GONDWANA UNIVERSITY, GADCHIROLI

Faculty of Science

Post Graduate course in Environmental Science

M.Sc. II year

Semester III and IV

Choice Based Credit System (CBCS)

w.e.f. the academic year 2017–18

Semester III

Code	Paper	Credits
PSCENVT09 (Core 9)	Paper IX: Water Treatment and Supply	4
PSCENVT10 (Core10)	Paper X: Wastewater Treatment	4
PSCENVT11 (Core Elective) **Any One**	Paper XI: 1.Air Pollution Control 2.Solid and Hazardous Waste Management 3.Atmosphere and Global Climate Change 4.Land and Soil Conservation	4
PSCENVT12 (Foundation Course) **Any One**	Paper XII: 1. Fundamentals of Environmental Science 2. Ecology	4

Practical

Code	Practical	Credits
PSCENVP05 (Core Pr. 5)	Water Treatment and Supply	4
PSCENVP06 (Core Elective Pr. 6)	Wastewater and Air Pollution	4
Seminar 03 (Ability Enhancement)	Seminar III	1
Total Credits		**25**

Semester IV

Code	Paper	Credits
PSCENVT13 (Core 11)	Paper XIII: EIA and Environmental Laws	4
PSCENVT14 (Core 12)	Paper XIV: Pollution Control and Industrial Safety	4
PSCENVT15 (Core Elective) **Any One**	Paper XV: 1. Environmental and Energy Management 2. Environment and Society 3. Wildlife Conflict and Management 4. Urban forestry and management	4
PSCENVT16 (Foundation Course) **Any One**	Paper XVI: 1. Sustainable Environment 2. Green Technologies	4

Practical

Code	Practical	Credits
PSCENVP07 (Core Pr. 7)	Environmental Management and Sustainable Environment	4
PSCENVP08 (Ability Enhancement)	Project (Dissertation)	4
Seminar 04 (Ability Enhancement)	Seminar IV	1
Total Credits		**25**

Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Environmental Science

Semester III

Code	Theory/ Practical	Teaching Scheme			Credit	Examination Scheme					
		Hrs./Week				Duration in Hours	Maximum Marks		Total	Minimum Marks	
		Theory	Practical	Total			External	Internal		Theory	Practical
PSCENVT09 (Core 9)	**Paper IX**	**4**	**-**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	
PSCENVT10 (Core10)	**Paper X**	**4**	**-**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	
PSCENVT11 (Core Elective)	**Paper XI**	**4**	**-**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	
PSCENVT12 (Foundation Course)	**Paper XII**	**4**	**-**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	
PSCENVP05 (Core Pr. 5)	**Practical V**	**-**	**8**	**8**	**4**	**12***	**80**	**20**	**100**		**40**
PSCENVP06 (Core Elective Pr. 6)	**Practical VI**	**-**	**8**	**8**	**4**	**12***	**80**	**20**	**100**		**40**
Seminar 03 Ability Enhancement	**Seminar III**	**2**	**-**	**2**	**1**	**-**		**25**	**25**	**10**	
Total		**18**	**16**	**34**	**25**		**480**	**145**	**625**	**170**	**80**

*Practical examination of 12 hours duration spread over two days.

Semester IV

Code	Theory/ Practical	Teaching Scheme			Credit	Examination Scheme					
		Hrs./Week				Duration in Hours	Maximum Marks		Total	Minimum Marks	
		Theory	Practical	Total			External	Internal		Theory	Practical
PSCENVT13 (Core 11)	**Paper XIII**	**4**	**-**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	
PSCENVT14 (Core 12)	**Paper XIV**	**4**	**-**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	
PSCENVT15 (Core Elective)	**Paper XV**	**4**	**-**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	
PSCENVT16 (Foundation Course)	**Paper XVI**	**4**	**-**	**4**	**4**	**3**	**80**	**20**	**100**	**40**	
PSCENVP07 (Core Pr. 7)	**Practical VII**	**-**	**8**	**8**	**4**	**12***	**80**	**20**	**100**		**40**
PSCENVP08 (Ability Enhancement)	**Project (Dissertation)**	**-**	**8**	**8**	**4**	**12***	**80**	**20**	**100**		**40**
Seminar 04 (Ability Enhancement)	**Seminar IV**	**2**	**-**	**2**	**1**	**-**		**25**	**25**	**10**	
Total		**18**	**16**	**34**	**25**		**480**	**145**	**625**	**170**	**80**

*Practical examination of 12 hours duration spread over two days.

M. Sc. II year
Semester III

PSCENVT09 (Core 9)
Paper IX
Water Treatment and Supply

Credit: 04

Unit I: Water Sources

1. Quality of water: Wholesome water, reason for the analysis of water, impurities in water-suspended, colloidal, dissolved. Examination of water-physical, chemical and biological test, maintenance of purity of water.
2. Quantity of water: Measurement of rainfall, rate of demand, factors affecting rate of demand, variations in rate of demand, estimating population, factors affecting estimated population.
3. Sources of water supply: Surface and underground sources, types of well, yield of a well, test for yield of a well, design of intake, intake towers, infiltration wells.

Unit II: Physical Treatment

1. Physical treatment: Important unit operations, gas transfer, ion transfer, solute stabilization, solid transfer, schematic layout of water treatment plant.
2. Preliminary treatment of water: screens, purpose, types, aeration-theory, types of aerators, factors governing aeration, design consideration of aerator's.
3. Sedimentation: Theory, sedimentation tank-horizontal, circular, hopper bottom, design consideration.

Unit III: Chemical Treatment

1. Coagulation: Theory, common coagulants, chemical reactions, dosage of coagulants, optimum coagulant dose by Jar test apparatus. Flocculation- theory, operations.
2. Filtration: Theory, types of filters (Slow sand filter, rapid sand filter and pressure filter),construction and operations.
3. Disinfection: Basic theory, chlorination forms-(Bleaching powder, liquid chlorine and chlorine gas), ozonisation, ultra purification, UV radiation.

Unit IV: Distribution System

1. Water distribution: Classification, gravity system, direct pumping system, methods of supply, economical and topographical considerations.
2. Distribution system: Layout of distribution system, dead end system, grid iron system,ring system, radial system, design consideration of distribution system, maintenance of distribution system.
3. Pumps and pumping: Necessity of pumping, pumps classification (displacement pumps,centrifugal pumps), operation of pumps, detection and prevention of leakages.

Books for Reference:
1. Instrumental Methods of Analysis: Willered Merit and Dean (CBS Publication, NewDelhi)
2. Wastewater Treatment for Pollution Control: Soli J. Arceivala, Tata McGraw Hill Publishing Company, New Delhi
3. Water Supply & Sanitary Engineering: G.S. Birdie
4. Textbook of Water Supply & Sanitary Engineering: S.K. Husain
5. Water Supply & Sanitary Engineering: R. C. Rangwala and S. C. Rangwala, Charotal Publishing House, Anand.

6. Wastewater Treatment: M. N. Rao, A. K. Datta, IBH Publishing Company, New Delhi.
7. A Textbook of Sanitary Engineering: Vinayak Gharpure, Engineering Book Publishing Company, Pune.
8. Water Pollution: V. P. Kudesia, Pragati Prakashan, Meerut.
9. Environmental Problems and Solution: D.K. Asthana, S.Chand and Company, NewDelhi.
10. A Textbook of Environment: K. M. Agarwal and P.K. Sikdar, Macmillon India Ltd,Nagpur
11. Environmental Engineering: H S Peavy, D R Rowe and G Tchobanoglous, McGraw Hill.
12. Introduction to Environmental Engineering and Science: Gilbert M Masters and W P Ela,PHI publication.
13. Environmental Engineering: G Kiely, Tata McGraw Hill.

PSCENVT10 (Core 10)
Paper X
Wastewater Treatment

Credit: 04

Unit I: Wastewater Sources

1. Sources of wastewater: Fundamentals of wastewater, domestic and industrial wastes,system of wastewater collection, concept of treatment.
2. Quality of sewage: Properties of sewage (physical, chemical and biological), cycles of decomposition, analysis of sewage (physical, chemical and bacteriological tests), relative stability, population equivalent.
3. Quantity of sewage: Measurement of wastewater, dry weather flow, storm water flow rates.

Unit II: Wastewater Engineering

1. Basic terms and plant layout: Concept of mass load, detention time (hydraulic retention time), horizontal and settling velocity, weir loading rate, organic loading, food to microorganism ratio, mean cell residence time, hydraulic loading, volumetric loading.Wastewater treatment plant layout: impact of flow rate and mass loading factors on design; evaluation and selection of design flow rates and mass loadings; elements of conceptual process, preparation of hydraulic profile. Design of sanitary sewers,construction and maintenance of sewers.
2. Design of preliminary and primary units: Design of sump and pump wells,equalisation basins, screen chambers, grit chambers, aerated grit chamber, oil and grease trap, settling and sedimentation tanks.
3. Design of biological units: Design of activated sludge process, secondary settling tank,waste stabilization pond, trickling filter tank, bio towers (vertical trickling filter), sludge drying bed.

