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(Accredited by NAAC)

GU/Acad –PG/BoS -NEP/2023/75/2 Date:23.05.2023

Ref: GU/Acad –PG/BoS -NEP/2022/339/15 dated18.08.2022

CIRCULAR

In supersession to the above referred Circular, the updated approved Syllabus with revised Course Codes of the **Master of Science/Master of Arts in Environmental Science** Programme is enclosed

The Dean/ Vice-Deans of the School of Earth, Ocean and Atmospheric Sciences/ Principals of Affiliated Colleges offering the **Master of Science/Master of Arts in Environmental Science** Programme are requested to take note of the above and bring the contents of the Circular to the notice of all concerned.

ASHWIN VYAS LAWANDE
Digitally signed by ASHWIN VYAS LAWANDE
Date: 2023.05.23 17:23:39 +05'30'

(Ashwin Lawande)
Assistant Registrar – Academic-PG

To,

1. The Dean, School of **Earth, Ocean and Atmospheric Sciences**, Goa University.
2. The Vice-Deans, School of **Earth, Ocean and Atmospheric Sciences**, Goa University.
3. The Principals of Affiliated Colleges offering the Master in Sciences in Environmental Sciences Programme.

Copy to:

1. The Chairperson, Board of Studies in Environmental Sciences.
2. The Programme Director, M. Sc. Environmental Sciences, Goa University.
3. The Controller of Examinations, Goa University.
4. The Assistant Registrar, PG Examinations, Goa University.
5. Directorate of Internal Quality Assurance, Goa University for uploading the Syllabus on the University website.

GOA UNIVERSITY

School of Earth, Ocean and Atmospheric Sciences, Goa University

Syllabus for the M. Sc. / M. A. in Environmental Science Programme

Effective from: AY 2022 -2023

Why a programme in Environmental Science?

Environmental science has conventionally studied physical, chemical and biological processes in the Earth system (Lithosphere, hydrosphere, atmosphere, biosphere and cryosphere). Increasingly, it now incorporates nature-human interactions and the social, political and cultural processes which impact the planet. The anthropogenic pressures on the ecological processes have forced disciplinary boundaries to merge and a student of environmental science must understand the complex relationships that drive nature-human interactions. Sustainability is one of the grand challenges that human survival faces on planet Earth.

Why at Goa University?

Goa is a biodiversity-rich state with Western Ghats on one side and the Arabian Sea on the other. It has both terrestrial as well as marine biodiversity that sustains human livelihoods and provides numerous ecosystem services.

Goa University is uniquely positioned to offer students a stimulating programme to study the human-environment interaction. The university has all conventional programmes along with frontier areas like biotechnology, data science, hospitality, marine science, microbiology, women's studies among others.

What the course offers?

Goa University has designed an unique two-year postgraduate programme in environmental science keeping the above grand challenge in mind. The programme is hosted by the School of Earth Ocean and Atmospheric Sciences (SEOAS) in collaboration with Departments of Botany, Biotechnology, Zoology, Microbiology, Philosophy, Sociology, History, Faculty of Life Sciences, Goa Business School, ManoharParrikar School of Law, Governance and Public Policy, and School of Chemical Sciences. It is conceived as a multidisciplinary programme which will teach students how to combine skills and knowledge from a variety of domains. It will allow students to explore courses from a large number of disciplines and skill themselves in a manner that they feel best suits them for their knowledge pursuits. The programme will provide a holistic approach to understand environmental issues and undertake environmental impact assessments with diverse perspectives, frameworks and using multiple data sources. All students will undertake fieldwork and laboratory work, to experience different habitats, climates, land formations and social structures.

Eligibility for admission to M. Sc. Environmental Science

Graduate in any science subject including Medicine and B. Tech.

Eligibility for admission to M.A. Environmental Science

Graduate in any discipline including Medicine and B. Tech.

Course structure and assessment methods

M. Sc. / M. A. in Environmental Sciences a two year programme. The initial stages (first two semesters) of a student's study include compulsory core and elective courses, which aim to impart a general understanding of environmental science and introduce the student to some of the main principles. The following two semesters will typically allow students to choose research specific elctive and generic

courses, allowing for growing specialization. Towards the end of the program, one is likely to have the opportunity to carry out research on a topic of one's choice. Assessment methods include essays, written discussions, exams, problem sheets, laboratory reports, field exercises, field notebooks and seminar presentations.

Key skills

Common skills gained from an Environmental Science degree include:

- Environmental Impact Assessment
- Numeracy and data analysis
- IT skills
- Research skills
- Laboratory and fieldwork
- Team work
- Self-management, including planning and meeting deadlines
- Critical evaluation
- Effective and professional communication, both spoken and written

M. Sc. / M. A. Environmental Science structure and syllabus (Semester I - IV).

Sr. no.	Course code	Course name	No. of credits
Semester I			
Core Courses			
1	ENV 500	Environmental Issues and Perspectives	3
2	ENV 501	Fundamentals of Economics	3
3	ENV 502	Environmental Ethics	3
4	ENV 503	Biodiversity Conservation	2
5	ENV 504	Biodiversity Conservation Practical	1
6	ENV 505	Land, Ocean and Atmospheric Interactions	3
7	ENV 506	Land, Ocean and Atmospheric Interactions Practical	1
Elective Courses			
8	ENV 521	Coastal Ecology	1
9	ENV 522	Mangrove Ecology	1
10	ENV 523	Mangrove Restoration and Conservation	1
11	ENV 524	Environmental Externalities and Policy	1
12	ENV 525	Concept of Sustainable Development	1
13	ENV 526	Introduction to Environmental Valuation	1
14	ENV 527	Basics of Geo-spatial Analysis	1
15	ENV 528	Spatial Economic Analysis	1
16	ENV 529	Measurement of Biodiversity	1
Semester II			
Core Courses			
17	ENV 507	Ecology and Society	2
18	ENV 508	Environmental Physiology Practical	1
19	ENV 509	Climate Change	3
20	ENV 510	Environmental Geology	2
21	ENV 511	Environmental Geology Practical	1
22	ENV 512	Basic Statistics	3
23	ENV 513	Environmental Management	3

24	ENV 514	Introduction to Environmental Impact Assessment	1
Elective Courses			
25	ENV 530	Mineral Resource Management	1
26	ENV 531	Pollution and Environment	1
27	ENV 532	Natural and Manmade Hazards	1
28	ENV 533	Marine Habitat Conservation and Restoration	1
29	ENV 534	Ecological significance of symbiosis	1
30	ENV 535	Nitrogen and Climate Change	1
31	ENV 536	Environment and Literature	2
32	ENV 537	Gender Sensitivity and Equity	2
33	ENV 538	Gender and Ecology in Goan Society	1
34	ENV 539	Coastal Geo-hazards	1
35	ENV 540	Analysis of Environmental Impact Assessment	1

Semester III (M. Sc.)

Research Specific Elective Courses

	Course Code	Course Title	Credit(s)
1	ENV 600	Research methodology in Environmental Science	4
2	ENV 601	Environmental Pollution Practical I	2
3	ENV 602	Environmental Pollution Practical II	2
4	ENV 603	Field work and Environmental Sampling Practical	1
5	ENV 604	Environmental Data Analysis	1

Generic Specific Elective Courses

Sr. No.	Course Code	Course Title	Credit(s)
6	ENV 621	Coral Ecosystem and Threats	3
7	ENV 622	Disaster Management	3
8	ENV 623	Ecotourism	3
9	ENV 624	Ecotoxicology	3
10	ENV 625	Environmental Biology	3
11	ENV 626	Environmental Chemistry	3
12	ENV 627	Environmental Implication of Marine Productivity	3
13	ENV 628	Environmental Microbiology	3
14	ENV 629	Green Chemistry	3
15	ENV 630	Marine Biodiversity and Conservation Practices	3
16	ENV 631	Marine Pollution	3
17	ENV 632	Microplastics in Environment	3
18	ENV 633	Polar Sciences	3
19	ENV 634	Water Resource Management	3
20	ENV 635	Industrial water and wastewater treatment technologies	3
21	ENV 636	Water and Wastewater: Monitoring and Treatment	3
22	ENV 637	Lab Course in Environmental Science	4

Semester IV (M. Sc.)

Research Specific Elective Courses

Sr. No.	Course Code	Course Title	Credit(s)
23	ENV 605	Environmental Impact Assessment I	2
24	ENV 606	Environmental Impact Assessment II	2

25	ENV 607	Sustainable Development	1
26	ENV 608	Solid Waste Management	1
27	ENV 609	Shrimp farming and Environmental Issues	1

Discipline Specific Dissertation / Internship

Course Code	Course Title	Credit(s)
ENV 651	Discipline Specific Dissertation	16

Semester III (M. A.)

Research Specific Elective (RSE) Courses

Sr. No	Course Code	Course Title	Credit(s)
1	ENV 610	Research Methodology in Economics	04
2	ENV 611	Environmental History of the World	04
3	ENV 612	Community Engagement for Sustainable Rural Development	04
4	ENV 613	Doing Feminist Research	04
5	ENV 614	Technology Enabled Solutions forSustainable Development	04
6	ENV 615	Research Methodology in International Relations	04

Generic Elective (GE) Courses

	Course Code	Course Title	Credit(s)
7	ENV 638	Environmental Economics	04
8	ENV 639	Environmental History of India	04
9	ENV 640	Environmental Politics	04
10	WST 623	Gender, Environment and Ecology	04
11	ENV 641	Eco-criticism	04
12	ENV 642	Environmental Security: Dimensions and Perspectives	04
13	ENV 643	Global Environmental Governance	04

Semester IV (M. A.)

Research Specific Elective (RSE) Courses

Sr. No	Course Code	Course Title	Credit(s)
	ENV 616	Academic Writing in English	04
	ENV 617	Idea of Nature in Eastern and Western Traditions	04

Discipline Specific Dissertation / Internship

Course Code	Course Title	Credit(s)
ENV 651	Discipline Specific Dissertation	16

Semester I

M. Sc. / M. A. Environmental Science

Title of the Course: Environmental Issues and Perspectives

Course Code: ENV 500
Number of Credits: 03
Effective from AY: 2022 -23

Prerequisites for the course:	There is no prerequisite for this course apart from the program requirements	
Objective:	This course is an invitation to the study of environment in its multiple nuances. While familiarising environmental issues, the course also intends to introduce students to perspectives on environment.	
Content:	**Module 1: Introduction to Environment** Concept of environment and types of environment Environmental heritage and human dimension of environmental science Interdisciplinary and multidisciplinary approaches to environment and major themes – biological, ecological and social ecological orientations **Module 2: Human population and environment** Basic concepts of population dynamics, population growth, demographic transition, human population effects on Earth. Environmental systems and ecosystems: Concepts and fundamentals. **Module 3: Environmental issues and concerns** Environmental conservation, Food and agriculture Environmental health, pollution and toxicology Climate and global warming Solid and hazardous waste **Module 4: Social issues and environment** Urban growth and industrial planning Development, displacement and rehabilitation Ideologies of environmentalism Towards articulating sustainable environmental future	06 hours 09 hours 15 hours 15 hours
Pedagogy:	Lectures/assignments/workshops/campus walks/documentaries and discussion/ presentations	
References/ Readings	1. Basu, M., & Xavier, S. (2016). *Fundamentals of environmental studies.* Cambridge University Press. 2. Carolyn, M. (Ed.). (1996). *Ecology*. Rawat Publications. 3. Gadgil, M., &Guha, R. (2000). *Use and abuse of nature*. Oxford University Press. 4. Gadgil, M., &Guha, R. (1995). *Ecology and equity.* Oxford University Press. 5. Guha, R. (2000). *Environmentalism: A global history.* Oxford	

	University Press. 6. Joseph, B. (2009). *Environmental studies* (2nd ed).Tata McGraw Hill. 7. Krishna, S. (1996). *Environmental politics.* Sage Publications. 8. Rangarajan, M. (Ed.). (2007). *Environmental issues in India: A reader.* Dorling Kindersley.	
Course Outcomes	1. Students are introduced to the multi-dimensional feature of environmental reality. 2. Students are familiarized with the plural perspectives on environment both as an academic focus and lived-in reality. 3. Students will be able to think critically and develop arguments about environment related issues 4. Students will be able to re-orient to the necessities of sustainability and continuity.	

Title of the Course: Fundamentals of Economics

Course Code: ENV 501
Number of Credits: 03
Effective from AY: 2022 -23

Prerequisites for the Course:	There is no prerequisite for this course apart from the program requirements	
Objective:	The aim of the course is to introduce students to the basic concepts, theories and principles that will provide the foundation for a proper understanding of how an economy works. The syllabus seeks to equip students with the basic tools necessary for an understanding and interpretation of economic issues affecting the economy.	
Content:	**Module 1: Introduction** Scope and method of economics; Building blocks of modern economy – agents, resources and classification of goods. **Module 2:Microeconomic analysis** Consumer equilibrium, producer equilibrium, market equilibrium, general equilibrium and possible disequilibrium situations. **Module 3: Macroeconomic analysis** Circular flow and national income, issues related to growth, unemployment and inflation. **Module 4:Public economics and international trade** Market failure, Taxation and Quotas, Efficiency versus Equity. Balanced budgets and Debt financing. International Trade: Comparative advantage theory, gains from trade; tariffs and protection, exchange rates.	06 hours 09 hours 15 hours 15 hours
Pedagogy:	Lectures/assignments/workshops/campus walks/documentaries and discussion/ presentations	
References/ Readings	1. Banerjee, A., & Duflo, E. (2019). *Good economics for hard times: Better answers to our biggest problems*. Penguin Books. 2. Dasgupta, P. (2010). *Economics: A very short introduction*. Sterling Pub. 3. Mankiw, G. (2020). *Principles of economics* (9th ed).Cengage Learning, Asia. 4. Samuelson, P., Nordhaus, W, Chaudhuri S., &Sen A. (2010). *Economics* (19th ed). McGraw-Hill.	
Learning Outcomes	1. The students will be able to understand the basic concepts-principles and theories of Economics. 2. This course will enable the students to understand and analyse different types of equilibrium, circular flow of the economy and factors affecting growth and employment in an economy. 3. The students will learn the basics of international trade and fundamental concepts in public economics.	

Title of the Course: Environmental Ethics

Course Code: ENV 502
Number of Credits: 03
Effective from AY: 2022 -23

Prerequisites for the course:	There is no prerequisite for this course apart from the programme requirements	
Objectives:	1. To analyse different approaches and broad theories of environmental philosophy. 2. Understand the philosophical basis of various conservative theories.	
Contents:	**Module 1: Introduction** Introduction to environmental ethics **Module 2:Value and Nature** Value and Nature: Moral theories (Consequentialism, Virtue Ethics and Kantianism), Intrinsic value and Instrumental values, anthropocentrism. **Module 3: Ecology** Land ethics & deep ecology, Bio centrism, Eco-centrism, Speciesism, Culture and ecology.	05 hours 20 hours 20 hours
Pedagogy:	Lectures/assignments/workshops/campus walks/documentaries and discussion/ presentations	
References/ Readings	1. Jaquet, F. (2019). Is Speciesism Wrong by Definition? *Journal of Agricultural and Environmental Ethics, 32 (3)*. 2. Kopnina, H., Washington, H., Taylor, B., & Piccolo, J.J.(2018). Anthropocentrism: More than Just a Misunderstood Problem. *Journal of Agricultural and Environmental Ethics, 31.* 3. Sandler, R. (2017). *Environmental Ethics: Theory in Practice*. Oxford University Press. 4. Attfield, R. (2014). *Environmental Philosophy*. Polity Press. 5. Jamieson, D. (2008). *Ethics and Environment- An Introduction*. Cambridge University Press. 6. Grim, J.A.(Ed.). (2001.). *Indigenous Traditions and Ecology- The Inter-being of Cosmology and Community.* Harvard University Press. 7.Taylor, P. W. (1986). *Respect for Nature: A Theory of Environmental Ethics.* Princeton University Press. 8. Passmore, J. (1974). *Man's Responsibility for Nature*. Charles Scribner's son.	
Course Outcomes	1. Students will be able to learn and evaluate different theories of environmental ethics. 2. The students will be able to reconstruct the essential forms of argumentation that can be offered for preserving natural entities and ensure the sustainable use of natural resources.	

	3. Realize the significant role and responsibility towards the protection of the environment. 4. The course will enhance the knowledge and abilities required to deal with complex environmental challenges by assisting students in understanding how their choices and actions will affect the environment.	

Title of the Course: Biodiversity Conservation

Course Code: ENV 503
Number of Credits: 02
Effective from AY: 2022 -23

Prerequisite for the course:	There is no prerequisite for this course apart from the program requirements	
Objective:	The course provides the fundamentals about ecosystems, their types, distribution, components, functioning, services and their role in biodiversity. Biotic components of ecosystems, fundamentally understood as Biodiversity, their measure, and factors that lead to enormous biodiversity, and essential components that maintain biodiversity.	
Content:	**Module 1: Introduction** Ecosystems - Development of concept and the current understanding; Ecosystem as a system. Structural and Functional components of Ecosystems. Ecological complexity. Energy flow in ecosystems; adaptive cycle view of ecosystem development and change; Ecosystem attributes and functioning. Thermodynamics and Information theory in ecosystems. Types of ecosystems, their distribution and composition. Case study - Tropical rain forests ecosystem. **Module 2: Ecosystems processes and applications** Role of species in ecosystem functioning. Applications of ecosystems knowledge. Ecosystem services. Measuring Ecosystem Health. Ecosystem Processes; Controls over Ecosystem Processes. Human-Induced Ecosystem Change: Human Impacts on Ecosystems, Resilience and Threshold Changes, Degradation in Ecosystem Services. **Module 3: Biodiversity** Definition; the past (diversity and extinction) and present; major groups of biological organisms; evolution of biodiversity and drivers of biodiversity. The role of geology and climate in their distribution. Patterns in biodiversity: Spatial and temporal patterns at genetic, species and taxonomic diversity, Approaches to biodiversity studies. Loss of biodiversity and biodiversity targets 2020. Bio-geographical regions of India; Forest types and major ecosystems of India. Major groups of organisms and their diversity. Endemism. Concepts of keystone, umbrella and flagship species.	09 hours 09 hours 12 hours

Pedagogy:	Lectures/assignments/workshops/campus walks/documentaries and discussion/ presentations.	
References/ Readings	1. Chapman, J. L., &Reiss, M. J. (1999). *Ecology: Principles and applications* (2nd ed). Cambridge University Press. ISBN: 0521588022, 9780521588027. 2. Kormondy, E. J. (2017). *Concepts of ecology* (4th ed) p. 978-9332586093. PubMed: 9332586098; ISBN-13. Pearson. 3. Singh, J.S., Singh, S.P., &Gupta, S.R. (2014). *Ecology,* Environmental Science & Conservation. Chand, S. *Publishing*. ISBN: 9383746009, 9789383746002. 4. Begon, M., Howarth, R.W., &Townsend, C.R. (2014). *Essentials of ecology* (4thed). ISBN: 1118802373, 9781118802373. 5. Bowman, W.D., Hacker, S.D., &Cain, M.L. (2020). *Ecology* (5th ed). Oxford University Press, Incorporated. ISBN: 160535922X, 9781605359229. 6. Chapin III, S.F., Matson, P.A., &Vitousek, P. (2011). *Principles of terrestrial ecosystem ecology* (2nd ed). Springer. ISBN: 1441995048, 9781441995049. 7. Gaston, K.J., &Spicer, J.I. (2004). *Biodiversity: An introduction* (2nd ed). Blackwell Science. ISBN: 978-1-405-11857-6. 8. Gaston, K.J. (Ed.). (1996). *Biodiversity: A biology of numbers and difference*. PubMed: 0865428042. Blackwell Science. ISBN: 978-0865428041 9. Groombridge, B., &Jenkins, M.D. (2002). *World Atlas of biodiversity: Earth's Living Resources in the 21stCentury*. University of California Press. ISBN: 0520236688, 9780520236684. 10. Henderson, P.A., &Southwood, T.R.E. (2016). *Ecological methods* (4thed). John Wiley & Sons. ISBN:1118895282, 9781118895283. 11. Jørgensen, S., Xu, L., &Costanza, R. (2016). *Handbook of ecological indicators for assessment of ecosystem health* (2nd ed). CRC Press. ISBN: 1439809372, 9781439809372. 12. Jorgensen, S. E. (Ed.). (2009). *Ecosystem ecology*. Elsevier. ISBN: 0444534660, 9780444534668. 13. Krebs, C.J. (2013). *Ecology: The experimental analysis of distribution and abundance* (6thed). Pearson. ISBN: 1292026278, 9781292026275. 14. Raffaelli, D.G., &Frid, C.L.J. (Eds.). (2010). *Ecosystem ecology: A new synthesis*. Cambridge University Press. ISBN: 1139486144, 9781139486149. 15. Smith, T.M., &Smith, R.L. (1988). Biodiversity in E.O. Wilson (Ed.). *Elements of ecology* (9th ed). Pearson. ISBN:	

	1292077409. National Academy Press, 9781292077406. ISBN: 030956736X, 9780309567367.	
Course Outcomes	After successful completion of the course, students will be able to: 1. Understand the basic concepts of ecosystem services such as structural and functional components, endemism, keystone, umbrella, and flagship species. 2. Explain the importance of biodiversity conservation for ecosystem and human health and sustainable development. 3. Analyze and summarise the factors contributing to biodiversity loss. 4. Evaluate the effectiveness of different conservation strategies and policies.	

Title of the Course: Biodiversity Conservation Practical

Course Code: ENV 504
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	There is no prerequisite for this course apart from the program requirements	
Objective:	The course will impart an insight to the students about the basic objectives and tools used to assess biodiversity and its assessment.	
Content:	1. Documentation of floral and faunal biodiversity on the campus (5 hours; Reference 1, 3). 2. Estimation of population density of trees using quadrant method (5 hours; Reference 4). 3. Field visit to aquatic, forest and other ecosystems for identification of biota(6 hours; Reference 5). 4. People's Biodiversity Register (PBR) preparation (6 hours; Reference 7). 5. Visit to Biodiversity Management Committee (BMC) to understand its functioning (4 hours; Reference 5, 7). 6. Documentation of commercial bio-resource (4 hours; Reference 2).	30 hours
Pedagogy:	Use of conventional, online and ICT methods. Lecture/tutorials/assignments	
References/ Readings	1. Whitaker, R., Captain, A., & Ahmed, F. (2004). Snakes of India. Draco books. 2. Dey, S. (2004). Bioresources and Genepool Conservation. Daya Books. 3. Bhatt, S., Kohli, K., & Kothari, A. (2006). Process Documentation of the National Biodiversity Strategy and Action Plan-India. Kalpavriksh Environmental Action Group. 4. Sawaiker, R. U. (2021). Conservation of biodiversity through scientifically validated and well participated people's biodiversity registers (PBRS) in Goa, India. Asian Journal of Conservation Biology, 10(1), 159-161. 5. Gupta, H. K. (2013). Institutional Framework for creating Biodiversity Commons through Biodiversity Management Committees in India. 6. Grimmett, R., Inskipp, C., Inskipp, T. (2016). Birds of the Indian Subcontinent: India, Pakistan, Sri Lanka, Nepal, Bhutan, Bangladesh and the Maldives. United Kingdom: Bloomsbury Publishing.	

	7. Biodiversity Act 2002 and Rules 2004.	
Course Outcomes	1. Identify and assess the biodiversity potentials of a region. 2. Develop appropriate methods for conservation of resources including field visits and documentation of resources.	

Title of the Course: Land, Ocean and Atmospheric interactions

Course Code: ENV 505
Number of Credits: 03
Effective from AY: 2022 -23

Prerequisites for the course:	There is no prerequisite for this course apart from the program requirements	
Objective:	The course will impart an insight to the students about the need for an integral approach to study an ecosystem.	
Content:	**Module 1: Introduction** Earth system science; Evolution of geosphere, biosphere, atmosphere, hydrosphere and cryosphere; Properties of sea and fresh water - distribution of temperature, salinity, density and oxygen in space and time. **Module 2:** Optical characteristics of sea water; Water type and masses: formation and classification, identification of water masses. General circulation of the world ocean; Wind driven and thermohaline circulation; Indian monsoon circulation. Tides-generation and propagation, characteristics of tides, spring and neap tides. **Module 3:** Atmospheric instability and convection-stability criteria; Mixing and convective condensation levels; Potential instability and latent instability; Cloud formation and types; Laws of black body radiation; Solar radiation transfer; Latitudinal and seasonal variation, absorption, scattering and reflection; Photosynthetically available radiation; Terrestrial radiation; Low and high pressure. **Module 4:** Upwelling and downwelling; Major and minor nutrients; Residence time; Dissolved gases; Marine habitats; Marine photosynthesis; Photosynthetic pigments; Biological productivity; Gross and net productivity; Redfield ratio; New and regenerated productivity; Food chain and food web; Exclusive economic zone.	06 hours 09 hours 15 hours 15 hours
Pedagogy:	Use of conventional, online and ICT Methods. Lecture/Tutorials/Assignments	
References/ Readings	1. Wallace, J.M., &Hobbs, P.V. (2006). *Atmospheric science: An introductory survey* (2nd ed).Elsevier Academic Press.	

	2. Marshall, J., &Plumb, R.A. (2008).Atmosphere ocean and climate dynamics: An introductory *Textile*. Elsevier Academic Press. 3. Hess, L.S. (1959). *Introduction to theoretical meteorology*.Holt, Rinehart & Winston, New York. 4. Houghton, J. T. (2002).*Physics of the atmosphere*. Cambridge University Press. 5. Stewart, R.L.(2008).*Introduction to physical oceanography*. Department of Oceanography, Texas A&M University. 6. Open University Course Team(1999).*Waves, tides and shallow water processes*. Butterworth-Heinemann Publications. 7. Williams, F.J., &Elder, S. (1989). *Fluid Physics for Oceanographers and Physics: An introduction to incompressible.* Butterworth-Heinemann, England. 8. Sverdrup, H.U., Johnson, M.W., & Flemming, R.H. (1962). *The ocean: Their physics, chemistry and biology*. Asia Publishing House. 9. Miller, C.B., &Wheeler, P.A. *Biological oceanography*. (2nd ed). Wiley-Blackwell Publishers. 10. Grant Gross, M. (1990). *Oceanography* (5th ed). Prentice Hall. 11. Thurman, H.V., & Mercill, C. (1988). *Introductory oceanography* (5th ed) Publ. CO, OH. 12. Talley, L.D., Pickard, G.L., Emery, W.J., &Swift, J.H. (2011). *Descriptive physical oceanography* (6th ed).Elsevier. 13. Lenton, T. (2016). *Earth system science: A very short introduction* (1st ed).Oxford University Press. 14. Ehlers, E., & Kraft, T. *Earth system science in the Anthropocene: Emerging issues and problems.* Springer.	
Course Outcomes	After successful completion of the course, students will be able to 1. Understand ocean currents, atmospheric circulation, and the earth system and explain its influence on climate and weather patterns. 2. Explain the physical and chemical properties of seawater. 3. Describe the role of marine microbes in regulating the earth's system. 4. Analyze the complex interactions between land, ocean, and atmosphere, and identify feedback mechanisms.	

