1) Title of the course – M.Sc. Environmental Science
2) Preamble of the Syllabus –

Environmental Sciences are necessarily to be taught in an inter-disciplinary curriculum. There is need to strengthen the students to understand essential aspects of environmental sciences in diverse subject areas such as chemistry, biology, pollution, geosciences, atmospheric sciences, biodiversity**,** natural resources management and wildlife management. There is also an additional emphasis in providing opportunities to understand the integration of modern sciences such as geographical information systems (GIS) and remote sensing applications to environmental sciences. This integration has been enabled in the syllabus.

Students would be encouraged to go beyond the classroom and conduct active action-research research projects with subject experts and institutions in different fields. Lectures and classroom sessions are accompanied by on-field visits, laboratory experiments and in-plant training. These interventions are compulsory and essential aspects of the curriculum.

There are optional subject areas that can be chosen by the students as per their desire about their future professional areas. The Masters in Environmental Sciences being offered by the University of Pune would allow the student to access a broad spectrum of environmental disciplines and would naturally extend well beyond the boundaries of any single subject area. The independent research areas and acquisition of subject-specific skills within an interdisciplinary group of subjects would help the student to proceed to conduct Ph.D.-level research in the future in Environmental Sciences.

Interface with research, industry, government and society is an important convergence paradigm that would be brought about by the Masters Program. Understanding the importance of crucial wildlife management and biodiversity conservation perspectives would help protect our ecosystems and the fragile wildlife sanctuaries and national parks in Maharashtra and India.

3) Credit System.
4) Eligibility – B.Sc. (any science subject) / B.E. / B.Sc. Agri.
5) Examination –

    A) Pattern of examination – University Department – In-Semester 50% and End-Semester 50%
    B) Pattern of examinations – College-level Examinations – As per University norms, as decided.
    C) Pattern of question paper – University Department – academic flexibility
    D) Standard of passing – University Department – 40% minimum to be gained from total of in-semester and end-semester. Derived from a total = minimum 30% in in-semester& (+) minimum 30% in end-semester
    E) ATKT rules – As per university rules.
    F) Award of class – Grade system.
    G) External students – Not applicable.
    H) Setting of question papers / Pattern of question papers – Academic flexibility
    I) Verification /Re-evaluation – as per University norms and procedures.

6) Structure of the course – As appended.

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M.Sc Part I

Course no.	Title	Credits
Semester I		
EVSC 101	Environmental Biology	4
EVSC 102	Environmental Chemistry	4
EVSC 103	Environmental Geosciences	4
EVSC 104	Environmental Statistics	4
EVSC 105	Practical Courses I	6
Semester II		
EVSC 201	Environmental Pollution and Control I**:** Water and Soil	4
EVSC 202	Biodiversity, Forestry and Natural Resources	4
EVSC 203	Atmospheric Sciences	4
EVSC 204	Remote Sensing and GIS	4
EVSC 205	Practical Courses II	6

Proposed structure for M.Sc Part II

Course no.	Title	Credits
Semester III		
Compulsory courses		
EVSC 301	EIA and Environmental Audit	4
EVSC 302	Environmental Pollution and control II**:** Air, Noise and Radiation	4
EVSC 303	Water and Wastewater Engineering	4
EVSC 304	Environmental Law, Ethics and Policy	4
EVSC 305	Practical Course III	6
EVSC 306	In-plant Training and Seminars	3
	Elective courses (any one)	
EVSC 307	Man and Environment	4
EVSC 308	Environmental Education	4
EVSC 309	Environmental Biotechnology	4
EVSC 310	Industrial Safety	4
Semester IV		
Compulsory courses		
EVSC 401	Environmental Toxicology and occupational Health	4
EVSC 402	Restoration Ecology and Watershed Management	4
EVSC 403	Solid Waste and Hazardous Waste Management	4
EVSC 404	Renewable and Non-Renewable Energy Resources	4
EVSC 405	Dissertation and Project Work	7
	Elective courses (any one)	
EVSC 406	Environmental Economics	4
EVSC 407	Advanced Treatment Processes	4
EVSC 408	Wild Life Management	4
EVSC 409	Sustainable Agriculture and Organic Farming	4

