Restructured Syllabus (CBCS Pattern as per NEP 2020)

To be implemented from Academic Year: 2024-25

Faculty	**Science**
Program	**Environmental Science**
Class	**M. Sc. I (Post Graduation)**

M. Sc. I ENVIRONMENTAL SCIENCE

SEMESTER I

Semester	Course Code	Type of Course	Course Title	Theory/ Practical	Credits	No. of clock hours per week
Semester I	ENV 501 MJ-TH	Core Compulsory Theory Papers	Fundamentals of Environmental Biology & Biodiversity	**Theory**	4	4
	ENV 502 MJ-TH		Fundamentals of Environmental Physics Chemistry	**Theory**	4	4
	ENV 503 MJ-TH		Environmental Statistics	**Theory**	2	2
	ENV 504 MJ-PR	Core Compulsory Practical paper	Practicals based on ENV 501 MH-TH, ENV 502 MH-TH and ENV 503 MH-TH	**Practical**	4	8
	ENV 531 RM-TH	Research Methodology Theory	Research Methodology	**Theory**	2	2
	ENV 531 RM-PR	Research Methodology Practical	Research Methodology Practical	**Practical**	2	4
	Group I ENV 510 MJ- TH	Choice Based Optional Papers Elective/ Departmental Course **Any one group**	Fundamentals of AtmosphericSciences	**Theory**	2	2
	Group I ENV 511 MJ - TH		Fundamentals of Geo-Sciences	**Theory**	2	2
	GroupII ENV 512 MJ-TH		Sustainable Development	**Theory**	2	2
	GroupII ENV 513 MJ-TH		Environmental Education	**Theory**	2	2

CourseCode: ENV 501 MJ-TH

Course Name: Fundamentals of Environmental Biology & Biodiversity

Credit: 4

Course Outcomes:

Course Outcome No.	Statements
CO 1	Outline of concept of Ecosystem, Ecology, Terrestrial and Aquatic biomes, Biodiversity
CO 2	Explain the components and functioning of Ecosystems, Discuss biogeochemical cycles
CO 3	Illustrate Various population dynamics and their impact on population growth
CO 4	Differentiate feeding, communication and reproductive behaviour of plants and animals
CO 5	Evaluate the role of different biological components in Ecological restoration and other environmental application.
CO 6	Derive energy flow in ecosystem, threats to biodiversity and plan for conservation of bio- resources

ENV 501 MJ-TH	ENVIRONMENTAL BIOLOGY & BIODIVERSITY (4 CREDITS)	No. of lectures in Clock Hours
1.	**Environmental Biology: Concepts and Scope:** • Concept of Ecosystem; Biosphere as an ecosystem; its ecologicalprocesses and life support systems. • Ecotone, and Role of biological processes in remedial measures and restoration.	**4**
2	**a) Fundamental Concepts of Ecology.** • Ecology: Definition, development and scope. Ecology as an experimentalscience • Ecosystems: concept, components and functioning. • Energy Fixation (photosynthesis and chemosynthesis) and energy flowthrough food chains (grazing and detrital) and webs (include Y shapedenergy flow model). • Ecological efficiencies and pyramids. Trophic levels • Influence of environmental factors (including temperature, light, moisture, soil, nutrients) on organisms and their adaptations in response to them.	**15**

	b) Ecology of Populations And Communities. **(i) Population Ecology:** ● Factors determining the abundance and distribution of a species ● Factors leading to the commonness, rarity and vulnerability of extinctionof a species. ● Population Dynamics: Patterns of survival, age distribution, dispersal andrates of change. Attributes of K- selected and r-selected species, Population Growth. **(ii) Community Ecology:** ● Competition, Exploitation (including herbivore, predation, parasitism), Mutualism (including commensalism, cooperation,symbiosis) ● Food webs and concepts of niche and keystone species. ● Nutrient cycling and retention: Biogeochemical cycles (Carbon, Nitrogen, Phosphorus), limiting factors and their tolerance. Succession, development, climax and stability of ecosystems (EXCLUDING Climax Theories), Cake and other ecological models, model of successions	
3	**Introduction To Plant And Animal Behaviour:** ● Ethology and socio-biology: General definition and concept ● Types of behaviour ● Feeding Behavior: Herbivores, Carnivores, Parasites, Saprophytes,Response of prey / plants (deterrence, defence, reward). ● Animal Architecture and use of tools ● Circadian and other rhythms. ● Migration, orientation, navigation, and homing. ● Communication (including visual, olfactory, tactile, auditory, chemical)Aggression, Territoriality, Altruism. ● Reproductive Behaviour: Courtship, Mating, Parental care, breedingsystems. ● Instinct and Learning: Genotype and phenotype behaviour. Insect and Vertebrate Societies, Associations	**12**
4	**Terrestrial and aquatic Biomes** ● Climatic and edaphic factors of terrestrial biomes. Heinrich Walter'sBiome Climate Diagrams ● Classification of land biomes with their soil, climate and vegetation characteristics. Their natural history, wildlife, geography and humaninfluences. ● Mountain Biome: Replication of latitudinal changes in the altitudes ofhigh mountains. ● Terrestrial biomes, ecosystem diversity, forest and vegetation types inIndia.	**10**

	• Challenges and adaptations of life in aquatic biomes (freshwater: still andflowing, marine). • Freshwater Biomes (Rivers, streams, lakes, ponds) • Marine Biomes (including mangroves, coral islands, kelp forests,saltwater marshes, seashores, estuaries) and their natural history Wetlands – definitions, types, ecological functions and resources.	
5.	**Environmental Microbial ecology:** • Classification of microbes and their metabolism and ecology • Micro-organisms and their association with man, animals and plants. • Role of microbes in bio-remedial processes, ecological restoration andother environmental applications • Environmental factors affecting microbes, their cultivation and growth. • Concept of bioindicators, bioindicators as plants, animals, bioindicatorsin manmade environment, role of bioindicator in pollution control. • Fundamentals of microbial nitrogen fixation and other pathways in terms • of enzymology.	**8**
6.	**Concept of Carrying Capacity** Biotic and abiotic components of environment, concept of sustainability and carrying capacity, tragedy of commons, human population and food, water and energy security, present status of environment and future scenarios.	**6**
7	**Introduction to Biodiversity** Biodiversity: An inventory of Global and Indian biological resources and their present and potential uses; Values of biodiversity; threats to biodiversity;Strategy for conservation of bio-resources.	**5**
	Reference Books: 1. Environmental Science - Arms Karen 2. Principles of Environmental Science-Watt, K. E. F. (1973) McGraw-HillBook Company. 3. Environmental Science –Noble, B .J. Kormandy, E.J. (1981). The wayworld works, Prentice-Hall Inc., N .J. 4. Environmental Science-Turk A. , Turk J. Wittes J.T. and Wittes, R.E. 5. Environmental Issues: Measuring, Analyzing, Evaluating, Abel, Daniel C.McConnell, Robert L. Abel, Daniel C. Edi. 2 Prentice Hall Publication 6. Chaudhuri AB and Sarkar DD (2003) Megadiversity Conservation, Flora, Fauna and Medicinal Plants of India's	