Title of the Course: Land, Ocean and Atmospheric Interactions Practical

Course Code: ENV 506
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Degree of Bachelor of Science of this University or an examination of any other university recognized as equivalent.	
Objective:	To acquaint the students on intereactions between land ocean and atmosphere by exposing data, using it and deciphering processes.	
Content:	1. Wind-Evaporation-SST (WES) Effect (7 hours; Reference 1) 2. Linkages between SST and rainfall (8 hours; Reference 2) 3. Relationship between rainfall and Aerosol Optical Depth (AOD) (7 hours; Reference 3, 4) 4. Impact of riverine flow on oceanic stratification (8 hours; Reference 5, 6).	30 hours
Pedagogy:	Tutorials/ assignments/ practicals/ field study	
References/ Readings:	1. Xie, S.-P. Ocean-Atmosphere Interaction and Tropical Climate. *The Encyclopedia of Life Support Systems (EOLSS)– Tropical Meteorology*. http://iprc.soest.hawaii.edu/users/xie/o-a.pdf 2. Stocker, T. F. et al. *Physical Cliamte Processes and Feedbacks.* https://www.ipcc.ch/site/assets/uploads/2018/03/TAR-07.pdf 3. Gunaseelan, I., B. Vijay Bhaskar and K. Muthuchelian. (2014) The effect of aerosol optical depth on rainfall with referenceto meteorology over metro cities in India. *Environmental Science and Pollution Research International,* 21, 8188–8197. doi: 10.1007/s11356-014-2711-4 https://pubmed.ncbi.nlm.nih.gov/24920428/ 4. Ng, D. H. L., R. Li, S. V. Raghavan and S.-Y. Liong. (2017). Investigating the relationship between Aerosol Optical Depth and Precipitation over Southeast Asia with Relative Humidity as an influencing factor. *Scientific Reports,* 7, 13395. doi: 10.1038/s41598-017-10858-1 5. Janout, M. A. et al. (2020). On the variability of stratification in the freshwater-influenced Laptev Sea region. *Frontiers in Marine Science*– Sec. Global Change and the Future Ocean. doi: https://doi.org/10.3398/fmars.2020.543489 . https://www.frontiersin.org/articles/10.3389/fmars.2020.5	

	43489/full 6. Mahadevan, A., G. Spiro Jaeger, M. Freilich, M. Omand, E.L. Shroyer, and D. Sengupta. (2016). Freshwater in the Bay of Bengal: Its fate and role in air-sea heat exchange. *Oceanography,* 29(2):72–81, https://doi.org/10.5670/oceanog.2016.40.	
Course Outcomes	1. Exposure to some data used in studies of interactions of land, ocean and atmosphere. 2. Development of a basic ability to use some data. 3. Gaining knowledge of some of the physical processes which occur on Earth. 4. Understanding some linkages between SST and rainfall. 5. Understanding relationships between rainfall and Aerosol Optical Depth. 6. Understanding the impacts of riverine flow on oceanic stratification.	

Elective Courses

Title of the Course: Coastal Ecology

Course Code: ENV 521
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Graduates in any discipline with science subjects at 10+2 level.	
Objective:	To introduce the students to the dynamic mangrove ecosystem, its composition – abiotic and biotic, benefits, threats and need for conservation.	
Content:	**Module 1: Introduction** Mangroves, global distribution, current status, threats, ecology and environment, relation with other ecosystems, uses of mangroves. **Module 2: Structure and function of mangrove ecosystem** Physical mangrove environment, forest types – overwashed, fringe, dwarf, riverine, basin, hammock; true mangroves – red, white, green, black; mangrove associates, adaptations in mangroves, patterns and processes in mangrove ecosystem, environmental factors - climate and habitats Biodiversity in mangrove ecosystem: flora and fauna	02 hours 13 hours
Pedagogy:	Lectures/ case studies/ tutorials/ videos/ assignments/ self-study/ visits	
References/ Readings	1. Kathiresan, K., & Ajmal Khan, S. (2005). UNU-INWEH-UNESCO International training course on Coastal Biodiversity in Mangrove Ecosystem- Course manual (pp. 410). Annamalai University, India. 2. FAO (2007). The world's mangroves: 1980–2005. FAO, Rome, Italy. 3. Sandilyan, S., & Kathiresan, K. (2012). Mangrove conservation: a global perspective. *Biodiversity Conservation*, *21*, 3523–3542. 4. Nagelkerken, I., Blaber, S.J.M., & Bouillon, S. et al. (2008). The habitat function of mangroves for terrestrial and marine fauna: a review. *Aquatic Botany, 89*, 155–185. 5. Nanjo, K., Kohno, H., Nakamura, Y., Horinouchi, M., & Sano, M. (2014). Effects of mangrove structure on fish distribution patterns and predation risks. *Journal of Experimental Marine Biology and Ecology, 461,* 216–225. 6. Shinnaka, T., Sano, M., Ikejima, K., Tongnunui, P., Horinouchi, M., & Kurokura, H. (2007). Effects of mangrove deforestation	

	on fish assemblage at Pak Phanang Bay, Southern Thailand. *Fisheries Science, 73*, 862–870. 7. 1st International Training Course on Mangrove Ecosystems in the Western Indian Ocean Region. (December 2-9, 2013) Mombasa, Kenya. UNU-INWEH-UNESCO. 8. Singh, V.P., & Odaki, K. (2004). *Mangrove ecosystem: structure and function.* Scientific Publishers, Jodhpur, India.	
Course Outcomes	Students will gain knowledge about: 1. Coastal and mangrove ecosystem and distribution 2. Types of mangroves 3. Adaptations in mangroves 4. Biodiversity of mangrove ecosystems	

Title of the Course: Mangrove Ecology

Course Code: ENV 522
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Graduates in any discipline with science subjects at 10+2 level.	
Objective:	To introduce the students to the dynamic mangrove ecosystem, its composition – abiotic and biotic, benefits, threats and need for conservation.	
Content:	**Module 1: Introduction** Mangroves, ecology and environment, uses of mangroves, threats to mangrove. **Module 2: Ecological importance of mangrove ecosystem and the impact of anthropogenic activities** Functional aspects – biomass, productivity, litter and its decomposition, carbon sink and organic carbon productivity, nitrogen and sulfur cycling, nutrient status, nurseries, biofilters for toxic pollutants, breeding grounds – fish, birds; mitigation of climate change, coastal defence mechanism Indigenous people of mangroves – livelihood dependency –Case study on Sunderban Anthropogenic destruction - deforestation, landfills, land reclamation, waste disposal sites, pollution – water quality and persistent chemicals, loss of mangrove biodiversity.	02 hours 13 hours
Pedagogy:	Lectures/ case studies/ tutorials/ videos/ assignments/ self-study/ visits	
References/ Readings	1. Kathiresan, K., & Ajmal Khan, S. (2005). UNU-INWEH-UNESCO International training course on Coastal Biodiversity in Mangrove Ecosystem- Course manual (pp. 410). Annamalai University, India. 2. FAO (2007). The world's mangroves: 1980–2005. FAO, Rome, Italy. 3. Nagelkerken, I., Blaber, S.J.M., & Bouillon, S. et al. (2008). The habitat function of mangroves for terrestrial and marine fauna: a review. *Aquatic Botany, 89*, 155–185. 4. Nanjo, K., Kohno, H., Nakamura, Y., Horinouchi, M., & Sano, M. (2014). Effects of mangrove structure on fish distribution patterns and predation risks. *Journal of Experimental Marine Biology and Ecology, 461,* 216–225. 5. Shinnaka, T., Sano, M., Ikejima, K., Tongnunui, P.,	

	Horinouchi, M., & Kurokura, H. (2007). Effects of mangrove deforestation on fish assemblage at Pak Phanang Bay, Southern Thailand. *Fisheries Science, 73*, 862–870. 6. 1st International Training Course on Mangrove Ecosystems in the Western Indian Ocean Region. (December 2-9, 2013) Mombasa, Kenya. UNU-INWEH-UNESCO. 7. Singh, V.P., & Odaki, K. (2004). *Mangrove ecosystem: structure and function.* Scientific Publishers, Jodhpur, India.	
Course Outcomes	1. Understand the ecological and economical importance of mangroves. 2. Imprint the importance of mangroves in maintaining the global climate and balance in the nutritional as well as biogeochemical cycles. 3. Create awareness about indigenous people and anthropogenic destruction.	

Title of the Course: Mangrove Restoration and Conservation

Course Code: ENV 523
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Graduates in any discipline with science subjects at 10+2 level.	
Objective:	To introduce the students to the dynamic mangrove ecosystem, its composition – abiotic and biotic, benefits, threats and need for conservation.	
Content:	**Module 1: Introduction** Mangroves, global distribution, current status, threats, uses of mangroves. **Module 2: Restoration and conservation** Restoration and afforestation projects, ecosystem based management, protected areas, restoration tools, monitoring methods – remote sensing and GIS, awareness programmes, training programmes, community based management, role of institutions, NGOs, global conservation strategies, economic valuation (cost benefit analysis), national and global mangrove conservation policies, conservation and mangrove protection laws, international agreements – Ramsar convention, case study – mangroves of Goa.	02 hours 13 hours
Pedagogy:	Lectures/ case studies/ tutorials/ videos/ assignments/ self-study/ visits	
References/ Readings	1. Kathiresan, K., & Ajmal Khan, S. (2005). UNU-INWEH-UNESCO International training course on Coastal Biodiversity in Mangrove Ecosystem- Course manual (pp. 410). Annamalai University, India. 2. FAO (2007). The world's mangroves: 1980–2005. FAO, Rome, Italy. 3. Sandilyan, S., & Kathiresan, K. (2012). Mangrove conservation: a global perspective. *Biodiversity Conservation*, *21*, 3523–3542. 4. Nagelkerken, I., Blaber, S.J.M., & Bouillon, S. et al. (2008). The habitat function of mangroves for terrestrial and marine fauna: a review. *Aquatic Botany, 89*, 155–185. 5. Nanjo, K., Kohno, H., Nakamura, Y., Horinouchi, M., & Sano, M. (2014). Effects of mangrove structure on fish distribution patterns and predation risks. *Journal of Experimental Marine Biology and Ecology, 461,* 216–225.	

	6. Shinnaka, T., Sano, M., Ikejima, K., Tongnunui, P., Horinouchi, M., & Kurokura, H. (2007). Effects of mangrove deforestation on fish assemblage at Pak Phanang Bay, Southern Thailand. *Fisheries Science, 73*, 862–870. 7. 1st International Training Course onMangrove Ecosystems in the Western Indian Ocean Region. (December 2-9, 2013) Mombasa, Kenya. UNU-INWEH-UNESCO. 8. Singh, V.P., & Odaki, K. (2004). *Mangrove ecosystem: structure and function.* Scientific Publishers, Jodhpur, India.	
Course Outcomes	This paper will highlight: 1. Ecological and economical importance of mangroves. 2. Mangrove conservation, propagation and protection strategies. 3. Role of governments and NGOs. 4. Status of mangroves in Goa.	

Title of the Course: Environmental Externalities and Policy

Course Code: ENV 524
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Graduate in any discipline from a recognised University	
Objective:	This course aims to equip the learner with tools of resource allocation using basic concepts in Economics. This will include market and non-market-based approaches to understanding problems of global and local pollution and challenges to sustainability using techniques of environmental valuation.	
Content:	**Module 1: Introduction** Meaning of externalities, environmental policy in the presence of externalities. **Module 2: Theory of externalities & environmental policy** Missing Markets, Non-convexity, Non-linearity, Public Goods, Common Property Resources, Coase Theorem and Issues in Property Rights; Pigouvian Taxes, Subsidies, Tradable Permits, Price v/s Quantity tools.	02 hours 13 hours
Pedagogy:	In class/online lectures, assignments, group activities, presentations.	
References/Readings	1. 1. Harris, J.M., & Roach, B. (2021). *Environmental and Natural Resource Economics: A Contemporary Approach*. Routledge. 2. Kolstad, C. (2012). *Intermediate Environmental Economics*. Oxford University Press. 3. Perman, R, Ma Y., Common, M., Maddison, D, & McGilvray. (2011). *Natural Resource and Environmental Economics* (4th ed). Addison Wesley. 4. Rondeau, D., & Conrad, J.M. (2020). *Natural Resource Economics: Analysis, Theory, and Applications*. Cambridge University Press. 5. Tietenberg, T. (2000). *Environmental and Natural Resource Economics* (5th ed). Addison Wesley.	
Course Outcomes	On successful completion, course participants will be able to: 1. Understand how the environmental resources affect human welfare. 2. Have an informed opinion on environment-development trade-offs. 3. Assess international challenges of sustainability.	

Title of the Course: Concept of Sustainable Development

Course Code: ENV 525
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Graduate in any discipline from a recognised University	
Objective:	This course aims to equip the learner with tools of resource allocation using basic concepts in Economics. This will include market and non-market based approaches to understanding problems of global and local pollution and challenges to sustainability using techniques of environmental valuation.	
Content:	**Module 1: Introduction** Meaning of sustainable development. **Module 2: Sustainable development** Renewable and Non-renewable Resources - Optimal use under different market Structures. Strong and weak sustainability; Global agreements, Economics of ecosystems and biodiversity. Issues of climate change adaptation and mitigation.	02 hours 13 hours
Pedagogy:	In class/online lectures, assignments, group activities, presentations.	
References/Readings	1. Harris, J.M., & Roach, B. (2021). *Environmental and Natural Resource Economics: A Contemporary Approach*. Routledge. 2. Kolstad, C. (2012). *Intermediate Environmental Economics*. Oxford University Press. 3. Perman, R, Ma Y., Common, M., Maddison, D, & McGilvray. (2011). *Natural Resource and Environmental Economics* (4th ed). Addison Wesley. 4. Rondeau, D., & Conrad, J.M. (2020). *Natural Resource Economics: Analysis, Theory, and Applications*. Cambridge University Press. 5. Tietenberg, T. (2000). *Environmental and Natural Resource Economics* (5th ed). Addison Wesley.	
Course Outcomes	On successful completion, course participants will be able to: 1. Understand how the environmental resources affect human welfare. 2. Have an informed opinion on environment-development trade-offs. 3. Assess international challenges of sustainability.	

Title of the Course: Introduction to Environmental Valuation

Course Code: ENV 526
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Graduate in any discipline from a recognised University	
Objective:	This course aims to equip the learner with tools of resource allocation using basic concepts in Economics. This will include market and non-market based approaches to understanding problems of global and local pollution and challenges to sustainability using techniques of environmental valuation.	
Content:	**Module 1: Introduction** Meaning, importance of environmental valuation. **Module 2: Issues in valuation** Costs and benefits. Use values, Non-use values, Option values, Discount rates. Methods of valuation: Revealed and stated preferences; Market and non-market valuation; Applications of valuation in developing countries.	02 hours 13 hours
Pedagogy:	In class/online lectures, assignments, group activities, presentations.	
References/Readings	1. Harris, J.M., & Roach, B. (2021). *Environmental and Natural Resource Economics: A Contemporary Approach*. Routledge. 2. Kolstad, C. (2012). *Intermediate Environmental Economics*. Oxford University Press. 3. Perman, R, Ma Y., Common, M., Maddison, D, & McGilvray. (2011). *Natural Resource and Environmental Economics* (4th ed). Addison Wesley. 4. Rondeau, D., & Conrad, J.M. (2020). *Natural Resource Economics: Analysis, Theory, and Applications*. Cambridge University Press. 5. Tietenberg, T. (2000). *Environmental and Natural Resource Economics* (5th ed). Addison Wesley.	
Course Outcomes	On successful completion, course participants will be able to: 1. Understand how the environmental resources affect human welfare. 2. Have an informed opinion on environment-development trade-offs. 3. Assess international challenges of sustainability.	

Title of the Course: Basics of Geo-spatial Analysis

Course Code: ENV 527
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Graduate in any discipline with science subjects at 10+2 level.	
Objective:	Introduce learners to understanding spatial data and its applications	
Content:	**Module 1: Introduction** Introduction to remote sensing and GIS. Application remote sensing and GIS, sources of information on remote sensing data. **Module 2: Spatial Analysis** Raster and vector data, Analysing raster data -clipping, analyzing elevation, terrain and raster calculator, Analysing vector- creating shape file, attribute table, field calculator and data joins, Layer styling, zonal statistics, print layout.	03 hours 12 hours
Pedagogy:	Lectures/ class discussion/case studies/ assignments	
References/ Readings	1. Chuvieco, E. (2016). *Fundamentals of satellite remote sensing: An environmental approach.* CRC press. 2. Cutts, A., Graser, A. (2018). *Learn QGIS, Your Step-by-step Guide to the Fundamental of QGIS 3.4*(4th ed). Packt Publishing, Livery Place, UK. 3. Menke, K.et. al. (2016).*Mastering QGIS*. Packt Publishing, Livery Place, UK.	
Course Outcomes	1. The students will gain knowledge on the fundamental techniques in remote sensing and GIS. 2. The students will be able to extract and process spatial images using open source software for economic decision-making.	

Title of the Course: Spatial Economic Analysis

Course Code: ENV 528
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Graduate in any discipline with science subjects at 10+2 level.	
Objective:	1. To introduce spatial economic analysis to the students to make them understand the development and growth process. 2. To expose the students to tools that integrate GIS (Geographic Information System) and remote sensing in order to analyse economic change.	
Content:	**Module 1: Introduction** Fundamentals of Remote Sensing Signals, Electromagnetic Spectrum, Spectral Signatures in the Solar Spectrum. **Module 2:Remote sensing applications in urban socio-economic analysis** Principles of urban socio-economic studies using remote sensing technologies, Socio-economic information estimation- Population estimation, Employment estimation, GDP estimation, Electrical power consumption estimation, Land use land cover, Advantages and limitations of remote sensing technologies in socio-economic applications.	03 hours 12 hours
Pedagogy:	Lectures/ class discussion/case studies/ assignments	
References/ Readings	1. Chuvieco, E. (2016). *Fundamentals of satellite remote sensing: An environmental approach.* CRC press. 2. Mesev, V. (2007). *Integration of GIS and Remote Sensing*. John Wiley & Sons. 3. Cutts, A., Graser, A. (2018). *Learn QGIS, Your Step-by-step Guide to the Fundamental of QGIS 3.4(*4th ed).Packt Publishing, Livery Place, UK.	
Course Outcomes	1. The students will be able to understand the techniques involved to obtain satellite images. 2. The students will be able to extract and process satellite data using open source software.	

Title of the Course: Measurement of Biodiversity

Course Code: ENV 529
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisite for the course:	There is no prerequisite for this course apart from the program requirements	
Objective:	The course provides the fundamentals about ecosystems and techniques to measure it.	
Content:	**Module 1: Measurement of Biodiversity** Species richness and biodiversity indices (diversity and evenness indices); Methods of measuring biodiversity; Alpha, Beta and Gamma-diversity; Genetic, species and ecosystem diversity; Centres of plant diversity, Hotspots of biodiversity and their distribution; Drivers of biodiversity change.	15 hours
Pedagogy:	Lectures/assignments/workshops/campus walks/documentaries and discussion/ presentations.	
References/ Readings	1. Chapman, J. L., &Reiss, M. J. (1999). *Ecology: Principles and applications* (2nd ed). Cambridge University Press. ISBN: 0521588022, 9780521588027. 2. Bowman, W.D., Hacker, S.D., &Cain, M.L. (2020). *Ecology* (5th ed). Oxford University Press, Incorporated. ISBN: 160535922X, 9781605359229. 3. Chapin III, S.F., Matson, P.A., & Vitousek, P. (2011). *Principles of terrestrial ecosystem ecology* (2nd ed). Springer. ISBN: 1441995048, 9781441995049. 4. Gaston, K.J., &Spicer, J.I. (2004). *Biodiversity: An introduction* (2nd ed). Blackwell Science. ISBN: 978-1-405-11857-6. 5. Gaston, K.J. (Ed.). (1996). *Biodiversity: A biology of numbers and difference*. PubMed: 0865428042. Blackwell Science. ISBN: 978-0865428041 6. Groombridge, B., &Jenkins, M.D. (2002). *World Atlas of biodiversity: Earth's Living Resources in the 21st Century*. University of California Press. ISBN: 0520236688, 9780520236684. 7. Henderson, P.A., & Southwood, T.R.E. (2016). *Ecological*	

	methods (4th ed). John Wiley & Sons. ISBN:1118895282, 9781118895283. 8. Smith, T.M., &Smith, R.L. (1988). Biodiversity in E.O. Wilson (Ed.). *Elements of ecology* (9th ed). Pearson. ISBN: 1292077409. National Academy Press, 9781292077406. ISBN: 030956736X, 9780309567367.	
Course Outcomes	After successful completion of the course, students will be able to: 1. Explain the different measures of biodiversity, such as species richness, evenness, and diversity indices. 2. Describe the benefits and drawbacks of different measures of biodiversity.	

Semester II
Core Courses

Title of the Course: Ecology and Society

Course Code: ENV 507
Number of Credits: 02
Effective from AY: 2022 -23

Prerequisites for the course:	There is no prerequisite for this course apart from the programme requirements	
Objective:	The larger objective of ecology is to understand the nature of environmental influences on individual organisms, their populations, and communities, on eco-scapes and ultimately at the level of the biosphere. One core goal of ecology is to understand the distribution and abundance of living things in the physical environment and its importance to humans.	
Content:	**Module 1: Introduction** Introduction to Ecology & Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche, niche, width and overlap, resource partitioning. Environmental concepts: laws and limiting factors, ecological models. Ecological structure, Ethno-zoology: The study of the past and present interrelationships between human cultures and the animals in their environment. **Module 2: Ecology and society** Culture and cultural ecology, Environmental ethics, Community based conservation (Sacred Grooves etc.), Society and Laws (Environment Protection Act, Biodiversity Act etc.) **Module 3: Disciplinary traditions** An overview of disciplinary traditions and the study of Environmental issues. Society, culture and environment; Ecological consciousness and ecological conflicts. Environment, development and sustainable development. Environmental movements in India: Issues, ideologies and methods.	06 hours 09 hours 15 hours
Pedagogy:	Lectures/assignments/workshops/ street play/brain storming sessions/outreach programmes/campus walks/documentaries and discussion/ presentations	
References/Readings	1. Chapman, J. L., & Reiss, M. J.(1999). *Ecology: Principles and applications*. Cambridge University Press. 2. Conklin, A.R. (2004).*Field sampling: Principles and practices in environmental analysis*. CRC Press. 3. Fahey, T.J., & Knapp, A.K. (2007).*Principles and standards for measuring primary production*. Oxford University Press.	

	4. Grant, W.E., & Swannack, T.M.(2008).*Ecological Modelling, Blackwell*. 5. Odum, E.P., & Barrett, G.W.(2004). *Basic ecology: Fundamentals of ecology* (5th ed).Oxford and IBH Publishing Co, Pvt. 6. Sutherland, W.J. (2006).*Ecological Census techniques a handbook*. Cambridge University Press. 7. Wilkinson, D. M.(2007). *Fundamental Processes in Ecology: An Earth system Approach*. Oxford University Press.	
Course Outcomes	1. Essential in depth understanding of the concepts and components of ecology. 2. Learners will learn ecosystem structure and function along with the interactions involved at various levels. 3. It would provide a vision to understand the ecosystem ecology along with sufficient knowledge of energy flow and exchange. 4. Sensitization of students towards the environment with respect to the global scenario and the related problems, impact, along with methods to tackle the problems.	

Title of the Course: Environmental Physiology Practical

Course Code: ENV 508
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisite for the course:	Knowledge on environmental physiology and biochemistry.	
Objectives:	Laboratory training based on skilled based courses on physiology.	
Contents:	1. Effect of thermal stress on the excretory rates in bivalves/fish (6 hours; Reference 1, 2). 2. Effect of salinity stress on the respiratory rates of bivalves/fish (6 hours; Reference 3). 3. Effect of salinity acclimation in the osmo-regulatory processes of mud crab / tilapia fish/bivalve (6 hours; Reference 4). 4. Effect of thermal stress on the carbohydrate metabolism of bivalve/fish (6 hours; Reference 3, 4, 5). 5. Effect of salinity stress on the membrane fluidity of gill epithelial cells of mud crab / tilapia fish (6 hours; Reference 3, 4, 5).	30 hours
Pedagogy:	Practicals, mini projects, group activities	
References/ Reading	1. Russel G Foster and Leon Kretzman, (2017); Circadian rhythm, A very short Introduction, Oxford University Press, UK 2. Roberto Refinetti, (2016); Circadian Physiology, RC Press, USA. 3. Hochachka PW and Somero GN; Biochemical Adaptation, Oxford University Press, UK. 4. Nielsen S, (1997); Animal Physiology: Adaptation and Environment, Cambridge University Press, Cambridge. 5. Wilimer P, Stone G and Johston IA, (2004); Environmental Physiology. of Animals, Wiley Blackwell Publishing Co, USA	
Course Outcomes	1. The course will provide hands on training in environmental physiology experiments. 2. The course will help the student understand the effect of different stressors on the organisms in the environment. 3. The course will help students understand the effect of environmental stressors on the physiology of the organism. 4. The course will help student analyse how the environmental changes can affect the living organisms normal functioning. 5. The course will help to stream line the parameters to understand the effect of different environmental stressor, analyse and interprete them.	

Title of the Course: Climate Change

Course Code: ENV 509
Number of Credits: 03
Effective from AY: 2022 -23

Prerequisites for the course:	Basic understanding of the marine environment and microorganisms.	
Objective:	To introduce the students to climate change and also examine the methods and policies for the mitigation of climate change	
Content:	**Module 1: Introduction** Earth system, greenhouse gases: carbon dioxide, methane, nitrous oxide, warming potential, radiation and energy balance, solar variability, ozone and chlorofluorocarbon, aerosols, paleoclimate, ice-ages, carbon budget and global carbon cycle. **Module 2: Impact of climate change and future projections** Land and water resources, global warming, weather and heatwave, drought, biodiversity, extinction, migration, vegetation, agriculture and food security, human livelihood and health, ozone layer depletion, melting ice sheets, sea-level rise, precipitation. **Module 3: Ecological response** Floods, cyclone, changes in physical and biogeochemical properties of ocean: ocean acidification, deoxygenation, oxygen minimum zones, ocean circulation, effect on marine organisms, effect on polar regions, future projections and predictions: decadal, centennial, economic consequences. **Module 4: Mitigation and sustainability** Future Earth, adaptation, alternate energy sources: solar, wind energy, geothermal, biomass, biogas, hydrogen, lithium-ion battery, ocean thermal energy conversion, integrated assessment, emission budgets, future technologies: biofuels, hydrogen, geoengineering, carbon sequestration, contribution of oceans in mitigation, ethics and environmental policy, International agreements: United Nations Framework Convention on Climate Change, Kyoto Protocol, Paris Agreement, role of India, youth and mass media in climate change mitigation.	06 hours 09 hours 15 hours 15 hours
Pedagogy:	Lectures/tutorials/assignments/self-study	
References/ Readings	1. Reichle, D. E. (2020). *The global carbon cycle and climate Change: Scaling ecological energetics from organism to biosphere*. Elsevier Science. 2. Johansen, B.E. (2017). *Climate Change: An encyclopedia of science, society, and solutions*. ABC-CLIO.	

	3. Mélières, M. A., & Maréchal, C. (2015). *Climate Change: Past, present and future*. Wiley-Blackwell. 4. Hodgson, P. E.(2010). *Energy, the environment and climate Change*. Imperial College Press. 5. Laczko, F., & Aghazarm, C. (2009). *Migration, Environment and Climate Change: Assessing the evidence*.International Organization for Migration. 6. National Research Council.(2008). *Ecological impacts of climate Change*. National Academies Press. 7. Dessler, A. (2016). *Introduction to modern climate change* (3rd ed). Cambridge University Press. 8. Srivastav, A. (2019). *The science and impact of climate change*. Springer. 9. Chen, W. Y., Suzuki, T., & Lackner, M. (2012). *Handbook of climate change mitigation and adaptation* (2nd ed). Springer.	
Course Outcomes	After completion of the course, students will be able to: 1. Understand key concepts and terminologies, such as global warming, warming potential, and carbon budget. 2. Explain and describe the consequences of climate change for the environment and society. 3. Evaluate the effectiveness of different mitigation and adaptation strategies. 4. Assess the potential trade-offs and unintended consequences of these mitigation strategies.	