Unit III: Primary Treatment

1. Primary treatment: Objectives and classification of wastewater treatment methods,screens- types, grit chamber: purpose, types, grit disposal.
2. Primary treatment processes: Detritus tank, skimming tank-operation plain sedimentation tanks (rectangular, hopper bottom and circular tank)
3. Coagulation: Necessity, principle of coagulation, different coagulant and their action, mixing devices for coagulation.

Unit IV: Secondary and Tertiary Treatment

1. Filters: Contact beds- theory, construction and working, trickling filters- theory,working, design aspects, bio filters.
2. Biological treatment process: Definition, action of activated sludge, flow diagram,method of aeration (diffused air, mechanical aerator, extended aeration, aerated lagoons)sludge bulking, SVI, SDI. Stabilization ponds (oxidation ponds), oxidation ditch, aeration ponds, aerobic ponds, facultative ponds, rotating biological contactors, disposal of sewage
3. Tertiary wastewater treatment: Removal of suspended solids, removal of dissolved solids, nutrient removal, ion exchange, reverse osmosis, recovery of materials from process effluents. Granular media filtration, ammonia removal, chlorination. Wastewater treatment for pulp and paper, iron & steel, and cement industry.

Books for Reference:

1. Wastewater Treatment Concepts and Design Approach: G L Karia and R A Christian, PHI Learning Private Limited.
2. Environmental Chemistry: B. K. Sharma, Goel Publishing House, Meerut.
3. Wastewater Engineering: Metcalf and Eddy, Tata McGraw Hill Publishing Company, New Delhi.
4. Environmental Chemistry: A. K. De, Wiley Eastern Limited, New Delhi.
5. Environmental Pollution: H. M. Dix, New York.
6. Environmental Chemistry: B. K. Sharma and H. Kour by Villa Publication, Meerut.
7. Introduction to Environmental Engineering: Mackenzie L. Davis & David A. Cornwell, McGraw Hill Publishing Company, New Delhi.
8. Basic Water Treatment: George Smethurst, Scientific Publishers, Jodhpur.
9. Chemical and Biological Methods for Water Pollution Studies: R. K. Trivedy, P. K. Goel,Environmental Publication, Karad.
10. Water Pollution and disposal of Wastewater on Land: U. N. Mahida, Tata Mc-Grew HillPublishing Company, New Delhi

PSCENVT11 (Core Elective)
Paper XI
1. Air Pollution Control

Credit: 04

Unit I: Air Quality

1. Air quality: Definition, atmospheric composition and stratification, urban and rural air quality. Air quality of major cities of India and world. Influence of natural and manmade factors, activities for deterioration of urban quality.
2. Sources of pollution: Stationary and mobile sources, criteria and non criteria pollutants.Classification of pollutants Fugitive -particulates and gaseous. Primary and secondary air pollutants. emissions. Urban heat island phenomenon.
3. Indoor air pollution: Introduction; mats, coils and aerosol spray. Indoor air quality in urban and rural area. Indoor air pollution's effects on health. Environmental tobacco smoke, asbestos. Radon, odour and volatile organic compounds: sources, effects and reduction techniques. Infiltration, ventilation and air quality. Indoor air quality model.

Unit II: Atmospheric Sampling and Analysis

1. Basic consideration: Consideration for air sampling, various instruments used for air sampling- high volume sampler, repairable dust sampler, fine particulate sampler:components, principle, working. Duration of sampling period, location of sampling sites,sampling methods -sedimentation, filtration, impingement methods, electrostatic precipitation.
2. Gaseous sampling: Classification of gaseous pollutants, inorganic: oxides of carbon,oxides of nitrogen, oxides of sulphur, H2S, ozone, ammonia, fluorine; organic:hydrocarbons, methane, organosulfur, organonitrogen compounds, alkenes, alkynes.Sulphation rate, chlorine, mercaptans, benzene, toluene and xylene and benzopyrene.Sampling of trace elements in air (viz. As, Pb, Ni etc.).
3. Particulate sampling: Analytical methods used for air pollutants SPM, RSPM, fine particulate matter, dust fall jar, heavy metals analysis in SPM.

Unit III: Stack Sampling and Analysis

1. Stack monitoring: Significance, planning, sampling train, sampling point selection for circular and rectangular duct, isokinetic sampling.
2. Stack sampling and analysis: Sampling system, stack monitoring parameters:particulate sampling, determination of gas composition, moisture content, temperature and velocity. Methodology for measurement of SO_2, NO_2 NH_3, and particulate matter at the source. Trace metals- As, Pb, Ni, Hg. Cascade impactor. Continuous monitors.
3. Air pollution and meteorology: Lapse rate, pressure system, wind, moisture, terrain w.r.t dispersion. Atmospheric dispersion-Gaussian, numerical, statistical, empirical and physical. Plume behaviour. Source apportionment.

Unit IV: Air Pollution Control

1. Particulate emission control: Atmospheric cleansing process, approaches to contaminant control. Gravitational settling chambers, centrifugal collectors, fabric filters(bag house filters), electrostatic precipitators (ESP), wet collectors.

2. Gaseous emissions control: Adsorption, absorption, combustion, automobile emission control. Air pollution control costs- coal fired power plants and automobiles emission. Carbon sequestration through forestry. Green belt development around industries.
3. Cleaner technologies: Particulate control: fuel substitution, process modification. Gas control: fuel substitution, fuel cleaning, flue gas desulfurization (FGD), NOX removal.Condensation and flaring.

Books for Reference:

1. Air Pollution and its Control: Sumit Malhotra (Pointer Publishers, Jaipur)
2. Air Pollution: M. N. Rao (Tata McGraw–Hill publishing company, New Delhi)
3. Air Pollution: B. K. Sharma, H. Kaur (Krishna prakashan media, Meerut)
4. Pollution of our Atmosphere: B. Henderson, (Sellers Adam Hilger Limited, Bristol)
5. Fundamentals of Air Pollution: Richard W. Bowbel, Donald L. Fox, D. Bruce Tunner, and A. C. Stern (Academic Press, California)
6. Air Pollution control Engineering: Noel De Nevers (McGraw – Hill international, New York)
7. Air Pollution: S. K. Agarawal (A. P. H. Publishing Corporation, New Delhi)
8. Air Pollution: V. P. Kudesia (Pragati Prakashan, Meerut)
9. Standard Handbook of Environmental Engineering: Second Edition, Robert A Corbitt, McGraw Hill Handbook.
10. Environmental Engineering: H S Peavy, D R Rowe and G Tchobanoglous, McGraw Hill.
11. Introduction to Environmental Engineering and Science: Gilbert M Masters and W P Ela, PHI publication.
12. Environmental Engineering: G Kiely, Tata McGraw Hill.

PSCENVT11 (Core Elective)
Paper XI
2. Solid and Hazardous Waste Management

Credit: 04

Unit I: Solid Waste

1. Characteristics of solid waste: Solid waste, changes in municipal solid waste, qualities and characteristics. Types of solid waste, factors affecting solid waste generation rate,composition (physical, chemical and biological) and classification of solid wastes.
2. Collection system: Collection services, types of collection systems, ease and frequency of pick up, collection equipment, transfer stations, location of transfer station, rail haul,route selection.
3. Separation and processing: At sources separation and processing, central separation and processing. Mechanical size alteration, component separation, magnetic and electrochemical separation, dewatering and drying. Material recovery.

Unit II: Municipal Solid Waste Management

1. Conversion of MSW: Incineration, composting, mechanical and thermal volume reduction, manual component separation.
2. Land filling: Design criteria for sanitary landfills and operation, problems with landfilling,leachetes generation control and treatment, gas production, GIS based site selection for land filling. Land farming and deep well injection.
3. Solid waste management: Sources reduction, reuse, recycling and recovery. Energy from solid waste, refuse derived fuel, anaerobic digestion and power production.Gasification and pyrolysis. Integrated waste management.

Unit III: Hazardous Waste

1. Hazardous waste: Types of hazardous waste, nuclear waste, biomedical waste, chemical waste. Identification of hazardous waste, collection, transportation and storage of hazardous waste.
2. Toxicity of hazardous waste: Corrosivity, ignetivity and reactivity. Basic division of toxicity, acute and chronic toxicity, factors influencing toxicity, dose response relationship, toxicity testing methods, acute toxicity test, chronic toxicity test, TCLP.
3. Public health hazard: Bioaccumulation and biomagnification, mutagenicity,teratogenicity, carcinogenicity, genotoxicity, toxicity due to pesticides, heavy metals,food adulterants and radioactive substances.

