hydro-energy, bioenergy, energy conservation and management.

Unit 8: Field survey based analysis, exercise, report preparation and interpretation:

- Water audit of college/ industry/ domestic area.
- Energy audit of college/ industry / domestic area

Suggested Readings:

1. Ginley, D. S. & Cahen, D. 2011. Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge University Press.
2. Klee, G. A. 1991. Conservation of Natural Resources. Prentice Hall Publication.
3. Miller, T. G. 2012. Environmental Science. Wadsworth Publishing Co.
4. Owen, O. S, Chiras, D. D, & Reganold, J. P. 1998. Natural Resource Conservation –Management for Sustainable Future (7^{th} edition). Prentice Hall.
5. Ramade, F. 1984. Ecology of Natural Resources. John Wiley & Sons Ltd.

Skill Enhancement Course :

Course Code: ENVS-SEC-1-P
Course Title: WATER AND AIR QUALITY ANALYSIS

Credits: 3, Full Marks: 35+10

Preamble: This paper aims to provide knowledge about different types of sampling techniques, instruments handling, calibration methods, analysis of water and air quality in order to develop skills among students.

Unit 1: Water and Air sampling techniques: Collection, processing and storage; Sample preparation methods; Standard curve preparation; Calibration of instruments - Method validation, Accuracy, Precision, Error analysis.

Unit 2: Estimation of physicochemical and biological properties of water: Temperature, pH, Eh, Conductivity, Turbidity, Total Solids, Total Suspended Solids and Total Dissolved Solids, Alkalinity, Hardness, Chloride, Dissolved oxygen, Qualitative and quantitative analysis of planktons.

Unit 3: Estimation of cations/anions by flame photometry (Na, K)/ spectrophotometry (Fe, Nitrate, Phosphate, etc.).

Unit 4: Air quality parameters, air quality standard (NAAQS), monitoring techniques using high volume sampler, estimation of Suspended Particulate matter, SOx, NOx, etc.

Unit 5: Estimation of relative humidity using dry and wet bulb thermometer; Preparation of wind rose plots.

Unit 6: Field visit.

Suggested readings:

1. Trivedy, R. K. and Goel, P. K. (1986) Chemical and Biological method for water pollution studies. Environmental publication (Karad, India).
2. Nandini, N. (2009). Handbook on water quality monitoring and Assessment, Sapna Book House, Bengaluru.
3. Sawyer, C. N. and Mc Carty, P. L. (1978). Chemistry for Environmental Engineering. Mc Graw – Hill International.
4. Saxena M M. (1990). Environmental Analysis: Water, Soil and Air. Edition, 2. Publisher, Agro Botanical Pub.
5. Standard Methods for Examination of Water and Wastewater. (2017). APHA – WEF.
6. Trivedi, P. K. and Goel, P. K. (1984). Chemical and Biological Methods of Water Pollution Studies. Environmental Publication.
7. Zhang, C. (2007). Fundamentals of environmental sampling and analysis. John Wiley & Sons.
8. Metcalf, L., Eddy, H. P., & Tchobanoglous, G. (1991). Wastewater engineering: treatment, disposal, and reuse (Vol. 4). New York: McGraw-Hill.

Value Added Course:

Course Code: ENVS-VA-1
Course Title: ENVIRONMENTAL EDUCATION

Credits: 4, Full Marks: 40+10

Preamble: The course examines the relationship between the environment and society enabling the students to understand and appreciate the role played by environment, society, and, their interface in shaping environmental decisions. The students will be enabled to think critically on environmental issues.

Unit 1: Humans and the Environment: The man-environment interaction; impact of anthropogenic activities on the environment; Population growth and natural resource exploitation; Environmental world views: eco-centric, bio-centric and anthropocentric perspectives.

Unit 2: Natural Resources: Definition of resource; Classification of natural resources, renewable and non-renewable; Water resources; Soil/Land and mineral resources; Energy resources; Bioresources; Issues and challenges related to resource management.