Title of the Course: Environmental Geology

Course Code: ENV 510
Number of Credits: 02
Effective from AY: 2022 -23

Prerequisites for the course:	Bachelor's degree of this University or an examination of any other University recognised as equivalent.	
Objective:	1. To understand the rock and soil mechanics. 2. To study civil structures and their implications on the environment. 3. To impart knowledge about different slope failures as well as understand the remedial measures.	
Content:	**Module 1: Introduction to rock and soil mechanics** • Engineering properties of the soil, soil profile, size of the soil particles; cohesion and alteration of clays. • Structure: Porosity, Voids ratio and degree of saturation. Plasticity and Atterberg limits, clay swelling and tests to determine. • Engineering properties of the rock: physical and mechanical properties, RQD, RMR.	02 hours
	Module 2: Civil structures and environment • Dams: Earth dams, classification, causes of failure, introduction to stability analysis; Gravity dams, forces acting, classification, modes of failure, factors of safety and stability analysis. Reservoir induced seismicity and case studies. • Tunnels and bridges: Design and construction, identifying and managing geologic hazards - groundwater, problematic ground conditions, impacts to existing utilities and adjacent structures. • Nuclear plants: Construction, nuclear reactor accidents and safety. Case study.	13 hours
	Module 3: Landslides and their mitigation • Introduction, Landslide classification, Natural landslides in soils and rocks. Types and modes of slope failure. Stability of slopes. Classification in slope stability evaluation. Remedial measures for stabilizing slopes. Monitoring and control.	15 hours
Pedagogy:	Lectures, case studies, discussions and assignments.	
References/ Readings	1. Keller, E.A. (2012). *Introduction to Environmental Geology* (5th ed). Prentice Hall. 2. Montgomery, C.W. (2010). *Environmental geology* (9th ed). Professor Emerita, Northern Illinois University. 3. Montgomery, C.W. (2020). *Environmental geology.* (11th ed).	

	Professor Emerita, Northern Illinois University. 4. Bodansky, D. (2007). *Nuclear energy: principles, practices, and prospects.* Springer Science & Business Media. 5. Krynine, D.P., Judd, W.R., & Krynine, D. P. (1957). *Principles of engineering geology and geotechnics* (pp. 1-3). New York: McGraw-Hill. 6. Meiswinkel, R., Meyer, J., & Schnell, J. (2013). *Design and construction of nuclear power plants.* John Wiley & Sons.	
Course Outcomes	In this course a student will learn about: 1. Concepts of engineering geology. 2. Engineering properties of soil. 3. Physical and chemical properties of rocks. 4. Types of major civil structures and their impact on the environment. 5. Different types of landslides, their stabilization and control measures.	

Title of the Course: Environmental Geology Practical

Course Code: ENV 511
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Bachelor's degree of this University or an examination of any other University recognised as equivalent.	
Objective:	1. To understand the rock and soil mechanics. 2. To study civil structures and their implications on the environment. 3. To impart knowledge about different slope failures	
Content:	1. Forces acting on dams and their distribution with respect to safety of dam (3 hours; Reference 3,4). 2. Dam site selection and failure assessment (6 hours; Reference 3,4). 3. Tunnel site selection and failure assessment (6 hours; Reference 3,4). 4. Problems on rock mechanics – Rock Quality Designation (4 hours; Reference 3,4). 5. Problems on rock mechanics - Rock Mass Rating (4 hours; Reference 3, 4). 6. Reading and interpreting bore hole data (3 hours; Reference 3,4). 7. Calculation of pore water pressure in a slope using groundwater flow net (4 hours; Reference 1,2,4).	30 hours
Pedagogy:	Lectures, practicals, exercises and discussions.	
References/ Readings	1. Keller, E.A. (2012). *Introduction to Environmental Geology* (5th ed). Prentice Hall. 2. Montgomery, C.W. (2020). *Environmental geology.* (11th ed). Professor Emerita, Northern Illinois University. 3. Krynine, D.P., Judd, W.R., & Krynine, D. P. (1957). *Principles of engineering geology and geotechnics* (pp. 1-3). New York: McGraw-Hill. 4. De Vallejo, L. G., & Ferrer, M. (2011). *Geological engineering*. CRC press.	
Course Outcomes	In this course a student will learn about: 1. Concepts of engineering geology 2. Basics of rock and soil mechanics. 3. Types of major civil structures 4. Impact of civil structures on the environment and forces affecting them. 5. Site selection and problem assessment for civil structures.	

Title of the Course: Basic Statistics

Course Code: ENV 512
Number of Credits: 03
Effective from AY: 2022 -23

Prerequisites for the course:	Completion of first semester of the programme	
Objective:	The aim of the course is to introduce students to the study of basic statistics so that they can independently explore data, analyse it and present it to academics, policy-makers and civil society.	
Content:	**Module 1: Introduction** Exploring Data: Basic concepts of descriptive statistics -- measures central tendency (mode, median and mean) and dispersion (range, interquartile range, variance and standard deviation). Displaying data. **Module 2:Correlation and regression** Bivariate analyses: Correlation, Measures of correlation: (Pearson's r). Scatter plots and Linear regression analysis. Goodness of fit (R-squared). **Module 3:Probability and distribution** Introduction to probability, random variables, concepts of events, sample space and random trials. Conditional probabilities, independence. Probability Distributions: Discrete probability distribution: Binomial and Poisson. Continuous probability distribution: Student-t, Normal, Standard Normal, Chi-square and F-distributions. **Module 4:Sampling distributions and inferential statistics** Sampling methods: Random, stratified random, non-random sampling methods. Determining sample size. Inferential statistics: Confidence interval; Testing of hypotheses: the null hypothesis and the alternative hypothesis.	06 hours 09 hours 15 hours 15 hours
Pedagogy:	Lectures/assignments/workshops/ street play/brain storming sessions/outreach programmes/campus walks/documentaries and discussion/ presentations.	
References/Readings	1. Heumann, C., Schomaker, M., & Shalabh. (2016). *Introduction to statistics and data analysis: With exercises, solutions and applications in R*. Cham, Switzerland: Springer. 2. Levine, S.D., Krehbiel, & Berenson. (2008). *Statistics for managers: Using Microsoft Excel* (5th ed). Pearson Education, Inc. 3. McClave, J.T., Benson, P.G., & Sincich, T. (2018). *Statistics for business and economics*. Pearson. 4. Witte, R.S., Witte, J.S. (2017). *Statistics* (11thed). John Wiley & Sons,	

	Inc.	
Course Outcomes	1. The students will be able to understand the basic concepts in statistics. 2. They will learn how to collect, arrange, present and analyze data.	

Title of the Course: Environmental Management

Course Code: ENV 513
Number of Credits: 03
Effective from AY: 2022 -23

Prerequisites for the course:	Completion of first semester of the programme	
Objective:	The objective of the course is to enable participants to have a holistic understanding of the environment and know the methods of managing environmental issues.	
Content:	**Module 1: Introduction environmental management** Introduction to environmental management: Pollution and its various forms, Sustainability and sustainable development. **Module 2: Biodiversity and resources** Biodiversity and Resources: Societal ownership, Biodiversity, Benefits of natural resource protection, Traditional biodiversity knowledge, Bio-piracy. **Module 3: Environmental policies and management** Environmental policies and legislations and life cycle assessment: Environmental sustainability index, National and international environmental legislation, Life cycle assessment, LCA framework, Stages in LCA Energy Management and ISO Certification: Energy audits and methods, Energy conservation, Energy demand and balances, ISO 9000 and ISO 14000 series, Environment management certification. **Module 4: Pollution management** Water, air and noise pollution: Water pollution and management of water, Waste water and industrial waste water, Air pollution control measures. Noise pollution law and control measures. Solid waste and hazardous waste: Solid and hazardous waste sources and composition, Effect on health, storage, treatment and disposal of hazardous waste, Landfill designs, methods of disposal of solid waste. Monitoring environment using analytical methods: Statistical and instrumental methods, Analyses of all types of environmental pollution.	06 hours 09 hours 15 hours 15 hours
Pedagogy:	Lectures/tutorials/ laboratory work /field work/outreach activities/ project work/ vocational training/ viva /seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings	1. Murali Krishna, V., & Manickam, V. (2017). *Environmental Management*. Butterworth-Heinemann. 2. Kulkarni, V., & Ramchandra, T.V. (2009).*Environmental management, commonwealth of learning*. Indian Institute of Science.	

Course Outcomes	At the end of the course the participant should be able to identify: 1. Environmental impact. 2. Methods of control of such impacts. 3. Analyse the impact using statistical and other analytical tools. 4. Suggest specific interventions to alleviate environmental issues.	

Title of the Course: Introduction to Environmental Impact Assessment

Course Code: ENV 514
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	There is no prerequisite for this course apart from the programme requirements	
Objective:	In order to overcome the problems of environmental degradation, it is very necessary to plan the development process in a sustainable manner so that control and mitigation measures can be undertaken prior to occurrence of degradation. One important tool to do this is carrying out Environmental Impact Assessment. Hence, knowledge of this subject is very important for an environmental engineer.	
Content:	**Module 1: Introduction to the Environmental Impact Assessment process** • **Introduction and principals:** Introduction; nature and purpose of EIA; Project, Environment and nature of Impacts; Changing perspective and current issues in EIA; EIA regulations. • **Starting up early stages:** Managing the EIA process; project screening, scoping; understanding the project/development action; establishing the environmental baseline; impact identification. • **Participation, presentation and review:** Impact prediction; Evaluation; mitigation and enhancement; public consultation and participation; the importance of monitoring and auditing in the EIA process; Monitoring and auditing practice; EIA presentation and review. • **Practice and prospects:** Legal Challenges, cost and benefits of EIA; Case studies of EIA in practice; strategic environmental assessment; extending EIA to project implementation.	15 hours
Pedagogy:	Lectures/assignments/workshops/ street play/brain storming sessions/outreach programmes/campus walks/documentaries and discussion/ presentations.	
References/ Readings	1. Glasson, J., Therivl, R., & Chadwick, A. (2005). *Introduction to environmental impact assessment*. Routledge, Taylor &Francis Group. 2. Arts, J., & Morrison-Saunders, A. (Eds.). (2012). *Assessing impact: Handbook of EIA and SEA follow-up*. Routledge, Taylor & Francis Group. 3. Abaza, H., Bisset, R., & Sadler, B. (2004). *Environmental Impact Assessment and Strategic Environmental Assessment: Towards an Integrated approach*. UN Environmental Program.	

	4. Therivel, R., & Wood, G. (Eds.). (2017). *Methods of environmental and social impact assessment*. Routledge, Taylor &Francis Group. 5. Morris, P., & Therivel, R. (Eds.). (2001). *Methods of environmental impact assessment*, *2*. Taylor & Francis.	
Course Outcomes	After learning the course the students will be able to: 1. Explain the need for EIA 2. Demonstrate the understanding of concept of Sustainable Development and justify the methods of achieving SD. 3. Appreciate the importance of EIA as an integral part of planning process. 4. Apply the different methodologies to predict and assess the impacts of minor/major projects on various aspects of environment.	

Semester II
Elective Courses

Title of the Course: Mineral resource management

Course Code: ENV 530
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Bachelor's degree of this University or an examination of any other University recognised as equivalent.	
Objective:	To understand the interaction of humans with the geological environment.	
Content:	**Module 1: Introduction** • Earth in space and time • Internal structure of the earth and Geological time scale **Module 2: Earth, its resources and the management** • Geological evolution of earth: plate tectonics and seafloor spreading • Mineral resources and reserves; UNFC. • Mining: surface and underground mining, mine ventilation, mine drainage, environmental effect of mining, environmentally sensitive green mining, mine closure. Trace elements and their implications on health.	02 hours 13 hours
Pedagogy:	Lectures, case studies, discussions and assignments.	
References/ Readings	1. Merrits. D., De Wet, A., & Menking, K. (1997). *Environmental Geology: an earth system science approach.* W. H. Freeman, New York. 2. Keller, E. A. (2012). *Introduction to Environmental Geology* (5th ed). Prentice Hall. 3. Montgomery, C. W. (2010). *Environmental geology*. (9th Ed.). Professor Emerita, Northern Illinois University. 4. Montgomery, C. W. (2020). *Environmental geology*. (11th ed). Professor Emerita, Northern Illinois University. 5. Pipkin, B. W., Trent, D. D., Hazlett, R., & Bierman, P. (2013). *Geology and the Environment*. Cengage Learning. 6. Valdiya, K. S. (1987). *Environmental geology, Indian context*. Tata McGraw-Hill Pub. Co.	
Course Outcomes	In this course a student will learn about: 1. Concepts of environmental geology and its interaction with the human beings. 2. Internal structure of the Earth. 3. Management of geological resources.	

Title of the Course: Pollution and Environment

Course Code: ENV 531
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Bachelor's degree of this University or an examination of any other University recognised as equivalent.	
Objective:	• To understand the interaction of humans with the geological environment. • To study pollutants in the environment and to find the suitable remedial measures to cover harmful effects.	
Content:	**Module 1: Introduction** • Human and geological environment **Module 2: Types of pollution and remedial measures** • Hydrology and pollution – Impact assessment of degradation and contamination of surface water and groundwater quality due to industrialization and urbanization; remedial measures. • Soil Science - Soil profile, soil types and their classification and formation; soil quality degradation, control measures Waste and its disposal - surface and subsurface disposal of toxic, metallic and radioactive wastes. Planning and management of hazardous waste. Domestic refuse and landfill.	02 hours 13 hours
Pedagogy:	Lectures, case studies, discussions and assignments.	
References/ Readings	1. Keller, E. A. (2012). *Introduction to Environmental Geology* (5th ed.). Prentice Hall. 2. Montgomery, C. W. (2010). *Environmental geology*. (9th Ed.). Professor Emerita, Northern Illinois University. 3. Montgomery, C. W. (2020). *Environmental geology*. (11th Ed.). Professor Emerita, Northern Illinois University. 4. Pipkin, B. W., Trent, D. D., Hazlett, R., &Bierman, P. (2013). *Geology and the Environment*. Cengage Learning. 5. Valdiya, K. S. (1987). *Environmental geology, Indian context*. Tata McGraw-Hill Pub. Co.	
Course Outcomes	In this course a student will learn about: 1. Concepts of environmental geology and its interaction with the human beings, 2. Management of geological resources 3. Hydrologic cycle, cause and effect of water pollution. 4. Different types of soil and their properties. 5. Soil loss problem and the ways it can be reduced 6. Appropriate use of the geological site for waste disposal.	

Title of the Course: Natural and Manmade Hazards

Course Code: ENV 532
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Bachelor's degree of this University or an examination of any other University recognised as equivalent.	
Objective:	1. To understand the interaction of humans with the geological environment. 2. To impart knowledge about different natural as well as manmade hazards with deterrent measures.	
Content:	**Module 1 : Introduction** • Life on Earth **Module 2 : Geological hazards** Assessing geological hazards and risks: Earthquakes, volcanic eruptions, floods and droughts, mass movement-landslides, rock fall, preventive and mitigation measures.	02 hours 13 hours
Pedagogy:	Lectures, case studies, discussions and assignments.	
References/ Readings	1. Keller, E. A. (2012). *Introduction to Environmental Geology* (5th ed). Prentice Hall. 2. Montgomery, C. W. (2010). *Environmental geology*. (9th ed). Professor Emerita, Northern Illinois University. 3. Montgomery, C. W. (2020). *Environmental geology*. (11th ed). Professor Emerita, Northern Illinois University. 4. Pipkin, B.W., Trent, D.D., Hazlett, R., & Bierman, P. (2013). *Geology and the Environment*. Cengage Learning. 5. Valdiya, K.S. (1987). *Environmental geology, Indian context*. Tata McGraw-Hill Pub. Co. 6. Valdiya, K. S. (2013). *Environmental Geology: Ecology, Resource and Hazard Management*. McGraw-Hill Education.	
Course Outcomes	1. The students will learn about origin and evolution of life on Earth. 2. The student will learn about recognition of natural hazards and mitigation.	

Title of the Course: Marine Habitat Conservation and Restoration

Course Code: ENV 533
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Bachelor's degree of this University or an Examination of any other University recognised as equivalent.	
Objective:	To create awareness regarding habitat degradation, monitoring and strategies for restoration with specific reference to coastal habitats.	
Content:	**Module 1 : Introduction** Introduction to restoration, importance, types, concepts and principles **Module 2 : Habitat monitoring and restoration** Habitat degradation, Human interference and anthropogenic inputs, tourism effect, damaged ecosystems, fragmentation Marine Protected areas, restoration ecology and global framework, Coral reef damage, bleaching, restoration, Seagrass beds, restoration initiatives at GBR and India, Cost-benefit analysis of restoration, ecosystem development and restoration program design, Monitoring and evaluation - adaptive management, the purpose and importance of monitoring and evaluation, and feedback mechanisms to improve the management of the restoration process.	03 hours 12 hours
Pedagogy:	Lectures, case studies, discussions and assignments.	
References/ Readings	1. Andrew, W. (2013). *Handbook of environmental degradation of materials* (3rd ed). Elsevier, Amsterdam, Netherlands. 2. Kellert, S.R. (1996). *The Value of Life: Biological Diversity and Human Society*.Island Press, Washington, DC. 3. Hawksworth, D.L. (2020). Books on biodiversity and conservation. Biodiversity and Conservation. *29*, 3843–3862. 4. Perrow, M.R., Davy, A.J. (Eds.). (2009). *Handbook of ecological restoration*, *Volume 1: Principles of Restoration.* Cambridge University Press.	
Course Outcomes	1. The students will be able to identify the potential areas likely to be subjected for degradation. 2. The students will learn to evolve with appropriate remedies for conservation and restoration.	

Title of the Course: Ecological Significance of Symbiosis

Course Code: ENV 534
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Graduate in any discipline with science subjects at 10+2 level.	
Objective:	1. To describe the diversity of symbiotic associations in the environment. 2. To understand the nuances of symbiotic interactions, their multifaceted nature, relevance and role in evolution.	
Content:	**Module 1: Introduction** • Concept of symbiosis. • Diversity of microbial symbiotic associations: Concept of rhizosphere, mycorrhizosphere, phycosphere, satellite bacteria, microbiome. **Module 2: Intricacies, molecular evolution and ecological significance of symbiosis** • Multipartner symbiotic systems: the multifaceted and dynamic nature of symbiotic interactions; establishment and maintenance of symbiotic associations, vertical versus horizontal transmission of symbionts; quorum sensing; mixotrophy, kleptoplastidy. • Influence of symbiotic interactions on Circadian rhythms and gene expression; holobiont concept, the hologenome theory of evolution and the role of microorganisms in speciation; endosymbiotic theory for the origin of eukaryotic organelles.	03 hours 12 hours
Pedagogy:	Lectures/ case studies/ tutorials/ videos/ assignments/ self-study	
References/ Readings	1. Duplouy, A., Dotson, B. R., Nishiguchi, M. K., & Cárdenas, C. A. (2021). Symbiosis in a Changing Environment. *Frontiers in Ecology and Evolution,* 536, https://doi.org/10.3389/fevo.2021.731892. 2. Lipnicki, L. I. (2015). The role of symbiosis in the transition of some eukaryotes from aquatic to terrestrial environments. *Symbiosis,* 65(2), 39-53. 3. Munn, C. B. (2011). *Marine microbiology: ecology & applications*. CRC Press. 4. Hawksworth, D. L., & Grube, M. (2020). Lichens redefined as complex ecosystems. *The New Phytologist*, *227*(5), 1281-1283.	

	5. Pacheco, A. R., & Segrè, D. (2019). A multidimensional perspective on microbial interactions. *FEMS Microbiology Letters*, *366*(11), fnz125. 6. Heath-Heckman, E. A. (2016). The metronome of symbiosis: interactions between microbes and the host circadian clock. *Integrative and Comparative Biology.* 56(5), 776-783. 7. Lee, S. J., Morse, D., & Hijri, M. (2019). Holobiont chronobiology: mycorrhiza may be a key to linking aboveground and underground rhythms. *Mycorrhiza*, *29*(5), 403-412. 8. Rosenberg, E., & Zilber-Rosenberg, I. (2018). The hologenome concept of evolution after 10 years. *Microbiome*, *6*(1), 1-14.	
Course Outcomes	At the end of the course, students will be able to: 1. Describe the concept of symbiosis in a lucid manner. 2. Develop knowledge of the diverse ecological roles of symbiotic interactions in the environment.	

Title of the Course: Nitrogen and Climate Change

Course Code: ENV 535
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Graduate in any discipline with science subjects at 10+2 level.	
Objective:	To enable students to understand: 1. Nitrogen (N) cycling in the marine environment. 2. Factors responsible for causing pertubations in biogeochemical cycling of the element. 3. Impact of oceanic production of the greenhouse gas nitrous oxide (N_2O) on the climate.	
Content:	**Module 1: Introduction** Nitrogen (N) species in the marine environment; Primary routes for entry of N into the marine environment; Spatial and seasonal distribution of dissolved nitrogen compounds in seawater. **Module 2: Nitrogen transformations in the marine environment and its impact on the climate** Biogeochemical cycling of N; Controlling factors; analytical methods for the study of N compounds; Disruptions caused to marine N cycle due to seawater stratification and upwelling; Impact of agricultural activities, fossil fuel burning and aquaculture; Nitrous oxide as a driver of climate change, Influence of warming, deoxygenation and acidification on oceanic N_2O cycling and emissions to the atmosphere, Mitigation strategies for excess N in aquatic systems.	03 hours 12 hours
Pedagogy:	Lectures/ case studies/ tutorials/ videos/ assignments/ self-study	
References/ Readings	1. Bonaglia, S. (2015). Control factors of the marine nitrogen cycle : The role of meiofauna, macrofauna, oxygen and aggregates (PhD dissertation, Department of Geological Sciences, Stockholm University). 2. Capone, D.G., Bronk, D.A., Mulholland, M.R., & Carpenter, E.J. (Eds.) (2008). *Nitrogen in the marine environment* (2^{nd}ed). Academic Press. 3. Capone, D.G., & Hutchins, D.A. (2013). Microbial biogeochemistry of coastal upwelling regimes in a changing ocean. *Nature Geoscience*, *6,* 711-717. 4. Fowler, D., Coyle, M., Skiba, U., Sutton, M. A., Cape, J.N.,	

	Reis, S., Sheppard, L.J., Jenkins, A., Grizzetti, B., Galloway, J. N., Vitousek, P., Leach, A., Bouwman, A.F., Butterbach-Bahl, K., Dentener, F., Stevenson, D., Amann, M., & Voss, M. (2013). The global nitrogen cycle in the twenty-first century. *Philosophical Transactions of the Royal Society B*: *Biological Sciences*, *368,* 1621. 5. Hutchins, D.A., & Capone, D.G. (2022). The marine nitrogen cycle: new developments and global change. *Nature Reviews Microbiology* .https://doi.org/10.1038/s41579-022-00687-z. Epub ahead of print. PMID: 35132241. 6. McCarthy, M.D., & Bronk, D.A. (2008). Analytical methods for the study of nitrogen. In:D.G. Capone, D.A. Bronk, M.R. Mulholland, E.J. Carpenter (Eds.). *Nitrogen in the Marine Environment* (2nd ed.), (pp. 1219-1275) Academic Press. 7. Reay, D. (2015). *Nitrogen and Climate Change: an Explosive Story* (pp. 193–205). Palgrave Macmillan, UK, London. 8. Voss, M., Baker, A., Bange, H., Conley, D., Cornell, S., Deutsch, B. et al. (2011). Nitrogen processes in coastal and marine ecosystems. In: M. Sutton, C. Howard, J. Erisman, G. Billen, A. Bleeker, P. Grennfelt, et al. (Eds.), *The European Nitrogen Assessment: Sources, Effects and Policy Perspectives* (pp. 147-176). Cambridge University Press. 9. Voss, M., Bange, H.W., Dippner, J.W., Middelburg, J.J., Montoya, J.P., & Ward, B. (2013). The marine nitrogen cycle: recent discoveries, uncertainties and the potential relevance of climate change. *Philosophical Transactions of the Royal Society B*: *Biological Sciences*, 368, 20130121. 10. Zehr, J.P., & Kudela, R.M. (2011). Nitrogen Cycle of the Open Ocean: From Genes to Ecosystems. *Annual Review of Marine Science*, *3*, 197-225.	
Course Outcomes	This course will enable students to: 1. Predict human impacts on nitrogen biogeochemistry in aquatic systems. 2. Understand the role of nitrogen in climate change. 3. Suggest and/or initiate mitigation measures to counter excessive nutrient input in coastal waters.	

Title of the Course: Environment and Literature

Course Code: ENV 536
Number of Credits: 02
Effective from AY: 2022 -23

Prerequisites for the course:	Bachelor's degree in any discipline	
Objectives:	1. To highlight the symbiotic relationship between environment and literature beginning from the Vedic times. 2. To focus on the preoccupation of modern writers with issues related to environmental degradation, consumerist culture etc. 3. To encourage the students to adopt an interdisciplinary perspective while dealing with the large spectrum of issues pertaining to environment and literature. 4. To drive home the idea that questions related to aesthetics cannot be divorced from ethics.	
Content:	**Module 1: Introduction** Tracing the Trajectory of Environmental Concerns in Indian & Western Literature: Moments & Movements **Module 2: Paradigms & Categories** Romanticism Martin Heidegger on Technology Ecocriticism Ecofeminism Environmental Humanities Externality Deep Ecology **Module 3: Indian Perspective** *The Upheaval* by Pundalik Naik (Novel) **Module 4: Western Perspective** *The Road* by Cormac McCarthy (Novel)	04 hours 08 hours 09 hours 09 hours
Pedagogy:	Lectures/tutorials/assignments/seminars.	
References/ Readings:	1. Bellamy P. (2007). *Dictionary of Environment* (3rd ed) New Delhi, Academic (India) Publishers.. 2. Blanning, T.C.W. (2010). *The Romantic Revolution*, George Weidenfield & Nicholson Publishers. *3.* Broswimmer, F.(2002). *Ecocide: A Short History of Mass Extinction of Species* Pluto Press Publishers. 4. Buell, L. 1998. *The Environmental Imagination: Thoreau,*	

	Nature Writing, and the Formation of American Culture. Cambridge: Harvard University Press. 5. Garrard, G. (2004). *Ecocriticism: The New Critical Idiom* Oxford, Blackwell. 6. McCarthy, C. (2006). *The Road*, London, Pan Macmillan. 7. Vacoch, D.A.& Mickey, S. (Eds.) (2018). *Literature and Ecofeminism: Intersectional and International Voices*(1st ed). Routledge, London. 8. Naik, P.N. (2002). *The Upheaval*. Translated by V Pai, Oxford University Press, New York.	
Course Outcomes	1. Understand the relationship between literature and environment. 2. Appreciate and recognise the aesthetic as well as the ethical dimensions of literature. 3. Make an independent analysis of literary texts in the context of issues related to environment.	

Title of the Course: Gender Sensitivity and Equity

Course Code: ENV 537
Number of Credits: 02
Effective from AY: 2022 -23

Prerequisites for the course:	Student should be registered with Goa University Post Graduate Programme	
Objective:	This course aims to develop the basic understanding of gender related issues in the society among students with multidisciplinary approach.	
Content:	**Module 1: Introduction** The universal commitment to Gender Equality and Social Equity – SDGs, Provisions in the Indian Constitution, Towards Equality Report and the creation of the discipline of Women's Studies in India. Sex and Gender: Non-duality of these terms. Nature vs Nurture debate, socialisation, stereotyping. **Module 2: Social Equity** Power, Intersectionality. Marginalised sections based on caste, class, abilities, religion etc. Women's rights as human rights. Women's issues in Goa. **Module 3: Introduction to Laws** Sexual Harassment at Work Place (Protection, Prohibition, and Redressal Act of 2013) and Protection of Women from Domestic Violence Act of 2005. Forms of violence against women: a review.	10 hours 10 hours 10 hours
Pedagogy:	This course will be taught through workshops/ lectures/ group discussions/assignment/quiz games/ tutorials/ assignments/ films/ documentaries/ group	
References/Readings	1. Government of India. (2005). DV Act 2005 http://ncw.nic.in/acts/TheProtectionofWomenfromDomesticViolence Act2005.pdf 2. Government of India, (2013). Sexual Harassment of Women at the Workplace (Prevention, Prohibition and Redressal) Act of 2013.http://www.iitbbs.ac.in/notice/sexual-harrassment-ofwomen-act-and-rules-2013.pdf 3. Pilcher J., &Whelehan, I. (2005). *50 Key Concepts in Gender Studies.*Sage Publications, New Delhi. 4. UNDP (2014). Women's Rights are Human Rights. file:///C:/Users/admin/Desktop/WomenRightsAreHR.pdf	
Course Outcomes	1. Students will be enabled to develop the sensitive approach towards gender issues.	