Unit IV: Hazardous Waste Management

1. Management: Components of hazardous waste management plan, hazardous waste minimization. Treatment and disposal of chemical wastes-treatment and disposal by industry, offsite hazardous waste treatment and disposal. Waste treatment: solid waste treatment, liquid waste treatment and gaseous waste treatment. Solidification and stabilization. Thermal destruction.
2. Secured landfill: Function, acceptable wastes, site selection and approval, design and construction. Treatment and disposal of leachates. Site remediation.
3. Waste minimization: Elements of a waste minimization strategy, benefits of waste minimization, elements of waste minimization program, waste reduction techniques.

Books for Reference:

1. Solid waste pollution: Dr. Aradhana Salpekar, Jnanada Prakashan, New Delhi, 2008
2. Principals of Soil Science: M. M. Rai, McMillon Publication.
3. Soil pollution & Soil organisms: P. C. Mishra
4. Environmental Chemistry: B. K. Sharma, Goyal Publishing House, Meerut, U.P. 1984
5. Environmental Science: S. C. Santra, New Central Book Agency, Kolkata, 2005
6. Environmental Pollution Control Engineering: C. S. Rao, New age International, Mumbai, 2003
7. Fundamentals of Soil Science: Henry D. Foth, John Wiley & Sons, New York, 1984
8. Environmental Engineering: Davis & Cornwell, McGraw – Hill Publications, New York, 1998
9. Environmental Science Principles and Practices: R. C. Das, D. K. Behra, Prentice Hall, New Delhi, 2008
10. Basic Environmental Technology: Jerry A. Nathanson, Prentice Hall of India Ltd. New Delhi, 2004
11. Environmental Biology and Toxicology: P. D. Sharma, Rastogi Publisher, Meerut, 2005
12. Environmental Engineering: H S Peavy, D R Rowe and G Tchobanoglous, McGraw Hill.
13. Introduction to Environmental Engineering and Science: Gilbert M Masters and W P Ela, PHI publication.
14. Environmental Engineering: G Kiely, Tata McGraw Hill.

PSCENVT11 (Core Elective)
Paper XI
3. Atmosphere and Global Climate Change

Credit: 04

Unit I

Introduction: Evolution and development of Earth's atmosphere; atmospheric structure and composition;significance of atmosphere in making the Earth, the only biosphere; Milankovitch cycles.Global energy balance: Earth's energy balance; energy transfers in atmosphere; Earth's radiation budget; green house gases(GHGs); greenhouse effect; global conveyor belt.

Unit II:

Atmospheric circulation: Movement of air masses; atmosphere and climate; air and sea interaction; southern oscillation; western disturbances; *El Nino* and *La Nina*; tropical cyclone; Indian monsoon and its development, changing monsoon in Holocene in the Indian subcontinent, its impact on agriculture and Indus valley civilization; effect of urbanization on micro climate; Asian brown clouds. Meteorology and atmospheric stability: Meteorological parameters (temperature, relative humidity, wind speed and direction, precipitation);atmospheric stability and mixing heights; temperature inversion; plume behavior; Gaussian plume model.

Unit III:

Atmospheric chemistry: Chemistry of atmospheric particles and gases; smog – types and processes; photochemical processes;ions and radicals in atmosphere; acid-base reactions in atmosphere; atmospheric water; role of hydroxyl and hydroperoxyl radicals in atmosphere. Global warming and climate change: Earth's climate through ages; trends of global warming and climate change; drivers of global warming and the potential of different green house gases (GHGs) causing the climate change; impact of climate change on atmosphere, weather patterns, sea level rise, agricultural productivity and biological responses - range shift of species, CO2 fertilization and agriculture; impact on economy and spread of human diseases.

Unit IV:

Ozone layer depletion: Ozone layer or ozone shield; importance of ozone layer; ozone layer depletion and causes; Chapman cycle; process of spring time ozone depletion over Antarctica; ozone depleting substances (ODS);effects of ozone depletion; mitigation measures and international protocols. Climate change and policy: Environmental policy debate; International agreements; Montreal protocol 1987; Kyoto protocol 1997;Convention on Climate Change; carbon credit and carbon trading; clean development mechanism.

Books for Reference:

1. Barry, R. G. 2003. *Atmosphere, Weather and Climate*. Routledge Press, UK.
2. Gillespie, A. 2006. *Climate Change, Ozone Depletion and Air Pollution: Legal Commentaries with Policy and Science Considerations*. Martinus Nijhoff Publishers.
3. Hardy, J.T. 2003. *Climate Change: Causes, Effects and Solutions*. John Wiley & Sons.
4. Harvey, D. 2000. *Climate and Global Climate Change*. Prentice Hall.
5. Manahan, S.E. 2010. *Environmental Chemistry*. CRC Press, Taylor and Francis Group.

6. Maslin, M. 2014. *Climate Change: A Very Short Introduction*. Oxford Publications.
7. Mathez, E.A. 2009. *Climate Change: The Science of Global Warming and our Energy Future*. Columbia University Press.
8. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. *Climate Change and India*. Universities Press, India.
9. Philander, S.G. 2012. *Encyclopedia of Global Warming and Climate Cha*nge (2nd edition).Sage Publications.

PSCENVT11 (Core Elective)
Paper XI
4. Land and Soil Conservation

Credit: 04

Unit I:

Introduction: Land as a resource, soil health; ecological and economic importance of soil; types and causes of soil degradation; impact of soil loss and soil degradation on agriculture and food security; need for soil conservation and restoration of soil fertility.

Unit II:

Fundamentals of soil science: Soil formation; classification of soil; soil architecture; physical properties of soil; soil texture; soil water holding capacity; soil temperature; soil colloids; soil acidity and alkalinity; soil salinity and sodicity; soil organic matter; micronutrients of soil; nitrogen, sulphur, potassium and phosphorus economy of soil; soil biodiversity; soil taxonomy maps. Soil degradation-causes:Soil resistance and resilience; nature and types of soil erosion; non-erosive and erosive soil degradation; losses of soil moisture and its regulation.

Unit III:

Landuse changes and land degradation: Land resources: types and evaluation; biological and physical phenomena in land degradation; visual indicators of land degradation; drivers of land degradation - deforestation, desertification; habitat loss,loss of biodiversity; range land degradation; land salinization; human population pressure, poverty,socio-economic and institutional factors; drivers of land use and land cover change in major geographic zones and biodiverse regions with particular reference to the Himalaya and the Western Ghats.

Unit IV:

Controlling land degradation: Sustainable land use planning; role of databases and data analysis in land use planning control and management; land tenure and land policy; legal, institutional and sociological factors; participatory land degradation assessment; integrating land degradation assessment into conservation.

Books for Reference:

1. Brady, N.C. & Well, R.R. 2007.*The Nature and Properties of Soils* (13th edition), Pearson Education Inc.
2. Gadgil, M. 1993. Biodiversity and India's degraded lands. *Ambio* **22:** 167-172.
3. Johnson, D.L. 2006. *Land Degradation* (2nd edition). Rowman& Littlefield Publishers.
4. Marsh, W. M. &Dozier,J. 1983. *Landscape Planning: Environmental Applications*. John Wileyand Sons.
5. Oldeman, L. R. 1994. The global extent of soil degradation. *Soil resilience and sustainable land use, 9*. (http://library.wur.nl/isric/fulltext/isricu_i26803_001.pdf).
6. Pandit, M.K. et. al. 2007. Unreported yet massive deforestation driving loss of endemic biodiversity in Indian Himalaya. *Biodiversity Conservation* **16**: 153-163.
7. Pandit, M.K. &Kumar, V. 2013. Land use and conservation challenges in Himalaya: Past, present and future. In: Sodhi, N.S., Gibson, L. & Raven, P.H. *Conservation Biology: Voices*

from the Tropics. pp. 123-133. Wiley-Blackwell, Oxford, UK. (file:///Users/mkpandit/Downloads/Raven%20et%20al.%202013.%20CB%20Voices%20from %20Tropics%20(2).pdf) .
8. Peterson, G. D., Cumming, G. S. & Carpenter, S. R. 2003. Scenario planning: a tool for conservation in an uncertain world. *Conservation Biology* 17: 358-366.
9. Scherr, S. J. 1999. *Soil degradation: A threat to developing-country food security by2020?* (Vol. 27). International Food Policy Research Institute.

PSCENVT12 (Foundation Course)
Paper XII
1. Fundamentals of Environmental Science

Unit I: Basics of Environmental Science

1. Atoms and Molecules: Origin of the Universe. The three era – radiation, matter and life era. Nucleosynthesis. Life cycle of a star. Distribution of elements. Big bang theory. Solar system. Aura and Meteorite.

2.Earth: Formation of the earth. Structure of the earth. Composition of crust. Mantle, core and earth as a whole. Differentiation of elements. Origin of life. Evolution of human being. Earth and its special features. Evolutions of India.