Unit 3: Ecosystems and Biodiversity: Major types of ecosystem in India and their basic characteristics- forests, wetlands, grasslands, agriculture, coastal and marine; Ecosystem services.
Definition, levels and types of biodiversity, biodiversity hotspots, importance of biodiversity: threats to biodiversity, Biodiversity loss; Conservation approaches, role of traditional knowledge, PBR.

Unit 4: Environmental Pollution and Degradation: Definition of pollution; point sources and non-point sources of pollution; sources, causes, health effects and control strategies of air pollution, water pollution, soil pollution, noise pollutionand radioactive pollution, fire cracker pollution; land degradation, deforestation, desertification, urbanization.

Unit 5: Climate Change: Weather vs Climate, greenhouse gases, greenhouse effect and global warming; Natural vs anthropogenic radiative forcing; concepts of mitigation, adaptation, vulnerability and resilience (with reference to climate change);

Impacts of climate change on: ocean and land systems, Sea level rise, marine and coastal ecosystems, forests and natural ecosystems, animal species, agriculture, health, urban infrastructure.

Adaptation and mitigation measures; National and international policy instruments for mitigation, Climate justice; National Action Plan on Climate Change (NAPCC).

Unit 6: Environmental Treaties and Legislation: An overview of instruments of international cooperation; bilateral and multilateral agreements; conventions and protocols;
Major International Environmental Agreements: Convention on Biological Diversity (CBD); Ramsar Convention on Wetlands of International Importance; Montreal Protocol; Basel Convention; United Nations Framework Convention on Climate Change (UNFCCC); Kyoto Protocol; Paris Agreement;
Major Indian Environmental Legislations: The Wild Life (Protection) Act, 1972; The Water (Prevention and Control of Pollution) Act, 1974; The Forest (Conservation) Act, 1980; The Air (Prevention and Control of Pollution) Act, 1981; The Environment (Protection) Act, 1986; The Biological Diversity Act, 2002; Noise Pollution (Regulation and Control) Rules, 2000; The Plastic Waste Management Rules, 2016; The Bio-Medical Waste Management Rules, 2016; The Solid Waste Management Rules, 2016; The e-waste (Management) Rules, 2016;Major International organisations and initiatives for environmental protection: United Nations Environment Programme (UNEP), International Union for Conservation of Nature (IUCN).

Unit 7: Environmental Ethics and Sustainable Development: Environmental ethics, Role of various religions and cultural practices in environmental conservation.

Environmental communication and public awareness: (Swachh Bharat Abhiyan, National Environment Awareness Campaign (NEAC); sustainability ethics and sustainable lifestyle.

Concept of Sustainable development; overview of the United Nations Sustainable Development Goals (SDGs).

Suggested readings:

1. Fisher, Michael H. (2018) An Environmental History of India- From Earliest Times to the Twenty-First Century, Cambridge University Press.
2. Headrick, Daniel R. (2020) Humans versus Nature- A Global Environmental History, Oxford University Press.
3. Perman, R., Ma, Y., McGilvray, J., and Common, M. (2003) Natural Resource and Environmental Economics. Pearson Education.
4. Chiras, D. D and Reganold, J. P. (2010). Natural Resource Conservation: Management for a Sustainable Future.10th edition, Upper Saddle River, N. J. Benjamin/Cummins/Pearson.
5. John W. Twidell and Anthony D. (2015). Renewable Energy Sources, 3rd Edition, Weir Publisher (ELBS)
6. William P.Cunningham and Mary A. (2015) Cunningham Environmental Science: A Global Concern, Publisher (Mc-Graw Hill, USA)
7. Gilbert M. Masters and W. P. (2008). An Introduction to Environmental Engineering and Science, Ela Publisher (Pearson)
8. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications https://sdgs.un.org/goals
9. Harper, Charles L. (2017) Environment and Society, Human Perspectives on Environmental Issues 6th Edition. Routledge.
10. Manahan, S.E. (2022). Environmental Chemistry (11th ed.). CRC Press. https://doi.org/10.1201/9781003096238
11. Rajagopalan, R. (2011). Environmental Studies: From Crisis to Cure. India: Oxford University Press.
12. Bhagwat, Shonil (Editor) (2018) Conservation and Development in India: Reimagining Wilderness, Earthscan Conservation and Development, Routledge.
13. Krishnamurthy, K.V. (2003) Textbook of Biodiversity, Science Publishers, Plymouth, UK
14. Jackson, A. R., & Jackson, J. M. (2000). Environmental Science: The Natural Environment and Human Impact. Pearson Education.
15. Ahluwalia, V. K. (2015). Environmental Pollution, and Health. The Energy and Resources Institute (TERI).
16. Theodore, M. K. and Theodore, Louis (2021) Introduction to Environmental Management, 2nd Edition. CRC Press.
17. Kanchi Kohli and Manju Menon (2021) Development of Environment Laws in India, Cambridge University Press.