	2. Students will have an understanding of equity, its importance in our society.	

Title of the Course: Gender and Ecology in Goan Society

Course Code: ENV 538
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	There is no prerequisite for this course apart from the programme requirements	
Objective:	The module on Goan Society, Gender and Ecology which is taught by faculty from the Women's Studies Programme of Manohar Parrikar School of Law, Governance and Public Policy will introduce students to the politics behind the popular connect between women and nature, and will deliberate on the concerns regarding land, water and livelihoods, menstruation and environment with a focus on issues in Goa.	
Content:	**Module 1: Gender and Ecology in Goan Society** "Is Female to Male as Nature is to Culture" Sherry Ortner. Menstruation: Hygiene, Management, Eco-cultural practices and social exclusion. Forest Law, Tribes and Livelihood: Women's experiences in Goa - Kumeri cultivation, Social Ecology, Traditional knowledge, Power and Agency. Ecology, Livelihood and Gender: Water, Land ownership, Work, Participation and impacts (tourism, mining, agriculture, fishing, craft and small scale industry).	15 hours
Pedagogy:	Lectures/assignments/workshops/ street play/brain storming sessions/outreach programmes/campus walks/documentaries and discussion/ presentations	
References/Readings	1. Garcia, S.L.(2019). Gender and water. *Gender CC—Women for climate justice*. UN. 2. Lynn, H.(2018). Seeing red: Menstruation and the environment, #PLASTICFREEPERIODS. *Women's environment network: London*. 3. Kaur, R., Kaur, K., & Kaur, R. (2018). Menstrual hygiene management, and waste disposal: Practice and challenges faced by girls/women of developing countries. *Journal of Environmental and Public Health* Feb 20; 2018:1730964. doi: 10.1155/2018/1730964. 4. Manisha, P.et al. (2009). *Human rights, gender and the environment*. Dorling Kinderseley.	
Course Outcomes	1. Learners will learn ecosystem structure and function along with the interactions involved at various levels.	

	2. Sensitization of students towards the environment with respect to the global scenario and the related problems, impact, along with methods to tackle the problems.	

Title of the Course: Coastal Geo-hazards

Course Code: ENV 539
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Bachelor's degree of this University or an examination of any other University recognised as equivalent.	
Objective:	To gain knowledge on coastal processes and hazards.	
Content:	**Module 1: Coastal processes and hazards** • Waves, beach form and processes, transport and deposition of sediment, rip currents, coastal erosion, and erosional factors. • Sea level changes, impact and responses. • Coastal hazards and stabilization: soft stabilization, hard stabilization and managed retreat; human activity and coastal erosion.	15 hours
Pedagogy:	Lectures, case studies, discussions and assignments.	
References/ Readings	1. Keller, E.A. (2012). *Introduction to Environmental Geology* (5th ed). Prentice Hall. 2. Montgomery, C.W. (2010). *Environmental geology* (9thed). Professor Emerita, Northern Illinois University. 3. Montgomery, C.W. (2020). *Environmental geology.* (11th ed). Professor Emerita, Northern Illinois University. 4. Krynine, D.P., Judd, W.R., & Krynine, D. P. (1957). *Principles of engineering geology and geotechnics* (pp. 1-3). New York: McGraw-Hill. 5. Charles W. Finkl, Christopher Makowski (auth.), Charles W. Finkl (eds.). (2013). *Coastal hazards.* Springer Netherlands	
Course Outcomes	1. The students will learn about various coastal processes. 2. The students will understand environmental anomalies resulting in natural hazards and their mitigation.	

Title of the Course: Analysis of Environmental Impact Assessment

Course Code: ENV 540
Number of Credits: 01
Effective from AY: 2022 -23

Prerequisites for the course:	Completion of first semester of the programme	
Objective:	To understand the Environmental Impact Assessment processes through the study of EIA reports available for various kinds of projects.	
Content:	**Module 1:** Study of EIA reports for major projects of the country available online and understand the methods used, interpretations made, conclusions drawn, objections raised and decisions taken and their implementation.	15 hours
Pedagogy:	Lectures/tutorials/ laboratory work /field work/outreach activities/ project work/ vocational training/ viva /seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
References/ Readings	1. Yerramilli, A., & Manickam, V. (2020). *Environmental impact assessment methodologies* (3rd ed). BS Publications/British Society of Periodontology Books. 2. Glasson, J., & Therivel, R. (2019). *Introduction to environmental impact assessment* (5th Ed.). Routledge. 3. Khandeshwar, S.R., Raman N.S., & Gajbhiye, A.R. (2019). *Environmental Impact Assessment.* Dreamtech Press. EIA manuals available at: 1. http://environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/ommodel3.html 2. Sectoral Manuals under EIA Notification, 2006: 3. http://environmentclearance.nic.in/writereaddata/Form-1A/HomeLinks/ommodel2.html 4. Anonymous. Environmental Impact Assessment Training Manual. 2016. International Institute for Sustainable Development. 5. http://www.iisd.org/learning/eia/wp-content/uploads/2016/06/EIA-Manual.pdf 6. EIA Online Learning Platform www.iisd.org/learning/eia	
Course Outcomes	1. The students will be able to perform screening and scoping of the developmental projects in view of environment. 2. The students will be trained to work and write EIA reports for each of the major sectors.	

Semester III(M.Sc)

Title of the Course: Research methodology in Environmental Science

Course Code: ENV 600
Number of Credits: 04
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	To understand the methodology and techniques involved in conducting environmental research	
Content:	**Module I** Research and Scientific Methods, Types of Research, Significance of Research, Selecting a Research Problem, Research Design, Formulation of Hypothesis, Procedure for Hypothesis Testing, Null hypothesis. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, types of sampling designs: Non-probability sampling, Probability sampling; Primary data, Secondary data, tools and methods of data collection, Sampling Distribution, data compilation, tools in data analysis, Graphical representation of Data, Processing of data.	15 hrs.
	Module II Descriptive statistics: Measurement Scales, Sources of error in measurement. Measures of dispersion (range, mean deviation, standard deviation) Inferential statistics: Normal Probability Curve - Meaning, characteristics and applications. Standard error, Confidence Intervals, Type I and Type II errors, Concept of Variance.	15 hrs.
	Module III Analysis of Variance (ANOVA), Testing the Significance of difference between means (z and 't' test), Non-Parametric Statistics: Sign Test, Mann-Whitney U Test, Kruskall-Wallis test, PCA, CCA, MDS, Cluster, Characteristics and applications, statistical software. Interpretation of results.	15 hrs.
	Module IV Air Sampling: Objective and Criteria of Air Sampling, Selection of Sampling Location, Sampling Methods (Sedimentation, Filtration, Centrifugal and Impingement Method), Instrumental Techniques used in Estimation of Atmospheric Air Pollutant, Dust Fall Jar, SPM and RSPM using Respirable Dust sample/High Volume Air Sampler. Soil and Solid Waste Sampling: Collection and Preparation of Soil Samples for Analysis, Physico-Chemical Parameters and their Significance (Quality and Productivity). Water Sampling: Objectives, Selection of Sampling Site,	15 hrs.

	Collection, Handling and Preservation, Sampling Equipment, Classification of Water Quality Parameters (Inorganic, Organic and Nutrient), Data Interpretation, Basic Concept, Significance, Measurement and analysis of DO, BOD, COD, Phenol, Pesticides and Polynuclear Aromatic Hydrocarbon (PAH) in Water and Wastewater.	
Pedagogy:	Discussions, tutorials, self-study, video lectures and presentations	
References / Readings:	1. Kothari, CR. (2004). *Research Methodology: Methods and Techniques* (Second edition), New Age International Publishers, New Delhi 2. Greenfield, T., Greener, S. (2016). *Research Methods for Postgraduates*, Third Edition, John Wiley & Sons, Ltd. 3. Gurumani, N. (2008). *Research Methodology for Biological Sciences*, MJP Publishers (Delhi) 4. Hawkins, DM. (2009). *Biomeasurement: a student's guide to biological statistics*, Oxford University Press, (New York). 5. Gupta, S.C. (1997). *Statistical Methods.* S. Chand & Sons Publishers, New Delhi	
Course Outcome	1. The students will be exposed to the analytical techniques involved in air, water and soil analysis. 2. The student will be trained to perform data analysis using various statistical tools. 3. The students will be able to conduct the analysis of water, soil and air to interpret the data.	

Title of the Course: Environmental Pollution Practical I

Course Code: ENV 601
Number of Credits: 02
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. To understand the concentration of various pollutants in natural waters and their influence in biota. 2. The routine instruments used for analysis of different pollutants natural waters 3. Analyses of BOD and COD to understandthe impact organic pollution in water bodies.	
Content:	**Module I** 1. Determination of dissolved oxygen in coastal waters. (5 hrs;Ref.1) 2. Estimation of dissolved oxygen in polluted water (5 hrs.Ref. 2, 3) 3. Determination of biochemical oxygen demand in coastalwaters (5 hrs; Ref. 1) 4. Estimation of hydrogen sulfide in coastal waters (5 hrs. Ref.3). 5. Estimation of phosphorous in polluted water (5 hours. Ref.1) 6. Determination of fluoride in drinking water (5 hrs. Ref.1) **Module II** 1. Determination of chemical oxygen demand in coastal waters by $KMnO_4$ method (5 hrs; Ref. 2) 2. Pre-concentration of sea water by solvent extraction methodfor analysis of trace metals by AAS (5 hrs; Ref 5, 6, 7). 3. Estimation of Cu in coastal waters by AAS method (5 hrs; Ref 5, 6, 7). 4. Estimation of Pb in coastal waters by AAS method (5hrs; Ref 5, 6, 7). 5. Determination of Zn in polluted water by AAS method (5 hrs. Ref. 5,6,7) 6. Determination of Fe in sea water by AAS method (5 hrs. Ref. 5,6,7)	30 hrs. 30 hrs.
Pedagogy:	Demonstrations/ Lab experiments/Operation of different instruments for analysis of pollutants in natural waters.	

References/Readings:	1. Martin, D. F. (1972). *Marine Chemistry*. (Second Edition). M. Dekker (Ed.). New York. 2. Standard methods for the examination of water and wastewater analysis. (22nd Edition). 3. Rice, E. W. and Bridgewater, L. (2012). *Standard Methods for the Examination of Water and Waste Water Analysis*. Washington DC: American Public Health Association. 4. Grasshoff, K., Kremling, K., Ehrhardt, M., editors (1999). *Methods of Seawater Analysis*. (Third Edition). Weinheim: Wiley-VCH. 5. Strickland, J. D. H., & Parsons, T. R. (1972). *A practical hand book of seawater analysis*. (Second Edition). Fisheries Board of Canada bulletin. 6. Riley, J. P. and Skirrow, G. (1975). *Chemical Oceanography*. Academic Press. 7. Allen, S. E., Grimshaw, H. M., Parkinson, J. A., Quarmby, C., & Roberts, J. D. (1976). (eds) Chapman S. B, Chapter 8. Chemical analysis. In *Methods in Plant Ecology*. Blackwell Scientific Publications.	
Course Outcomes	1. Student will be in position to use different techniques for qualitative and quantitative estimation of environmental samples. 2. These studies would help to regulate the release of a particular pollutant in the marine environment.	

Title of the Course: Environmental Pollution Practical II

Course Code: ENV 602
Number of Credits: 02
Effective from AY: 2022-2

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. Introduction of basic laboratory techniques for analysis of environmental samples. 2. Evaluate the utility of various analytical techniques as a qualitative and quantitative tool.	
Content:	**Module I** 1. To prepare standard solution of different concentrations; Molarity, Normality, Parts per million, percentage (W/W, W/V, V/V). (3 hrs;Ref.1,2) 2. Procedures of water and wastewater sample collection from natural reservoirs and industries and preservation techniques. (3 hrs; Ref.1,3,4) 3. Calibration of glass electrode and determination of pH of different water samples (surface water, ground water and sea water). (3 hrs; Ref.7) 4. Calibration of conductivity meter and determination of conductivity of different water samples (surface water, ground water and sea water). (3 hrs;Ref.7) 5. Determination of pH and conductivity of soil samples. (3 hrs; Ref.7) 6. Standardisation of titrimetric reagents for acid base and complexometric titrations. (3 hrs; Ref. 2) 7. Determination of alkalinity of surface, ground and sea water sample using titrimetric analysis. (3 hrs;Ref. 3,4,7) 8. Determination of acidity of surface, ground and sea water sample using titrimetric analysis. (3 hrs;Ref. 3,4,7) 9. Estimation of total solids, dissolved solids, suspended solids of surface, ground and sea water samples (3 hrs;Ref.3,4) 10. Determination of moisture content of soil using gravimetry. (3 hrs; Ref. 3,4). **Module II (Any 5 experiments)** 1. Determination of nitrite in water sample using colorimetry (6 hrs;Ref.1,2,3) 2. Demonstration of UV-visible spectrophotometer and determination of nitrate in water. (6 hrs;Ref.1,2,3) 3. Determination of chromium in water sample by UV-Visible spectrophotometry. (6 hrs; Ref.1,2,3) 4. Estimation of total residual chlorine and hardness of water samples. (6 hrs; Ref.1,2,3) 5. Determination of Pb/Cd in water samples by MP-AES. (6 hrs; Ref. 2,3,4). 6. Determination of chemical oxygen demand in given water sample (6 hrs; Ref. 3,4). 7. Estimation of phosphate in water by colorimetry (6 hrs;	30 hrs. 30 hrs.

	Ref.3,4) 8. Determination of elements (Fe/Mn/Zn/Pb/Cd etc) in air using high volume sampler. (6 hrs; Ref.2,3,4). 9. Determination of adsorption capacity of activated charcoal for various coloured water samples. (3 hrs;Ref.2,4). 10. Estimation of sulphate in water samples (tap water) by turbidimetry. (6 hrs;Ref.3,4).	
Pedagogy:	Pre-lab and post-lab assignments or a combination of some of these. Sessions shall be interactive in nature to enable peer group learning.	
References / Readings:	1. Christian, G. D. (2013). *Analytical Chemistry* (Sixth Edition) Wiley. 2. Jeffery, G.H., Bassett, J., Mendham, J., Denney R.C. (1989). *Vogel's textbook of quantitative chemical analysis* (Fifth Edition) Longman Scientific & Technical, U.K. 3. Dey, A. K. (2010). *Environmental Chemistry* (Seventh Edition). New Age International Publishers. 4. Rice, E.W., Baird, R. B., Eaton, A, D., Clesceri, L. S. (2012) *Standard methods for the examination of water and waste water analysis.* (Twenty Second Edition). Amer Public Health Assn. 5. Sawyer, C. N., McCarty, P. L., and Parkin, G. F. (2002). *Chemistry for Environmental Engineering and Science*. (Fifth Edition). McGraw-Hill Education 6. Moore, J. W., and Moore, F. A. (2012). *Environmental Chemistry* Academic Press, New Delhi. 7. Hota R. N. (2021). *Geochemical Analysis* (Second Edition) CBS Publisher.	
Course Outcomes	1. Student will be able to use different techniques for qualitative and quantitative estimation of environmental samples. 2. Students will be in a position to determine an unknown concentration of pollutant in given sample (water and soil).	

Title of the Course: Field work and Environmental Sampling Practical

Course Code: ENV 603

Number of Credits: 01

Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	To understand the techniques in environmental sampling and get firsthand experience in field sample collection.	
Content:	**Module I** 1. Sampling methods for collection of soil and water. (5 hrs; Ref. 2, 3) 2. Determination of pH and Electrical conductivity of water and soil sample (5 hrs;Ref.1, 3). 3. Estimation of organic matter in soil (5 hrs;Ref. 3). 4. Estimation of available phosphates and total nitrogen in soil and water (5 hrs; Ref.3). 5. Determination of Total Dissolved Solids in water samples (5 hrs; Ref.1, 2). 6. Determination of Total hardness, calcium hardness and magnesium hardness by EDTA complex metric method (5 hrs; Ref.1, 2).	30 hrs.
Pedagogy:	Hands on practical demonstrations	
References / Readings:	1. Lakshmi, G. S. (2010). *Environmental Science: A practical manual*. (First Edition)). BS publications. 2. Strickland, J. D. H., & Parsons, T. R. (1972). *A practical hand book of seawater analysis* (Fisheries Board of Canada bulletin) (Second Edition). 3. Aery, N.C. (2016). *Manual of Environmental Analysis*. New Delhi: Ane Books.	
Course Outcomes	1. The students will be able to carry out sampling of water, soil and air. 2. The students will be able to analyze the collected samples for various environmental parameters.	

Title of the Course: Environmental Data Analysis

Course Code: ENV 604
Number of Credits: 01
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science) and have basic knowledge of operating computers.	
Objective:	The objective of the course is to enable students to analyze environmental data using appropriate statistical tools.	
Content:	**Module I** 1. Graphical analysis of data. (02 hrs, Refs. 1-3) 2. Preparation of Contour maps. (08 hrs, Ref. 4) 3. Statistical analysis of data: analysis of normality, parametric analysis (ANOVA, Tukey's/Dunnett's post-hoc test); non-parametric analysis (Kruskal-Wallis test). (10 hrs, Refs. 3, 5-7) 4. Multivariate analysis – construction of dendograms and Nonmetric Multi-Dimensional Scaling (NMDS) ordination diagrams. (06 hrs, Ref. 8) 5. Principal Component Analysis/Canonical Component Analysis. (04 hrs, Refs. 9-10).	30 hrs.
Pedagogy:	Data processing/computation	
References/Readings:	1. Basic Tasks in Excel - https://support.microsoft.com/en-us/office/basic-tasks-in-excel-dc775dd1-fa52-430f-9c3c-d998d1735fca 2. Grapher User's Guide (2020). Golden Software, LLC USA, www.GoldenSoftware.com 3. Statistica for Windows, Data Analysis Software System, www.statistica.com 4. Surfer 12 Full User's Guide (2014). Golden Software, LLC USA, www.GoldenSoftware.com 5. Christian, H. & Michael, S. (2016). Introduction to Statistics and Data Analysis: With Exercises, Solutions and Applications in R. Springer Publications. 6. Kothari, C. R. (1992). Quantitative Techniques, Vikas Publishing House. 7. Arora, P.N. & Malhan, P.K. (2012). Biostatistics, Himalaya Publishing House, New Delhi. 8. PRIMER: User Manual/Tutorial. PRIMER-E. Plymouth. 9. Kovach, W. (1998). Multi-Variate Statistical Package. Ver.3.01, Pentraeth. 10. ter Braak, C.J.F. (1995). Ordination. In: Jongman, R.H.G., ter Braak, C.J.F. & van Tongeren, O.F.R. (eds.), Data Analysis in Community and Landscape Ecology. Cambridge University Press, Cambridge, pp. 91e173.	
Course Outcomes	At the end of the course, students will be able to: 1. Identify the different types of softwares used for data	

	analysis and their utility. 2. Discriminate between analytical methods for different types of environmental data. 3. Design analysis strategies for environmental data.	

Generic Specific Elective Courses

Title of the Course: Coral Ecosystem and Threats

Course Code: ENV 621
Number of Credits: 03
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. To understand the reef formation, distribution and biological/ecological processes of coral reefs. 2. To explore the coral biome and its ecological interactions. 3. To study the climate change adversities, conservation and restoration of coral habitats.	
Contents	**Module I** Coral reef distribution, evolution and significance: Types of coral reefs and their global distribution with special emphasis to Indian waters. Salient features of the ecosystem: Habitat characteristics, reef biodiversity and nursery grounds, interactions with seagrass ecosystem and migratory corridors, natural barriers. Paleoecology of corals. Theories of evolution: Subsidence theory, Glacial Control Theory, Stand Still Theory, Cycle of Erosion theory. Coral reef formation, morphology and functional zones, Ocean chemistry and aragonite saturation. Hydrodynamics and lagoon circulation. Economic Importance: Fisheries and marine products, tourism and recreational activities. **Module II** Factors influencing coral biome: Environmental factors (pH, temperature, salinity, sedimentation, waves, ocean currents, weather, nutrients, aerial exposure, light) and their impact. Competitors, Microbial infections, predators, parasites. Coral communities and trophic structure: Primary producers, consumers, food webs, productivity in coral reefs. Symbiotic associations: Algal-coral associations, bacterial symbiosis, multi-partner symbiosis. Internal nutrient cycling, Energy transfer/trophodynamics, Adaptive bleaching hypothesis, Coral probiotic hypothesis, Rosenberg's hologenome hypothesis. **Module III** Threats to corals, disease spread assessment and prophylactic measures: Anthropogenic threats: Tourism and its impact, pollution, overfishing, habitat destruction. Global warming, thermal bleaching, ocean acidification, sea level rise and its effect on coral health. Coral disease survey and monitoring protocols. Disease response plan and outbreak management. Ex-situ treatment measures: Use of antibiotics, anti-oxidants and Phage therapy. Cultivation and conservation of corals: Coral Restoration and Health	15 hrs. 15 hrs. 15 hrs.

	Consortium (CRHC), Global Coral Reef Conservation Project, Resilient Reef Initiative Project, Mithapur Coral Reef Recovery Project. Traits of climate change resilient clades. Laws and policies for conservation and management of corals in Indian seas/waters.	
Pedagogy:	Lectures/tutorials/assignments/self-study/case-studies	
References/Readings:	1. Sheppard, C., Davy, S., Pilling, G., & Graham, N. (2018). *The Biology of Coral Reefs (Biology of Habitats Series)* (2nd ed.). Oxford University Press. 2. Dubinsky, Z., & Stambler, N. (2014). *Coral Reefs: An Ecosystem in Transition* (1st ed.). Springer. 3. van Oppen, M. J. H., & Blackall, L. L. (2019). Coral microbiome dynamics, functions and design in a changing world. *Nature Reviews Microbiology*, *17*(9), 557–567. https://doi.org/10.1038/s41579-019-0223-4 4. van Oppen, M. J. H., Oliver, J. K., Putnam, H. M., & Gates, R. D. (2015). Building coral reef resilience through assisted evolution. *Proceedings of the National Academy of Sciences*, *112*(8), 2307–2313. https://doi.org/10.1073/pnas.1422301112 5. Harvell, D., Jordán-Dahlgren, E., Merkel, S., Rosenberg, E., Raymundo, L., Smith, G., Weil, E., & Willis, B. (2007). Coral Disease, Environmental Drivers, and the Balance Between Coral and Microbial Associates. *Oceanography*, *20*(1), 172–195. https://doi.org/10.5670/oceanog.2007.91 6. Chakravarti, L. J., & van Oppen, M. J. H. (2018). Experimental Evolution in Coral Photosymbionts as a Tool to Increase Thermal Tolerance. *Frontiers in Marine Science*, *5*. https://doi.org/10.3389/fmars.2018.00227 7. Contardi, M., Montano, S., Liguori, G., Heredia-Guerrero, J. A., Galli, P., Athanassiou, A., & Bayer, I. S. (2020). Treatment of Coral Wounds by Combining an Antiseptic Bilayer Film and an Injectable Antioxidant Biopolymer. *Scientific Reports*, *10*(1). https://doi.org/10.1038/s41598-020-57980-1 8. Laurie J. R., Courtney S. C., Drew Harvell. C. (2021). Coral Disease Handbook Guidelines for Assessment, Monitoring & Management. ISBN-13 978-1921317019.	
Course Outcomes	1. Describe coral ecosystem function and examine its economic implications. 2. Indicate the physico-chemical and biological factors influencing coral ecology. 3. Educate and create awareness of impact of anthropogenic activities on coral health. 4. Survey the conservation and management strategies of damaged corals and their recovery.	

Title of the Course: Disaster Management

Course Code: ENV 622
Number of Credits: 03
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	To provide basic conceptual understanding of disasters, understand approaches of Disaster Management and build skills to respond to disasters	
Content:	**Module I** Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, Capacity – Disaster and Development, and disaster management. Natural and Man-made disasters, Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters – The Refugee Problem. Types, trends, causes, consequences and control of disasters - Geological Disasters (earthquakes, volcanic eruptions, landslides, tsunami, land subsidence); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves). Biological Disasters (epidemics, pest attacks, forest fire); and Anthropogenic Disasters (building collapse, mining mishaps, rural and urban fire, road and rail accidents, oil spills, nuclear, radiological, industrial, chemicals and biological disasters, terrorism). **Module II** Disaster management cycle and framework, and applications of science and technology to disaster management: Disaster Management Cycle and the Paradigm Shift in Disaster Management. Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness During Disaster – Evacuation, Disaster Communication, Search and Rescue, Emergency Operation Centre, Incident Command System, Relief and Rehabilitation. Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure, Early Recovery, Reconstruction and Redevelopment Geo-informatics in Disaster Management (RS, GIS, GPS). Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations. Disaster Safe Designs and Constructions. Structural and Non Structural Mitigation of Disasters. S&T Institutions for Disaster Management in India **Module III** International organisations, NGOs, best practices and disaster management in India: International organisations:	15 hrs. 15 hrs. 15 hrs.

	Red Cross, Sphere, Oxfam, World Relief, CBM International, UNDRO, UNDDR. Yokohama Strategy, Hyogo Framework of Action, UNISDR. Critical analysis of NGO experience. Community Based Disaster Risk Reduction (CBDRR). Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism. National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national), Non-Government and Inter-Governmental Agencies.	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References / Readings:	1. Coppola, D. P. (2007). *Introduction to International Disaster Management*, Elsevier Science (B/H), London. 2. Gupta, M. C., Sharma. K., Gupta, L. C. & Tamini, B. K. (2001). *Manual on natural disaster management in India*. National centre for disaster management, Govt. of India. 3. Lopez-Carresi, A., Fordham, M., Wisner, B., Kelman, I. & Gaillard, J.C. (2014). *Disaster Management: International Lessons in Risk Reduction, Response and Recovery.* Routledge. 4. Goyal, S. L. (2006). *Encyclopaedia of disaster management, Vol I, II and III.* Deep & Deep, New Delhi. 5. Gunn, A.M. (2008). *Encyclopaedia of Disasters – Environmental Catastrophes and Human Tragedies, Vol. 1 & 2.* Greenwood Press. 6. Kapur, A. (2005). *Disasters in India: studies of grim reality*. Jaipur: Rawat Publications. 7. Srivastava H. N. & Gupta, G.D. (2006). *Management of Natural Disasters in developing countries.* Daya Publishers, Delhi. 8. Alexander, D. (1999). *Natural Disasters.* Kluwer Academic London. 9. Rubin, C. B., Cutter, S. L. (2020). *U.S. Emergency Management in the 21st Century*. *From Disaster to Catastrophe.* Routledge. 10. UNISDR. (2002). *Natural Disasters and Sustainable Development: Understanding the links between Development, Environment and Natural Disasters*, Background Paper No. 5. 11. Gupta A. K., Niar S. S & Chatterjee S. (2013). *Disaster management and Risk Reduction, Role of Environmental Knowledge*. Narosa Publishing House, Delhi. 12. Modh, S. (2010). *Managing Natural Disasters.* Mac Millan publishers India LTD. 13. *Disaster Management Act 2005*. Govt. of India. 14. *Disaster Management Guidelines* (2009)–(2020), GOI-UN Disaster Risk Program. 15. *World Disasters Report*, (2009)–(2020). International Federation of Red Cross and Red Crescent, Switzerland. 16. Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster	

	Management.	
Course Outcomes	1. Students will acquire a comprehensive understanding of natural and man-made disasters. 2. Students will understand the Disaster Management Cycle and evaluate technologies for disaster mitigation 3. Students will understand the role of international treaties and disaster relief organisations in disaster management 4. Students will be able to analyse and evaluate the relationship of disasters with development.	