3.Basics of Environmental Science: Definition, History of Environmental science: Conservation and environmentalism. Key Concepts in Environmental Science, General principles. Components: Atmospheric sciences, Ecology, Environmental chemistry, Geosciences, Theoretical &Applied aspects of Environmental Science. Need and Scope of Environmental Science.

Unit ll: Earth surface processes

1. Atmosphere: Evolution of earth's atmosphere, composition of atmosphere, physical and optical properties, circulation; interfaces: atmosphere–ocean interface, atmosphere–land interface,

2.Earth system processes: Movement of lithosphere plates; major plates and hot spots, plate boundaries; sea floor spread; earthquakes; volcanic activities; gravitational and magnetic fields of the earth; origin of the main geomagnetic field; continental drift, continental collision and mountain formation with specific example of the Himalaya.

3. Land surface processes: Ocean–land interface; fluvial and glacial processes, rivers and geomorphology; types of glaciers, glacier dynamics, erosional and depositional processes and glaciated landscapes; coastal processes.

Unit III: Environmental Problems

1. Global Warming: Definition. Green house gases.Greenhouse gases in the atmosphere – sources and their impacts on health and agriculture, levels and mechanisms of action.Global warming potential of GHG's. Pre-industrial and existing atmospheric CO_2 concentration. Green house effects and climate change, consequences of greenhouse effect and global warming. Control measures. Carbon credits, CO_2 emissions: local and global scenario.

2.Global Climate change: Science of climate change, Global climate change process. Earth's carbon reservoirs and carbon cycle, Effects: Rise in earth's temperature; effects on forests, agro-ecosystems; desertification, freshwater ecosystems, oceans; sea level rise; melting of polar ice and glaciers; rainfall patterns; extreme events, socio-economic and public health consequences. India's response to climate change. Intergovernmental Panel for Climate Change (IPCC) and its role.

3.Ozone Layer: Significance. Measurement of ozone layer (Dobson unit). Formation. Mechanism of ozone depletion. Effects of ozone layer depletion on man, plants and biotic communities. Status of ozone layer, present research and techniques to protect ozone layer. Global debates on Ozone layer protection

UNIT- IV: Sustainable development

1. Sustainability and Sustainable Development: Sustainability theory, sustainability and society (social justice, development, economy).Concepts and principles of sustainable development. Case studies.

2.Ethics and Landmark Judgments: Value education and community, corporate social responsibility. Environmental Movements related to Environment – Sacred groves, Bishnoi tradition, Chipko movement, Apiko movement, Tehri dam, Sardar Sarovar, Narmada dam, Almatti dam, Silent Valley. Environmental ethics: issues and solutions

3. Sustainable development action plan: Agenda-21; UNEP programmes towards sustainable development: Sustainable development goals. Transforming our world: the 2030 Agenda for Sustainable Development. World summit on sustainable development (WSSD 2002). List of actions in everyday life.

Books for Reference:

1. Environmental Science –W. Cunningham and Saigo, McGraw Hill, New York.
2. A textbook of environment –Agrawal, Mcmillion publication, Mumbai
3. A textbook of geology –Purbeen Singh.
4. Climatology – D.S. Lal, Sharda Pustak Bhawan, Allahbad, 2003.
5. Environmental Chemistry – S.S. Dara, S. Chand and Company, New Delhi 2002.
6. Environmental Chemistry- B.K. Sharma, Goel Publication, Meerut.
7. Air Pollution –M.N. Rao, Tata McGraw Hill Publishing Company Limited, New Delhi, 2003
8. Air Pollution –A .C. Stern
9. Environmental Problems and solution- Asthana, S. Chand and company, New Delhi.
10. Environmental Science-S.C. Santra, New Central Book Agency private Limited, 2006.
11. Fundamental concepts of Environmental Chemistry-G.S.SODHI, Narosa Publishing House, New Delhi, 2002
12. Environmental Education –V.K. Rao, R.S. Reddy, Commonwealth Publisher, New Delhi.
13 A Textbook of Environmental Science-R.N. Trivedi, Amol Publications private limited, 1997
14. Man and Environment-P.R. Trivedi, Gurdeep Raj, Akshadeep Publishing House, New Delhi, 1997.
15. Environmental Studies-Kuashik and Kaushik, New Age International Publishers, 2004.
16. Environmental Geography-Savindra Singh. Prayag Pustak Bhawan, Allahabad (U.P.) 2001.
17. Fundamental Concepts in Environmental Studies – Dr. D.D. Mishra, S. Chand Publication, 2009.
18. Environmental Chemistry-A.K.DE, New Age International Publishers, 2001.
19. Plant ecology and Soil Science- Shulka and Chandel, S. Chand and Co., New Delhi.

PSCENVT12 (Foundation Course)
Paper XII
2. Ecology

Unit I:

Introduction: Basic concepts and definitions: ecology, landscape, habitat, ecozones, biosphere, ecosystems,ecosystem stability, resistance and resilience; autecology; synecology; major terrestrial biomes. Ecology of individuals **:**Ecological amplitude; Liebig's Law of the Minimum; Shelford's Law of Tolerance; phenotypic plasticity; ecotypes; ecoclines; acclimation; ecological niche; types of niche: Eltonian niche,Hutchinsonian niche, fundamental niche, realized niche; niche breadth; niche partitioning; niche differentiation; thermoregulation; strategies of adaptation in plants and animals.

Unit II:

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

Unit III:

Ecology of communities: Discrete versus continuum community view; community structure and organization: physiognomy,sociability, species associations, periodicity, biomass, stability, keystone species, ecotone and edge effect; species interactions: mutualism, symbiotic relationships, commensalism, amensalism,protocooperation, predation, competition, parasitism, mimicry, herbivory; ecological succession:primary and secondary successions, models and types of successions, climax community concepts,examples of succession.

Unit IV:

Ecosystem ecology: Types of ecosystem: forest, grassland, lentic, lotic, estuarine, marine, desert, wetlands; ecosystem structure and function; abiotic and biotic components of ecosystem; ecosystem boundary; ecosystem function; ecosystem metabolism; primary production and models of energy flow; secondary production and trophic efficiency; ecosystem connections: food chain, food web; detritus pathway of energy flow and decomposition processes; ecological efficiencies; ecological pyramids: pyramids of number, biomass, and energy.Biogeochemical cycles and nutrient cycling:Carbon cycle; nitrogen cycle; phosphorus cycle; sulphur cycle; hydrological cycle; nutrient cycle models; ecosystem input of nutrients; biotic accumulation; ecosystem losses; nutrient supply and uptake; role of mycorrhizae; decomposition and nutrient release; nutrient use efficiency; nutrient budget; nutrient conservation strategies.

Books for references:

1. Michael L. Cain, William D. Bowman, and Saily D. Hacker (2014). Ecology, 3rd Edition. Sinauer Associates Inc. US, 648p.
2. Odum, Eugene P., and Gary W. Barrett. (2007). Fundamentals of Ecology, 5th edition. Thomson Brooks / Cole.
3. Begon, M., Townsend, C. R., and Harper, J. L.(2005). Ecology from Individuals to Ecosystems. Wiley-Blackwell, USA.
4. Gotelli, Nicholas J. (2008). A Primer of Ecology, 4th edition. Sinauer.
5. Stiling, Peter. (2001). Ecology: Theories and Applicatios, 4th edition. Prentice Hall.
6. Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. (2007).An Introduction to Sustainable Development. Earthscan.
7. Edwards, Andres R. (2005). The Sustainability Revolution: Portrait of a Paradigm Shift. New Society. 8. Primack, Richard B. (2010).Essentials of Conservation Biology, 5th edition. Sinauer.
8.. Groom. B. & Jenkins. M. 2000.*Global Biodiversity: Earth's Living Resources in the 21st Century*. World Conservation Press, Cambridge, UK.
9.. Gurevitch, J., Scheiner, S. M., & Fox, G. A. 2002. *The Ecology of Plants*. Sinauer associates incorporated.
10. Loreau, M. & Inchausti, P. 2002. *Biodiversity and Ecosystem functioning: Synthesis and Perspectives.* Oxford University Press, Oxford, UK.
11.. Odum, E.P. 1971. *Fundamentals of Ecology*. W.B. Sounders.
12. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. *Ecology, Environment and Resource Conservation.* Anamaya Publications.
13. Wilson, E. O. 1985. The Biological Diversity Crisis. *BioScience* **35**: 700-706.