Hotspots. Daya Publishing House,New Delhi.
7. Gary K Meffe and Ronald Carroll C (1994) Principles of ConservationBiology. Sinauer Associates Inc., Massachusetts.
8. Groombridge B (Ed.) (1992) Global Biodiversity Status of the EarthsLiving Resources. Chapman & Hall, London.
9. IUCN (1992) Global Biodiversity and Strategy.
10. Sharma PD (2000) Ecology and Environment. Rastogi Publications,Meerut, India.
11. Singh MP, Singh BS and Soma S. Dey (2004) Conservation of Biodiversity andNatural Resources. Daya Publishing House, New Delhi. Virchow D (1998) Conservation and Genetic Resources, Springer-Verlag,Berlin.
13. Singh B, (1992).Social Forestry for Rural Development, Anmol Publishers,New Delhi
14. Raymond F Dasmann(1984), Environmental Conservation, John Wiley.
15. Kato, M. The Biology of Biodiversity, (1999), Springer Verlag, Tokyo.
16. Kotwal, P.C. and S. Banerjee(2002) Biodiversity Conservation – In Managed forest and Protected areas. Agrobios, India.
17. Krishnamurthy, K.V. (2003)An Advanced Textbook on Biodiversity –
12. Principles andPractice. Oxford and IBH Publishing, New Delhi.

CourseCode: ENV 502 MJ-TH

Course Name: Fundamentals of Environmental Physics & Chemistry

Credit: 4

Course Outcomes:

Course Outcome No.	Statements
CO 1	Describe fluids, waves, optics, Nuclear Physics.
CO 2	Explain various techniques of element estimation, Fresnel and Fraunhofer diffraction
CO 3	Write application of Microscope, Crystallography, water waves, Atomic Physics, Spectroscopy.
CO 4	Compare between unsaturated and saturated hydrocarbon.
CO 5	Estimate DO, BOD, COD, Coagulation, Filtration of different water resources.
CO 6	Develop computational tools to model optical systems and simulate various experiments

ENV 502 MJ-TH	ENVIRONMENTAL PHYSICS AND CHEMISTRY (4CREDITS)	No. of lectures in Clock Hours
1	Estimation of various elements at major, minor, trace, rare level concentrations: choice of a technique, principle, merits and demerits of the techniques – neutron activation analysis, isotope dilution analysis, colorimetry, atomic absorption, spectroscopy, ICPAES, chromatography, HPLC, ion exchange chromatography, X-ray fluorescence, X-ray diffraction, Flame photometry, Polarography UV Spectrophotometer, Mass Spectrometry	**15**
2	Stoichiometry, Gibb's energy, Chemical Potential, Chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbon, radionuclides,Chemical bonding, chemical reactions and equations, Organic functional groups, classes of organic compounds. Free radical reactions, catalytic processes. Elemental cycles (C, H, N, S, O, P) and their environmental significance. Reversible and irreversible reactions of water, Cations and anions in water and their sources, Mass Balancing, concepts of DO, BOD, COD, sedimentation,coagulation, filtration, redox potential.	**10**

3	**Fluids:** Pressure, buoyancy, fluid flow, viscosity, surface tension. Applications to hydraulics, biology, biophysics, atmospheric physics, aerodynamics **Waves and oscillations: r**eflection, refraction, superposition, resonance,energy transport, absorption, Doppler effect. Applications towater waves,acoustics, seismology **Optics:** Geometrical optics including dispersion, lenses, mirrors,interference, diffraction, polarisation. Applications to microscopy, imaging, vision, crystallography **Quantum physics:** interaction of light with matter, x- rays. Application to atomic physics, lasers, and spectroscopy	**15**
4	**Nuclear physics:** Atomic nucleus, radioactive decay, half-life, ionising radiation, nuclear fission and fusion. Application to nuclear energy, radiation safety, nucleo-genesis, carbon dating. Effects of radiation on living tissue, background radiation, radon; units for radiation exposure; applications of nuclear technology, nuclear medicine, contaminant tracing,ion beam analysis **Thermodynamics:** Carnot cycle, refrigerators, heat engines, throttling process; Helmholtz and Gibbs Free energies, and phase transformations. Heat Energy And Kinetic Theory Heat and Temperature. Internal Energy, Specific Heat. Ideal gas Equation. Kinetictheory interpretation of pressureand temperature. Work, heat, and laws of thermodynamics. Adiabatic lapse rate. Radiant energy. **Optics:** Fourier optics, Fourier transforms in 1 and 2D, Dirac delta function and comb, discrete Fourier transforms and the sampling theorem, convolution, cross and autocorrelation. Fresnel and Fraunhofer diffraction, Polarized light including production and control of polarization.	20
	Reference Books 1. Environmental Chemistry by A. K. De 2. Destruction of hazardous chemicals- G.Lunn, E.B.Sandome 3. Hazardous substances in chemical lab-G.D.MuMivir 4. Essentials of Nuclear Chemistry, H. J Arnikar, Wiley Eastern Limited,4th Edition.(1995)	

CourseCode: ENV 503 MJ-TH

Course Name: Environmental Statistics

Credit: 2

Course Outcomes:

Course Outcome No.	Statements
CO 1	Recall key statistical concepts and terms related to data analysis
CO 2	Explain measures of central tendency and dispersion in statistics
CO 3	Utilize inferential statistical tests to draw conclusions and make predictions based on environmental datasets
CO 4	Analyse environmental datasets to identify trends, patterns and correlations
CO 5	Evaluate the significance of statistical results in context of objective
CO 6	Carry statistical data analysis based on variables and samples

ENV 503MJ-TH	ENVIRONMENTAL STATISTICS (2 Credits)	No. of lectures in Clock Hours
1.	**Foundation of environmental statistics –** Nature of environmental data: Survey based (empirical) and experimental data. Concepts of population and sample – Random variable and parameters of interest. Concepts of statistical inference, Simple random sampling for selection of sampling units for making observations.	3
2.	**Univariate data –** Frequency distribution and their properties (including Skewness and Kurtosis), Histogram, Frequency Curve and Ogive Curves. Measure of central tendancy: Mean, Median and Mode. Measure of Dispersion: Range, Variance, standard deviation and co-efficient of variation. Presentation of data: Summery statistics and graphical methods.	**4**
3	**Bivariate data -** Obtaining bivariate data by measuring two variables on a single sampling unit. Summary statistics for bivariate data: Mean, standard deviation and covariance, correlation coefficient. Scatter plot and its interpretation.	**4**