Title of the Course: Ecotourism

Course Code: ENV 623
Number of Credits: 03
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	To understand ecotourism potential, resources and management issues.	
Content:	**Module I** Definition, history, scope, principles, and characteristics of ecotourism. Tourist motivation, tourist interaction, and intensity of interaction with nature. Ecotourist, eco-sensitivity, ecocentrism, ethics of ecotourism, local participation benefits, and conservation. Resource potentials: Flora and fauna of Wildlife Sanctuaries, Bird Sanctuaries, National Park, sacred grooves, mangroves, backwater, waterfalls, springs, beaches, hill stations, deserts, butterfly parks, spice plantations. Taxonomy and ecology of aquatic faunal resources (Dolphin, crocodile, corals, mollusca) and terrestrial faunal resources (birds, butterflies, other insects). **Module II** Ecotourism Management: Marketing of ecotourism, Economic impact, development, governance and policy, programme planning, codes of practice carrying capacity, resource management and impact of ecotourism, impact assessment and management analysis. Visitor activity and impact management, role of interpretation centre. Safety measures on field and first aid. **Module III** Designing ecotourism projects: Designing, interpretation centres, ecotourism websites, portals and documentaries, Identification of site-specific flora and fauna.	15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Use of conventional, online and ICT methods. Field visit, case study/ ecotourism project proposal/project/self-study. Lecture/tutorials/assignments.	
References/Readings:	1. Bhatia, A.K. (2014). *Tourism development: principles and practices*, New Delhi: Sterling Publishers Pvt. Ltd. 2. Cooper, Chris (1994). *Tourism Principles and practice*. Great Britain Pitman publishing. 3. Fennell David, S. (2004). *Ecotourism* 4th edition Routledge Taylor & Francis group 4. Fennell, David A. (2007). *Ecotourism policy and planning*. CABI Publishing, Wallingford, Oxon, UK 5. Hill, J., Gale, T. (2009). *Ecotourism and Environmental sustainability Principles and practice*, Aghgate ebook. 6. Raju, Aluri J. S. (2007). *A Textbook of Ecotourism Ecorestoration and Sustainable Development* by New Central Book Agency (P) Ltd, Kolkata.	

	7. Sinha, P. (2003). *Encyclopaedia of ecotourism*, Anmol Publications, New Delhi. 8. Singh, R. (2003). *Indian Ecotourism: Environmental Rules and Regulations* Kaniskha Publishers, New Delhi. 9. Trivedi, Priya R. (2006). *Encyclopaedia of the Ecotourism (Vol. 1): Introduction to the Ecotourism*, Jnanada Prakashan, New Delhi. 10. Wearing, S. Neil, J. *Ecotourism, impacts, potentials and possibilities* 2nd edition Elsevier.	
Course Outcomes	1. To identify ecotourism potential sites and assess resources. 2. Design and execute visitor management plan and promotional material for ecotourism.	

Title of the Course: Ecotoxicology

Course Code: ENV 624
Number of Credits: 03
Effective from AY: 2022-23

Prerequisites for course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	Students will be able to understand the basic concepts of toxicology, bio-monitoring and application of microbes for bioremediation.	
Content:	**Module I** Introduction: Important concepts of ecotoxicology, Routes by which pollutants enter ecosystems; Major classes of pollutants, their sources and Eco toxicological effects, permissible levels of toxicants in the environment. Concepts of toxicology: Acute and chronic toxicity**,** dose response, bioaccumulation**,** bio magnification**,** bioavailability**,** biodegradation; Toxicokinetics: Absorption, Distribution, Metabolism, Biotransformation and Elimination of Toxicants, Physiological and biochemical effects of toxic substances: Genotoxic, neurotoxic compounds, endocrine disruptors; Effects at the molecular level, cellular level, organism level (physiological, reproduction, behaviour). **Module II** Biomonitoring: Eco-toxicity tests (lab-based and field tests) in air, water and soil, biosensors, molecular biology assays, Use of model organisms for ecotoxicology: fish, helminthes, molluscs, mice, Environmental Risk Assessment. Environmental bio-indicators of eco-toxicity with faunistic studies. **Module III** Microbial Ecotoxicology and Biotechnology for mitigating environmental toxicity: Interaction between microorganisms and pollutants; Role of microorganisms in detoxification and degradation of environmental pollutants, Metagenomic techniques to study microbial diversity in polluted environment. Biological consortia to degrade or sequester in situ toxic materials. Primary, secondary and tertiary treatment of wastewater. Ameliorating nutrient toxicity (Nitrates and Phosphates), Handling sludge toxicity, Microbial and Phytoremediation (wetlands), Treatment of domestic wastewater using wetlands – a case study.	15 hrs. 15 hrs. 15 hrs.
Pedagogy:	In class/online lectures, assignments, group activities, presentations.	
References / Readings:	1. Walker, C. H., Sibly, R. M., Hopkin, S. P., & Peakall, D. B. (2012). *Principles of Ecotoxicology. 4th Edition*. CRC Press, Taylor and Francis. 2. Jorgensen, S. E. (2010). *Ecotoxicology: A derivative of encyclopedia of ecology.* Academic Press. 3. Moriarty, F. (1999). *Ecotoxicology: The study of pollutants in ecosystems. 3rd Edition.* Academic Press. 4. Peakall, D. (2012). *Animal Biomarkers as Pollution Indicators.* Chapman and Hall. 5. Hayes, W. A. (2014). *Principles and Methods of Toxicology.*	

	CRC Press, Taylor and Francis. 6. Naik, M. M., & Dubey, S. K. (2017). *Marine pollution and Microbial remediation.* Springer. 7. Cravo-Laureau, C., Cagnon, C., Duran, R., & Lauga, B. (2017). *Microbial Ecotoxicology*. Springer. 8. Scragg, A. (2005). *Environmental Biotechnology*. Oxford University Press. 9. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2017). *Prescott's Microbiology*. *10th Edition.* McGraw-hill Education. 10. Munn, C. (2020). *Marine Microbiology: Ecology and applications. 3rd edition*. Garland science. 11. Satyanarayana, T., Johri, B., & Anil, T. (2012). *Microorganisms in Environmental Management*. Springer.	
Course Outcomes	1. Students will be able to understand the toxic effects of pollutants on ecosystem function. 2. Apply concepts of ecotoxicology using model organisms for assessing environmental risk. 3. Suggest mitigation strategies using micro-organisms.	

Title of the Course: Environmental Biology

Course Code: ENV 625
Number of Credits: 03
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	To understand the role of biota in ecosystem function and to conserve and restore affected habitats.	
Content:	**Module I** Definition & principle of environmental science and ecology, interface between man and environment, physico-chemical and biological factors affecting the environment, concept and principles of ecosystems, components and functions of ecosystems, ecological pyramids, energy flow, consequences and disruption of food chain, ecological succession, modern conception of ecosystem classification (terrestrial and aquatic ecology), types of major biomes, population ecology-fundamentals, characteristics, growth and regulations, community ecology. **Module II** Terrestrial: Impact of forests on climate regulation, wildlife habitat protection, soil erosion, forest fires and its consequences on ecosystem, hydrology and moisture conservation, green belt and its implications on urban environment, carbon sequestration, Kyoto convention. Aquatic: species-specific interactions (parasitic, mutualisms, symbiosis, inquilism), predator-prey relationship, ecological sub-divisions of aquatic environment and their floral & faunal inhabitants. **Module III** Concept of biodiversity, taxic, genetic and phylogenetic, measurement of biodiversity (species richness, dominance, species diversity); biodiversity hot spots of India, National parks and sanctuaries, biosphere reserves, marine protected areas, keystone species, IUCN red list of threatened and endemic species. Eco-restoration and sustainable development at local, National and International levels, habitat degradation and fragmentation, endangered species, conservation and restoration with advanced technologies.	15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Lecture/tutorials/assignments.	
References / Readings:	1. Ramesh, V. K. (2005). *Environmental Microbiology*. MGP Publishers, Chennai. 2. Kormondy, E. J. (1962). *Concepts of Ecology*, Prentice Hall. 3. Singh, H.R. (1989). Animal Ecology and Environmental Biology. 4. Eiseth, G. D. & Baumgardener, K.D. (1981). *Population biology*, Van Nos Strand Co., N.Y. 5. Owen, O. S., & Chiras, D. D. (1990). *Natural resource conservation: an ecological approach* (No. Ed. 5). Macmillan	

	Publishing Company. 6. Daniel, D. C. (1994). Environmental Science, 4th Ed., The Benjamin/Cummings Publishing Co., Inc. 7. *Conservation and Sustainable Use: A Handbook of Techniques*. Oxford University Press. 8. Hilleman, T. B. (2009). *Environmental Biology*. CRC Press. 9. Stachowicz, J.J. & Tilman, D. (2005). *Species invasions and the relationships between species diversity, community saturation and ecosystem function. In species Invasions, Insights into Ecology, Evolution and Biogeography* (Sax, D.F. et al. eds.), Sinauer Associates, Sunderland, MA.	
Course Outcomes	At the end of the course students will be able to: 1. Describe the key aspects of ecology, ecosystem, biodiversity and its threats. 2. Understand the role of biota in the functioning of various ecosystems. 3. Explain various management plains and techniques for the restoration of the affected habitats.	

Title of the Course: Environmental Chemistry

Course Code: ENV 626
Number of Credits: 03
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. To introduce fundamentals of environmental chemistry and environmental pollution. 2. Awareness of harmful effects of pollutants and control measures.	
Content:	**Module I** Introduction: Environmental segments (Lithosphere, Hydrosphere, Atmosphere, and Biosphere). Biogeochemical cycles (hydrogen, carbon, nitrogen, oxygen, phosphorus, and sulphur). Introduction to Air, Water and Soil Pollution. Air pollution: Air pollutants (primary and secondary), photochemical reaction, Acid rain, Ozone layer depletion, global warming. Carbon monoxide, nitrogen oxides, sulphur dioxide and hydrocarbons (sources, harmful effects, analysis and control measures). Particulate matters (inorganic, organic and radioactive), health hazards, analysis, control devices (Gravitational settlings, particulate air filters, centrifugal separators, wet scrubbers). Case study: London smog and Los Angeles smog. **Module II** Water pollution: Water analysis (salinity, hardness, pH BOD, COD, colour, turbidity, taste and odour); Water pollutants: nitrates, phosphates, phenols, cyanides, heavy metals (Cd, Hg) and analysis methods. Lake and river water treatment, municipal waste water treatment and industrial effluent treatment (from pesticides, pharmaceutical and electroplating). Case study - DDT, Kepone, Minamata. Soil pollution: Inorganic and organic components in soil, Reactions in soil, waste pollutants in soil. Excess usage of agrochemicals, soil contamination with pollutants Pesticides (toxicity, biochemical effects and control measures). **Module III** Introduction to Environmental Hazards: Plastics (harmful effects, preventive measures and control measures), Microplastics and Nanoplastics, E-waste (impact on environment, harmful effects and control measures) Radioactivity (contamination of radioactivity, radiation hazards, control measures). Waste Management: Waste Management (sources and types of solid wastes, disposal techniques, collection methods, waste management approach). Energy Resources and Conservation of energy resources: Energy Resources and Conservation Renewable and non-renewable energy resources, growing energy need, sun as source of energy, solar radiation and its spectral characteristics, fossil fuels classification, composition. Principle of generation and conservation of conventional and non-conventional energy. Energy from biomass and biogas, energy conservation policies.	15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Lectures/tutorials/seminars/assignments/presentations/self-study.	

References / Readings:	1. De, A. K. (2005). *Environmental Chemistry* (Third Edition). New Age International Publishers, New Delhi, 2. Salker, V. (2017). *Environmental Chemistry* (First Edition). Narosa Publishing House, New Delhi. 3. Sharma, K. (2003). *Environmental Chemistry* (First Edition). GOEL Publishing House, Meerut. 4. O'Neill, P. (2009). *Environmental Chemistry* (Third Edition). Blackie Academic and Professional, London. 5. Khopkar, S. M. (2005). *Environmental Pollution Analysis* (First Edition). New Age International Publishers, New Delhi.	
Course Outcomes	1. Students will be able to understand the basic environmental chemical processes. 2. Students will be able to explain the origin and harmful effects of toxic chemicals in the environment.	

Title of the Course: Environmental Implication of Marine Productivity

Course Code: ENV 627

Number of Credits: 03

Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. To describe the role of plankton communities in marine ecosystem function. 2. To understand the factors responsible for marine productivity and its implication on the health of marine environment.	
Content:	**Module I** Marine environment zonation, coastal and open ocean, significance of oceans and its diversity to humans, importance of planktonic biota to the health of oceans, distribution of plankton in the Tree of Life, major groups of virioplankton (viruses), picoplankton, phytoplankton and zooplankton, their biology and role. Diatom/dinoflagellate index as an indicator for ecosystem change, haptophytes (prymnesiophytes), prasinophytes, zooplankton (holoplankton, meroplankton): chaetognaths, cnidarians, molluscs, radiolarians, foraminiferans, crustaceans, larvaceans, multiple marine protistan lineages in seven supergroups of eukaryotic tree of life, factors affecting primary production: light, nutrients, mixed layer depth, chelating agents, tides, turbulence, grazing, mixotrophy, interactions within and across trophic levels (allelopathic interactions).	15 hrs.
	Module II Significance of plankton in marine ecosystem functioning: Planktonic food web structure and trophic transfer, microbial food webs, viral shunt, phytoplankton C:N:P ratios, stoichiometric plasticity, phenotypic plasticity, role in biogeochemical cycles, carbon Sequestration, biological carbon pump (soft and hard), ecological success of diatoms, blooms, Harmful Algal Blooms (HABs) and biotoxins, morphological and physiological characteristics of HAB species, HAB dynamics, implications of climate change on plankton (global warming, ocean acidification).	15 hrs.
	Module III Quantitative observations of planktonic ecosystems: Primary productivity measurements: oxygen technique, chlorophyll extraction method, Radiocarbon technique, Satellite colour scanning, techniques and instruments used in plankton studies: advances in automated technology to observe and measure plankton, pigment composition, optical and	15 hrs.

	acoustical methods (Optical Plankton Counter, Zooglider), quantitative imaging devices (Flow Cytometry, FlowCAM, FlowCytoBot), molecular phylogenetic approaches, high throughput 'omics' data, monitoring plankton in oceans through various international projects: Continuous Plankton Recorder (CPR), Global Alliance of CPR Surveys (GACS), The Scientific Committee on Oceanic Research (SCOR), Global Ocean Observing System (GOOS), Global Ocean Ecosystem Dynamics (GLOBEC), Integrated Marine Biosphere Research (IMBeR), TARA Oceans, GEOHAB .	
Pedagogy:	Lectures/tutorials/assignments/self-study/Moodle/Videos	
References / Readings:	1. Morrissey, J.F, Sumich, J. L (2018). Pinkard-Meier DR (Eds) *Introduction to the Biology of Marine Life*. 11th Ed. Jones & Bartlett Learning. 2. Sardet, C., Rosengarten R. D., (Eds) (2015). *Plankton: wonders of the drifting world*. The University of Chicago Press, Chicago. 3. Lalli, C. M, Parsons TR (Eds) (2010). *Biological Oceanography: an introduction*. 2nd Ed. Elsevier, Amsterdam. 4. Nybakken, J.W, Bertness, M.D (Eds) *Marine Biology: an Ecological Approach*. Pearson Education, San Francisco. 5. Mitra, A., Banerjee, K., Gangopadhyay, A., (Eds) (2004) *Introduction to marine plankton*. Daya Publishing House, Delhi. 6. Levinton, J. S., (Ed) (2011) *Marine Biology: Function, biodiversity, ecology*. Oxford University Press, New York. 7. Ormond, R, (Ed) (1997) *Marine Biodiversity: Patterns and Processes*. Cambridge University Press. 8. Jungblut, S., Liebich, V., Bode, M. (Eds) (2018) YOUMARES 8 – Oceans Across Boundaries: Learning from each other. Springer Open.	
Course Outcomes	1. Discuss the significance and diversity of planktonic biota in the marine ecosystem 2. Analyse their role in ocean productivity, biological carbon pump and to the health of the oceans and global climate. 3. Identify various techniques for measuring productivity. 4. Discover on-going research at global scale through monitoring projects.	

Title of the Course: Environmental Microbiology

Course Code: ENV 628
Number of Credits: 03
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	This course focuses on microbial diversity in different ecosystems, their role in habitat functioning and microbial remediation towards sustainable habitats.	
Content:	**Module I** Introduction to the microbial world and a brief history of microbiology; microbial groups (archaea, bacteria, protists, fungi, viruses) from diverse terrestrial and aquatic environments; classical and molecular methods to study microbial diversity; microbial associations- mutualism, protocooperation, commensalism, syntrophism, predation, competition, amensalism and parasitism. **Module II** Impacts of microorganisms on environment and humans: role of microorganisms in food web, biogeochemical cycling of carbon, nitrogen and phosphorus. microorganisms and climate change, range extension of species; disease outbreaks and epizooitics; antibiotic-resistant bacteria and their implications; ballast water and bio-invasion - concept, implications and preventive measures, ballast water management convention, bio-fouling and corrosion associated with shipping industry - progression, impacts and preventive measures. **Module III** Environmental microbiology in sustainable development microorganisms in agriculture - nitrogen-fixing bacteria, Mycorrhizae, phosphate solubilizing bacteria, plant growth promoting Rhizobia, biocontrol agents. Microorganisms for food security, clean energy, bioremediation of oil spills, heavy metals, xenobiotics and wastewater treatment.	15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Lectures/tutorials/assignments/case study.	
References / Readings:	1. Willey, J. M., Sherwood, L. M., & Woolverton, C. J. (2017). Prescott's Microbiology. McGraw-hill Education. 10th Edition. 2. Medigan, M. T., Bender, K. S., Bukley, D. H., Sattley, W. M., & Stahl, D. A. (2019). *Brock Biology of Microorganisms*. Pearson. 15th Edition. 3. Munn, C. (2020). *Marine Microbiology: Ecology and applications*. Garland science. Third edition. 4. Naik, M. M., & Dubey, S. K. (2017). *Marine pollution and Microbial remediation.* Springer. 5. Satyanarayana, T., Johri, B., & Anil, T. (2012). *Microorganisms in Environmental Management*. Springer. 6. King, R. B., Sheldon, J. K., & Long, G. M. (2019). *Practical Environmental Bioremediation*: The Field Guide. CRC Press. second edition. 7. Meena, S. M., & Naik, M. M. (2019). *Advances in Biological Science*	

	Research: a practical approach. Elsevier. 8. Bertrand, J. C., & Coumette, P. (2015). *Environmental Microbiology: Fundamentals and Applications*. Springer. 9. Yates, M., Nakatsu, C. H., Miller, R. V., & Pillai, S. D. (2016). Manual of Environmental Microbiology. ASM press. 10. Cavicchioli, R., Ripple, W. J., Timmis, K. N., Azam, F et al. (2019). *Scientists' warning to humanity: microorganisms and climate change*. Nature reviews microbiology, 17, 569- 586.	
Course Outcomes	At the end of the course students will be able to: 1. Understand the microbial community structure and its functioning in diverse environments. 2. Identify and analyze the impacts of microorganisms on the environment and humans. 3. Explore the potential of microorganisms in sustainable development.	

Title of the Course: Green Chemistry

Course Code: ENV 629
Number of Credits: 03
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. To learn basic knowledge and principles involved in green chemistry and create awareness. 2. To understand energy saving and making green processes in chemical reactions. 3. To develop social concern for waste generated from various processes.	
Content:	**Module 1** Introduction to Green Chemistry: Need for Green Chemistry; Overview of twelve green chemistry principles as proposed by Paul Anastas and John Warner; Explanation with examples under each principle. New trends in green chemistry, Basic principles, Atom economy concept and its environmental importance, Green reagents and Green solvents. Waste Production, Problems and Prevention: Problems caused by waste; Sources of waste from the chemical industry; Waste minimization techniques; On-site waste treatment; physical treatment; Chemical treatment; Biotreatment; Degradation; Rules for degradation; Polymer recycling.	15 hrs.
	Module II Chemicals from Renewable Raw Materials: Carbohydrates; Ethanol; Lactic acid; Indigo-natural colour; Riboflavin; Ascorbic acid; Fats and Oils; Biodiesel; Fatty acid esters; Terpenes; Green Polymers from Renewable Raw Materials. Alternative energy sources for greener processes: Design for Energy Efficiency; Photochemical Reactions; Advantages of and Challenges Faced by Photochemical Processes; Examples of Photochemical Reactions; Chemistry Using Microwaves; Microwave Heating; Microwave-assisted Reactions; Sonochemistry; Electrochemical Synthesis. Designing greener approaches - Successful Industrial Case Studies: Safer designs for the target molecule, Minimization, Simplification, Substitution, Moderation, Limitations, Replacement of Toxic Reagents, Use of Alternative Solvents (suitable examples in each case). Process Improvement- Acetic Acid Manufacture; Vitamin C; Leather Manufacture; Dyeing; Polyethene; Eco-friendly Insecticides.	15 hrs.
	Module III Sustainable Development and Regulation: Introduction to sustainable development; Why regulation is required to achieve sustainable development; Environmental policy and innovation; Future trends and challenges in sustainable development. Bio-inspired Green Nanomaterials: Bio-inspired Green Nanomaterials – microbial synthesis of nanoparticles – Biosynthesis of Nanoparticles by bacteria and Fungi – Biosynthesis of nanoparticles using plant extracts – Advantage of biosynthesis. Future Trends in Green Chemistry:	15 hrs.

	Introduction to solid acid catalysts and their significance in industrial applications; phase-transfer catalysis, Biocatalysis: basic principles, enzyme catalysed reactions, Photocatalysis: Introduction and significance with examples.	
Pedagogy:	Lectures/tutorials/seminars/assignments/presentations/self-study	
References / Readings:	1. Lancaster, M. (2002). *Green Chemistry-An Introductory Text, Royal Society of Chemistry* 2. Sheldon, R. A., Arends, I., Hanefeld U. (2007). *Green Chemistry and Catalysis*, WILEY-VCH 3. Afonso, C. A. M. & Crespo, J. G. (2005) *Green Separation Processes*, WILEY-VCH, 4. Matlack, S. (2001). *Introduction to Green Chemistry*, Marcel Dekker, Inc., 5. Ahluwalia, V. K., Kidwai, M., (2004). *New Trends in Green Chemistry, Anamaya Publishers.* 6. Basiuk, V. A., Elena, V., Basiuk (2015). Springer *Green Processes for Nanotechnology: From Inorganic to Bioinspired Nanomaterials.*	
Course Outcomes	1. Student will be able to apply the basic principles of Green chemistry in daily life. 2. Students will understand control measures of waste, and green Industrial processes.	

Title of the Course: Marine Biodiversity and Conservation Practices

Course Code: ENV 630

Number of Credits: 03

Effective from AY: 2022-23

Prerequisites for the Course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. Addresses basic concepts of marine biodiversity at all levels, 2. IPR, life patenting and its implications on the environment and human life.	
Content:	**Module 1** Biodiversity, definition, concept, types; Biodiversity measurements - taxic, phylo-genetic and molecular approaches. Intra-specific Genetic variance and factors affecting, biodiversity and intra-specific variations, dominance and over-dominance hypothesis, adaptive polymorphism, genetic variations, loss and increase dynamics of biological diversity, conceptual models, hypothesis proposed in deep sea biodiversity. **Module II** Marine Biodiversity and ecosystem functions, competition, predation and heterogeneity as biodiversity determinants; ecosystem approach, functions and keystone species, engineer organisms, diversity-stability, rivet, drivers and passenger, idiosyncratic hypothesis, co-operative relations, top down and bottom up theories, cascade effects and fishing through the food webs. **Module III** Biodiversity and Intellectual Property Rights (IPR) and bio-piracy, life patenting and implications, impact of GATT/WTO on farmer's right, indigenous, traditional knowledge. Biodiversity conservation - Biological diversity Act, sanctuaries, marine parks, protected areas, hotspots and marine biosphere reserves of India.	15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Lectures/tutorials/assignments/self-study.	
References/ Readings:	*1.* Hiscock, K. (2014). *Marine biodiversity conservation: A practical approach*. Routledge Taylor & Francis Group. *2.* Kumar, A. (2004). *Biodiversity & environment*. A.P.H. Pub. Corp. *3.* Ormond, R., Gage, J. D., & Angel, M. V. *(1997). Marine biodiversity: Patterns and processes. Cambridge University* Press. 4. Queiroga, H. (2006). *Marine biodiversity: Patterns and processes, assessment, threats, management and conservation*. Springer. 5. Shiva, V. (1994). *Cultivating diversity: Biodiversity conservation and the politics of the seed*. Research Foundation for Science, Technology & Natural Resource	

	Policy.	
Course Outcomes	1. The students will be able to gain a holistic view of the marine biodiversity with emphasis on ecosystem functions and conservation policies. 2. The students will be introduced to IPR and life patenting.	

Title of the Course: Marine Pollution

Course Code: ENV 631
Number of Credits: 03
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. To characterize the potential exogenous material added to the sea, their effects on marine and human life. 2. Remedial measures adopted to reduce undesirable effects.	
Content:	**Module I** Introduction: Introduction to Environment, Objectives of environment, Marine pollution definition, Some questions, Categories of additions, Nature of inputs, and Sources of inputs. Gross chemical composition of seawater, Sources of dissolved and particulate matter in the sea, Geochemical balance and residence times of elements in seawater. Organic wastes: Biochemical oxygen demand, the dilution factor, Settlement, Oxygen budget, Consequences of organic discharges into Thames and Mersey estuaries. Decomposition of organic matter in oxic and anoxic environments. Sewage and sewage treatment, Disposal of sewage sludge, Industrial wastes and treatment processes with reference to wastes from paper and pulp and soap manufacturing industries. Oil spills and Consequences of oil pollution: Introduction, Inputs, major accidental spills, fate of spilled oil at sea and Treatment of spilled oil. **Module II** Conservative pollutants: Measures of contamination, Toxicity, Acute, Chromic exposure and detoxification. Trace metal pollution in coastal waters (Hg, Cd, Pb, Cu and Fe), and Radioactive pollution: Sources, classification, effects of radiation, MPD concept, protection and control from radiation, Beneficial aspects of radiation and Disposal of royal wastes. Halogenated hydrocarbons; Low molecular weight compounds, High molecular weight compounds, Inputs to sea, fate in the sea, Biological effects, environmental impact, mode of poisoning of pesticides. **Module III** Pollution indicators: Criteria for selection of indicator organism, Quantification of pollution load, basic pre requisites, Response to different pollution load and Time integration capacity. Macro algae and Mollusc as indicators to monitor trace metal pollution in coastal waters. Monitoring strategies of Marine pollution: Critical pathway approach and Mass balance approach. Marine corrosion: Definition, Corrosion theory,	15 hrs. 15 hrs. 15 hrs.

	Effects, classification, factors affecting corrosion of metal in seawater and control of marine corrosion. Standards in water quality and instrumental techniques, Pollution status of the North Sea. Present status of coastal pollution in India and Future strategies. Assessment of pollution damage: The need, serious ness of damage and assessment of damage.	
Pedagogy:	Lectures/tutorials/assignments/self-study	
References / Readings:	1. Riley, J. P., & Skirrow, G. (Eds.). (1975). Chemical oceanography. Academic Press Vol: 3 2. Goldberg, E. D. (1976). *The health of the oceans*. UNESCO Press. 3. Clark, R. B. (1986). *Marine pollution*. Oxford Science Publications. 4. Phillips, J. D. H. (1980). *Quantitative aquatic biological indicators.* Applied Science Publishers. *5.* Sharma, B. K., & Kaur, H. (1994). *Thermal and radioactive pollution*. Krishna Prakasham Mandir. *6.* Sharma, B. K., & Kaur, H. (1994). *Water pollution.* Krishna Prakasham Mandir, Meerut. 7. Chandler, K. A. (1985). *Marine and offshorecorrosion.* Butter Worths, London.	
Course Outcomes	1. To understand the impact of various pollutants on marine ecosystems. 2. To create awareness to safeguard the marine environment through identification of factors responsible for causing marine pollution. 3. To suggest policy measures to prevent marine pollution.	