Practical
PSCENVP05
(Core Practical 05)
Practical V
Water Treatment and Supply

Credit: 04

1. Analysis of water for purity: pH, D.O. and free chlorine, conductivity, TDS, total, calcium and magnesium hardness.
2. Determination of impurities in water: suspended, dissolved and total solids.
3. Examination of water for various physical tests (temperature, odour, colour, taste, viscosity,density, surface tension).
4. Examination of water for different chemical tests (pH, conductivity, acidity, alkalinity, chloride, sulphate, phosphate, nitrate, fluoride).
5. Examination of water for bacteriological tests (presumptive, confirmed, completed).
6. Calculation of rate of demand with the help of data.
7. Collection and interpretation of data about surface water sources.
8. Study of design aspects of intake towers.
9. Draw schematic layout of water treatment plant.
10. Measurement of dissolved oxygen of aeration tank.
11. Design mechanical aerators by given set of data.
12. Calculate suspended solids from surface, middle layer of sedimentation tank.
13. Determination of optimum coagulant dose of water samples by Jar Test Apparatus.
14. Study of design aspect of flocculator.
15. Study of efficiency of rapid sand and pressure filter by analysis of inlet and filter outlet water samples.
16. Study of design aspects of rapid and pressure filters.
17. Determination of chlorine dose of a water sample.
18. Visit to water treatment plant and study different unit operations.
19. Study of layout of water distribution system.

PSCENVP06
(Core Elective Practical 06)
Practical VI
Wastewater and Air Pollution

Credit: 04

1. List out the sources of domestic and industrial waste in your region.
2. Determination of properties of soil: Determination of physical properties of soil (bulk density, porosity and water holding capacity).Determination of chemical properties of soil (pH, EC, organic carbon, nitrogen,phosphorous and potassium).Determination of biological properties of soil (total viable count, fungi, Actinomycetes,Rhizobium, Azatobactor).
3. Determination of pollution potential of wastewater by using Tiddys test.
4. Determination of Langelier calcium carbonate saturation index.
5. Calculate quantity of sewage by dry weather flow method by given set of data.
6. Study design aspects of grit chamber and sedimentation tank.
7. Pilot plant study for removal of colloidal solids by coagulation.
8. Determination of Sludge Volume Index of the sludge.
9. Determination of Sludge Density Index of the sludge.
10. Estimation of fixed solids, organic matter of sludge drying bed's sludge cake.
11. Determination of efficiency of water/wastewater treatment plant w.r.t. TDS, hardness, pH, acidity,COD and BOD from inlet and outlet.
12. Analysis of effluents for BOD, COD, sulphide and nitrogen.
13. Determination of iron and manganese from industrial waste.
14. Demonstration on impact of iron and manganese waste on water quality.
15. Undertake a study on impact of cement plant dust on crops and their productivity.
16. Enlist criteria pollutants, non criteria pollutants for pollution study.
17. Demonstration on fugitive emissions from industry.
18. Comparative analysis of air sampling from clean and polluted area using key parameter.
19. Determination of settable particles by dust fall jar method.
20. Analysis of trace metals from SPM.

M. Sc. II year
Semester IV

PSCENVT13 (Core 11)
Paper XIII
EIA and Environmental Laws

Credit:04

Unit I: Fundamentals of Environmental Impact Assessment

1. Basic concept of EIA: Introduction, salient features of EIA, EIA procedure (Initial Environmental examination IEE, Analytical Functions of EIA, (Scope of EIA,Identification of Impact, prediction, Impact evaluation & analysis).
2. EIA as planning tool: Role of EIA in the planning and decision making process. Public participation in EIA, definition and concepts, objectives, techniques, advantages and limitations. Strategies for environmental management plan and green belt development.Role of mathematical models in EIA. Role of statutory agencies in EIA clearance.
3. EIA for industry: EIA process to project, planning and implementation, guideline for preparation of Environmental Base Map (EBM), Identification of study area,classification of environmental parameters, formation of EIA study team, Preparation of EIA Report-Essential steps to complete an environmental impact assessment, EIA format by CPCB, Environmental monitoring and management plan, final content of Environmental Impact Statement.

Unit II: EIA Methodologies

1. Methodology: General criteria for the selection of EIA methodology (impact identification, impact measurement, impact interpretation and evaluation, impact communication)
2. EIA methods: Adhoc methods, advantages and disadvantages, checklist-simple,descriptive, scaling, scaling weighting checklist, Battelle Environment Evaluation System(BEES). Computer aided EIA.
3. Matrix methods, general characteristics, salient features of matrices methods. Simple interaction matrix method, stepped matrix method, network methods, stepped matrix technique for networks, overlay methods, cost benefit analysis, prediction and assessment of impacts on soil and groundwater, surface water, biological environment, air environment, noise, socio-economic and human health impacts. EIA case studies, environmental audit-pre, onsite and post audit.

Unit III: Constitution and Environment

1. Constitutional law: Environmental concerns in constitution such as State, fundamental rights, directive principles, fundamental duties, judicial activism, VII schedule,provisions relating to environment in these.
2. Constitution and environment: Provisions relating to control of pollution in India,Penal Code 1860, Code of Criminal Procedure 1973, Code of Civil Procedure 1908.

3. Judicial activism and environmental protection: Indian constitution and environmental protection, Water (Prevention and Control of Pollution) Act 1974, Salient features, Air(Prevention and Control of Pollution) Act 1981, Noise Pollution (Regulation and Control)Rules, 2000.

Unit IV: Environmental Laws

1. Environmental protection: Issues and problems, key interactional efforts for environmental protection, Indian movement for environmental protection-Bishnoi tradition, Chipko movement, Silent valley movement, Sardar Sarovar Project.

2. Basic environmental laws:

1986- The Environmental (Protection) Act.
1989- The Manufacturing, Storage and Impact of Hazardous Rules.
1995- The National Environmental Tribunal Act.
1998- The Biomedical Waste (Management and Handling) Rules.
2000- The Municipal Solid Waste (Management and Handling) Rules.
2000- The Ozone Depleting Substances (Regulation and Control)

3. Specific environmental laws:

1948- The Factories Act and Amendment in 1987.
1972- The Wildlife Protection Act, Rules 1973 and Amendment, 1991.
1977- The Water (Prevention and Control of Pollution) Cess Act.
1980- Forest Conservation Act.
1988- The Motor Vehicles Act.
1991- The Coastal Regulation Zone Modification.
2002- The Biological Diversity Act.

Books for Reference:

1. Environmental Impact Assessment: Principles and Procedures, John Wiley and Sons, New York.
2. Environmental Impact Assessment: A.K. Shrivastav, APH Publishing Corporation, NewDelhi.
3. Environmental Impact Assessment: S. A. Abbasi, D. S. Arya, Discovery Publishing House, New Delhi.
4. Environmental Pollution Control: Neelima Rajvidya and Dilipkumar Markandey, APH Publishing Corporation, New Delhi. (2005)
5. Environment Problems and Solutions: D. K. Asthana and Meera Asthana, S.Chand & Co. Ltd. New Delhi.
6. An Introduction to Environmental Management: Dr. Anand S. Bal, Himalaya Publishing House, New Delhi.
7. Environmental Impact Analysis Handbook: John G.R. and David C. Wooten, McGraw Hill Publications. (1987)
8. Encyclopedia of Ecology and Environment: Environmental Impact Assessment Vol. 7: By Trivedi P.R., Indian Institute of Ecology and Environment, New Delhi (1999)
9. Environmental Law and Policy in India: Divan S and Rosencraz A, Oxford University Press,New Delhi. (2001)
10. Environmental Laws of India - An Introduction: CPR Environmental Education Centre, Chennai (2001).
11. Environmental Impact Assessment Methodologies Anjaneyulu, Y. and Manickam W. BSPBooks Pvt. Ltd., Hyderabad (2010)
12. Environmental Impact Analysis Handbook: J. G. Rau and D. C. Wooten; McGraw-Hill Book Co.

PSCENVT14(Core 12)
Paper XIV
Pollution Control and Industrial Safety

Credit: 04

Unit I: Industrialization

1. Basis for industrialization: Industrial development in India, The role and pattern of industrialization, large and small scale industries, their nature, importance and problems,factors of industrialization.
2. Industrial economics: Scope of industrial economics, industrialization and economic development, Industrial sickness: problems and remedial measures.
3. Industrial policy: New industrial policy and its appraisal, the legal framework of industrial regulation in India. Categories of industries-red, orange and green.

Unit II: Pollution Control in Industries

1. General treatment: Common effluent treatment plant (CETP), principles, on site pretreatment of wastewaters, step wise treatment in CETP.
2. Pollution control for specific pollutants: Removal of BOD; biological oxidation units,removal of chromium and mercury, reduction, precipitation, ion exchange, reverse osmosis, lime coagulation and adsorption, removal of mercury from gaseous streams and liquid streams.
3. Removal of ammonia/urea and phenolic effluents: Sources of nitrogenous waste in fertilizer industries, methods for removal of nitrogen, physicochemical process,biological methods, algal-bacterial flocculation system, phenolic effluents: sources and treatment.