4	**Multivariate data –** Multivariate analysis, Regression Multivariate Analysis, PCA, Q-mode and R- Mode Factor analysis, Time-series data analysis, Moving averages, Wavelet analysis / Spectral analysis; Introduction to MATLAB	**5**
5	**Tests of Significance-** Chi- squared test: goodness of fit. Independence of attributes, T and F tests for significance	**2**
6	**Statistical models –** Distribution models: Normal distribution and its properties. Fitting of normal distribution. Calculation probabilities of different events for normal distribution. Standardization of data and approximation by normal distribution. Prediction models: linear and non- linear regressionmodels, fitting a regression line and parabolic curve, estimating regression coefficients. Calculation of fitted values and residuals.	**6**
7	**Statistical models in environmental science-** Population growth model, Catch model.	**3**
8	**Statistical Quality Control (SQC) Technique-** Meaning of Quality/SQC, Control Chart for variables (X-Bar and R-Charts)	**3**
	Reference books: 1. Barnett Vic (2004) Environmental Statistics: methodsand applications. 2. Ott, Wayne R. (1995) Environmental Statistics and data analysis. 3. Zar, Jerrold H. (1997) Biostatistical Analysis. Prentice Hall (India) 4. Nychka, Douglas and Piegorsch Walter W (1998) Case studies inenvironmental Statistics. 5. Manly Bryan F.J. (2001) Statistics for Environmental Science andManagement. 6. Walpole R. and Myem R. (1993) Statistics for engineers and scientists	

CourseCode: ENV 504 MJ-PR

Course Name: PRACTICALS RELATED TO ENV 501 MJ-TH, ENV 502 MJ-TH J & ENV 503 MJ-TH

Credit: 4

Course Outcomes:

ENV 504MJ-PR	**PRACTICALS RELATED TO ENV 501 MJ-TH, ENV 502 MJ-TH J & ENV 503 MJ-TH (4 Credits)**
	ENV 501 MJ-TH FUNDAMENTALS OF ENVIRONMENTAL BIOLOGY &BIODIVERSITY 1. Determining the rate of photosynthesis in an aquatic plant (hydrilla or elodea) 2. Estimation of chlorophyll content from given plant leaves 3. Vegetation studies by line and belt and quadrates methods 4. To study wetland bird diversity 5. Phytoplankton and zooplankton analysis from freshwater samples 6. Estimation of Productivity of lake 7. Preparation of media for microbial culture, Isolation and culturing ofmicrobes from soil / water samples, Gram Staining. 8. Bacterial growth curve 9. Enzyme analysis from soil samples
	ENV 502 MJ-TH FUNDAMENTALS OF ENVIRONMENTAL PHYSICSAND CHEMISTRY 1. Preparation of samples and analysis using Chromatography 2. Determination of Nitrogen, Phosphorus, Sulphur 3. Estimation of halides in water samples by Potentiometry 4. Preparation of samples and analysis using titration 5. Preparation of samples and analysis using Flame photometer 6. Preparation of samples and analysis using Spectrophotometer / UV Spectrophotometer

	ENV 503 MJ-TH Environmental Statistics Practicals 1. Grouping of data and preparation of frequency distribution. Histogram andfrequency polygon 2. Calculating mean, median and mode for grouped and ungrouped data 3. Calculating variance, standard deviation and coefficient of variationfor grouped and 4. ungrouped data 5. Fitting simple linear regression. Plotting scatter diagram and regression line 6. Computing correlation coefficient and testing its significance for groupedand ungrouped data 7. Comparison between means of two independent samples. Paired t-test 8. Analysis of variance: one way classification 9. Analysis of variance: two- way classification 10. Multivariate Analysis STATISTICA/ANOVA/SPSS Fitting statistical model of air pollution to data

CourseCode: ENV 531 RM-TH

Course Name: Research Methodology

Credit: 2

Course Outcomes:

Course Outcome No.	Statements
CO 1	Understand the concept of research and its terminology
CO 2	Understand types of research and approaches to research
CO 3	Demonstrate understanding of research methods and design for data collection
CO 4	Analyze and interpret the data
CO 5	Evaluate current trends in research and develop multidisciplinary approach
CO 6	Propose research proposal and represent data

ENV 531 RM-TH RM- Research Methodology Compulsory Theory Paper
Total: 2 Credits Workload: -15hrs/credit
(Total Workload: -2 credits x 15 hrs =30 hrs in semester)

Credit	Credit Title and Contents	No. of lectures in Clock Hours
I	**1.** History of research. **2.** Research concept: Definition, Characteristics, Objectives, Utility **3.** Types of Research: Descriptive vs. Analytical Research; Applied vs. Fundamental Research; Quantitative vs. Qualitative Research; Conceptual vs. Empirical Research **4.** Problem Identification & Formulation: Formulating the research problem, Defining the research problem, Origin of the research problem **5.** Literature Review: Purpose of the literature review, Types of information and sources, Primary and secondary sources **6.** Research Objectives **7.** Research design: Types of research design (descriptive research design, correlational research design, experimental research design, explanatory research design) **8.** Research methods: Quantitative research, Qualitative research, Experimental research, and mixed methods approaches, Data Analysis and Interpretation, Sample collection and processing	15

	techniques (Water, soil, air and medical) **9.** Citation: Methods, Bibliography, citation rules **10.** Current trends in Research: Mono-disciplinary Research, Trans-disciplinary Research, Inter-disciplinary Research, Threats and Challenges to Good Research	
II	1. Data Presentation: Presentation skills, formal scientific presentation skills; Preparing power point presentation, Presenting the work,Scientific poster preparation 2. Research report writing: Purpose of the writing, Types and Formats of scientific reports, scientific writing skills, Significance of communicating science, ethical issues, Copy rights and plagiarism, Components of a research paper 3. Preparation of Project Proposal – Time frame and work plan – Budget and Justification	15

CourseCode: ENV 531 RM-PR

Course Name: Research Methodology Practical

Credit: 2

Course Outcomes:

ENV 531 RM-PR Research Methodology Compulsory Practical Paper **Total: 2 Credits Workload: 30hrs/credit** **(Total Workload: 2 credits x 30 hrs =60 hrs in semester)**		
Credit	**Title and Contents**	**Number ofhours**
	Seminar presentations, group activities, and scientific writing sessions based on above theory course. These willinclude but not limited to- 1. Use of search engines for scientific data mining 2. Use of reference management tools 3. Preparing power point presentation 4. Statistical data analysis using software 5. Presenting a research article 6. Writing an abstract for a research paper 7. Preparing a graphical abstract using software 8. Writing a concept note for research project 9. Scientific poster preparation & presentation 10. Writing a scientific news article or a science blog 11. Preparing and scientoon 12. Participating in group discussions, conferences, symposia etc.	**60**

CourseCode: ENV 510 MJ- TH (Group I)

Course Name: Fundamentals of Atmospheric Sciences

Credit: 2

Course Outcomes:

Course Outcome No.	Statements
CO 1	Describe the basics of evolution of earth, its process, hydrology and soil.
CO 2	Discuss the correlation between various process and earths stability
CO 3	Examine the impact and changes caused by over utilization of earths resources and pollution
CO 4	Investigate the root causes of imbalances in earth process
CO 5	Measure the present conditions based on study of environmental parameters
CO 6	Propose a base plan for achieving environmental stability through monitoring parameters