Semester - II

Major course:

Course Code: ENVS-M-2
Course Title: ENVIRONMENTAL POLLUTION AND MITIGATION

Full marks: 75, Credits: 4(L) +2(P) = 06

Preamble: This paper deals with different aspects of environmental contamination, which have adverse effects on human health. It will lay emphasis on understanding mechanisms of pollutants impacting human health by developing an understanding of different types of pollutants, their sources and mitigation measures. The students will also be introduced to the concept of permissible limits.

ENVS-M-2-L

Credits: 3, Full Marks: 35+10

Unit 1: Introduction: Definition of pollution; pollutants; classification of pollutants.

Unit 2: Air pollution: Ambient air quality: sources and types of air pollutants (primary and secondary); monitoring and standards (National Ambient Air Quality Standards of India); National air quality index; smog (case study); effects of different pollutants on human health (NO_x, SO_x, PM, CO, CO_2, hydrocarbons and VOCs) and control measures; indoor air pollution: sources, effects on human health and remedial strategies. Vehicular pollution and control strategies.

Unit 3: Water pollution: Sources of surface and ground water pollution; emerging pollutants: micro plastics, bisphenol-A, antibiotics; water quality parameters and standards; organic waste and water pollution; eutrophication; DO, BOD and COD; effect of water contaminants on human health (nitrate, fluoride, arsenic, heavy metals, pesticides); water borne diseases; concept and working of effluent treatment plants (ETPs); thermal pollution and its effects.

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Unit 4: Soil pollution: Causes of soil pollution and degradation; effect of soil pollution on plants, animals and human health; control strategies.

Unit 5: Noise pollution: sources; frequency, intensity and permissible ambient noise levels; effect on communication, impacts on life forms and humans - working efficiency, physical and mental health; control measures.

Unit 6: Radioactive: Radioactive material and sources of radioactive pollution; effect of radiation on human health (somatic and genetic effects).

Unit 7: Marine pollution: Marine resources and their importance; sources of marine pollution; oil spill and its effects; coral reefs and their demise; coastal area management; existing challenges and management techniques (planning, construction, environmental monitoring of coastal zones), London convention on the prevention of marine pollution.

Unit 8: Pollution control: Activated Sludge Process (ASP) – Trickling Filters – oxidation ponds, fluidized bed reactors, membrane bioreactor neutralization, ETP sludge management; digesters, up flow anaerobic sludge blanket reactor, fixed film reactors, sequencing batch reactors, hybrid reactors, bioscrubbers, biotrickling filters; regulatory framework for pollution monitoring and control; case study: Ganga Action Plan; Application of clean technologies for pollution control.

Unit 9: Environmental Disasters: Minamata Disaster, Love Canal Disaster, Bhopal Gas Disaster, 1984, Chernobyl Disaster, 1986, Fukusima Daiichi nuclear disaster, 2011.