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M.Sc Part I

Course no.	Title	Credits
	Semester I	
EVSC 101	**Environmental Biology**	**4**
	EVSC 101 FUNDAMENTALS OF ENVIRONMENTAL BIOLOGY Credits 4 1. ENVIRONMENTAL BIOLOGY: Concepts and Scope. (4 lectures) • Biosphere as an ecosystem, its ecological processes and life support systems. • Anthropogenic impact on the biosphere and its life support systems (including Flora, Fauna, soil, climate, atmosphere, terrestrial and aquatic ecosystems). • Role of biological processes in remedial measures and restoration. 2. FUNDAMENTAL CONCEPTS OF ECOLOGY. (8 lectures) • Ecology: definition, development and scope. Ecology as an experimental science • Ecosystems: concept, components and functioning. • Energy Fixation (photosynthesis and chemosynthesis) and energy flow through food chains (grazing and detrital) and webs. • 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. 3. ECOLOGY OF POPULATIONS AND COMMUNITIES. (8 Lectures) (a) Population Ecology: • Factors determining the abundance and distribution of a species • Factors leading to the commonness, rarity and vulnerability of extinction of a species. • Population Dynamics: Patterns of survival, age distribution, dispersal and rates of change. • Attributes of K- selected and r-selected species. • Population Growth. (b) 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 • Succession, development, climax and stability of ecosystems 4. INTRODUCTION TO PLANT AND ANIMAL BEHAVIOUR. (8 Lectures) • 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)	

Course no.	Title	Credits
	Semester I	
	• Aggression, Territoriality, Altruism. • Reproductive Behavior: Courtship, Mating, Parental care, breeding systems. • Instinct and Learning: Genotype and phenotype behaviour. • Ethology and socio-biology: Insect and Vertebrate Societies, Associations 5. TERRESTRIAL BIOMES. (7 Lectures) • Climatic and edaphic factors of terrestrial biomes. Heinrich Walter's Biome Climate Diagrams • Classification of land biomes with their soil, climate and vegetation characteristics. Their natural history, wildlife, geography and human influences. • Mountain Biome: Replication of latitudinal changes in the altitudes of high mountains. • Terrestrial biomes, ecosystem diversity, forest and vegetation types in India. 6. FRESHWATER AND MARINE BIOMES. (7 Lectures) • Challenges and adaptations of life in aquatic biomes (freshwater: still and flowing, marine). • Freshwater Biomes (Rivers, streams, lakes, ponds) and their natural history • Marine Biomes (including mangroves, coral islands, kelp forests, saltwater marshes, seashores, estuaries) and their natural history • Wetlands – definitions, types, ecological functions and resources. 7. ENVIRONMENTAL MICROBIOLOGY (6 Lectures) • 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 and other environmental applications. • Environmental factors affecting microbes, their cultivation and growth.	
	Reference Books • Microbes, Man and Animals : The Natural History of Microbial Interactions: Linton, A. H. and Burns, R.G. (1982) john Wiley and Sons. • Elements of Microbiology : Pelczar, M.J. and Chan ECS, 1981 McGraw Hill. • General Microbiology: Stainer, R.Y.., Adelberg, E.A. and Ingraham, J.L. 1977. Macmillan Press. • Microbial Methods for Environmental Biotechnology : Grainer, J.M. and Lynch, J.M. 1984. Academic Press. • Microbiological Methods for Environmental Scientists and Engineers : Gaudy, A.F. and Gaudy, E.T. 1980, McGraw Hill. • Fundamentals of Ecology: E. P. Odum • Modern concepts in Ecology: H. D. Kumar • Inorganic Chemistry of Earth: Fergusson J. E. • Introduction to Geochemistry: Krauskoph K. B. • Environmental Chemistry: Raiswell • Environmental Chemistry: S. E. Manahan	