ENV 510 MJ-TH	FUNDAMENTALS OF ATMOSPHERIC SCIENCES (2 Credits)	No. of lectures in Clock Hours
1	• Evolution, Composition and Structure; Elements of weather and climate; Weather Parameters (temperature, wind pressure, relative humidity, rainfall); Climatology of weather parameters; Long- and Short-term climatic effects • Insolation; The energy system and its balance; Flux of solar system in thebiosphere; Earth's radiation budget; Net radiation and latitudinal heat balance; Green House Effect and Human influence on radiation balance. • Atmospheric pressure, measurements & Distribution; Pressure & Wind Belts; local winds; Geostrophic & gradient winds; Air masses, Classification and modifications of air masses. Fronts, Classification of fronts. Atmospheric moisture- Condensation; Forms of precipitation; Cloud Classification; Indian Monsoon; Inter-tropical Convergence Zone (ITCZ); • Walker Circulation: El Nino- La Nina • Atmospheric Stability & Instability; Dry and moist adiabatic lapse rate; • Environmental lapse rate, plume behaviour • Environmental Meteorology - Atmospheric chemical transport	**20**

	models; emission inventory- aerosol and gas pollutants; National Air QualityStandards and Indices; Dry and wet deposition fluxes of gas and aerosol pollutants; Intercontinental and hemispheric transport of air pollutants	
2.	**Ocean Science:** ● Ocean Basins and Physical structure of ocean floor; Oceanicenvironments ● Vertical stratification of water column (Temperature, Pressure,Salinity, pH, Oxygen, CO2, Nutrients) ● Waves, Tides, Currents, Tsunamis; Importance of winds & Hadley's Cell;Coriolis Effect; Geostrophic Currents; Ekman Spiral; Upwelling ● & Productivity; Surface; Thermohaline and Bottom water circulation	**8**
3	**Earth Resources:** Occurrence, exploitation and environmental impacts Coal, Hydrocarbons and mineral resources.	**2**

CourseCode: ENV 511 MJ – TH (Group I)

Course Name: Fundamentals of Geo-Sciences

Credit: 2

Course Outcomes:

Course Outcome No.	Statements
CO 1	Describe the basics of atmosphere and oceans and its process
CO 2	Discuss the correlation between various ocean process and atmosphere stability
CO 3	Examine the impact and changes caused by over utilization of ocean resources and pollution
CO 4	Investigate the root causes of imbalances in atmosphere and oceans
CO 5	Measure the present conditions based on study of environmental parameters
CO 6	Propose a base plan for achieving environmental stability through monitoring parameters

ENV 511 MJ-TH	FUNDAMENTALS OF GEO SCIENCES (2 Credits)	No. of lectures in Clock Hours
1.	**Earth: Origin, Structure, Dynamics & Composition** ● **Origin:** Origin of Earth & its spheres (Lithosphere,Biosphere, Hydrosphere, Atmosphere) ● **Structure:** Internal Structure of Earth - Core, Mantle and Crust; Thermal,Magnetic & Gravitation Fields of the Earth ● **Dynamics:** Concepts of Plate Tectonics & Sea Floor Spreading, Mountainbuilding (folding and faulting), Earthquakes, Volcanism ● Composition: Igneous, Sedimentary & Metamorphic Rocks; Processes and formation; Characteristics of major Rocks andMinerals.	**9**
2.	**SURFACE PROCESSES & LANDFORMS** ● Processes and agents of weathering, erosion, transportation anddeposition; Cycles of erosion- Davis and Penck Models ● Mass-wasting; ● Erosional and depositional landforms: Glacial, Aeolian, Fluvial, Coastal,shallow marine and deep marine.	**6**

	• Concept of Engineering & Urban Geology	
3.	**Soil:** Genesis of Soil; Soil Profile; Soil texture, structure; Bio-, Physico- Chemical properties of soil; Soil Classification; Soil types w.r.t. genesis;Fertility; Lateritization; Land use and Land capability classification; Water-logging, salinization, desertification and degradation of soil.	**7**
4.	**Hydrology:** • Concept of Hydrology & Hydrogeology • Hydrological Cycle (Precipitation, Infiltration, Surface Run off, Evapo-transpiration) • Surface & Groundwater Resources; • Vertical distribution of groundwater: Types of Aquifers & Springs; Hydrological properties of rocks: Darcy's Law, Storativity, HydraulicConductivity, Transmissivity, • Concept of Drainage Basin and Watershed.	**8**

CourseCode: ENV 512 MJ-TH (GroupII)

Course Name: Sustainable Development

Credit: 2

Course Outcomes:

Course Outcome No.	Statements
CO 1	Define and List down the sustainable development goals.
CO 2	Discussion of current and future challenges to achieve sustainable development.
CO 3	Demonstrate how renewable energy resources contribute to achieving SDG's.
CO 4	Distinguish between the social, environmental and economic need of present and future generation and Investigate the effectiveness of government policies.
CO 5	Evaluate the role of local communities in driving sustainable development in rural area and evaluate the impact of sustainable agricultural practices on food security.
CO 6	Design a global strategy to achieve the Sustainable Development Goals by 2030

ENV507 MJ	**SUSTAINABLE DEVELOPMENT (2 Credits)**	**No. of lectures in Clock Hours 30**
1	**Sustainable development** Impact of development of environment, sustainability, World Commission on Environment and Development, definitions of sustainability and sustainable development, need for sustainable development	**6**
2	**Ecosystem & Sustainability:** Fundamentals of ecology - types of ecosystems & interrelationships, factors influencing sustainability of ecosystems, ecosystem restoration - developmental needs. Introduction to sustainability & its factors, requirements for sustainability: food security and agriculture, renewable resources - water and energy, non-renewable resources, factors and trade-offs, sustainability conflicts	**6**
3	**Dimensions to Sustainable Development** - society, environment, culture and economy; current challenges - natural, political, socioeconomic imbalance; sustainable development initiatives and	**6**

	policies of various countries : global, regional, national, local; needs of present and future generation - political, economic, environmental.	
4	**Gauging Sustainable Development** - Sustainability and development indicators and SDGs, UN's outlook of sustainable development and efforts, UN SDGs - structure, governance and partnerships; communities / society: ensuring resilience and primary needs in society; biosphere: development within planetary boundaries; strengthening institutions for sustainability; shaping a sustainable economy.	**6**
5	**Case Studies & Projects on Urban and Rural Sustainable Development (Indian perspectives) –** Sustainable cities, smart infrastructure, resilience, Village resources (broad perspectives); current challenges and thematic areas; village social hierarchy; village economy; needs of present and future generation; conflicts - sustainability and rural culture & tradition; road to achieving sustainable development goals - bridging conflicts and way forward.	**6**
	Suggested reading • Franco, I.B. and Tracey, J. (2019), "Community capacity-building for sustainable development: Effectively striving towards achieving local community sustainability targets", International Journal of Sustainability in Higher Education, Vol. 20 No. 4, pp. 691-725 • Our Common Journey: A Transition Toward Sustainability. National Academy Press, Washington D.C. Soubbotina, T. P. 2004. • Elliott, Jennifer. 2012. An Introduction to Sustainable Development. 4th Ed. Routledge, London. • Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. "An introduction to sustainable development." (2012). • Sachs, J. D. 2015. The Age of Sustainable Development. Columbia University Press, New York. • Soubbotina, Tatyana P. 2004. Beyond Economic Growth: An Introduction to Sustainable Development. WBI learning resources series. Washington DC ; World Bank.	