ENVS-M-2-P

Credits: 2, Full Marks: 20+5

Practical:

- Estimation of water quality parameters (dissolved oxygen, nitrate, sulphate, phosphate, chloride, arsenic etc.).
- Wastewater characterization: Biochemical Oxygen Demand, Chemical Oxygen Demand, Analysis of anions: (Sulphate, Phosphate, Nitrate, Chloride etc.), oil, grease and phenolics, MLSS, MLVSS, SVI, SDI and coliform load.
- Physicochemical characterization of sludge.
- Estimation of air quality parameters (NO_x, SO_x, SPM).
- Total coliform load of water sample.
- Noise monitoring (Leq).
- Visit to effluent treatment plants (ETP)/ sewage treatment plants (STP).

Suggested Readings

1. Gurjar, B. R., Molina, L. T. & Ojha C. S. P. 2010. Air Pollution: Health and Environmental Impacts. CRC Press, Taylor & Francis.
2. Hester, R. E. & Harrison, R. M. 1998. Air Pollution and Health. The Royal Society of Chemistry, UK.
3. Park, K. 2015. Park's Textbook of Preventive and Social Medicine (23rd edition). Banarsidas Bhanot Publishers.
4. Pepper, I. L., Gerba, C.P. & Brusseau, M. L. 2006. Environmental and Pollution Science. Elsevier Academic Press.
5. Purohit, S. S. & Ranjan, R. 2007. Ecology, Environment & Pollution. Agrobios Publications.
6. Vesilind, P. J., Peirce, J. J., & Weiner R. F. 1990. Environmental Pollution and Control. Butterworth-Heinemann, USA.
7. Trivedy, R. K. and Goel, P. K. (1986) Chemical and Biological method for water pollution studies. Environmental publication (Karad, India).
8. Nandini, N. (2009). Handbook on water quality monitoring and Assessment, Sapna Book House, Bengaluru
9. Sawyer, C. N. and Mc Carty, P. L. (1978). Chemistry for Environmental Engineering. Mc Graw – Hill International.
10. Saxena M M. (1990). Environmental Analysis: Water, Soil and Air. Edition, 2. Publisher, Agro Botanical Pub.
11. Standard Methods for Examination of Water and Wastewater. (2017). APHA – WEF.
12. Zhang, C. (2007). Fundamentals of environmental sampling and analysis. John Wiley & Sons.
13. Metcalf, L., Eddy, H. P., & Tchobanoglous, G. (1991). Wastewater engineering: treatment, disposal, and reuse (Vol. 4). New York: McGraw-Hill.

Minor course:

Course Code: ENVS-MI(II)-2
Course Title: SOCIETY, GENDER AND ENVIRONMENT

Credits: 4, Full Marks: 40+10

Preamble: The course examines the relationship between the environment and society enabling the students to understand and appreciate the role played by environment, society, and, their interface in shaping environmental decisions. The concept of gender in society and its relevance in the environmental context is also included.

Unit 1: Issues in environmentalism: Historical developments in cultural, social and economic issues related to land, forest, and water management in a global context; interface between environment and society, Environmental Ethics, Significant global environmental issues such as acid rain, climate change, and resource depletion.

Unit 2: Development-environment conflict: Developmental issues and related impacts such as ecological degradation; environmental pollution; development-induced displacement, resettlement, and rehabilitation: problems, concerns, and compensative mechanisms; discussion on Project Affected People (PAPs).

Unit 3: Urbanization and environment: Production and consumption oriented approaches to environmental issues in Indian as well as global context; impact of industry and technology on environment; urban sprawl, traffic congestion and social-economic problems.

Unit 4: Community participation: State, corporate, civil society, community, and individual-level initiatives to ensure sustainable development; case studies of environmental movements (Appiko Movement, Chipko Movement, Narmada Bachao Andolan); corporate responsibility movement; role of environment related NGOs; environmental education and awareness.