Course no.	Title	Credits
	Semester I	
EVSC 102	Environmental Chemistry	4
	EVSC 102 ENVIRONMENTAL CHEMISTRY 4 Credits 1. PHYSICO-CHEMICAL METHODS FOR ANALYSIS OF ENVIRONMENTAL SAMPLES (20 Lectures) • Estimation of various elements at major, minor trace, ultra trace level concentrations : choice of a technique, principle, merits and demerits of the techniques - neutron activation analysis, isotope dilution analysis, colorimetry, atomic absorption spectroscopy, ICPAES, gas chromatography, HPLC, ion exchange chromatography, X-ray fluorescence, X-ray diffraction, flame photometry, and polarography 2. INTRODUCTION TO SOIL CHEMISTRY. (6 Lectures) • Definition of soil, life on soil, composition of soil, mineral matter in soil, organic matter in soil, soil respiration, process of soil formation, factors affecting soil, soil profile, soil microorganisms, types of soils, micro and macro plant nutrients, nutrient functions 3. CHEMISTRY OF BIOLOGICALLY IMPORTANT MOLECULES. Chemistry of Water: (4 Lectures) • Unusual physical properties, hydrogen bonding in biological systems, unusual solvent properties, changes in water properties by addition of solute. Protein structure and biological functions, enzymes, enzyme metabolism, biosynthesis of DNA and RNA, mutations and Gene control during embryogenesis Hydrocarbons: (3 Lectures) • Chemistry of hydrocarbon decay, environmental effects, effects on macro and micro organisms Surfactants: (3 Lectures) • Cationic, anionic and nonionic detergents, modified detergents Pesticides: (3 Lectures) • Classification, degradation, analysis, pollution due to pesticides and DDT problems Synthetic Polymers: (3 Lectures) • Microbial decomposition, polymer decay, ecological considerations, Photosensitive additives 4. DESTRUCTION OF SOME HAZARDOUS SUBSTANCES: (6 Lectures) • Definition, characterization, UN classification, Identification, Chemistry of Various Organic and Inorganic Compounds. Carcinogenic compounds and their effects , Acid halides and anhydrides, alkali metals, cyanides and cyanogens bromides, chromium, aflotoxins, halogenated compounds • Lead and its compounds: Physical and chemical properties, behavior, human exposure, absorption, influence	
	Reference books • Environmental Chemistry- A.K.Dey New Age International publishers • Destruction of hazardous chemicald- G.Lunn, E.B.Sandome • Hazardous substances in chemical lab-G.D.MuMivir • Essentials of Nuclear Chemistry, H. J Arnikar, Wiley Eastern Limited, 4th Edition.(1995)	