CourseCode: ENV 513 MJ-TH (Group II)

Course Name: Environmental Education

Credit: 2

Course Outcomes:

Course Outcome No.	Statements
CO 1	Define sustainable development and describe the guiding principles of environmental education
CO 2	Explain the role of environmental education in promoting sustainable practices
CO 3	Demonstrate the the importance of integrating environmental education and sustainability principles into school curriculum.
CO 4	Appraise the role of eco clubs and project based education in enhancing students understanding of environmental aspects.
CO 5	Evaluate how well current environmental education policies address the environmental conservation and natural resource management
CO 6	Propose an outdoor education program and project based learning activity that encourages the sustainable practices among students

ENV 513 MJ-TH	Environmental Education	No. of lectures in Clock Hours 30
1	**Introduction to Environmental Education (EE) and Education for Sustainable Development (ESD)** Importance of EE and ESD as essential tool for achieving sustainable development. Evolution of the concepts of EE and ESD at the international level, Agenda 21 and Earth Charter; Traditional and community based approaches of teaching and learning; Guiding Principles of Environmental Education.	**6**
2	EE in Formal Education Current policies and status of EE and ESD in Indian school systems and other countries. Evolution of EE in Indian school systems, the importance to Environment in India's National Policy on Education, EE in National Curriculum Framework; Quality Education and ESD; extra-curricular approaches; the whole-school, whole-systems approach: textbooks and EE; school infrastructure and habitat; eco-clubs; project-based learning EE at college/ university level. Teacher orientation for EE and ESD	**6**

3	**ESD and Communication, Education and Public Awareness (CEPA)** Policies and approaches to public awareness. EE/ ESD/ CEPA as elements of multilateral environmental agreements, national programmes, and civil society efforts in environmental conservation, natural resource management, health and sanitation, waste reduction and management, pollution abatement, consumption and lifestyles.	**6**
4	**Educator Competence** The role of the educator and facilitator. Understanding advocacy, communication, facilitation, collaborative and action learning. Framework of competence for Education for Sustainable Development.	**6**
5	**Teaching-Learning Approaches** Introduction to teaching-learning processes and techniques in the context of EE and ESD; developing and using different approaches. Roles and use of traditional and new media. Experiencing nature/ nature camps. Communication campaigns, mass media. Deliberative and participatory techniques. Techniques to enhance systems thinking, critical thinking, values clarification, empathy. Evaluation of EE and ESD programmes	**6**
	Readings and references Tbilisi to Ahmedabad – Centre for Environment Education Green Teacher - Centre for Environment Education Green Action Guide - Centre for Environment Education UNECE Strategy for Education for Sustainable Development National Curriculum Framework – NCERT ESD Toolkit – UNESCO Engaging People in Sustainability (IUCN, Gland, Switzerland) - Tilbury, D. and Wortman, D. (2004) Power: A practical guide for facilitating social change - Raji Hunjan and Jethro Pettit Wals, A. (ed.) (2007). Social learning towards a sustainable world. Wagening: Academic Publisher Ison, R. (2010) Systems Practice: How to Act in a Climate Change World**.** Dordrecht: Springer.	

M. Sc. I ENVIRONMENTAL SCIENCE

SEMESTER II

Semester	Course Code	Type of Course	Course Title	Theory/ Practical	Credits	No. of clock hours per week
Semester II	ENV 551 MJ-TH	Core Compulsory Theory Papers	Water & Soil Pollution: Management & Mitigation	**Theory**	4	4
	ENV552 MJ-TH		Air, Noise & Radiation Pollution:Management & Mitigation	**Theory**	4	4
	ENV 553 MJ-TH		Environmental Law	**Theory**	2	2
	ENV 554 MJ-PR	Core Compulsory Practical paper	Practicals based on ENV551 MJ-TH, ENV 552 MJ-TH and ENV 553 MJ-TH	**Practical**	4	8
	ENV 581 OJT	Internship On job training	Internship /On Job training	**Practical**	4	(Total Clock Hours 120)
	Group I ENV 560 MJ-TH	Choice Based Optional Papers Elective / Departmental Course **Any one group**	Water & Wastewater technology-I(Basic)	**Theory**	2	2
	Group I ENV 561 MJ-TH		Water & Wastewater technology-II(Advanced)	**Theory**	2	2
	GroupII ENV 562 MJ-TH		Environmental Management	**Theory**	2	2
	GroupII ENV 563 MJ-TH		International Environmental Law	**Theory**	2	2

CourseCode: ENV 551 MJ-TH
Course Name: Water & Soil Pollution: Management & Mitigation
Credit: 4
Course Outcomes:

Course Outcome No.	Statements
CO 1	Recall the sources and pathways of water and soil pollution
CO 2	Explain the environmental and socioeconomic impacts of water and soil pollution
CO 3	Implement sampling and analysis techniques to assess water and soil quality.
CO 4	Analyze the effectiveness of different pollution control techniques and management strategies.
CO 5	Evaluate the sustainability of remediation techniques and long-term impacts on ecosystems
CO 6	Conduct a public awareness campaign to educate communities about the importance of water and soil conservation and pollution prevention

ENV 551 MJ-TH	Water and Soil Pollution: Management & Mitigation (4 Credits)	No. of lectures in Clock Hours
1.	**Freshwater Pollution** • Types and sources, Inorganic and organic pollutants responsible for water pollution: Biological pollutants; Pesticides; Radioactive pollutants, etc. • effluent standards, Drinking water standards, Characteristics of Domestic waste, Characteristics of Agricultural waste. • Consequences of water pollution: Effects on health, on biosphere and on economy. • Remedial measures of Freshwater pollution. • Case studies based on freshwater remediation using traditional and moderntechnology.	**16**