Title of the Course: Microplastics in Environment

Course Code: ENV 632
Number of Credits: 03
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	This course introduces to the concept of microplastics as a pollutant and its impact on the environment and human.	
Content:	**Module I** Introduction to microplastics: Introduction to Plastics and microplastics: Types of plastics: PET, HDPE, PVC, LDPE, PP, PS, Other; and microplastics types: fibres, microbeads, fragments, nurdles, foam. Primary and Secondary, microplastics and its formation. Distribution of microplastics: Global occurrence, sources of microplastics. Distribution and fate of plastic in the environment. Microplastics pollution in Land, Water-Freshwater and Marine waters, Air, Snow. **Module II** Impacts of microplastics: Potential impacts on the environment and human health. Microplastics as carriers of trace and heavy metals and its role as pollutant. Microplastic in plants, animals and humans. **Module III** Sampling and characterization: Methods used for sampling, quantification of microplastics. Instrument for identification of microplastics- FTIR and Raman Spectroscopy. Mitigation: Mitigation methods for microplastics and role of Blue Flag certification-international eco-level tag Foundation for Environmental Education. G20 and United Nations Environment Assembly resolution on marine litter and microplastics. Case studies: Microplastics pollution studies in India-Case studies with special reference to Goa.	15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Case studies will be discussed and seminar topics other than from the syllabus will be given to students.	
References / Readings:	1. Crawford, B. C & Quinn, B. (2016). *Microplastic Pollutants* (1st ed.). Elsevier Science. 2. Rocha-Santos, T., Costa, M. & Mouneyrac, C., (Eds.). (2022). *Handbook of Microplastics in the Environme*nt (1st ed.). Springer. 3. Rocha-Santos, T.A.P. & Duarte, A.C. (Eds.). (2017). *Characterization and Analysis of Microplastics* (1st ed.). Elsevier Science.	

Course Outcomes	1. Understanding the formation of microplastics and its impact on the environment. 2. Create awareness among students about microplastic pollution. 3. Suggest mitigation strategies for overcoming such problems 4. The student will get an overview of regulatory measures undertaken by international committees.	

Title of the Course: Polar Sciences

Course Code: ENV 633
Number of Credits: 03
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. The students will gain information on Polar regions and biota. 2. The course would include the significance of the Polar Regions in context of atmospheric circulation and energy exchange. 3. The students will understand the role of Polar regions in influencing circulation in the Southern Ocean and its sensitivity to global climate change.	
Content:	**Module I** Introduction: Delimitation of Arctic and Antarctic, their basic differences, discovering, exploitation and scientific utilizability. Astronomic factors and their reflexion in polar regions. Ecology of polar region: Climate of polar regions - energy balance of the ground surface, water balance, baric field and atmospheric circulation, air temperature and air humidity, precipitation. Climate change and climate variation and their consequences i.e. polar regions (glacials and interglacials and their influence on the hydrosphere, geosphere, cryosphere and biosphere). Freshwater hydrology and oceanology. Surface water and ground water. Polar oceans - submarine relief, systems of sea currents, water substitution with the lower latitudes and its energy consequences. **Module II** Glaciology: Glaciology of polar regions - reasons of glaciation and its development, glaciation of continents and of sea surface, ice mass balance. Cryosphere as a stabilizer of Earth climate. Development of earth surface in polar regions, glacial and periglacial geomorphologic processes - permafrost and its energy roots, regional structure, active layer of permafrost, frost weathering, slope dynamics. Soil in polar regions. **Module III** Flora and fauna: Vegetation in polar regions - limiting by abiotic factors (microclimate, nutrients, water), soil flora, space structure of polar vegetation (subpolar, polar, polar deserts and semideserts, polar wetlands). Origin of polar (alpine) plants, vascular plants and their adaptation and acclimatization on the polar environment. Cryptogams in polar regions. Stress physiology of polar plants. Fauna of polar regions - invertebrates, evolution and space structure, physiological adaptation on polar conditions, nutrient succession. Microbial	15 hrs. 15 hrs. 15 hrs.

	diversity - Anthropogenic impacts on polar ecosystems - heat pollution of planetary geosystem, changes in chemical composition of atmosphere and their consequences (global transport of pollutants, anthropogenic change in greenhouse effect, ozone depletion and its consequences), changes in biodiversity.	
Pedagogy:	Lectures/tutorials/assignments/visit to research laboratory	
References / Readings:	1. Holdgate, M.W. (1970). Antarctic Ecology. *Academic Press, London*, New York. 2. King, J.C. & Turner, J. (1997). Antarctic meteorology and climatology. *Cambridge University Press.* xi, 409. 3. Oke, T. R. (1987). Bounrady Layer Climates. *Routledge, London and New York*, 435. 4. Przybylk, R. (2003). The climate of the Arctic. *Dordrecht: Kluwer Academic Publishers,* 270. 5. Richard, S., Per, M. (2006). Buffalo A complete guide to Arctic wildlife. *N.Y.: Firefly Books*, 464. 6. Stonehouse, B. (1989). Polar Ecology. *Blackie, Glasgow – London*. 7. Thurman, H.V. & Alan, P.T. (2005). Oceánografie: [tajemnýsvětmořĭaoceánů]. *Praha: Computer Press*, viii, 479. 8. Warwick, F., Johanna, V., Parry, L. (2008). Polar lakes and rivers: limnology of Arctic and Antarctic aquatic ecosystems. *Oxford: Oxford University Press*, xviii, 327.	
Course Outcomes	1. The student will get a detailed understanding of polar ecosystem functioning. 2. The students will get an idea of polar diversity.	

Title of the Course: Water Resource Management

Course Code: ENV 634
Number of Credits: 03
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. To understand occurrence and circulation of water in nature. 2. To study the functioning, problems and measures for sustainable development of water resource.	
Content:	**Module I** Hydrological Cycle and Aquifer: Traditional methods of water management. Hydrological cycle: Evaporation, evapotranspiration, precipitation, runoff and infiltration**.** Classification of aquifers and confining layers, hydraulic properties of aquifers, water table and piezometric surface. Water control and crop production. Construction and technology of water control system. Problems related to overexploitation and groundwater mining. Saline water intrusion in coastal aquifers and its control. Fresh-salt water interface. **Module II** River flooding and rain water harvesting: Nature, extent, magnitude and frequency of floods, urbanization and flooding. Availability of water in Lakes, ponds, streams and rivers Impact of climate change on water availability. Subsurface investigation of groundwater. Classification of rocks based on water bearing capacity. Drilling methods, construction, development and maintenance of wells. Rainwater harvesting and water conservation techniques and its importance. Concept of artificial recharge: methods, wastewater recharge for reuse. **Module III** Pollution and water governing laws: Pollution of surface and groundwater: Municipal sources, industrial sources, agricultural sources. Case studies of water pollution in India. Physical, chemical, biological properties of water. Quality criteria for different uses. Concept of Groundwater flow lines and flow net. Water Governance: Salient features of The Water (Prevention and control of pollution) Act, 1974 and Goa water (Prevention and Control of Pollution) Rules, 1988.	15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Lectures/assignments/seminars/group discussion/self-study	
References / Readings:	1. Arakeri, H. R., & Donahue, R. (1984). *Principles of soil conservation and water management*. Rowman & Allanheld, Publishers. 2. Fetter, C. W. (2018). *Applied hydrogeology*. Waveland Press. 3. Grafton, R. Q., & Hussey, K. (Eds.). (2011). *Water resources planning and management*. Cambridge University Press. 4. Jain, S. K., Agarwal, P. K., & Singh, V. P. (2007). *Hydrology and water resources of India* (Vol. 57). Springer Science & Business Media. 5. Johnson, W. (1982). *Environmental Geology-Coates*, *DR.* 6. Keller, E. A. (2007). *Introduction to environmental geology*. Prentice-Hall, Inc.	

	7. Kumar, R., Singh, R. D., & Sharma, K. D. (2005). Water resources of India. *Current science*, 794-811. 8. Nitya, J. (2008). *Jalatra: exploring India's traditional water management systems.* 9. Pennington, K. L., & Cech, T. V. (2009). *Introduction to water resources and environmental issues*. Cambridge University Press. 10. Todd, D. K., & Mays, L. W. (2004). *Groundwater hydrology*. John Wiley & Sons. 11. Vaidyanathan, A. (1999). *Water resource management: institutions and irrigation development in India*. Oxford University Press.	
Course Outcomes	1. Students will understand about the natural occurrence and circulation of surface and groundwater. 2. Identify problems related to water pollution and precautionary measures. 3. Understand use of various techniques in exploration of water. 4. Learn about governance related to water management in the state and country.	

Title of the Course: Industrial water and wastewater treatment technologies

Course Code: ENV 635

Number of Credits: 03

Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. Explain the sources and effects of water pollution from various industries. 2. Understand the principles and processes in wastewater treatment technologies. 3. Identify suitable technologies for wastewater treatment.	
Content:	**Module I** Introduction: Types of industrial pollutants, Industrial wastewater characterization, Categorization of industries - green, orange and red industries, Standards of industrial waste disposal, Minimum National Standards (MINAS) and Goa State Regulatory Framework for effluents and trade waste. Industrial wastewater treatment: Primary, secondary and tertiary/polishing treatment such as equalisation, neutralisation, precipitation. Physico-chemical and biological treatment processes: Sedimentation, Oil separation, Floatation, Coagulation, Filtration, Ion exchange membranes. Biological oxidation**:** Removal of organics (Sorption, Stripping, bio-degradation), Unit operations and electromechanical equipment used in the treatment processes.	15 hrs.
	Module II Advance wastewater treatment process: Removal of specific pollutants – nitrification, denitrification / anammox process, SHARON-ANAMMOX process for treatment of ammonium rich wastewater, Biological Phosphate Removal (BPR). Membrane processes: Fundamentals, Membranes – Types, classifications, Microfiltration, Ultrafiltration, Nanofiltration and reverse osmosis, Electrodialysis, Ion exchange. Advance oxidation process: Photocatalysis, Ozonation –Ozone / UV, Ozone / Hydrogen peroxide, Hydrogen peroxide/ UV applications and other significant proven technologies.	15 hrs.
	Module III CETP and DWT: Requirement and objectives Planning andmanagement of CETP and DWT, facilities for small scale industries. Energy recovery from wastewater: Microbial fuel cells,microbial electrolysis cell, microbial desalination cell, biohydrogen production and combination of technologies.	15 hrs.
Pedagogy:	Lectures/ video/ Powerpoint presentation/ Industrial visit / documentaries and discussion / research article analysis / mini projects / survey and mapping projects.	

References / Readings:	1. De, A. K. (2019). *Environmental Chemistry*. (9th Ed.).New Age International Publishers. 2. Bennett, M. R. & Doyle, P. (2016). *Environmental Geology. In, Geology and the Human Environment*. Wiley India Pvt. Ltd. 3. Patwardhan, A.D. *Industrial Wastewater Treatment*. (2nd Ed.). Eastern Economy Edition. 4. Karia, G. L. & Christian, R. A. *Wastewater Treatment: Concepts and Design Approach*, Eastern Economy Edition. 5. Bratby, J. (2006). *Coagulation and flocculation in water and wastewater treatment*. (2nd Ed.). London, UK:IWA Publishing. 6. Grady, C. P., Daigger, G.T. & Lim H.C. (1999). *Biological wastewater treatment*. (2nd Ed). New York: Marcel Dekker, Inc. 7. Abbasi, S.A. (1998). *Environmental pollution and its control*. Pondicherry: Cogent. 8. Abbasi, S.A. (1998). *Water Quality Sampling and Analysis. Discovery*, New Delhi. 9. Aery, N.C. (2016). *Manual of Environmental Analysis*. New Delhi: Ane Books. 10. Droste, R. L. & Gehr, R. L. (2018). Theory and Practice of Water and Wastewater Treatment. (2nd Ed). 11. Kumar, R. & Singh, R.N. *Municipal water and wastewater treatment. Environmental Engineering Series*. ISBN: 9788179931882 12. Lal, B. & Sarma, P.M. *Wealth from waste: trends and technologies*. (3rd Ed). TERI press. 13. Lin, S. D. (2014). *Water and Wastewater Calculation Manual*. McGraw-Hill Education. ISBN: 9780071819817 14. Asiwal, R.S., Sar, S.K., Singh, & S., Sahu, M. (2016). *Waste Water treatment by effluent treatment plants*. SSRG International Journal of Civil Engineering, 3 (12).	
Course Outcomes	1. The student will be able to identify different pollutants from various industries. 2. Suggest suitable technologies for the wastewater treatments depending on type of pollutants. 3. Design the suitable process for wastewater treatment plants. 4. Manage and supervise the maintenance of treatment plants.	

Title of the Course: Water and Wastewater: Monitoring and Treatment

Course Code: ENV 636
Number of Credits: 03
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. Understand the water quality criteria and standards of water for domestic, industry and agriculture consumption. 2. Learn the causes and effects of water pollution and quality deterioration. 3. Learn the principles and instrumentation for water quality control and monitoring. 4. To enable students to design innovative methodologies in monitoring and treatment of water and wastewater.	
Content:	**Module 1** Water balance and benchmarks: Earths water budget, Hydrological cycle, Demand - supply situation and global benchmarks for major water dependent industries. Water quality: water quality standards, Standards for Package Drinking water and mineral water, Water quality standards and parameters (ISI-BIS and USPH), Water pollution: Sources and types of water pollution, Causes and impacts on Environment. Water pollutants: Organic (Pesticides, oil spill, tar balls and toxic organic chemicals, antibiotics), Inorganic, Sediments, Marine, Radioactive, Eutrophication, trace and heavy elements in water, Bioindicators. Water and wastewater: Characteristics, Classification of wastewater Sampling techniques: Separation scheme for organic compounds in water. Preservation techniques for sample. Monitoring techniques and methodology: Physical, Chemical and biological analysis of water and wastewater parameters such as pH, Conductance, Turbidity, Temperature, Total Dissolved Solids (TDS), Total Suspended Solids (TSS), TKN, Dissolved Oxygen (DO), Acidity and Alkalinity, Ammonia, Chlorides, Fluoride, Nitrate and Nitrite, Cyanide, sulphide, Sulphate, Phosphate, Total Hardness, Boron, Silica, Metal and Metalloids, Heavy metals and other pollutants, Chemical Oxygen Demand (COD) and Biochemical Oxygen Demand (BOD).	15 hrs.
	Module II Water treatment - Treatment of water: Conventional and modern methods of treatment, Flowchart of the Water Treatment Plant, Treatment Methods (Theory and Design). Treatment processes: Screening, Oil Separation, Sedimentation, Coagulation-Flocculation, Settling tanks, Aeration and Gas transfer, Precipitation, Softening, Filtration- Sand, Charcoal, Multimedia etc., Reverse Osmosis technology, Membrane processes, Ultra filtration. Disinfection System: chemical based and other disinfection methods such as Chlorination, Ozonation, UV, Adsorption and Ion exchange, Electrochemical and other methods.	15 hrs.

	Module III Biological treatment - Types of treatment processes: attached and submerged, aerobic and anaerobic, facultative etc., Aerobic processes: Activated Sludge Process and various modified processes, SBR, MBR, UA-SBR, FAB etc, Oxidation ponds and Rotating Biological Contactors Anaerobic processes: Up flow Anaerobic Sludge Blanket, Anaerobic digesters, Anaerobic filters. Sludge treatment: Preliminary operation, thickening, conditioning, Dewatering, Filtration, Digesting andDrying of sludge, Sludge disposal Modular Sewage Treatment Plant: Water reuse and recycling (Industry / Site visit for Water treatment plant and STP).	15 hrs.
Pedagogy:	Lectures/case studies /workshops/industrial visit /documentaries and discussion/ research article analysis /mini projects / survey or mapping projects.	
References / Readings:	1. De, A.K. (2019). *Environmental Chemistry* (9th Ed.) New Age International Publishers. 2. Bennett, M. R. & Doyle, P. (2016). *Environmental Geology. In, Geology and the Human Environment*. Wiley India Pvt. Ltd. 3. Pipkin, B.W., & Trent, D.D. *Geology and the environment*. 3rd Edition. ISBN 0-534-51383-2 4. Patwardhan, A.D. *Industrial Wastewater Treatment*. (2ndEd.). Eastern Economy Edition. 5. Karia, G. L., & Christian, R.A. *Wastewater Treatment: Concepts and Design Approach*, Eastern Economy Edition. 6. Bratby, J. (2006). *Coagulation and flocculation in water and wastewater treatment*. (2nd Ed.). London: IWA Publishing, 7. Grady, C. P. L. Jr., Daigger, G.T., & Lim, H.C. (1999). *Biological wastewater treatment*. (2nd Ed.). New York: Marcel Dekker, Inc. 8. Abbasi, S. A. (1998). *Environmental pollution and its control*. Pondicherry: Cogent. 9. Abbasi, S.A. (1998). *Water Quality Sampling andAnalysis*. New Delhi: Discovery. 10. Aery, N. C. (2016). *Manual of Environmental Analysis*.New Delhi: Ane Books. 11. Ahluwalia, V. K. (2008). *Environmental Chemistry*. (2nd Ed). Ane, New Delhi. 12. Chand, A. (1989). *Environmental pollution and protection*. (1st Ed.). H.K. Publishers, New Delhi. 13. Droste, R. L., & Gehr, R. L. (2018). *Theory and Practice of Water and Wastewater Treatment*. (2nd Ed). 14. Kumar, R. & Singh, R.N. *Municipal Water and Wastewater Treatment. Environmental Engineering Series*. ISBN: 9788179931882 15. Lal, B. and Sarma P.M. *Wealth from Waste: Trends and technologies*. (3rd Ed.), New Delhi: TERI press. 16. Lin, S.D. (2014). *Water and wastewater calculation manual*. McGraw-Hill Education. ISBN:9780071819817	
Course Outcomes	After successful completion of the course student will be able to: 1. Explain the causes and effects of water pollution. 2. Analyze the water as per BIS and international standards.	

	3. Identify suitable technologies for the treatment of waterand wastewater. 4. Design, operate and manage water and wastewater treatment plants.	

Title of the Course: Lab Course in Environmental Science

Course Code: ENV 637
Number of Credits: 04
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. To introduce students to basic instruments in chemistry laboratory, significance of standardization and calibration of reagents and instruments respectively. 2. To acquaint students with analysis of various pollutants including trace metals in water, soil and air. 3. Develop analytical skills for water and wastewater analysis.	
Content:	**Module I** 1. Demonstration of instruments (colorimeter, pH meter, conductivity meter, Karl Fischer titrator) & Calibration of glass electrode and conductivity meter. (4 hrs; Ref.7, 8, 10) 2. Determination of pH and conductivity of surface, ground and sea water. (4 hrs;Ref.7, 8, 4) 3. Determination of alkalinity and acidity of surface, ground and sea water sample using titrimetric analysis. (4 hrs;Ref.7, 8, 6) 4. Estimation of total solids, dissolved solids, suspended solids of a given water sample (river/lake/pond/seawater). (4 hrs; Ref.7, 8) 5. Estimation of total residual chlorine of water samples. (4 hrs; Ref.7, 8, 3) 6. Estimation of salinity of a given water sample by Molar Knudsen chlorinity titration method. (4 hrs; Ref.7, 8, 9) 7. Estimation of sulfate in water samples (tap water) by turbidimetry. (4 hrs;Ref.7, 8, 11)	28 hrs.
	Module II 1. Determination of pH and conductivity of soil samples. (4 hrs; Ref.7, 8) 2. Determination of moisture content of soil samples. (4 hrs;Ref.7, 8, 1) 3. Estimation of hardness of water samples by complexometric method. (4 hrs; Ref.7, 8, 6) 4. Determination of pH, conductivity and Turbidity of water and wastewater samples (pH meter, conductometer, and nephelometer). (4 hrs; Ref.7, 8, 5) 5. Determination of nitrite in water sample using colorimetry. (4 hrs;Ref.7, 8, 9) Determination of chromium in water sample by colorimetry. (4 hrs; Ref.7, 8, 10)	24 hrs.
	Module III 1. Determination of dissolved oxygen in coastal waters. (4 hrs; Ref.7, 8, 11) 2. Estimation of dissolved oxygen in polluted water. (4 hrs;Ref.7,	24 hrs.

	8) 3. Determination of dissolved oxygen and total hardness of (Ca and Mg) of wastewater sample. (4 hrs;Ref.7, 8, 3) 4. Determination of biochemical oxygen demand in coastal waters. (4 hrs;Ref.7, 8, 4) 5. Determination of BOD of wastewater samples. (4 hrs;Ref.7, 8) 6. Estimation of hydrogen sulfide in coastal waters. (4 hrs;Ref.7, 8) **Module IV** 1. Determination of chemical oxygen demand in given water samples. (4 hrs;Ref.7, 8) 2. Determination of chemical oxygen demand in coastal waters by KMnO4 method. (4 hrs;Ref.7, 8, 3) 3. Determination of COD of wastewater samples. (4 hrs;Ref.7, 8) 4. Estimation of Metals and metalloids using spectrophotometry. (4 hrs;Ref.7, 8) 5. Estimation of ammonia from wastewater samples (Nessler's Method). (4 hrs;Ref.7, 8) 6. Determination of chromium in given water sample using UV-VIS spectrophotometer. (4 hrs;Ref.7, 8, 2) 7. Nitrate and nitrite using spectrophotometric method. (4 hrs; Ref.7, 8) 8. Determination of fluoride using spectrophotometer. (4 hrs; Ref.7, 8) 9. Determination of phosphates in wastewater using spectrophotometric method. (4 hrs;Ref.7, 8) 10. Estimation of total cyanide in wastewater using titrimetric and spectrophotometric method. (4 hrs;Ref.7, 8). 11. Estimation of tannin and lignin and surfactants from Wastewater. (4 hrs; Ref.7, 8, 1)	44 hrs.
Pedagogy:	Pre-lab and post-lab assignments or a combination of some of these.	
References / Readings:	1. Sawyer, C. N., McCarty, P. L., & Parkin, G. F. (2002). *Chemistry for Environmental Engineering and science.* (5th Ed.). McGraw-Hill. 2. Jeffery, G. H., Bassett, J., Mendham, J., & Denney, R. C. (1989). *Vogel's Textbook of quantitative chemical analysis.* (5th Ed.). Longman Scientific and Technical, U.K. 3. Mitra, S., Patnaik, P., & Kebbekus, B. (2019). *Environmental chemical analysis: Laboratory Experiments in Environmental Chemistry.* (2nd Ed.). CRC Press. 4. Rice, E. W., & Bridgewater, L. (2012). *Standard methods for the examination of water and waste water analysis.* (22nd Ed.). American Public Health Association. 5. Grasshoff, K., Ehrhardt, M., & Kremling, K. (1983). *Methods of Seawater analysis*. Verlag Chemie, Weinheim. 6. Kaur, K. (2007). *Handbook of Water and wastewater Analysis*. Atlantic. 7. Maiti, S.K. (2011). *Handbook of Methods in Environmental Studies: Water and Wastewater Analysis*. Oxford Book Company. 8. De, A. K. (2019). *Environmental Chemistry*. (9th Ed.). New Age International Publications.	

	9. Das, A. K. & Das, M. (2015). *Environmental Chemistry with Green Chemistry.* Books & Allied (P) Ltd. 10. Kudesia, V. P. (2008). *Water Pollution*. (8th Ed.). Pragati Prakashan. Sharma, B. K. (2018). *Industrial Chemistry*. (21st Ed.). Goel publishing House.	
Course Outcomes	1. The students will be able to explain the origin and harmful effects of toxic chemicals in the environment. 2. Students will be able to use different techniques for qualitative and quantitative estimation of various environmental pollutants.	

Semester IV(M.Sc)

Title of the Course: Environmental Impact Assessment I

Course Code: ENV 605
Number of Credits: 02
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	To understand the Environmental Impact Assessment processes through the study of EIA reports available for various kinds of projects.	
Content:	**Module I** EIA guidelines Cost-benefit analysis, Detailed project report, Feasibility report. Terms of Reference (TOR), Generic structure of EIA document and description of the project. Public consultation, Environmental Clearance (EC) processes, validity, extension, monitoring, transfer compliance report, Role of statutory agencies in environmental clearance. EIA consultant accreditation process in India. Components of EIA-Physical, Biological and Socio-cultural environment. EIA methods – Checklist & matrices. **Module II** Comparative Evaluation of Alternatives Selecting a Preferred Alternative. Conceptual Basis for Trade-Off Analysis. Importance Weighting of Decision Factors. Plans and Monitoring. Elements of Mitigation. Environmental Management Plan (EMP), elements, structure and examples of various projects. Objectives of EIA implementation and follow up. Tools of EM & performance review. Environmental auditing. Evaluation of EIA effectiveness and performance.	15 hrs. 15 hrs.
Pedagogy:	Lectures/tutorials/ laboratory work /field work/outreach activities/ project work/ vocational training/ viva /seminars / term papers/ assignments / presentations / self-study/case studies etc. or a combination of some of these.	
References / Readings:	1. Yerramilli, A., & Manickam, V. (2020). *Environmental impact assessment methodologies* (Third Edition). BS Publications/British Society of Periodontology Books. 2. Glasson, J., & Therivel, R. (2019). *Introduction to environmental impact assessment* (Fifth Edition). Routledge. 3. Khandeshwar, S.R., N.S. Raman and A.R. Gajbhiye. Environmental Impact Assessment. 2019. Dreamtech Press. EIA manuals available at: http://environmentclearance.nic.in/writereaddata/Form 1A/HomeLinks/ommodel3.html 3. Sectoral Manuals under EIA Notification, 2006: http://environmentclearance.nic.in/writereaddata/Form 1A/HomeLinks/ommodel2.html 4. Anonymous. Environmental Impact Assessment Training Manual. 2016. International Institute for Sustainable Development. 5. http://www.iisd.org/learning/eia/wp content/uploads/2016/06/EIA-Manual.pdf, EIA Online Learning Platform www.iisd.org/learning/eia	

Course Outcomes	1. The students will be able to understand the formalities for conduct of EIA. 2. The students will be able to write EIA reports as a part of EMP.	

Title of the Course: Environmental Impact Assessment II

Course Code: ENV 606
Number of Credits: 02
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	The students will be trained to conduct EIA studies of mining and industrial projects in view of EIA notification 2006.	
Content:	**Module I** EIA of mining potential sites, brief description of the project, identification, nature of mineral, Quality and quantity, resource available, geology, types of mining, carrying capacity, Blasting - Rules and Guidelines, Dust and noise pollution, transportation, Biodiversity assessment, Impact on human settlement, restoration, reclamation and mitigation measures, hydrology, safety and prevention measures. EIA and development EIA with reference to land-use pattern, centralized land-use, procedures and methodologies, EIA plans (state and central legislation), EIA (waste management), guidelines for the preparation of EIA document, Quality Management System for EIA. **Module II** EIA for specific projects Industrial setup and establishment - infrastructure, operation and management, effluent and waste, practices, effectiveness, practices. Biodiversity assessment, inventorization of flora and fauna, impact on migratory population and existing settlement, strategic mitigation measure. EIA rules and notifications Legal, policy and regulation framework- Global and Indian context. Policy and legislation: Environmental Protection Acts & Rules. EIA notification 1994 and 2006 and amendments. EIA 2020 draft notification and objections. Public hearing guidelines. Case studies and reports.	15 hrs. 15 hrs.
Pedagogy:	Lectures/assignments/workshops/street play/brain storming sessions/outreach programmes/campus walks/documentaries and discussion/ presentations	
References / Readings:	1. Glasson, J., Therivl, R., & Chadwick, A. (2005). *Introduction to environmental impact assessment*. Routledge, Taylor & Francis Group. 2. Arts, J., & Morrison-Saunders, A. (Eds.). (2012). *Assessing impact: Handbook of EIA and SEA follow-up*. Routledge, & Francis Group. 3. Abaza, Taylor H., Bisset, R., & Sadler, B. (2004). *Environmental Impact Assessment and Strategic Environmental Assessment: Towards an Integrated approach*. UN Environmental Program. 4. Therivel, R., & Wood, G. (Eds.). (2017). *Methods of environmental and social impact assessment*. Routledge, Taylor & Francis Group. 5. Morris, P., & Therivel, R. (Eds.). (2001). *Methods of environmental impact assessment*, *2*. Taylor & Francis. 6. Yerramilli, A., & Manickam, V. (2020). *Environmental impact assessment methodologies* (Third Edition). BS	

	Publications/British Society of Periodontology Books.	
Course Outcomes	1. The students will be able to understand the EIA process. 2. The students will be able to prepare and present EIA reports for obtaining EC.	