Course no.	Title	Credits
	Semester I	
	• Instrumental methods of analysis-Chatwal and Anand	
EVSC 103	Environmental Geosciences	4
	EVSC 103 ESSENTIALS OF GEOSCIENCES Credits 4 1. Dynamics and structure of the Earth: (10 Lectures) • Structure and composition of Earth. Earth's material: Rocks and minerals. Uniformitarianism; geological time scale, Earthquakes, volcanoes, Continental drift, sea floor spreading and plate tectonics 2. Earth surfaces processes and landforms: (10 Lectures) • Weathering and erosion, Mass wasting. Geomorphology of fluvial tracts, arid zones, coastal regions, Karst landscapes and glaciated regions, Cycle of erosion: Davis and Penck. 3. Land use Planning: (6 Lectures) • Soil genesis, factors, soil profile, soil classification soil fertility, etc. Land use and Soil surveys, Land capability classification Land use planning and sustainable development Hydrology: (6 Lectures) • The Hydrologic Cycle and the Hydrologic Budget., Drainage basins. Catchment hydrology – precipitation, infiltration, evapo-transpiration and runoff, Surface water and groundwater (aquifers) Oceanography: (6 Lectures) • Ocean basins and physical structure of the ocean floor. Properties of sea water, waves and tides, ocean Currents, El Niño and Southern Oscillation, Thermohaline circulation and the global conveyor belt, Sea level changes. Natural hazards and disaster: (10 Lectures) • Concepts; Landslides and slope failures, earthquakes, river and coastal erosion, Tsunami, Desertification, water logging, salinization and soil degradation. Atmospheric disturbances: Thunderstorms, cyclones, lightening, flood, and drought. Impact of anthropogenic activities such as urbanisation, mining, river-valley projects, excess withdrawal of ground water, etc	
	Reference Books: • Lutgens F. K., Tarbuck, E. J. and Tasa, D. 2008. Essentials of Geology, Prentice Hall Publishers. • Bell F. G., 1998. Environmental geology: principles and practice. Blackwell Sc.. Oxford. • Thurman, H.V. and Trujillo, A.P., 2004, Introductory Oceanography, Prentice Hall. • Randolph, J. 2004 Environmental land use planning and management, Island Press, Washington. • Strahler, A.H and Strahler A.N (2002): Modern Physical Geography, John Wiley and Sons. • Kale, V. S. and Gupta, A. 2001. Introduction to Geomorphology, Orient Longman, Calcutta. • Chamley, H. and Chamley, H. 2003. Geosciences, Environment and Man Elsevier Science & Technology. • Savindra Singh (2002): Geomorphology, PrayagPustakBhawan, Allahabad.	

Course no.	Title	Credits
	Semester I	
	• Sharma &Vatal (1962): Oceanography for Geographers. Chaitanya Publishing House, Allahabad. • Basu S.K. (2003) (ed): Handbook of Oceanography, Global Vision, Delhi. • Kusky, T. M. 2003. Geological Hazards, Greenwood Press, Westport, Conn. London.	
EVSC 104	Environmental Statistics	4
	EVSC – 104 Environmental Statistics Credits 4 Foundation of environmental statistics – (4 lectures) 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. Univariate data – (16 lectures) 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. Bivariate data – (6 lectures) 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. Statistical models – (14 lectures) 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 regression models, fitting a regression line and parabolic curve, estimating regression coefficients. Calculation of fitted values and residuals. Chi- squared test : goodness of fit. Independence of attributes. (2 lectures) Statistical models in environmental science : (6 lectures) Population growth model, Catch model. Cohort projections, Pope's approximation.	
	Reference books: • Barnett Vic (2004) Environmental Statistics: methods and applications. • Ott, Wayne R. (1995) Environmental Statistics and data analysis. • Zar, Jerrold H. (1997) Biostatistical Analysis. Prentice Hall (India) • Nychka, Douglas and Piegorsch Walter W (1998) Case studies in Environmental Statistics. • Manly Bryan F.J. (2001) Statistics for Environmental Science and Management. • Walpole R. and Myem R. (1993) Statistics for engineers and scientists.	
EVSC 105	Practical Courses I	6
	EVSC 105 Practical Courses I Credits 6 I. **Practicals based on environmental microbiology** • Two season visits to a sacred grove to assess its biodiversity and steps for ecological	