2.	**Groundwater Pollution** • Sources, groundwater contamination zones, groundwater remediation *in situ* and *ex situ* techniques; • bioremediation strategies of groundwater using bio-venting, bio- sparging,bio- slurping, permeable reactive barriers; • groundwater monitoring using Piezometer, slug and pumping tests; • Darcy's Law for estimation of hydraulic parameters, Numerical simulationfor aquifer yield prediction, Artificial recharge and induced infiltration, Land subsidence; • Coastal aquifers & Sea water intrusion • Environmental regulatory bodies preventing groundwater pollution; • Case studies-based insight in to groundwater remediation techniques.	**16**
3.	**Marine Water Pollution:** • Sources, types and consequences; • Ballast water pollution • pollution due to off shore drilling, deep mining and oil extraction and othersources; • prevention methods, control measures using bioremediation (bio- surfactants, microcosms), physical (booms, skimmers, absorbents etc) and chemical methods (dispersants, detergents etc). • Case studies-based analysis of marine water pollution and prevention strategies.	**12**
4	**Soil Pollution and Control** • Types, Effects and sources and consequences. • Mechanism of interaction of waste with soil. • Transport processes — biological process-microbial transformation of heavy metals. • Specifications for disposal of sewage and effluent on land for irrigation and groundwater recharge. • Methodology of wastewater disposal on land in India. • Impacts of usage of land for solid waste disposal both municipal solid waste and industrial solidwastes (fly ash from thermal power station, lime sludge from pulp and papermills). • Disposal of hazardous solid waste (heavy metals, toxic organic compounds) on land and its impact on soil pollution. • Deterioration of soil due to mining activities • Case study of restoration of land due to a disposal of fly ash, dumping overburden and tailing in iron ore extraction.	**16**

	Reference Books: • Groundwater In the Environment: An Introduction, Paul L Younger2014, ISBN:978-265-4636-7 • Groundwater Hydrology, Bhagu R Chahar, McGraw Hill • EducationEnvironmental Chemistry, B. K. Sharma • Environmental Chemistry and Pollution Control, S. S. • DaraEnvironmental Pollution, N. Manivasakam • Environmental Chemistry, Samir K. Banerji	

CourseCode: ENV552 MJ-TH
Course Name: Air, Noise & Radiation Pollution:Management & Mitigation
Credit: 4
Course Outcomes:

Course Outcome No.	Statements
CO 1	Describe Air, Noise and Radiation Pollution
CO 2	Summarise the effects on Air, Noise and Radiation Pollution
CO 3	Demonstrate the working of Air pollution control by fuel selection.
CO 4	Investigation and assessment of impact of Air and Noise
CO 5	Measure Noise pollution in all four zones and also assess Air Quality of the indoor and outdoor.
CO 6	Compose a plan to reduce Air, Noise and Radiation Pollution

ENV552 MJ-TH	Air, Noise & Radiation Pollution: Management & Mitigation	No. of lectures in Clock Hours
1.	**Air Pollution: Causes and Effects:** • Definition, Composition of air, • Classification of air pollution, Sources, • Effect of gaseous and particulate pollutants on animals, plant and humanhealth, • Economic effects of air pollutants, Vehicular Pollution, Industrial Pollution.	4
2.	**Air Pollution Meteorology & Chemistry** • Wind as a factor, • Temperature structure, • The role of atmospheric stability, • Dispersion of air pollutants. • Chemical Principles and Troposphere and Stratospheric Ozone Chemistry: Ozone formation & destruction, Polar Stratospheric Clouds (PSPs).	8
3.	**Air Quality Analysis** • Air monitoring instruments and techniques: SOX, NOX, O3, C6H6,Pb, CO, H_2S, NH_3, HC, Fluoride, SPM, RPM	8

4.	**Air Pollution Control Technology:** • Equipment's and Basic Operating Principle; • Control of air pollution by fuel selection, • principle and working of – cyclones, scrubbers, settling chambers and electrostatic precipitators. • Control of gaseous pollutants: absorption, adsorption, condensation, vapor incineration. • Equipment for control of air pollution – Cyclones, Wet scrubbers, Electrostatic precipitators, fabric filters, absorption.	8
5.	**Air Quality Management: Policy and Institutional Framework** • Ambient Air Protection Policy, Air Quality Norms, Regulation of Emissions from Stationary & Non-Stationary Sources. • Public Informing and Participation in Decision Making Process, Planning and Implementation of Ambient Air Protection Measures. • Strategies for Air Pollution Control - Control of air pollution by fuel selection and utilization, by process modification or equipment, by site selection and zoning.	8
6.	**Air Pollution Episodes:** Case Studies	2
7.	**Noise Pollution & Control** • Introduction to noise and vibrations, • physics of sound and hearing, • Noise pollution, sources and effects. • Noise control at source: Source path receiver concept, control bydesign, control by redress • Noise control in the transmission path: Acoustical separation, physicalbarriers, Isolators and Silencers • Protecting the receiver: personal protection device	6
8.	**Noise Monitoring and Impact Criteria** • Noise measuring techniques, national standard for noise, • noise monitoring methods, A-weighted Sound Level: The Basic Noise Unit; Maximum Sound Level (Lmax) During a Single Noise Event; • Sound Exposure Level (SEL): Exposure from a Single Noise Event HourlyEquivalent Sound Level (Leq (h)); Day-Night Sound Level (Ldn): 24- Hour Exposure from All Events; A Noise-Exposure Analogy for Leq andLdn	6

	• Investigation and assessment of impact of noise, Considerations in applying the Noise Impact Criteria; • Mitigation Policy Consideration;Determining the Need for Noise Mitigation.	
9.	**Radiation Pollution** • Radioactivity – types and measurement. Detection of nuclear radiations– G. M. counter, scintillation counter, semi-conductor detector. • Radiation hazards and safety – natural and manmade. • Types of radiations. Internal and external radiation hazards, safe handling methods, personal dosimeter, reactor safety. Interaction of radiation withmatter. • Units of measurements, half-life period, radiation dose measurement. • Biological effects and health hazards associated with radiation. Interaction of radiations with biological cells, somatic and genetic effects. • Classification of radio-active wastes – gas, solid, liquid. • Control measures – treatment and disposal of radio-active waste, generation of waste from various sources. • ICRP recommendations. AERB classification, maximum permissible dose. • Three miles and Chernobyl accidents.	10
	Reference Books • Fundamentals of Air Pollution – Daniel A. Vallero • Air Pollution: Health and Environmental Impacts – L.T Molina & B.R Gurjar • Advanced Air and Noise pollution Control – L.K Wang & N.C Pereira • Textbook of Noise Pollution & Its Control – S.C. Bhatia Environmental Chemistry - A.K. De • Environmental Chemistry – B.K. Sharma	

CourseCode: ENV 553 MJ-TH

Course Name: Environmental Law

Credit: 2

Course Outcomes:

Course Outcome No.	Statements
CO 1	Recall the legal provisions for environment
CO 2	Associate the importance of environment in legal systems National and International for sustainable development
CO 3	Demonstrate the implications of environmental offence with respect to legal provisions
CO 4	Inspect the mandatory procedure to followed with respect to provisions
CO 5	Argue and defend the sustainable approach and ethical dilemma governing the legal process to be adapted
CO 6	Design and develop polices

ENV 553 MJ-TH	ENVIRONMENTAL LAW (2 CREDITS)	No. of lectures in Clock Hours
1.	Introduction to Law and Policy- basic concept of Law and Policy(Importance and difference)	1
2.	International Conferences impacting Indian legal system such as Stockholm conference, Rio conference, Rio+5,Rio+10.	1
3.	Environmental Policies in the Indian Constitution - Role of constitution in environment protection, Fundamental rights and duties, Article 48A,51A (g), 58A, etc.	1