Unit 5: Gender and society: Gender existence in society; gender: matriarchy and patriarchy as means of social exclusion (case studies in an Indian context); gender equity issues in rural and urban settings, Knowledge about the environment among men and women, gendered division of roles in cultural, social and economic perspective; gender inequalities.

Unit 6: Women and environment: Relevance of the concept in an environmental context; Women's participation in environmental movements and conservation; concept of eco feminism; historical and contemporary case studies; role of women in environmental education, awareness and sustainable development. Instruments for change: education, media, action groups, policy and management; equity in resource availability and consumption for a sustainable future.

Unit 7: Field survey based analysis, exercise and interpretation:

- Interactive session with community for awareness development and survey documentation (Socio-economic/socio cultural/ and other environmental perspectives).
- Assignment on gender/environment: gender equity issues in rural and urban society/ evaluation of gendered responses to environmental degradation.

Suggested Readings:

1. Chokkan, K. B., Pandya, H. & Raghunathan, H. (eds). 2004. *Understanding Environment*. Sagar Publication India Pvt. Ltd., New Delhi.
2. Robbins, P, J Hintz & SA Moore. 2014. Environment and Society. Wiley Blackwell.
3. Elliot, D. 2003. *Energy, Society and Environment, Technology for a Sustainable Future*. Routledge Press.

4. Guha, R. 1989. *Ecological change and peasant resistance in the Himalaya*. Unquiet Woods, Oxford University Press, Delhi.
5. Leopold, A. 1949. *The Land Ethic*. pp. 201-214. Chicago, USA.
6. National Research Council (NRC). 1996. *Linking Science and Technology to Society's Environmental Goals*. National Academy Press.
7. Pandit, M. K. 2013. Chipko: Failure of a Successful Conservation Movement. In: Sodhi, N. S., Gibson, L. & Raven, P. H. *Conservation Biology: Voices from the Tropics.* pp. 126-127. Wiley-Blackwell, Oxford, UK.
8. Agarwal, B. 1992. The Gender and Environment Debate: Lessons from India. Feminist Studies (Minnesota).
9. Agarwal, B. 1997. Gender, Environment and Poverty Interlinks: Regional Variations and Temporal Shifts in Rural India: 1971-1991. World Development 25: 1-42.
10. Agarwal, B. 2001. Participatory exclusions, community forestry, and gender: An analysis for South Asia and a conceptual framework. World Development 29: 1623-1648.
11. Jackson, C. 1993. Doing what comes naturally? Women and environment in development World Development 21:1947-63.
12. Krishna, S. 2004. Livelihood and Gender. New Delhi, Sage.
13. Leach, M. 2007. Earth Mother myths and other ecofeminist fables: How a strategic notion rose and fell. Development and Change 38: 67-85.
14. Miller, B. 1993. Sex and Gender Hierarchies. Cambridge University Press.
15. Stein, R. (ed.). 2004. New Perspectives on Environmental Justice: Gender, Sexuality, and Activism. Rutgers University Press.
16. Steingraber, S. 1998. Living Downstream: A Scientist's Personal Investigation of Cancer and the Environment. New York: Vintage Books.
17. Zwarteveen, M. Z. 1995. Linking women to the main canal: Gender and irrigation management. Gatekeeper Series 54, IIED.

Multidisciplinary Course:

Course Code: ENVS-MDC-2
Course Title: CLIMATE CHANGE AND GLOBAL ENVIRONMENTAL ISSUES

Credits: 3, Full Marks: 35+10

Preamble: The paper deals with climate change and global environmental issues which includes composition and processes of atmosphere, meteorological phenomena and atmospheric chemistry. The paper also highlights the anthropogenic intervention in 'anthropocene', which has led to global climate change. The paper also explores effects of global changes on human communities and initiatives taken at global and regional levels to combat them.