Unit III: Operation and Maintenance of Treatment Units

1. Preliminary treatment units: Pumps, screen's, grit chamber, oil and grease trap,equalization tank.
2. Primary treatment units: Aeration tank. Clariflocculator. Flash mixer. Agitator and dosing tank. Settling tank.
3. Secondary and tertiary treatment units: Activated sludge, trickling filter, oxidation ponds, sludge drying bed, ion exchange and reverse osmosis.

Unit IV: Industrial Safety and Security

1. Industrial accidents: Nature and causes of accidents, types of accidents, classification of accidents, cost of accidents.
2. Industrial hazards: Industrial fatigue nature, types and measurement, heat stress in industry, noise, vibrations, occupational stress and health.
3. Industrial safety and security: Planning for safety, controlling hazards, mitigation of fatigue, control of heat exposure, control of noise, controlling exposure to vibration,stress

prevention and management, occupational safety, general safety rules, safety standards. Safety from fire: equipments and operational procedure.

Books for Reference:

1. Environmental Pollution Control Engineering, C. S. Rao, New Age International Publisher, New Delhi, 2009
2. Pollution Control in Process Industries, S. P. Mahajan, Mc-Graw Hill Publishing Company Limited, New Delhi
3. Industrial Safety and Environment, Anupama Prashar, S. K. Katariya and Son's, Delhi,2012
4. Environment Problems and Solution, D. K. Asthana, and M. Asthana S. Chand Company Ltd. New Delhi. (2006)
5. Environmental Pollution and Control in Chemical Process Industries, S, C, Bhatia,Khanna Publishers, Delhi, 2001
6. Industrial Chemistry, B. K. Sharma, Goel Publishing House, Meerut, 2001

PSCENVT15 (Core Elective)
Paper XV
1. Environmental and Energy Management

Credit: 04

Unit I: Industry and Environment

1. Industry and environment: Need of industries, industrial pollution and development,industrial clusters and pollution. Prominent industries in India and pollution. Types of industrial waste and their impact on air, water, soil with reference to pulp and paper,cement and coal mining.
2. Industrial pollution control: Pollution abatement measures, rating of industries.Pollution control strategies-economic incentives, ambient and effluent standards,pollution charges, regulations for controlling environmental pollution.
3. Greening of industry: Need of greening industry. Integration of government, market and community. Options for greening industry: cleaner technologies, pollution prevention,end of pipe technology.

Unit II: Corporate Environmental Management

1. Environmental management system: Environmental management system. ISO 14001-Specification of environmental management system, ISO 14004-EMS: General guidelines on principles, systems and supporting techniques, ISO 14010-ISO 14015-Environmental auditing and related activities, ISO 14020-ISO 14024- Environmental labeling, ISO 14031-ISO 14032- Environmental performance evaluation, ISO 14040-ISO14043- Life cycle assessment, ISO 14050- terms and definitions, ISO guide 64- Product specification.
2. EMS structure: Environmental policies, environmental auditing, measuring environmental performance, environmental reporting.
3. EMS and industries: EMS in small scale industries, Integration of ISO 9001: 2008 and ISO 14001:2004.

Unit III: Energy and Environment

1. Energy basics: Energy conservation and efficiency, energy flows. Energy sources and overall energy demand and availability. Energy consumption in various sectors and its changing pattern, exponential increase in energy consumption and projected future demands. Energy consumption and its impacts on environmental climatic change.
2. Energy and environment: Environmental issues, Environmental pollution and energy,Environmental management and energy. Rational use of energy-Meeting future energy needs, Government policy for energy efficiency, energy conservation.
3. Energy pattern: Sources of primary energy, projections of future energy use pattern,environmental effects of energy use- coal, petroleum, biomass, hydro power, socioeconomic implications of energy use pattern.

Unit IV: Energy Technology and Management

1. Renewable technology: Electricity-conventional fuels, hydro electricity, solar energy,wind electricity, fuel cell, geothermal energy, OTEC, MHD, comparing the different technologies.
2. Advanced technology: Biomass, briquetting, combined heat and power, anaerobic digestion, fuel switching, cleaner production, biochar, energy from solid waste,hydrogen-future energy source.
3. Management: Energy management in practice, implementing on energy management system, energy auditing, energy economics.

Books for Reference:

1. Corporate Environmental Management, Ed. Richard Welford, Earth Scan Publications Ltd, London, 1999
2. Installing Environmental Management Systems: A Step-by-Step guide, Christopher Sheldon and Mark Yoxon, Earth Scan Publications Ltd, London, 1999
3. Renewable Energy and Environment-A policy analysis for India, N H Ravindranath, K Usha Rao, Bhaskar Natrajan, Pradeep Monga, Tata McGrow Hill Publishing Company Ltd, 2000
4. Energy and Environment, H V Jadhav, Himalaya Publishing House, 1997
5. Non Conventional Sources of Energy, G D Rai, Khanna Publishers, Delhi, 1992
6. Sustainable Environmental Management, L.V. Gangawane and V.C. Khilare Daya Publishing House, 2007
7. Environmental Management, N.K. Uberoi, Excel Book, New Delhi, 2006
8. Energy and Environment, H. V. Jadhav, Himalaya Publishing house, Mumbai, 1997
9. Energy Management, W. R. Murphy, G. Mckay (Butterworths).
10. Energy Management Principles, C. B. Smith (Pergamon Press)
11. Efficient Use of Energy, I. G. C. Dryden (Butterworth Scientific)
12. Energy Economics, A. V. Desai (Wieley Eastern)
13. Industrial Energy Conservation, D. A. Reay (Pergammon Press)
14. Energy Management Handbook, W. C. Turner (John Wiley and Sons, A Wiley Inter Science Publication)
15. Industrial Energy Management and Utilization, L. C. Witte, P.S. Schmidt, D.R. Brown (Hemisphere Publication, Washington, 1988)
16. Industrial Energy Conservation Manuals, MIT Press, Mass, 1982
17. Energy Conservation guide book, Patrick/Patrick/Fardo (Prentice hall1993)
18. Pollution Control Strategies: World Bank Report

PSCENVT15 (Core Elective)
Paper XV
2. Environment and Society

Credit: 04

Unit I:

Introduction: Social and cultural construction of 'environment'; environmental thought from historical and contemporary perspective in light of the concepts of Gross Net Happiness and Aldo Leopold's Land Ethic. Issues in environmentalism**:** Significant global environmental issues such as acid rain, climate change, and resource depletion; historical developments in cultural, social and economic issues related to land, forest, and water management in a global context; interface between environment and society.

Unit II:

Development-environment conflict: Developmental issues and related impacts such as ecological degradation; environmental pollution; development-induced displacement, resettlement, and rehabilitation: problems, concerns, and compensative mechanisms; discussion on Project Affected People (PAPs). Urbanization and environment**:** Production and consumption oriented approaches to environmental issues in Indian as well as global context; impact of industry and technology on environment; urban sprawl, traffic congestion and social-economic problems; conflict between economic and environmental interests.

Unit III:

Environment and social inequalities: Inequalities of race, class, gender, region, and nation-state in access to healthy and safe environments; history and politics surrounding environmental, ecological and social justice; environmental ethics,issues and possible solutions. Regulatory framework: Brief account of Forest Conservation Act 1980 1988; Forest Dwellers Act 2008; Land AcquisitionAct1894, 2007, 2011, 2012; Land Acquisition Rehabilitation and Resettlement Act 2013.

Unit IV:

Community participation: State, corporate, civil society, community, and individual-level initiatives to ensure sustainable development; case studies of environmental movements (Appiko Movement, Chipko Movement, Narmada Bachao Andolan); corporate responsibility movement; appropriate technology movement; environmental groups and movements, citizen groups; role played by NGOs; environmental education and awareness.

Books for Reference:

1. Chokkan, K.B., Pandya, H. & Raghunathan, H. (eds). 2004. *Understanding Environment*. Sagar Publication India Pvt. Ltd., New Delhi.
2. Elliot, D. 2003. *Energy, Society and Environment, Technology for a Sustainable Future*. Routledge Press.
3. Guha, R. 1989. *Ecological change and peasant resistance in the Himalaya*. Unquiet Woods,Oxford University Press, Delhi.
4. Leopold, A. 1949. *The Land Ethic*. pp. 201-214. Chicago, USA.
5. National Research Council (NRC). 1996. *Linking Science and Technology to Society's Environmental Goals*. National Academy Press.

6. Pandit, M.K. 2013. Chipko: Failure of a Successful Conservation Movement. In: Sodhi, N.S.,Gibson, L. & Raven, P.H. *Conservation Biology: Voices from the Tropics.* pp. 126-127. Wiley-Blackwell, Oxford, UK.