4.	Important Environmental Laws in India • The Wildlife (Protection) Act, 1972 • The Water (Prevention and Control of Pollution) Act, 1974 • The Air (Prevention and Control of Pollution) Act, 1981 • The Environment (Protection) Act, 1986 and importantnotifications issued under this Act • Coastal Regulation Zone Notification 2018 • The Energy Conservation Act, 2001 • Biological Diversity Act 2002 • Scheduled Tribes and Other Traditional Forest Dwellers(Recognition of Forest Rights) Act, 2006 (FRA) • The National Green Tribunal Act, 2010 • Compensatory Afforestation Fund Act, 2016 • The Forest (Conservation) Act, 1980	15
5.	Rules and Regulations (As amended) • Hazardous Waste Rules • Solid Waste Management Rule • Biomedical Waste Rules • Batteries Rules • E- waste rules • Plastic Waste Management Rules, Extended ProducerResponsibility (EPR) • Construction and Demolition waste Rules • Concept of Eco sensitive zones,	08
6.	International Environmental Laws and Policies • UNFCCC, Paris climate accord or Paris climate agreement 2015 • Kyoto Protocol • Convention on Biodiversity • International Solar Alliance • CITES • Ramsar Convention • Basel Convention • MARPOL • Cartagena Protocol on Bio-safety • AGENDA 21 Others	04

	Reference Books: 1. T S Doabia. 2017. Environmental and Pollution Laws In India.3rd Edition. Publisher: Lexis Nexis 2. P. Leelakrishnan. 2016. Environmental Law in India. 4thedition. Publisher: Lexis Nexis. 3. S. K. Mohanty. 2009. Environment and Pollution Laws.Publisher: Universal. 4. P. Leelakrishnan. 2006. Environmental Law Case Book. 2ndedition. Publisher: Lexis Nexis. 5. Divan Shyam and Rosencranz Armin. 2002. Environmental Law and Policy in India: Cases, Material & Statutes. Publisher: Oxford.	

CourseCode: ENV 560 MJ-TH (Group I)
Course Name: Water & Wastewater technology-I(Basic)
Credit: 2
Course Outcomes:

Course Outcome No.	Statements
CO 1	Describe population forecasting methods, state different water quality standards.
CO 2	Explain the application of various units of Water and Waste Water Plant.
CO 3	Apply Various advanced treatment methods in appropriate unit operations. .
CO 4	Compare various techniques for improvement in quality of water and Waste Water
CO 5	Estimate for designing of each operational units in Water and Waste Water Treatment Plant. Selection of appropriate unit operation for treatment.
CO 6	Create flow chart of Water Treatment and Waste Water plant. Construct and design Water Treatment and Waste Water plant

ENV 560MJ-TH	WATER & WASTEWATER TECHNOLOGY-I (BASIC) (2 CREDITS)	No. of lectures in Clock Hours
1	• Quantity of water - Water Requirements for domestic consumption. Population forecasting by the following method; Demographic method, Arithmetical progression method, Geometrical progression method,Logistic methods, Graphical projection method, Final prediction. Variation in quantity of water and waste water, Factors affecting rate of demand. • Quality of water required for – Domestic, Institutional (Schools, Hostels, Hospitals), Firefighting, Commercial (Shopping complex, Hotels, Restaurant), Industrial (Dairy, Sugar, Pulp and Paper, etc.). Specific requirement at pilgrimage place and recreation activities Quality parameters for water analysis, methods for analysis.	**8**

2	• Impact of future growth and development and change in quality of life on water requirement. • Need of water quality standards for domestic &industrial purpose. Specifications for drinking water (physical, chemical &bacteriological) by Bureau of Indian Standards & World Health Organization. Packaged drinking water. Coliform bacteria as indicator organisms, Tests for the coliform group (MPN Method), growth kinetics.	**6**
3	• Water Treatment – Principle, Application & Designing of following unit operation water treatment. • a. Collection & pumping; b. Aeration; c. Flocculation; d. Sedimentation; e. Filtration; f. Disinfection; g. water softening	10
4	Wastewater technology – • Impact of Future growth & development & change in quality of life on sewage quality & quantity. • (Physical, Chemical and Biological Treatment), different models of aerobic and anaerobic digestion by combination of attached & suspended growth • Role of microorganisms, Kinds of Microorganisms, Pathogenic microbes, indicator microbes, enumeration of microbes, Water borne diseases, • Importance of public health perspectives, socioeconomic impacts, Types of waterborne diseases (Protozoan, Algal, Fungal, Bacterial, and Viral diseases), prophylactic measures	6
	Reference Books: 1. Water Supply and Sanitary Engineering –G.S.Birdie and J.S.Birdie 2. Water Supply Engineering –Dr. P.N.Modi 3. Water Supply and Wastewater Engineering –Dr. B.S.N.Raju 4. Water Supply Engineering –B.C. Punmia 5. Water Supply Engineering –Hussain 6. Water Supply Engineering –Chatterjee 7. Water supply and sanitary engineering - Rangwala	

CourseCode: ENV 561 MJ-TH (Group I)

Course Name: Water & Wastewater technology-II (Advanced)

Credit: 2

Course Outcomes:

ENV 561 MJ-TH	WATER & WASTEWATER TECHNOLOGY-II (ADVANCED) (2CREDITS)	No. of lectures in Clock Hours
1	• Specifications of treated wastewater for disposal into surface water, on land & in marine waters after treatment. • Self-purification of water bodies	4
2	• Advanced treatment methods: a. Demineralization; b. Ultra-filtration; c. Reverse osmosis; d. Color & odor removal by activated carbon; e. Iron removal; f. Nitrification and denitrification • Selection of appropriate unit operations for the treatment and flow chart of water treatment plant	6
3	• Wastewater engineering - Primary, secondary and Tertiary treatment process. • Principle and designing of following Unit Operations in wastewater treatment: Collection system - Methods of collection, conservancy systems, collection system, water carriage system, sewerage system. Screen chamber, Grit chamber, Oil & grease removal, Aeration and sedimentation, Stabilization Pond, Aerated lagoon, activated sludgeprocess, trickling filter, Rotating biological contactors Anaerobic digestion processes, fluidized bed reactor, UASB Treatment and Disposal of sludge (composting, sludge cakes, sludge digestion, energy recovery) Special treatments like septic tanks, soak pits.	15
4	• Industrial Wastewater-Selection of appropriate unit operations for thetreatment and flow chart of wastewater treatment plant for a. Dairy; b. Pulp & Paper; c. Galvanizing, etc.	5
	Reference Books: • Waste water engineering – Metcalf & Eddy • Elements of Environmental Engineering –K.N. Duggal • Environmental Biotechnology-T Srinivas (New Age Publications) • Environmental Engineering - Peavy, Rowe, Tchenobolus • Water supply and sanitary engineering - Rangwala	