Title of the Course: Sustainable Development

Course Code: ENV 607
Number of Credits: 01
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. To create awareness of sustainable development and adopt various practices used in urban, industrial and agricultural fields. 2. To understand the role of policies and strategies towards sustainable development at local and global scale.	
Content:	**Module 1** Definition, history, goals and principles of sustainability, domains of sustainability, ecological footprints, waste recycling, environmental management and innovative strategies - crop rotation, organic farming, agroforestry, designer ecosystem, sustainable habitats - green spaces, green buildings, satellite towns and cities, zero waste concept; global policies, policies and programs adopted in India, role of Government and NGOs, eco-consciousness and awareness.	15 hrs.
Pedagogy:	Lectures/tutorials/assignments.	
References/Readings:	1. Rogers, P. P., Jalal, K. F., & Boyd, J. A. (2012). An introduction to sustainable development. Routledge. 2. Keeble, B. R. (1988). *The Brundtland report: 'Our common future'*. Medicine and war, 4(1), 17-25. 3. Kilcher, L. (2007). How organic agriculture contributes to sustainable development. Journal of Agricultural Research in the Tropics and Subtropics, Supplement, 89(1), 31-49. 4. Vidal, D. G., Barros, N., & Maia, R. L. (2020). Public and green spaces in the context of sustainable development. In Sustainable cities and communities, 479- 487). Cham: Springer International Publishing. 5. Hamid, S., Skinder, B. M., & Bhat, M. A. (2020). *Zero waste: A sustainable approach for waste management. In Innovative Waste Management Technologies for Sustainable Development*,134-155`. IGI Global. *6.* Jabareen, Y. (2008). *A new conceptual framework for sustainable* 7. *development.* Environment, development and sustainability, 10(2), 179-192. 8. Zoeteman, K. (Ed.). (2012). *Sustainable Development drivers: The role of leadership in government, business and NGO performance.* Edward Elgar Publishing. 9. Krishnan, S. A., & Sujith, K. M. (2021). *Understanding the need of satellite towns in India. In IOP Conference Series: Materials Science and Engineering,* 1114 (1) 012043. IOP Publishing. 10. Ross, M. R., Bernhardt, E. S., Doyle, M. W., & Heffernan, J. B. (2015). Designer ecosystems: incorporating design approaches into applied ecology. Annual review of environment and resources, 40, 419-443	

Course Outcomes	1. Students will be able to understand the concept of sustainable development. 2. The students will understand the implications of sustainable development in the urban, agricultural and industrial sectors.	

Title of the Course: Solid waste Management

Course Code: ENV 608
Number of Credits: 01
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objectives:	1. To understand the concept of solid waste, its types, classification, characterization and disposal. 2. To probe the effect of solid waste on environment and public health.	
Content:	**Module I** Solid waste: Introduction and type of solid waste (domestic waste, commercial waste, industrial waste, market waste, agricultural waste, biomedical waste, E-waste, hazardous waste, institutional waste), Sources of solid waste - classification (hazardous and non-hazardous). Characteristics of municipal solid waste (physical, chemical and biological); waste prevention and waste reduction techniques; storage, collection and transportation of municipal solid waste; disposal of Municipal solid waste – landfilling, site identification, investigation and characterization, planning and design, construction and operational practices; quality check and control measures; types of composting - vermicomposting, biogas production from municipal solid waste; Incineration of waste.	15 hrs.
Pedagogy:	Lectures/tutorials/assignments/case study.	
References / Readings:	1. Sasikumar, K., & Krishna, S. G. (2009). Solid waste management. PHI Learning Pvt. Ltd. 2. WHO Manual on solid waste management. 3. CPHEEO Manual on solid waste management. 4. Hosetti, B. B. (2006). Prospects and perspective of solid waste management. New Age International. 5. Gordon, A. T. (2000). Solid waste management. MC Graw Hill, New York. 6. Ayilara, M. S., Olanrewaju, O. S., Babalola, O. O., & Odeyemi, O. (2020). Waste management through composting: Challenges and potentials. Sustainability, 12(11), 4456. 7. Tchobanoglous, G., & Kreith, F. (2002). Handbook of solid waste management. McGraw-Hill Education.	
Course Outcomes	At the end of the course students will be able to: 1. Understand and explain the concept of solid waste. 2. Learn and apply the knowledge of various techniques of solid waste management and disposal. 3. Practice and propagate the importance of solid waste management to the general public.	

Title of the Course: Shrimp farming and Environmental issues

Course Code: ENV 609
Number of Credits: 01
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. Sc. Part I (Environmental Science).	
Objective:	The students will be trained on the various technologies available for pond based shrimp cultivation along with the associated environmental issues.	
Content:	**Module I** Shrimp aquaculture, types of culture practices, traditional, modified traditional, extensive, modified extensive, semi intensive and intensive, critical requirements, affected habitats, mangroves, mudflats, low lying areas, alterations in water flow, environmental costs, problems associated with conservation of mangroves. Salinization of ground water, water quality deterioration, Eutrophication, dynamics of bloom formation and collapse, ecosystem function, CRZ Act and Coastal Aquaculture Authority.	15 hrs.
Pedagogy:	Lectures/ tutorials/assignments/self-study	
References / Readings:	1. Allen, R. and Steene, R.C. (1987). Reef Fishes of Indian Ocean by Gerald TFH Publication, USA. 2. Bal, D.V., and Rao, V, K. (1990). Marine Fisheries of India, Tata McGrawHill, 472 p. 3. Jhingran, V. G. (1991). Fish and Fisheries of India, Hindustan Pub. Corp. (India), ISBN 9788170750178., 727 p. 4. Kurian, C.V., and Sebastian, V.O. (1976). Prawn and Prawn Fisheries of India. Hindustan Pub. Corp., Delhi. 5. Modayil, M. J. and Jayaprakash, A. A. (2003). Status of Exploited Marine Fishery Resources of India, CMFRI, Kochi. Morgan, R. 1956. 6. Chandra, P. (2007). Fishery Conservation Management and Development. SBS Publ. 7. Michael, R.R. (2005). Fisheries Conservation and Management. Prentice Hall. Pascoe, S.	
Course Outcomes	1. Students will gain knowledge on the problems associated with the semi-intensive type of shrimp culture and its management. 2. The students will also learn about the CRZ guidelines.	

Semester – III(M.A)

Title of the Course: Research Methodology in EconomicsCourse Code: ENV 610
Number of Credits: 4
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. A. Part I.	
Objectives:	1. Expose students to the methodological approaches to research. 2. Help formulate research problem. 3. Scientific methods for sampling and data collection. 4. Writing a research report/thesis/paper.	
Content:	**Module I** The meaning of research - types of research - importance of research- research and policy- Deductive and Inductive Reasoning – Steps of scientific methods in research – Qualitative and Quantitative Approach - Mixed Methods.	15 hrs.
	Module II The Research Process: Formulation of a Research problem – Guiding principles in the choice of a Research topic and Formulation of ResearchQuestions –Writing a Proposal - Review of Literature and identification of research gap –Theoretical and Conceptual Framework-Formulation of Research Design – Hypothesis; concept, definition, formulation and testing.	15 hrs.
	Module III Sampling Techniques - field survey - Primary Data Collection - Tools – Observation, Schedule, Questionnaire – principles underlying construction of a questionnaire – data processing and Analysis – Use of Statistical packages.	15 hrs.
	Module IV Writing a Research report - research paper – Bibliography - reference styles - Ethics in Research - Plagiarism - Writing a thesis - Do's and Dont's.	15 hrs.
Pedagogy:	Lectures/ case analysis/assignments/class room interaction	

References / Readings:	1. Kothari C.R., Garg, Gaurav; Research Methodology, Fourth Edition, New Age International, New Delhi, 2020. 2. Wilkinson T. S. and Bhandarkar P.L.: (2016) *Methodology and Techniques of Social Science Research*, Himalaya Publishing House, New Delhi. 3. Panneerselvam, R., (2013) *Research Methodology*, Prentice Hall of India Pvt Ltd. 4. Young P.V., (2012) *Scientific Social Surveys and Research*, Prentice Hall of India Pvt Ltd. 5. Parsons C.J., (2006) *Thesis and Project Work*, Allen &Unwin. 6. Babbie, Earl. R. (2013). "*The Practice of Social Research*." Cengage Learning, Canada. 7. John W. Creswell. (2014). "*Research Design: Qualitative, Quantitative and Mixed Methods Approaches.*" Sage Publication, Washington, USA. 8. Kate L. Turabian. (2006). "*A Manual for Writers of Term papers, Theses and Dissertations*." The University of Chicago press, Chicago. 9. Blaug, Mark. (2009). "*The Methodology of Economics.*" Cambridge University Press, Cambridge. 10. Daniel M. Hausman. (2007). "*The Philosophy of Economics: An Anthology*." Cambridge University Press, Cambridge	
Course Outcomes	1. The students will be able to define a research problem and prepare the appropriate research design for theresearch problem. 2. Develop the most appropriate methodology for the research studies in socialsciences. 3. Interpret and write research reports.	

Title of the Course: Environmental History of the World

Course Code: ENV 611
Number of Credits: 4
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. A. Part I.	
Objective:	To learn environmental history of the world focusing on human interactions with nature.	
Content:	**Module I** Humans and nature in a time-dimension: Ibn Khaldun; Montesquieu; George Perkins Marsh; Fernand Braudel. Historicizing climate; Early humans; Early Agriculture; the Metal Ages. **Module II** Biological and cultural consequences. Industrial world, Environmental Relationships. **Module III** Environment and empire—Imperialism and environmentalchange; Significance of *Silent Spring*; science and the discourse ofecological crisis; the ideology of scientific conservation, the environmental debate, green capitalists, environmental justice. **Module IV** Energy, population, urbanisation, 'world hunt'—commodification of animals, environmentalism and political economy, shape of the future.	15 hrs. 15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Lecture method/project-based learning/collaborative learning/field-work.	
References / Readings:	1. Anker, P. (2002) *Imperial Ecology*. Cambridge, MA. 2. Arnold, D. and R. Guha (1995). *Nature, Culture, and Imperialism: Essays on the Environmental History of South Asia*. Delhi. 3. Beinart, W. and L. Hughes (2009). *Environment and Empire*. Oxford. 4. Crosby, A. (1972). *The Columbian Exchange: Biological and Cultural Consequences of 1492*.Westport. 5. Crosby, A. (1986). *Ecological Imperialism*: The Biological Expansion of Europe, 900–1900. New York. 6. de Melo, Cristina Joanaz EstelitaVaz and Lígia M. Costa Pinto., eds (2016). *Environmental History in the Making. Volume I: Explaining*. New York. 7. de Melo, Cristina Joanaz EstelitaVaz and Lígia M. Costa Pinto., eds (2017). *Environmental History in the Making.*	

	Volume II: Acting. New York. 8. Diamond, Jared. (1997). *Guns, Germs, and Steel: The Fates of Human Societies*. New York. 9. Diamond, Jared. (2005). *Collpase: How Societies Choose to Fail or Succeed*. New York. 10. Grove, R. (1995). *Green Imperialism*. New York. 11. Guha R. (2000). *Environmentalism: A Global History.* New York. 12. Hornborg, Alf., J. R. McNeill and John Martínez–Alier.(2007). *Rethinking Environmental History*. New York. 13. Hughes J. D. (2001). *An Environmental History of the World*. London. 14. Khaldun, Ibn. (1967). *The Muqaddimah: An Introduction to History.* Princeton. 15. Marks, R. (2002). *The Origins of the Modern World*. Lanham. 16. Marsh G. P. (1864). *Man and Nature*. Cambridge. 17. McNeill J. R. (2003). 'Observations on the Nature and Cultureof Environmental History', *History and Theory*, Vol. 42 (4), pp. 5–43. 18. McNeill, J. R and Peter Engelke. (2015). *An Environmental History of the Anthropocene since 1945*. London. 19. McNeill, William H. (1980). *The Human Condition: An Ecological and Historical View*. Princeton. 20. Ponting, C. (1991) *A Green History of the World*. London. 21. Radkau, J. (2008). *Nature and power: a global history of the environment*. Cambridge, UK. 22. Richards, J. F. (2014). *The world hunt: an environmentalhistory of the commodification of animals*. Berkeley. 23. Simmons, I. G. (2008). *Global Environmental History 10,000BC to AD 2000*. 24. Tucker, R and E. Russell. (2004). *Natural Enemy, Natural Ally*. Corvallis.	
Course Outcomes	Upon the successful completion of this course, the student would be able to: 1. Understand the historical relationship between humans and the environment; 2. Learn about the ways in which humans modified and adapted nature; 3. Engage with the nature of environmental change that world has gone through historically and how they have impacted nations and different segments of society; 4. Understand the role of the modern states in regulating and extracting natural resources; 5. Attain the ability to apply academic knowledge to a critical analysis of environment in the local context. 6. Understand an ethic which applies to the whole of nature, including humans.	

Title of the Course: Community Engagement and Rural Development

Course Code: ENV 612
Number of Credits: 4
Effective from AY: 2022-23

Prerequisite for the course:	Students who have undergone M. A. Part I.	
Objectives:	1. To enable students to understand rural society. 2. To familiarize students with community development programmes and train themto prepare proposals for community development. 3. To train students in participatory research methods. 4. To enable students to understand rural institutions and their functioning byengaging with these institutions. 5. To enable students to understand Human Rights based approach to rural development.	
Content:	**Module I** Meaning and Characteristics of Rural Society and Rural Development, Distinction between rural and urban. Participatory Rural Appraisal Methods & Techniques – Transect Walk, Seasonal Calendar, Venn Diagram, Daily Routine Charts, Timeline, Flow Diagram, Interviewing, Preference ranking, Mapping and Modelling (Social, Resource and Topical Mapping & other methods). Rural Resilience in relation to Environmental and Livelihood issues: Climate Change, Habitat degradation, Water conservation and Waste management. Local Bodies:Panchayats, Gram Sabhas, Village Committees; Gram Panchayat Development Plan (GPDP). **Module II** Institutions in Rural Development: Schools, Health Centres, Self Help Groups, Cooperatives, Farmers Clubs. Human Rights and Rural Development; Rural Poverty – nature and extent. Community Development: Introduction, Objectives, Approaches, Programmes. **Module – III** Field Component: Planning for Community Development, Gram Panchayat Development Plan (GPDP), Situational Analysis, Participatory Rural Appraisal (PRA). **Module – IV** Visits to model Panchayats, attending and reporting on Gram Sabha meeting and other activities as planned from time to time.	15 hrs. 15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Lectures/ assignments/field visits/learning by engaging with the rural community	

References / Readings:	Chatterjee, Shankar (2011)., *Implementation of Rural Development, New Delhi*: Serials Publication Pvt. Ltd. 2. Desai, A.R. (2009). *Rural Sociology in India*, Mumbai: Popular Prakashan. 3. Desai, Vasant (2012). *Rural Development in India*, Mumbai: Himalaya Publishing House. 4. M.J. Vinod and Meena Deshpande (2013). *Contemporary Political Theory*, NewDelhi: Axis Publications. 5. Mukerjee, Neela (2003). *Participatory Rural Appraisal*, New Delhi: ConceptPublisher 6. Narayanaswamy, N. (2009). *Participatory Rural Appraisal: Methods and Application,* New Delhi: Sage Publication 7. Rani, K.S. (2011). *Peoples Participation in Development*, New Delhi: Discovery Publishing House. 8. Singh, Preeti (2010). *Panchayati Raj Institution andRural Development*, Delhi: Axis Publication 9. Somesh Kumar (2002). *Methods for Community Participation: A complete guidefor practitioners*. Vistaar 10. Sudharshu, Shekhar (ed.) (2003), *Regional Planning in India*, vol-Iand II, New Delhi: Anmol Publications. *11*. Vijayakumar, K. (2011). *Empowerment of weaker section future planning and strategies for Rural Development in India*, New Delhi: Serials Publication Pvt. Ltd. 12. Government Reports on Rural Development of Goa and India 13. EPW Issue on Rural Affairs Vol. 53, Issue No. 51, 29 Dec, 2018 Participation Pays by Praxis (http://www.praxisindia.org/PARTICIPATIONPAYS.php) 14. The Human Rights based approach to development in the era of globalisation, (https://www.ohchr.org/Documents/Issues/Development/RTDBook/PartIIChapter8.pdf) 15. Rural Community Engagement, National Council of Rural Institute, Departmentof Higher Education, MHRD.
Course Outcomes	Students will be able to: 1. Understand theoretical and practical aspects of rural planning and development. 2. Prepare community development plans. 3. Carry out research on rural development and engage with rural institutions.

Title of the Course: Doing Feminist Research

Course Code: ENV 613
Number of Credits: 4
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. A. Part I.	
Objectives:	1. This course will aim at equipping students with knowledge of research methods andtechniques. 2. The student will be introduced to the nature and purpose of doing feminist research,the politics of knowledge and knowledge creation and the different ways of knowing. 3. They will be taken through the theoretical foundations of feminist research and acritique of conventional research. 4. Feminist research positions both epistemological and methodological will bediscussed.	
Content:	**Module I** What is research? Steps in social science research. A critique of conventional research, limitations of methodology of social science, feminist empiricism vs positivism Research methods and methodology, Feminist standpoint, situated knowledge.	15 hrs.
	Module II Qualitative Research Methods: feminist ethnography narratives, oral history, discourse analysis, participatory and action research, focus group discussions, grounded theory, self-reflexivity, etc. Reviewing literature on a selected topic. Reference management software (Zotero, Mendeley, etc.)	15 hrs.
	Module III Using unconventional data sources. Research designs, sampling and qualitative data collection methods (case studies, survey, exploratory studies, diagnostic, experimental and action research).	15 hrs.
	Module IV Proposal writing, conducting a pilot study and writing a report, Feminist research ethics, Research writing, academic writing skills, use of writing assistance software	15 hrs.
Pedagogy:	Lectures/assignments/self-study/ documentaries and discussion/ group readings anddiscussions/ presentations	

References / Readings:	1. Biber Sharlene Nagy Hesse. (2007), *Feminist Research Practice*. Thousand Oaks: Sage. 2. Brooks, Abigail. (2007). *Feminist Standpoint Epistemology: Building knowledge and empowerment through women's lived experience*, in Sharlene J. Nagy Hesse-Biber andPatricia Lina Leavy (eds.) *Feminist Research Practice: A Primer*, London: Sage Pub. 3. Code, Lorraine. (1995). *How do we know? Questions of method in feminist practice*, in Sandra Burt and Lorraine Code (eds.) *Changing Methods: Feminist Transforming Practice,* 13-44, Canada: Broadview Press. 4. Delamont Sara and Paul Atkinson. (2008). *Gender and Research*. Los Angeles: Sage. 5. Denscombe Martyn. 2003. *The Good Research Guide for small scale Social Research Projects*. Second Edition. Philedelphia: Open University Press. 6. Haraway, Donna, J. (1988). *Situated Knowledges: The Science Question in Feminism and the Privilege of Partial Perspective*. Feminist Studies, Vol.14, No.3 (Autumn), 575-599 7. Harding, Sandra. (1987). Is there a Feminist Method*?* In *Feminism and Methodology*. Bloomington and Indianapolis: Indiana University Press. p 1-14 8. Hughes Christina. (2002). *Key Concepts in Feminist Theory and Research*. London: Sage. 9. Jarvlluoma Helmi. (2003). *Gender and Qualitative Methods*. London: Sage. 10. Kannabiran K & Padmini Swaminathan (eds.). (2017). *Re-Presenting Feminist Methodologies: Inter-Disciplinary Explorations*. NY: Routledge. 11. Kleinman, Sherryl. (2007). *Feminist Fieldwork Analysis*. Los Angeles: Sage Publications. 12. Reinharz Shulamit & Lynn Davidman.(1992). Feminist Methods in Social Research.Oxford University Press 13. Robert Helen.(1986). *Doing Feminist Research*. London: Routledge. 14. Stanley L. and Sue Wise.(1993). *Breaking Out Again: Feminist Ontologyand Epistemology*. London: Routledge. 15. Tannen Deborah. (1994). *Gender and Discourse*. New York: OUP.
Course Outcomes	Students at the end of the course will understand the research process and will develop skills in: 1. Conducting a review of literature and undertake a pilot study. 2. Develop a research proposal.

Title of the Course: Technology Enabled Solutions for Sustainable Development

Course Code: ENV 614
Number of Credits: 4
Effective from AY: 2022-23

Prerequisite for the course:	Students who have undergone M. A. Part I.	
Objectives:		
Content:	**Module I** Introduction – Technology, Sustainability, Sustainable Development, Technology enabled Sustainable Development. Examples of Technology forSustainable Development. Components of Sustainability – Social, Economicand Environmental, Sustainable Development Goals, Measuring Sustainability.	15 hrs.
	Module II Sustainable Development Discussions and innovative solutions under the following themes – Sanitation and Hygiene for Overall Health, Water Management, Waste Management, Energy Management and Greenery, Technology for Sustainable Development under following themes – Sanitationand Hygiene for Overall Health, Water Management, Waste Management, Energy Management and Greenery.	15 hrs.
	Module III Challenges for use of Technology for Sustainable Development in Villages,Digital Divides – Awareness, Availability, Accessibility and Affordability. Role of Stakeholders for addressing these issues to support Technology Enabled Solutions for Sustainable Development.	15 hrs.
	Module IV Choose any Village and Apply the concepts learnt in theory above and preparereport showing impact of Technology Enabled Solutions for Sustainable Development in the Village Selected.	15 hrs.
Pedagogy:	Lectures/ assignments/presentations/field visits/learning by engaging with the villagers and thestakeholders	
References / Readings:	1. https://www.undp.org/sustainable-development-goals, accessed on 6th November2022 2. https://www.researchgate.net/publication/342624965_SUSTAINABLE_DEVELOPM ENT_AND_ENVIRONMENTAL_ETHICS, accessed on 6th November 2022 3. Rogers, P.P., Jalal, K.F.and Boyd, J.A., An Introduction to Sustainable Development, Prentice-Hallof India Pvt. Ltd., New Delhi, 2008. 4. Dorf, Richard C., Technology, humans, and society: toward a sustainable world,Academic Press, 2001. 5. Published papers and reports.	

Course Outcomes	Students will be able to: 1. Appreciate the goals of sustainable development. 2. Understand use of technology for sustainable development. 3. Measure the impact of using technology for sustainable development in the villages 4. Understand Challenges faced while implementing Technology enabled solutions for sustainable development.

Title of the Course: Research Methodology in International Relations.

Course Code: ENV 615
Number of Credits: 4
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M.A. / M.Sc. Part I.	
Objective:	1. The course seeks to offer insights on various theories as well as methods and techniques of research in International Relations. 2. Students will be given some modest training in the application of the methodological approaches by way of sessional work on themes of current issuesrelated to the discipline.	
Content:	**Module I** Meaning and Objectives of Research, Formulation of Aims and Objectives; Research Types: Quantitative and Qualitative, Deduction, Induction, Empirical and Normative; Various Other Methods: Participant Observation, Case Study Mode, Survey.	15 hrs.
	Module II Challenges to Theme Selection, Wide Gamut of Areas: Politics, Society, Economy, History, Science and Technology; General Usageof Concepts and Terms of Research Methodology; Comparative Approach to Research and Analysis.	15 hrs.
	Module III Definition of Analysis, Levels of Analysis, Content Analysis, Analytical Rigor and Richness, Elements and Style of Research Proposal Writing in International Relations: Salience of Objectives, Significance, Relevance and Impact of Themes, Tentative Chapterisation.	15 hrs.
	Module IV Collection of Data, Challenges to Data Interpretation, Drawing Inferences; Types of Reports, Salience and Features of Reports, Steps in Report Writing**.** Footnotes, Endnotes, Bibliography, Formatting the Research Paper and Reports; Ethics and Riskin Research--Plagiarism, Role of Integrity in Research.	15 hrs.
Pedagogy:	Lectures/Tutorials/Assignments/Self-Study/Discussions/Audio-Visuals	

References / Readings:	1. AudieKlotz and Deepa Prakash. (2008).*QualitativeMethodsinInternational Relations: A Pluralist Guide*. New York: Palgrave Macmillan. 2. ChristopherLamont. (2015) . *Research Methods in International Relations*.New York: Sage. 3. Datlef F. Sprinz and Yael Wolinsky-Nahmia. (2007). Eds. *Models, Numbers & Cases: Methods for Studying International Relations*. Ann Arbor: University of Michigan Press. 4. David E. McNabb. (2002). *Research Methods in Political Science*.New Delhi: Prentice Hall of India Pvt. Ltd. 5. Dina Zinnes. (1976). *Contemporary Research in International Relations: A Perspective and a CriticalAppraisal*. New York: The Free Press. 6. Flyod J. Fowler, Jr. (1984). *Survey Research Methods*. Beverley Hills: Sage Publications. 7. JeffreyS.Lantis,LynnM.KuzmaandJohnBoeher. (2000). Eds.*TheNewInternationalStudiesClassroom:ActiveTeaching, Active Learning*. Boulder and London:Lynne Rienner Publishers. 8. Paul Pennings. (2006). *Doing Research in Political Science*. Thousand Oaks,California:Sage. 9. SantoshGupta. (1995). *ResearchMethodologyandStatisticalTechniques*. NewDelhi: Deepand Deep Publications. 10. William J.Goode and PaulK.Hatt.(1982) .*MethodsinSocialResearch*.Tokyo: McGrawHill-KogaKausha.	
Course Outcome	1. A student will acquire knowledge of research techniques widely used in the discipline.	

Title of the Course: Environmental Economics

Course Code: ENV 638

Number of Credits: **4**

Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. A. Part I.
Objective:	To understand the implications of production and consumption outcomes on the environment and how market and non-market tools can be used in policy-making to move towards sustainable development.

Content:	**Module I** Perspectives On The Environment - Economics and the Environment; A Framework for Environmental Analysis; Environmental Microeconomics and Macroeconomics. Resources, Environment, And Economic Development - A Brief History of Economic Growth and the Environment;A Summary of Recent Growth; The Future of Economic Growth and the Environment; Sustainable Development. The Theory Of Environmental Externalities - The Theory of Externalities; Welfare Analysis of Externalities; Property Rights and the Environment. Common Property Resources And Public Goods - Common Property, Open Access, and Property Rights; The Environment as a Public Good; The Global Commons **Module II** Resource Allocation Over Time - Allocation of Nonrenewable Resources; Hotelling's Rule and Time Discounting. Valuing The Environment - Total Economic Value; Overview of Valuation Techniques: Revealed Preference Methods, Stated Preference Methods; Cost-Benefit Analysis and its role in Policy Decisions. Ecological Economics: Basic Concepts - An Ecological Perspective; Natural Capital; Issues of Macroeconomic Scale; Long-Term Sustainability; Energy and Entropy. **Module III** Ecosystem Management And Biodiversity - The Economics of Biodiversity; Reconciling Economic and Ecological Principles. Pollution: Impacts And Policy Responses - The Economics of Pollution Control; Policies for Pollution Control; The Scale of Pollution Impacts; Assessing Pollution Control Policies; Pollution Control Policies in Practice. National Income And Environmental Accounting - Greening the National Income Accounts; Environmentally Adjusted Net Domestic Product; Adjusted Net Saving; The Genuine Progress Indicator; The Better Life Index; Environmental Asset Accounts; The Future of Alternative Indicators. **Module IV** Global Climate Change - Causes and Consequences of Climate Change; Responses to Climate Change; Economic Analysis of Climate Change; Adaptation and Mitigation; Climate Change Mitigation: Economic Policy Options; Climate Change: The Technical Challenge; Climate Change Policy in Practice; Economic Policy Proposals. Institutions And Policies For Sustainable Development - The Concept of Sustainable Development; The Economics of Sustainable Development; Reforming Global Institutions; New Goals and New Production Methods.	15 hrs. 15 hrs. 15 hrs. 15 hrs.
Pedagogy:	ICT enabled lectures/PC lab exercises/Assignments and presentations/Group activity/MOOC (or similar) component.	