PSCENVT15 (Core Elective)
Paper XV
3. Wildlife Conflict and Management

Credit: 04

Unit I:

Socio-economic and legal basis of conflicts: Insight into the important conflicts: Keoladeo National park conflict of Bharatpur, Human and elephant conflicts of Kerala, Fisherman and tiger conflict of Sundarbans forest, shifting cultivation in North east India.Concepts of development and encroachment, who is the intruders: human or animal? Impact of conflict on humans and wildlife, impact of habitat fragmentation, social inequality in terms of forest conservation: luxury hotels within protected areas vs. displacement of native tribes, forest produce as a need vs. forest exploitation, introduction to tribal rights in India, demographic profile of tribes in India, importance of forest produce to tribal populations, Scheduled tribes and other traditional Forest dwellers (Recognition of forest right) Act, 2006.

Unit II:

Introduction to wildlife management: Need of environmental management; wildlife conservation: moral obligation? philosophy of wildlife management; why is it necessary to worry about human wildlife conflicts? What is the role of government, wildlife biologists and social scientists, concept of deep and shallow ecology.

Unit III:

Evolution of the concept of wildlife management: Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: records from Bhimbetkawall paintings; conservation of wildlife in the reign of king Ashoka: excerpts from rock edicts; Bishnoi community; understanding wildlife management, conservation and policies regarding protected areas in 21st century; positive values provided by wildlife conservation (monetary, recreational, scientific and ecological benefits).

Unit IV:

Wildlife conservation laws in India: Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves); IUCN categories of protected areas, Natural World Heritage sites; concept of core and buffer area in a protected range,brief introduction to Wildlife Protection Act of 1972, Forest act 1927, Environmental Protection Act 1986, and Forest conservation Act 1920; introduction of Tiger task force, Status of current protected areas in India.

Books for References:

1. Conover, M. 2001. *Resolving Human Wildlife Conflicts*, CRC Press.
2. Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. *Animal Conservation* **13:** 458-466.
3. Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turning challenges into opportunities. *International Biodeterioration & Biodegradation* **45**: 97-102.
4. Paty, C. 2007. *Forest Government and Tribe*. Concept Publishing Company.
5. Treves, A. & Karanth, K. U. 2003. Human---carnivore conflict and perspectives on carnivore management worldwide. *Conservation Biology* **17**: 1491-1499.

6. Woodroffe, R. 2005. *People and Wildlife: Conflict and Coexistence*. Cambridge.
7. Woodroffe, R., Thirgood, S., & Rabinowitz, A. 2005. *People and Wildlife, Conflict or Coexistence?* (No. 9). Cambridge University Press.

PSCENVT15 (Core Elective)
Paper XV
4. Urban forestry and management

Credit: 04

UNIT-I

Concepts: Urban greens, landscape, urban forestry and biodiversity, Indian and global perspectives of urban forestry. Human dimensions of urban forests - Migration, Urban poverty and livelihood.Environmental problems in urbanizing world.Ecological, social, economic, health, cultural, recreation values of urban green space.Benefits of linking forest and vegetation with urban planning.Contribution of urban forests in generating livelihoods for urban poor in India.Concept of sustainable cities, Smart cities and green space.

UNIT-II

Urban biodiversity: Floral and faunal diversity in urban landscape. Urban trees and shrubs. Threats and significance of Urban biodiversity in India. Characteristics of selected urban forestry species. Significance of biodiversity parks. Design wildlife habitat. Climate change affect and urban vegetation. Preparation of urban biodiversity register (UBR). Monitoring the loss of Urban Biodiversity.Strategy for Urban biodiversity planning, conservation and development.

UNIT-III

Management of urban forest landscape: Urban landscape elements. Species choice for Urban forestry. Technical aspects of tree maintenance-pruning, cleaning, post plantation care, cleaning, nursery, water management. Types of plantation, design & tree architecture, monitoring, urban forestry management issues, stake holder's analysis.
Case study of Urban area restoration- waterbody and wasteland.

UNIT-IV

Urban forestry planning policy and application: Integration of urban forestry in city planning, institution policy and social issues, incentives and partnerships. Role of government, NGOs, corporate houses and civil society organizations in urban green space development, Public, private partner (PPP) model. Urban planning and its environmental aspects from historical and contemporary perspectives; benefits of environmental management; political complexity of applying ecological science to urban policy and planning, smart cities.

Text/References:

1. Grey, G.W., and F.J. Denke. (1986). Urban Forestry. Wiley Publication.
2. Miller, R.W. (1997). Urban Forestry: Planning and Managing Urban Green Spaces, 2nd edition. Prentice Hall.
3. Konjendijk, et al. (2005). Urban Forests and Trees. Springer.
4. Kuchelmeister, G. (1998). Urban Forestry in the Asia – Pacific Region: Status and Prospects. APFSOS Working Paper #44, Food and Agriculture Organization.
M.Sc. Environment Management w.e.f. August 2015
5. Bradley, Gordon A., (editor) Urban Forest Landscapes: Integrating Multidisciplinary Perspectives.

PSCENVT16 (Foundation Course)
Paper XVI
1. Sustainable Environment

Credit: 04

Unit I: Emission Trading

1. Introduction: Conventions associated with Kyoto Protocol, prologue to greenhouse gas emissions, UN appointed panel on climate change, emission trading schemes, carbon credit mechanisms, valuation method of emission reduction units, profiles of companies which have benefitted from climate propriety, annexure of the countries
2. Emission trading: History and design of the Kyoto Protocol, greenhouse gas trading system; joint implementation (JI); clean development mechanism (CDM); reductions of emissions from deforestation and degradation (REDD).
3. Emission trading scenario: Systems for Kyoto Protocol implementation in different countries; the European Union, Indian emissions trading system; results to date.

Unit II: Environmental Accounting

1. Introduction: Definition, National account, basic concept, objectives, scope, forms of EA, environmental management account (EMA), environmental financial account,environmental national account, balance sheet w.r.t. profit and loss under environmental accounting
2. Environmental accounting: Preparation of integrated environmental and economic accounts (Satellite accounts); Produced asset, non produced economic assets, other non produced environmental assets, system of integrated environmental and economic accounts.
3. Valuation of natural assets: Methods of valuation- market value approach, present value approach, net price approach, maintenance cost approach, compensation cost approach,general valuation techniques, application of methods, merits and demerits of environmental accounting.

Unit III: Environmental Philosophy

1. Environmental ethics: Introduction, concept, basic facts and Environmental Ethics,values, science and Environmental Ethics, ethical theories applied to the environment,historical causes of environmental decline.
2. Ecocentric theories of nature: Deep ecology and animal rights, environmental rights,environmental racism, environmental and business ethics, foundation of environmental ethics for business.
3. Environmental attitudes: Categorization of environmental attitudes in development ethics, preservation ethics, conservation ethics, societal environmental ethics, corporate environmental ethics, individual environmental ethics, global environmental ethics,challenges of World Environmental Ethics.

Unit IV: Sustainable Development

1. Basics of sustainable development: Definition. Concepts, principles, issues in sustainable development, strategic planning for sustainable development, economic reforms and sustainable development.
2. Environmental sustainability: Types of environmental sustainability (Institutional,economical, financial and ecological sustainable agriculture, sustainability of forests and forestry, sustainable earth economy, water resources,

3. Society and environment: Involving people, peoples biodiversity register (PBR),process of PBR, biological diversity act, Case study: Mendha-Lekha, village, Gadchiroli district (MS). City planning, garden cities and new towns urban redesign, designing for open space. Intellectual property rights, patenting procedure in India and abroad.

Books for Reference:

1. A Textbook of Ecotourism, Eco Restoration and Sustainable Development, A J Solomon Raju, New Central Book Agency (P) Ltd, Kolkata
2. Environmental Accounting, N. Das Gupta, S. Chand and Company Ltd. New Delhi, 2005
3. Peoples Biodiversity Register, Center for Ecology Sciences, Bangalore, 2003
4. Emissions Trading: Principles and Practice, Thomas H. Tietenberg, (Washington D.C.: Resources for the Future Press, 2006).
5. Post-Kyoto International Climate Policy: Implementing Architectures for Agreement, JosephE. Aldy and Robert N. Stavins, (Cambridge University Press, 2010)

PSCENVT16 (Foundation Course)
Paper XVI
2. Green Technologies

Credit: 04

Unit I:

Introduction: Definition and concepts: green technology, green energy, green infrastructure, green economy, and green chemistry; sustainable consumption of resources; individual and community level participation such as small-scale composting pits for biodegradable waste, energy conservation; encouraged use of public transport instead of private transport. Green technologies: Green technologies in historical and contemporary perspectives; successful green technologies: wind turbines, solar panels; 3 R's of green technology: recycle, renew and reduce; paradigm shift from'cradle to cradle' to 'cradle to grave'.