CourseCode: ENV 562 MJ-TH (Group II)

Course Name: Environmental Management

Credit: 2

Course Outcomes:

Course Outcome No.	Statements
CO 1	Outline the fundamentals, tools and standards for environmental management
CO 2	Explain the environmental management systems
CO 3	Demonstrate Life Cycle Analysis
CO 4	Apparaise environmental designs
CO 5	Evaluate application of environmental management systems in economy

ENV 562MJ-TH	ENVIRONMENTAL MANAGEMENT (2 CREDITS)	No. of lectures in Clock Hours
1.	• Environmental Management, role in sustainable development, Fundamentals of environmental management, • Tools of environmental management, international standards in environmental management. • Background and development of the ISO 14000 series of standards. EMAS- European Union	5
2.	• Environmental Management Systems Definition and scope, • Goals and purposes of EMS, Planning, • Implementation, Review and Improvement (Plan, do, check, act model), • Benefits of EMS- Environmental benefits, economic benefits, Costs associated with EMS	5
3	• Life Cycle Analysis Definition, Goals and purpose, • Stages in product LCA,Procedure for LCA- defining the goal and scope, analyzing the inventory, • Assessing the environmental impact and evaluating the environmental profiles, LCA uses and tools, Variants of LCA- cradle to grave, cradle to gate, cradle to cradle, gate to gate, well to wheel, • Benefits and limitations of conducting LCA	8

4.	• Environmental design Principles, benefits, motivation, ED for manufactured products, • ED for buildings ED for developmental planning	6
5	• Circular Economy vs linear economy, rationale for why we need to transform to a Circular Economy, closed loop systems, • Economic and social value, role of governments and networks and how policies and sharing best practices can enable the circular economy	6
	References/texts • Vijay Kulkarni and T V Ramchandra. "Environmental management"Capital Publishing • Bala Krishnamoorthy. "Environmental Management: text & case studies"PIH learning • ISO14001 standard for EMS	

Course Code: ENV 563 MJ-TH (Group II)

Course Name: International Environmental Law

Credit: 2

Course Outcomes:

Course Outcome No.	Statements
CO 1	Outline International legal provisions and conferences
CO 2	Review International environmental principles and concepts, declarations, conventions and treaties.
CO 3	Inspect the mandatory procedure to followed with respect to provisions
CO 4	Summarize the legal procedures and approaches
CO 5	Design and develop polices with reference to international regulations

ENV 563 MJ-TH	INTERNATIONAL ENVIRONMENTAL LAW (2 CREDITS)	No. of lectures in Clock Hours
1.	• Development of international environmental law, nature and scope of keyinternational environmental law principles and rights (substantive and procedural) • U.N. Conference on Human Environment, 1972 – Stockholm Principles, Establishment of Environmental Institutions like UNEP, World Charter for Nature	5
2.	• Rio conference, Rio declaration, conventions and treaties signed at Rio Agenda 21, Millennium development goal (now sustainable development goals) • Role of international institutions and actors involved in InternationalEnvironment Law. • Some basic environmental principles and concepts developed by the international legal system like Prevention, • Sustainable development, Polluters pay/liability, • Precautionary principles, • Inter- generational equity which are integral part of National Environmental Policy (2006) of India	10

3	• Laws of climate change • Montreal Protocol • United Nations Framework Convention on Climate Change (UNFCCC) • The Kyoto Protocol, • Paris Agreement (2015) • International Solar Alliance	6
4.	• Laws on hazardous wastes • Basel Convention on Transboundary Movement of Hazardous Waste, • Rotterdam Convention on Prior Informed Consent, • Protocol on liability and compensation for damage resulting from trans boundary movements of hazardous wastes and their disposal, 1999. • MARPOL	3
5	**Laws on Biodiversity Protection** Important provisions under the • Convention on Biological Diversity (CBD) • CITES • Ramsar Convention • Cartagena Protocol on Bio-safety	6

ASSESSMENT AND EVALUATION

- **Course Evaluation:**

Each course will be evaluated for 70% marks by End- Semester examination and 30 % will be based on In-semester continuous assessment.

- **Examination Results:**

Results at the end of the semester will be declared using a grade point system as per the University rules.

- **The GPA:**

The formula for GPA will be based on weighted average. The final GPA will not be printed unless a student passes courses equivalent to minimum 88 credits. Total credit hours mean a sum of credit hours of the courses which a student has passed.

- **Rules and University Guidelines:**

All other rules will be as per the university guidelines for postgraduate courses under credit-based system.

a) **IN-SEMESTER ASSESSMENT**: The Departmental Internal Assessment Committee will coordinate this activity. Internal assessment for each course would be continuous and dates for each tutorials/practical tests will be pre-notified in a separate time table.

- An in-semester assessment of 30% marks should be continuous and at least two tests should be conducted for courses of 4 credits and a teacher must select a variety of procedures for examinations such as:

1. Written test and/or midterm test (not more than one or two for each course)
2. Term paper
3. Journal/Lecture/Library notes
4. Seminar presentation
5. Short Quizzes
6. Assignments
7. Extension work
8. An open book test (with the respective subject teacher deciding what books are to be allowed for this purpose)
9. Mini research project by individual student or group of students

- **Field Work**: Fieldwork/visits is compulsory. Evaluation will be based on Performance of the student in the field, field diary and comprehensive field visit report

b) **END SEMESTER EXAMINATION**: The end semester examination of for remaining

70% marks will be conducted separately. The student has to obtain 40% marks in the both examination of In-semester assessment and Semester-End assessment.

- To pass the degree course, a student shall have to get a minimum aggregate 40% marks (E and above grade point scale) in each course. If a student misses an internal assessment examination, he/she will have a second chance with the permission of the Principal in consultation with the concerned teacher. Such a second chance shall not be the right of the student.
- Internal marks will not change. A student cannot repeat internal assessment. Students who have failed the semester-end exam may reappear for semester-end examination only twice in subsequent periods. The students will be finally declared as failed if he/she does not pass in all credits within a total period of four years. After that, such students will have to seek fresh admission rules prevailingat that time.
- A student cannot register for the third semester, if she/he fails to complete 50% credits of the total credits expected to be ordinarily completed within two semesters.
- There shall be Revaluation of answer scripts of semester examination but not of internal assessment papers as per the Ordinance no. 134 A and B. While marks will be given for all examinations, they will be converted into grades. The semester end grade sheets will have only grades and final grade sheets and transcripts shall have grade points average and total percentage of marks (up to two decimal points). The final grade sheet will also indicate the PG center to which the candidate belongs.
- Each assessment/test will be evaluated in terms of grades. The grades for separate assignments and the final (semester-end) examination will be added together and then converted into a grade and later a grade point average. Results will be declared for each semester and the final examination willgive total grades and grade point average.

Reference: Savitribai Phule University‘s circular on –Rules and Regulation for PG Choice Based credit system for Science Programme of Affiliated Colleges effective from June 2019 and further amendments.