References / Readings:	1. Jonathan M. Harris and Brian Roach (2018) *Environmental and Natural Resource Economics: A Contemporary Approach, Fourth Edition, Taylor and Francis, New York* *2.* Partha D. (2021), *The Economics of Biodiversity: The Dasgupta Review*. Abridged Version. (London: HM Treasury) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/957292/Dasgupta_Review_-_Abridged_Version.pdf 3. Lynne Lewis, Thomas H. Tietenberg (2020) Environmental Economics and Policy, Routledge, London *4.* Charles D. Kolstad (2012) *Intermediate Environmental Economics*, Oxford University Press, New Delhi *5. Stephen Smith (2011) Environmental Economics: A Very Short Introduction,* Oxford University Press, Oxford.	
Course Outcome	1. Students will be able to undertake basic environmental valuation, cost-benefit analysis, and analyse environmental policy.	

Title of the Course: Environmental History of India

Course Code: ENV 639
Number of Credits: 04
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. A. Part I.	
Objectives:	1. To cover in a systematic, comprehensive and critical way the nature, issues, problems and movements related to environmental history in India. 2. To encourage an interdisciplinary approach to environmental history. 3. To inculcate the spirit of environmental ethics.	
Content:	**Module I** Definition of Environmental History – Historiography - Sources. Habitats in Human History: Modes of Production and Modes of Resource Use – Gathering Stage to Industrial Stage. Hunter-Gatherer Societies to Agricultural Societies – the Eclectic Belief Systems - Cultural Ecology – Sacred Groves.	15 hrs.
	Module II Environmental change and conflict in modern India, Colonial Interests on Forests, Forest Acts (1865, 1878 and 1927) and Policies – Systematic Conservation vs. Exploitation Debate – Shifting Cultivation - Settled Cultivators and the State – Decline of Artisanal Industry – Deforestation – Protests Against the British Forest Acts and Policies.	15 hrs.
	Module III Independent India, Policies towards Forestry – Forest Policy Resolutions and Acts (1952, 1980 and 1988) – Policies towards Environment - Role of NGOs. Environmental Movements: Chipko Movement - Appiko Movement – Narmada Bachao Andolan - Save Silent Valley Movement - Scientific Conservation of Environment - Environmental Ethics - Major International Environmental Conventions and Protocols.	15 hrs.
	Module IV Economic Development and its Impact on the Environment Agriculture - Industry - Urbanisation and problem of Environmental Degradation – Sustainable Development - Conflict Between Socio-Economic Developments and Sustainable Development - Environmental Pollution and Methods of Control - Wild Life Conservation: Animals v/s Humans.	15 hrs.
Pedagogy:	Lectures/tutorials/assignments/ seminars/field work based write up.	

References / Readings:	1. Allchin, B. and R. Allchin. *The Birth of Indian Civilization: India and Pakistan before 500 B.C.* Harmondsworth: Penguin, 1968. 2. Alvares, C. ed., *Fish Curry and Rice, A Sourcebook on Goa, its Ecology and Life-Style.* 4th Edition. Goa: The Goa Foundation, 2002. 3. Arnold, D. and R. Guha. eds., *Nature, Culture, Imperialism, Essays on the Environmental History of South Asia.* Delhi: Oxford University Press, 1996. 4. Bellamy, P. *Dictionary of Environment*. 3rd Edition. New Delhi: Academic (India) Publishers, 2007.	
	5. Chakrabarti, R. ed., *Situating Environmental History.* New Delhi: Manohar, 2007. 6. Dasgupta, P. *The Control of Resources*, Delhi: Oxford University Press, 1982. 7. Desai, A.R. ed., *Agrarian Struggles in India.* Delhi: Oxford University Press, 1979. 8. Dhavalika, M.K. *The First Farmers of the Deccan.* Pune: Deccan College, 1988. 9. Fernandes W. and G. Menon, *Tribal Women and Forest Economy: Deforestation, Exploitation and Status Change.* New Delhi: Indian Social Institute, 1987. 10. Gadgil, M. and R. Guha. *The Use and Abuse of Nature (incorporating This Fissured Land An Ecological History of India and Ecology and Equity).* New Delhi: Oxford University Press, 2008. 11. Gill, Singh M., and J. Kewlani. eds*., Environmental Conscience Socio-Legal and Judicial Paradigm.* New Delhi: Concept Publishing Co., 2009. 12. Guha, R. ed., *Subaltern Studies, Vol. I*, Delhi: Oxford University Press. 1982. 13. Guha R. Forestry in British and Post-British India: A Historical Analysis. *Economic and Political Weekly*. Vol.18, (1983). No.44, pp.1882-1896. 14. Guha, R. Forestry in British and Post-British India: A Historical Analysis. *Economic and Political Weekly*. Vol.18, (1983). No.45/46, pp.1940-1947. 15. Guha R. and Gadgil M. 1989. *State Forestry and Social Conflict in British India. Past and Present.* No.123, PP.141-177. 16. Guha, R. *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya*. Berkeley: University of California Press, 1989. *17.* Guha, R. Sumit. *Environment & Ethnicity in India 1200-1991.* Cambridge: Cambridge University Press,1999. 18. Joseph B. *Environmental Studies. 2nd Edition*. New Delhi: Tata McGraw-Hill Pubg. Co., 2009. 19. Murthy, Linga and others, eds., *Environmental Concerns of Economic Development.* New Delhi: Serials Publications, 2008. 20. Raju, A.J. and Solomon. *A Textbook of Ecotourism Ecorestoration and Sustainable Development.* Kolkata: New Central Book Agency, 2007. 21. Singh, K.S. ed., *Tribal Movements in India, Vo. II.* New Delhi: Manohar, 1983.	

Course Outcomes	1. Understand the environmental history of India through the ages from ancient to the modern. 2. Appreciate cultural ecology and its significance. 3. Comprehend environmental ethics. 4. Understand sustainable development, rational use of natural resources,renewable sources of energy, and methods of controlling pollution	

Title of the Course: Environmental Politics

Course Code: ENV 640
Number of Credits: 04
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. A. Part I.	
Objectives:	1. The address the role of politics in shaping the discourse on environment at various levels. 2. It shall address how actors and institutions of politics impinge on decision makingand outcomes in addressing environmental problems of the day. 3. To expose the students to issues of power, contestation and cooperation that often emerge at local, national as well as international environmental domain.	
Content:	**Module I** Introduction - Concept of Power, Conflict and Interests in relation to Environment, Green Political Theory, Green Political Parties. **Module II** State and environmental politics - State as repository of Power andAuthority, Regulation, State as an agency of development. **Module III** Non-state actors and environmental politics - Non-Governmental organizations as pressure groups/advocates/partners in environmental change, Conflict with state andcorporations. **Module IV** Multilateral institutions and environmental regimes - International and regional organizations relating to environment, Multilateral institutions as sites of international negotiations,goal setting and accountability.	15 hrs. 15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Lectures, tutorials, assignments based on self-study, case-studies	

References / Readings:	1. John B., (1999). *Rethinking Green Politics Nature*, Virtueand Progress, Sage Publishers. 2. Schumacher E.F. (1993). *Small Is Beautiful: A Study of Economics as if People Mattered*, RHUK Publishers 3. Guha R. (2016). *Environmentalism: A Global History*, Penguin Random House. India. 4. Gareth P. (1995). *Global Environmental Politics: Second Edition* (Dilemmas in World Politics), West view Press 5. Neil C. (2012). *The Politics of the Environment: Ideas, Activism andPolicy*, Cambridge University Press. 6. Duit A. et al., (2014). *State and Environment – The Comparative Study of Environmental Governance*, MIT Press. 7. Newell P. (2006). *Climate for Change: Non-State Actors and the Global Politics of the Greenhouse*, Cambridge University Press. 8. Schiele S. (2014). *International environmental regimes and their treaties*, Cambridge University Press. 9. Gupta S.S. 2016. *Caring for Nature: The River of life (The Story of the Narmada Bachao Andolan*), The Energy and Resources Institute. 10. Khanna D.R., Kumar P. and Singh V. 2013. *Ecology of the TehriDam*, Biotech Books. 11. 11. Kutting G. and Herman K. (2018). *Global Environmental Politics: Concepts,Theories and Case Studies*, Taylor and Francis.	
Course Outcomes	1. The student should be able to understand the relationship between environment and politics. 2. He/she would be able to understand key environmental issues at local and national level. 3. The course would enable students to understand about governance and policies related to environment.	

Title of the Course: Eco-criticism

Course Code: ENV 641
Number of Credits: 04
Effective from AY: 2022-23

Prerequisites for thecourse:	Students who have undergone M. A. Part I.	
Objectives:	1. To highlight the symbiotic relationship of humans and ecology in literature andother writings. 2. To focus on the various perspectives discussed by the traditional and modern writers and thinkers in the context of environmental and cultural issues. 3. To evaluate the representation of anthropogenic connections with nature andculture in various texts. 4. To encourage the students to adopt an interdisciplinary approach while dealing with the various dimensions of issues pertaining to ecology and culture.	
Content:	**Module I** Introduction - History of Ecocriticism, Understanding the concept ofEcocriticism, Defining the Ecocritical theory.	15 hrs.
	Module II Background: Traditional Approaches - English Romanticism, William Blake, William Wordsworth, S.T. Coleridge, P.B. Shelly. American Transcendentalism, Ralph Waldo Emerson, Henry David Thoreau, Walt Whitman - Pathetic Fallacy, John Clare, Thomas Hardy.	15 hrs.
	Module III Modern Theories and Movements - Understanding the major theories and concepts: Green Cultural studies, Blue Cultural studies, Anthroprocene age and Consumer culture, Global Governance and New Conflicts, Capitalism in the Age of Globalization.	15 hrs.
	Module IV Indian Perspective - Cultural and Spiritual quest in India's Past from Antiquity, Gandhi's Critique of Modernity, Indian women and nature Chipko Movement, Contemporary Indian Writers: Vandana Shiva, Amitav Ghosh, Ruskin Bond.	15 hrs.
Pedagogy:	Lectures/tutorials/assignments/seminars.	

References / Readings:	1. Buell, Laurence. (1995). *The Environmental Imagination: Thoreau, Nature Writing, and the Formation of American Culture*. Cambridge: Harvard UP, 2. Dryzek, John. *The Politics of the Earth: Environmental Discourses*. Oxford: Oxford UP, 2005.Garrard, Greg. *Ecocriticism*. London: Routledge, 2011. 3. Garrard, Greg, ed. (2012). *Teaching Ecocriticism and Green Cultural Studies.* New York: Palgrave Macmillan, 4. Glotfelty, Cheryll, and Harold Fromm, eds. (1996). *The Ecocritical Reader: Landmarks in Literary Ecology*. Athens: The U of Georgia P, 5. Ghosh, Amitav. (2016). *The Great Derangement: Climate Change and the Unthinkable*. University of Chicago Press. 6. Hamilton, Geoff, and Brian Jones, eds. (2013). *Encyclopedia of the Environment in American Literature.* Jefferson: McFarland, 7. Handley, George B. (2007). New World Poetics: *Nature and the Adamic Imagination of Whitman, Neruda, and Walcott*. Athens: U of Georgia P, 8. Schweninger, Lee. (2008). *Listening to the Land: Native American LiteraryResponses to the Landscape.* Athens: U of Georgia P, 9. Shiva, Vandana and Mies. Maria. (2014) *Ecofeminism*. Zed Books. 10. Vakoch A. Douglas and Sam Mickey. (2018) *Literature and Ecofeminism:Intersectional and International Voices*. Routledge, Taylor & Francis Group.	
Course Outcomes	1. The students will be acquainted with the various dimensions of environmental discourses as well as the theoretical works. 2. Outline the interconnectivity of humans and ecology as expressedin various writings. 3. Evaluate and interpret a text in the light of Ecocritical theory.	

Title of the Course: Environmental Security: Dimensions and Perspectives

Course Code: ENV 642
Number of Credits: 04
Effective from AY: 2022-23

Prerequisites for the Course:	Students who have undergone M. A. Part I.
Objectives:	1. To disseminate rudimentary knowledge in the realm of environmental security, aligned with concurrent analytical comprehension of the natural and human induced environmental mutations, plausibly impacting human security and well-being. 2. Information coalesced around conflicts impelled by environmental resources-scarcity and instituted peace-building processes, would find vivid elaboration, so that the students-genre can emerge as stakeholder-contributors to wide-ranging policy analysis in environmental security and peace, beyond their preferred domain of core-competent scientific expertise. 3. Emphasis on national, regional and global environmental contexts, would serve to bring typologies of environmental stresses, such as demographics and migration, the dialectic choices between conventional and renewable energy sources, and socio-economic underpinnings of poverty-led insecurity, to public domain discussion, in requisite appraisal and appreciation of Environmental Security, on broad canvass.

Content:	**Module I** Introduction - Conceptual-Construct and Topical Phenomenon, Definitions,Narratives in Discourse, Schools of Thought, Theoretical Paradigms (Securitisation Debate). **Module II** Environmental Security qua 'Conventional' and 'Non-Conventional' Security - Typologies of Armed Conflicts & Analysis; Inter-State Conflicts in the Global South (Case Studies from Africa, West Asia, South Asia); Population Pressures and Migration Patterns in Conflict; Role of Non-StateActors; Socio-Economic Issues (Poverty, Occupation and Livelihoods, Infectious Diseases, Industrialisation and Urbanisation Trends) **Module III** Environmental Security and Sustainability Imperatives for Ecological Harmony and Development: Food Security; Water Scarcity; Energy Security and Independence; Coastal, Marine, and Blue Economy Resources;Climate Change; Natural Resources Administration; Disaster Management; Land and Forests Vulnerability. **Module IV** Environmental Security as Global Commons and Global Good – Perspective on Challenges; Template for Cooperation; Environmental Peace-buildingMovements, Environmental Justice.	15 hrs. 15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Classroom lectures, Written and oral assignments, Audio-Visual presentations.	
References / Readings:	1. Hough, P. (2021). *Environmental Security: An Introduction*, Routledge (2nd Ed.), 2. Lanicci J., et. al. (2020). Environmental Security – Concepts, Challenges and Case Studies, AMS, 3. Lee, J. (2019). *Environmental Conflict and Cooperation: Premise, Purpose, Persuasion and Promise*, Routledge (1st Ed.), 4. Das, O. (2013). *Environmental Protection, Security and Armed Conflict: A Sustainable Development Perspective*, Edward Elgar Publishing Ltd., 5. Scheffran, J., et al., (eds.), (2012). *Climate Change, Human Security and Violent Conflict: Challenges for Societal Stability*, Springer, 6. Richard, M. (2010). *Global Environmental Change and Human Security*, (London: MIT Press), 7. Pirages, D., et al., (2011). *'Ecological and Non-traditional Security Challengesin South Asia'*, NBR Special Report,	

Course Outcomes	1. The course is designed to accomplish the ostensible objective of acquainting students with the latest discourse on environmental security and peace-building, in a manner that helps internalise the conceptual phenomenon, as cross-cutting generations, policy-axes, and vectors of human endeavour. 2. Students would glean, as to how environmental harness and the excesses of it materially impinge, on the natural security calculus of individual nation-states, inducing the imperative for responsible and sustainable recourses, by sovereign and institutional actors, alike. 3. Environmental preservation and protection remains pivotal, to beneficently shaping critical sustainable development concerns, of water, food and energy security, that intimately segue with existential aspects of upholding livelihoods and fostering societal-uplift, vide ecological sentience.	

Title of the Course: Global Environmental Governance

Course Code: ENV 643
Number of Credits: 04
Effective from AY: 2022-23

Prerequisites for the course:	Students who have undergone M. A. Part I.	
Objectives:	1. To provide interdisciplinary knowledge and competences that assist in dealing with environmental governance in an international context. 2. This inter-disciplinary course provides in-depth insights to the actors, processes and problems of global environmental politics and aims to summarize debates about 'global' environmental problem. 3. It will also aim to understand the various international organisations and their role in global governance.	
Content:	**Module I** Introduction: Globalization of Environmental Threats and Impact on Security, Trade, Health and Development. Actors, Institutions—International Organizations—the UN System and Global Environment.	15 hrs.
	Module II Core Dimensions and Key Actors of Global Environmental Governance: Environment Summits—From Stockholm to Rio to Johannesburg; India's Environmental Diplomacy; Millennium Development Goals, Concept of Sustainability, Factors Governing Sustainable Development, Linkages Among Sustainable Development, Environment, and Poverty, Determinants of Sustainable Development, Case Studies on Sustainable Development,Sustainable Development Goals (SDGs).	15 hrs.
	Module III Environmental Accords and Governance: History of Environment's Lawmaking and Institution Building Processes—1987 BrundtlandCommission Report, International Environmental Agencies including UNEP, Commission on Sustainable Development, Select Multilateral Environmental Agreements-Agreements on Climate Change, Antarctica Treaty, Polar Regions and the Amazonia.	15 hrs.
	Module IV The Indigenous and Environmental Governance in Comparative Perspective: Case Studies from the High North (Polar Region) and the Amazonia: Evolving Indigenous Governance in the Arctic; Rights of Minorities and Indigenous Peoples in the Arctic Region; Indigenous People and the Amazonia—Issues,	15 hrs.

	Challenges and Governance of the Region; Role of Groups and Questions of Land and Water Rights in the High North and the Amazonia.	
Pedagogy:	Lectures, Interactions, Assignments, Presentations.	
References / Readings:	1. Chasek, Pamela S., David L. Downie, and Janet Welsh Brown. Eds. (2017). *Global Environmental Politics: Dilemmas in World Politics*.New York: Routledge. 2. Dauvergne, Peter. (2005). *Handbook of Global Environmental Politics*. Cheltenham: Edward Elgar. 3. Delmas, Magali A. and Oran R. Young. Eds. (2009). *Governance for the Environment*. Cambridge: Cambridge University Press. *4.* Elliot, Jennifer A. (2010). *An Introduction to Sustainable Development.* New York: Routledge. 5. Jakobson, L. and N. Melvin. (2016). *The New Arctic Governance*. Oxford: Oxford University Press. 6. Lalfagianni, Agni, Doris Fuchs, and Andres Hayden. Eds. (2020). *Routledge Handbook of Global Sustainability Governance*. London: Routledge. *7.* Nicholson, Simon and Paul Wapner. (2014). *Global Environmental Politics: From Person to Planet.* London: Routledge. 8. Rogers, Peter P., Kazi F. Jalal and John A. Boyd. (2008). *An Introduction to Sustainable Development*. Sterling, VA: Earthscan. 9. Speth, James Gustave and Peter M. Haas. Eds. (2006). *Global Environment Governance*. London: Oisl and Press. 10. Andonova, Liliana B., and Matthew J. Hoffmann. (2012). "From Rio to Rio and Beyond: Innovation in Global Environmental Governance". *The Journal of Environment & Development*. 21(1): 57-61. 11. Andonova, Liliana B., M. Betsill, and H. Bulkeley. (2009). "Transnational Climate Governance". *Global Environmental Politics*. 9(2): 52–73. 12. Chase, Veronika Miranda. (2019). "The Changing Face of Environmental Governance in the Brazilian Amazon: Indigenous and Traditional Peoples Promoting Norm Diffusion". *Revista Brasiliera de Politica Internacional.*62 (2) https://doi.org/10.1590/0034-7329201900208 13. Dubash, Navroz K. (2012). "Toward Enabling and Inclusive Global Environmental Governance". *The Journal of Environment & Development*. 21(1): 48-51. 14. Esty, Daniel C. (2009). "Revitalizing Global Environmental Governancefor Climate Change". *Global Governance*. 15(4): 427-434. 15. Hey, Ellen. (2006). "International Institutions and Global Environmental Governance". *Proceedings of the Annual Meeting*. 100 (29 March - 1 April): 310-312. 16. Johnson, Samantha. (2021). "Indigeneity, Environment, and Governance in the Amazon: The Impact of Indigenous Movements on Environmental Conservation Policy in Nation-States of the Amazon Rainforest". https://academiccommons.columbia.edu/doi/10.7916/d8-9vvv-rk15/ 17. Rechkemmer, Andreas. (2003). "Rio and the Origins of Global	

	Environmental Governance". *Security and Peace*. 21(3/4): 173-178. 18. Toohey, David E. (2012). "Indigenous Peoples, Environmental Groups, Networks and the Political Economy of Rainforest Destruction in Brazil". *International Journal of Peace Studies*. 17(1): 73-97. 19. *Global Environmental Governance: A Reform Agenda. (*2006).Winnipeg: International Institute for Sustainable Development (IISD). https://sustainabledevelopment.un.org/content/documents/global%20e nvironmental%20governance.pdf	
Course Outcomes	1. The students can retrieve and recognize knowledge on global environmental issues. 2. The students will understand environmental problems and issues. 3. The students will gain knowledge on International organizations and regimes.	

Semester – IV(M.A)

Title of the Course: Academic Writing in English

Course Code: ENV 616
Number of Credits: 4
Effective from AY: 2022-23

Prereq uisites for the course:	Students who have undergone M. A. Part I.	
Objectives:	1. To refine the writing skills of students. 2. To discourage plagiarism and inculcate research ethics. 3. To introduce tools beneficial while conducting research.	
Content:	**Module I** Academic and Research Writing – Introduction, Importance and Basic Rules, Importance of the English language in Academic Writing.	15 hrs.
	Module II MLA Style – Referencing and Citation, Research Ethics – Types of Plagiarism, Detection tools and how to avoid Plagiarism.	15 hrs.
	Module III Journal and Author Metrics, Literature Review – Process, Online databases, Tools, Review Paper Writing, Research Proposal and Thesis Writing – Process, Empirical and Non-Empirical Studies.	15 hrs.
	Module - IV Abstract, Conference/Research Paper, Book Chapter – Process, Team and Time Management, Challenges in Indian Research Writing, Open Educational Resources.	15 hrs.
Pedagogy:	Lectures/tutorials/assignments/seminars.	

References / Readings:	1. Adler, Abby. "Talking the Talk: Tips on Giving a Successful Conference Presentation." *American Psychological Association,* April 2010,apa.org/science/about/psa/2010/04/presentation 2. Anson, Chris M. and Robert A. Schwegler. *The Longman Handbook for Writers and Readers*.6th edition. 3. Creswell, J. W. (2008). *Educational Research: Planning, conducting, and evaluating quantitative and qualitative research* (3rd ed.). Upper Saddle River: Pearson. 4. Gibaldi, Joseph. (2009). *MLA Handbook for Writers of Research Papers*. Modern LanguageAssociation of America, Print. 5. Henly, Susan. "Finding the right journal to disseminate your research." Nursing Research, Wolters Kluwer Health Inc, November-December 2014, journals.lww.com/nursingresearchonline/Fulltext/2014/11000/Finding_the_Right_Journal_to_Disseminate_Your.1.aspx? WT.mc_id=HPxADx20100319xMP. 6. Hadley, Chris. "How to Get Started With a Research Project".*wikiHow*, 5 January 2021, wikihow.com/Get-started with-a-Research-Project. 7. Modern Language Association.*MLA Handbook Eighth Edition. https://style.mla.org/*"Open Educational Resources". *Wikipedia*, Wikimedia Foundation, 15 March 2021, en.wikipedia.org/wiki/Open educational_resources. 7. Pappas, Christopher. "Top 10 Free Plagiarism Detection Tolls for eLearning Professionals". *eLearning Industry*, 18 November 2013, elearningindustry.com/top-10-free-plagiarism-detection-tools-for-teachers. 8. Roberts J. "Plagiarism, Self-Plagiarism, and Text Recycling." *Headache,* John Wiley& Sons Inc, 26 February 2018, headachejournal.onlinelibrary.wiley.com/doi/full/10.1111/head.13276.
Course Outcome	1. The students will be able to write in a professional and academic manner, having learnt to use the appropriate style and cite sources.

Title of the Course: Idea of Nature in Eastern and Western traditions

Course Code: ENV 617
Number of Credits: 4
Effective from AY: 2022-23

Prerequisitesfor the course:	Students who have undergone M. A. Part I.	
Objectives:	1. To comprehend the conceptualization of nature and the interplay between humans,the divine, and the natural world in eastern and western traditions. 2. To examine the significant contributions and approaches employed by thesetraditions in nature conservation.	
Content:	**Module I** Introduction - Introduction to the concept of nature: Philosophical, Religious, and Spiritual Interpretations. **Module II** Eastern traditions - Indic and East Asian religious views on nature:Nature as Divine, Sacred natural sites, Animism. **Module III** Western traditions - Ancient Greek and Abrahamic views on nature: Cosmogonic myth, Genesis/ Anthropogenesis, Stewardship theory. **Module IV** Conservation through traditional beliefs and practices - Customary laws,Indigenous practices, Spiritual and religious ecology.	15 hrs. 15 hrs. 15 hrs. 15 hrs.
Pedagogy:	Lectures/assignments/workshops/visits/documentaries and discussion/presentations.	

References / Readings:	1. Glacken, Clarence J. (1992). "Reflections on the History of Western Attitudes to Nature," *GeoJournal,* Vol. 26, No. 2. 2. Nakamura, Hajime. (1992). "The Idea of Nature in the East in Comparison with the West,"*GeoJournal,* Vol. 26, No. 2. 3. Barnhart, Michael G. (1997). "Ideas of Nature in an Asian Context,"*Philosophy East and West,* Vol. 47, No. 3. 4. Evans, J. C. (2005).*With Respect for Nature: Living As Part of the Natural World*, New York: State University of New York Press. 5. Naddaf, Gerard. (2005). *The Greek Concept of Nature*. New York: State University of New York Press. 6. Foss*,* Jeffrey E. (2009). *Beyond Environmentalism: A Philosophy of Nature*. New Jersey: John Wiley & Sons, Inc. 7. Baindur, Meera. (2015). *Nature in Indian Philosophy and Cultural Traditions.* New Delhi: Springer (Sophia Studies in Cross-cultural Philosophy of Traditions and Cultures, Vol. 12.) 8. Vetlesen, Arne J. (2015). *The Denial of Nature: Environmental Philosophy in the Era of Global Capitalism*, New York: Routledge. 9. Rots, Aike P. (2015). "Sacred Forests, Sacred Nation: The Shinto Environmentalist Paradigm and the Rediscovery of "Chinju no Mori"." *Japanese Journal of Religious Studies*, Vol. 42, No. 2. 10. Lie, Svein A. N. (2016). *Philosophy of Nature: Rethinking Naturalnes,*New York*:* Routledge. 11. Liu, Jing. (2016). "What is Nature? Ziran in Early Daoist Thinking,"*Asian Philosophy,* Vol. 26, NO. 3.	
Course Outcomes	1. The students will be able to appreciate traditional ideas and the interrelationship between humans and nature. 2. The students will develop an ecological conscience by critically appraising the traditional belief systems in order to maximize the potential for conserving nature and its diversity. 3. The students will learn to embrace the differences between eastern and western conceptions of nature. 4. The traditional theoretical approaches will explain how customary rules and practices have evolved. 5. Traditional and indigenous practices and beliefs will help students understand and respect the boundaries and limits of human intervention in nature.	