Unit II:

Green infrastructure, planning and economy: Green buildings; history of green buildings, need and relevance of green buildings over conventional buildings, construction of green buildings; associated costs and benefits; outlined examples of green buildings; LEED certified building; Eco-mark certification, establishment of Eco-mark in India, its importance and implementation; Green planning: role of governmental bodies, land use planning,concept of green cities, waste reduction and recycling in cities, role of informal sector in waste management, public transportation for sustainable development, green belts. ; Introduction to UNEP's green economy initiative, inclusive economic growth of the society, REDD+ initiative, and cap and trade concept; green banking.

Unit III:

Applications of green technologies: Increase in energy efficiency: cogeneration, motor system optimization, oxy-fuel firing, isothermal melting process, energy efficient fume hoods, compact fluorescent lights (CFLs), motion detection lighting, or programmable thermostats). Green House Gas (GHG) emissions reduction: carbon capture and storage (CCS) technologies, purchase and use of carbon offsets, promotion and/or subsidy of alternative forms of transportation for employees, such as carpools, fuel efficient vehicles, and mass transit, methane emissions reduction and/or reuse).Pollution reduction and removal (Flue Gas Desulfurization (FGD) methods, catalytic or thermal destruction of NOX, Fluidized Bed Combustion, Dioxins reduction and removal methods, Thermal Oxidizers or Wet Scrubbers to neutralize chemicals or heavy metals, solvent recovery systems, LowVolatile Organic Compound (VOC) paints and sealers).

Unit IV:

Green nanotechnology: Introduction to nanotechnology; principles and recognition of green criteria in environmental science; biodegradable and bio-accumulative products in environment; green nanotechnology; reagents, reactions and technologies that should be and realistically could be replaced by green alternatives; photodegradable plastic bags.

Books for Reference:

1. Anastas, P.T. & Warner, J.C. 1998. *Green Chemistry: Theory & Practice*. Oxford UniversityPress.
2. Arceivala, S.L. 2014. *Green Technologies: For a Better Future*. Mc-Graw Hill Publications.

3. Baker, S. 2006. *Sustainable Development*. Routledge Press.
4. Hrubovcak, J., Vasavada, U. & Aldy, J. E. 1999. *Green technologies for a more sustainableagriculture* (No. 33721). United States Department of Agriculture, Economic Research Service.
5. Thangavel, P. & Sridevi, G. 2015. *Environmental Sustainability: Role of Green Technologies*.Springer Publications.
6. Woolley, T. & Kimmins, S. 2002. *Green Building Handbook* (Volume 1 and 2). Spon Press

PSCENVP07
(Core Practical 07)
Practical VII
Environmental Management and Sustainable Environment

Credit: 04

Solid Waste

1. Determination of moisture content of fly ash/ solid waste.
2. Estimation of calorific value of solid waste.
3. Calculation of volatile matter of solid waste.
4. Determination of water holding capacity of fly ash/ composted solid waste.
5. Determination of pH, EC, alkalinity, hardness, chloride of fly ash/ composted solid waste.
6. Study of solid waste management practices in the area.
7. Estimation of %organic matter, % organic carbon, NPK in composted solid waste.
8. Study the design criteria of sanitary landfill.
9. Collect data on sale of plastic bag below permissible size.
10. Study and demonstration on type of biomedical waste generation and its disposal in city.
11. Determination of pesticides and inorganic contamination from wastewater of chemical industry.
12. Identification and categorisation of industries in your area as red, orange and green.
13. Determination of the mineral matter in given sample of Biomass

Environmental Management

1. Demonstration on environmental and energy audit of a industry.
2. Demonstration on ISO: 14001, ISO:14004, ISO: 9001.
3. Demonstration on Total Quality Management in Industry.

Industrial Safety

1. Graphically highlight industrial clusters in the map of India and study their impacts on environment, economy and society.
2. Socio-economic survey on workers w.r.t. stress, fatigue, vibration in an industry.
3. Collection of data about safety measures, first aid practices in industry.
4. Studies on use of fire fighting equipments in an industry.
6. Studies on common effluent treatment plant for treatment of heterogeneous wastewater.

Sustainable Environment

1. Preparation of environmental accounting of profit loss balance sheet.
2. Studies on environmental ethics.
3. Studies on PBR of Mendha Lekha village.
4. Study and demonstration on schematic layout of open space, garden in city, design aspect of new garden.

Environmental Engineering

1. Calculation and design of sedimentation tank, clariflocculator, aeration tank, ASP, TF, Disinfection Process, Sanitary Landfills, ESP, and Cyclone.
2. Treatability studies using the activated carbon for the removal of metals, uses of local adsorbent viz. rice husk, brick, and fly ash and evaluation of the absorption capacity using Langmuir or Freundlich adsorption isotherm.
3. Pilot plant study on BOD and COD removal from sewage/ industrial waste by aeration.
4. Sewage treatment plant study for working units and maintenance procedure, treatment efficiencies w.r.t. physicochemical analysis of inlet, outlet parameters.
5. Determination of the concentration of Oil & Grease in waste water sample.
6. Determination of Total Kjheldahl Nitrogen in waste water sample

7. Estimation of Nitrate in water/wastewater sample by spectrophotometric method.
8. Estimation of phosphorous from waste water sample by spectrophotometric method.
9. Studies on microorganisms of aeration tank/ trickling filter/sewage treatment plant
10.. Determination of noise level at a given place using Sound Level Meter.
11. Study of principle, components and working operation of respirable dust sampler

PSCENVP08
(Ability Enhancement)
Project Work (Dissertation)

Credit: 04

Project Work Instructions for Students

(Total marks: 100. Project work: 80 marks, internal: 20 marks)
Candidates will write a dissertation on issues related to Environmental Science under the guidance of their respective guides. Each student will work independently on the topic. The dissertation must consist of review of literature and produce a deep insight of the subject on the basis of personal research.Dissertation work will be initiated at the start of M.Sc. II year (IIIrd semester). The students will undertake field work in terms of collection of data and surveys. The dissertation will have to be submitted for appraisal and acceptance by the University to the concerned college. The students should submit their dissertation in the following format.

Chapter I: Introduction with Aims and Objectives: A background with historical information and a review of existing material or data on the subject along with the aims and objectives of the study.

Chapter II: Methodology with Material and Methods: Description of the issue, methodology adopted for the study.

Chapter III: Experimental: Presentation of data collected and detailed analysis of results.

Chapter IV: Result and Discussion: Discussion on the data and results obtained and presentation of method suggested to solve the problem.

Chapter V: Summary and Conclusions: A summary of the dissertation and important conclusions drawn at the end of the investigation.

Bibliography or References: A list of references of cited in the text.

The dissertation should be typed on A4 size bond paper with 1.5 line spacing. Illustrations and photographs should be of high quality. The report should be flawless without any spelling mistakes or grammatical errors. Students will have to submit their dissertation one month before the final practical examination at the end of M.Sc. II year (IVth semester).The dissertation will carry 100 marks. Assessment of the dissertation will be done at the end of the year. Students have to present a Power Point Presentation. Assessment of the dissertation shall be done by the external examiner appointed by the Gondwana University, Gadchiroli.

A) Industrial training

Students are encouraged to undergo summer/winter in plant training in a suitable industry so as to get firsthand experience of corporate environmental management.

B) Study visits

i) National Environmental Engineering Research Institute (NEERI), Nagpur
ii) Remote Sensing Center, Nagpur
iii) Regional Meteorological Center, Nagpur
iv) Maharashtra Pollution Control Board, Nagpur
v) Industrial visits

C) Seminar

Student may select any environmental related topic of their choice (in consultation with the faculty) and make a power point presentation for 30 minutes. They shall be able to answer questions invited from the audience.

D) Field diary

The student shall prepare their field diary under the following heads
i) Issue on local/regional/national problem of environmental interest (Case Studies).
ii) About famous personalities in environmental movements.
iii) New Acts and Judgments of environmental interests.

E) Guest lecture series

In each year guest lectures will be given by the faculty and other invited speakers on current topics and environmental issues. The course would run as a guest lecture series (at least five guest lecturers in chosen topics) with compulsory attendance.

Gondwana University, Gadchiroli
Model Question Paper (Theory)
M. Sc. Environmental Science

Time: Three Hours **Maximum Marks: 80**

Q. 1: Long Question from unit I	16 marks
OR	
a) Short Question from unit I	08
b) Short Question from unit I	08
Q. 2: Long Question from unit II	16
OR	
a) Short Question from unit II	08
b) Short Question from unit II	08
Q. 3: Long Question from unit III	16
OR	
a) Short Question from unit III	08
b) Short Question from unit III	08
Q. 4: Long Question from unit IV	16
OR	
a) Short Question from unit IV	08
b) Short Question from unit IV	08
Q. 5: Short Answer questions	4x4 = 16
a) From unit I	
b) From unit II	
c) From unit III	
d) From unit IV	

The End