Unit 1: Composition and processes of atmosphere: Atmospheric structure and composition. Chemistry of atmospheric particles and gases; smog – types and processes; photochemical processes; ions and radicals in atmosphere; acid-base reactions in atmosphere; atmospheric water; role of hydroxyl and hydroperoxyl radicals in atmosphere. Green house gases (GHGs); greenhouse effect; global warming.

Unit 2: Meteorology and atmospheric stability: Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation); atmospheric stability and mixing heights; temperature inversion; plume behaviour; Gaussian plume model. Movement of air masses; southern oscillation; western disturbances; *El Nino* and *La Nina*; tropical cyclone; Indian monsoon and its development, its impact on agriculture Asian brown clouds.

Unit 3: Global warming and climate change: Trends of global warming and climate change; drivers of global warming and the potential of different greenhouse gases (GHGs); radiative forcing and feedbacks (natural climate forcing, greenhouse gas forcing, atmospheric aerosol forcing, land-use change forcing) impact of climate change on atmosphere, weather patterns, sea level rise, water resources, biological responses, agriculture, and human health; Climate Change Mitigation and Adaptation; Carbon capture and storage (CCS); Carbon sequestration.

Unit 4: Acid Rain: Causes, nature and effects of acid rain on soil, water, biota and archaeological and heritage structures; trans-boundary nature; case studies; combating strategies.

Unit 5: Ozone layer depletion: Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS); effects of ozone depletion; mitigation measures and international protocols.

Unit 6: Climate change and policy: International agreements; Montreal Protocol (1987); Kyoto Protocol (1997); Convention on Climate Change; carbon credit and carbon trading; clean development mechanism (CDM); National Action Plan for Climate Change (NAPCC).

Suggested Readings:

1. Barry, R. G. 2003. Atmosphere, Weather and Climate. Routledge Press, UK.
2. Gillespie, A. 2006. Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations. Martinus Nijhoff Publishers.
3. Hardy, J. T. 2003. Climate Change: Causes, Effects and Solutions. John Wiley & Sons.
4. Harvey, D. 2000. Climate and Global Climate Change. Prentice Hall.
5. Manahan, S. E. 2010. Environmental Chemistry. CRC Press, Taylor and Francis Group.
6. Maslin, M. 2014. Climate Change: A Very Short Introduction. Oxford Publications.
7. Mathez, E. A. 2009. Climate Change: The Science of Global Warming and our Energy Future. Columbia University Press.
8. Mitra, A. P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. & Sen, K. 2004. Climate Change and India. Universities Press, India

Skill Enhancement Course :

Course Code: ENVS-SEC-2-P
Course Title: SOIL QUALITY ANALYSIS AND NOISE MONITORING

Credits: 3, Full Marks: 35+10

Preamble: This paper aims to provide knowledge about soil sampling techniques, analysis of soil and sediment, understanding of sound quality and noise level monitoring practices for skill development among students.

Unit 1: Soil sampling techniques: collection, processing, and storage; Sample preparation and analysis techniques.

Unit 2: Physicochemical analysis of soil and sediment: pH, Conductivity, Texture, Porosity and Bulk density, Water holding capacity, Moisture content, Hardness, Organic carbon, Nitrate, phosphate, cation exchange capacity, NPK etc.

Unit 3: Measurement of sound quality and noise level, $L_{eq.}$

Unit 4: Field visit.

Suggested Readings:

1. Trivedy, R. K. and Goel, P. K. (1986) Chemical and Biological method for water pollution studies. Environmental publication (Karad, India).
2. Saxena M M. (1990). Environmental Analysis: Water, Soil and Air. Edition, 2. Publisher, Agro Botanical Pub.
3. Sawyer, C. N. and Mc Carty, P. L. (1978). Chemistry for Environmental Engineering. Mc Graw – Hill International.
4. A text book of soil chemical analysis- P. R. Hesse CBS (2002).
5. Soil chemical analysis- M. L. Jackson- Scientific Publishers (2012).
6. Noise and vibration analysis- Anders Brandt (2011) Wiley.