Course no.	Title	Credits
	Semester I	
	restoration in the vicinity using its gene pool Vegetation studies by line and belt transects and quadrats, Monitoring a wetland especially for its vegetation and birdlife. • Microscopy. Preparation of media for microbial culture, Isolation and culturing of microbes from soil / water samples, Gram Staining. II. **Practicals based on Environmental Chemistry** • Estimation of halides in water samples by Potentiometry • Estimation of $Co^{2+}$and Ni^{2+} by Colorimetry / Spectrophotometry • Estimation of sulfates by Turbidometry • Estimation of alkali metals in various samples by Flame-photometry • Water analysis for physico-chemical characteristics • Estimation of heavy metals in various samples by AAS • Determination of half-life period of a given radionuclide Soil Analysis • Measurement of Bulk density • Calculate Specific gravity of given soil sample • Estimation of Water content, • Determine the Conductivity of Soil sample • Estimation of pH • Estimation of Alkalinity • Measurement of Soluble ion from different soil sample • Determination of Nitrogen • Estimation of Phosphorus • Determination of Sulphur III. **Practicals on Geosciences and Atmospheric science** • Drainage basin and network morphometry • Slope and aspect maps • Critical slope for specified activities • Profiles • Climatic maps and diagrams: circular graph, climograph, water budget, wind roses • (Simple and compound) • Station Model – Coding decoding and plotting of synoptic data • Exercises based on adiabatic lapse rates IV. **Practicals based on Environmental Statistics** • Grouping of data and preparation of frequency distribution. Histogram and frequency polygon • Calculating mean, median and mode for grouped and ungrouped data • Calculating variance, standard deviation and coefficient of variation for grouped and ungrouped data • Fitting simple linear regression. Plotting scatter diagram and regression line • Computing correlation coefficient and testing its significance for grouped and ungrouped data • Comparison between means of two independent samples. Paired t-test • Analysis of variance: one way classification • Analysis of variance: two- way classification • Fitting statistical model of air pollution to data	

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M.Sc Part I

Course no.	Title	Credits
	Semester II	
EVSC 201	Environmental Pollution and Control I**:** Water and Soil	4
	EVSC- 201: Environmental Pollution and Control I: Water and Soil 4 Credits 1. Freshwater Pollution: Types and sources, sampling methods. (10 Lectures) (a) Water Quality parameters, (b) Types and sources of water pollution, various pollutants responsible for water pollution: Biological pollutants; Inorganic; Organic; Heavy metals; Pesticides; Radioactive pollutants, etc. (c) Various sources effluent standards, Drinking water standards, Characteristics of Domestic waste, Characteristics of Agricultural waste, (e) Consequences of water pollution: Effects on health, on biosphere and on economy, (f) Sampling methods: Purpose of sampling, different types of samples, collection methods and various instruments used for it. (g) Methods involved in estimation of parameter for pollution levels. 2. Eutrophication: (4 Lectures) Definition, Limnology of lake, process of eutrophication. 3. Ground water pollution: (8 Lectures) Piezometer test – Pumping tests – Estimation of saturated hydraulic conductivity – Numerical simulation for aquifer yield prediction – Artificial recharge and induced infiltration – Land subsidence – Sea water intrusion. 4. Marine water pollution: (6 Lectures) Types, sources and consequences. Specifications for disposal of sewage and industrial waste into sea. Disposal of sewage and wash water from MV cargo and ships. Pollution due to off shore drilling, deep mining and oil extraction. 5. Control measures of water pollution: (6 Lectures) Stabilization of ecosystem, Reutilization and Recycling of waste water, Removal of Pollutants through laws and regulations. 6. Soil pollution: (10 Lectures) Types, sources and consequences. Sampling methods. Contaminant fate and transport in soil. Transport processes — biological process-microbial transformation of heavy metals. Specifications for disposal of sewage and effluent on land for irrigation and ground water recharge. Methodology of wastewater disposal on land in India. Impacts of usage of land for solid waste disposal both municipal solid waste and industrial solid wastes (fly ash from thermal power station, lime sludge from pulp and paper mills). 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 7. Control measures of soil pollution: (4 Lectures) Case study of restoration of land due to a. disposal of fly ash, b. dumping overburden and tailing in iron ore extraction.	
	Reference Books:	

Course no.	Title	Credits
	• Environmental Chemistry, B. K. Sharma • Environmental Chemistry and Pollution Control, S. S. Dara • Environmental Pollution, N. Manivasakam • Environmental Chemistry, Samir K. Banerji • Calvin Rose, An Introduction to the Environmental Physics of Soil, Water and Water Sheds, Cambridge University Press, 2004. • Paul Nathanail C. and Paul Bardos R., Reclamation of Contaminated Land, John Wiley & Sons Limited, 2004. • Hari D. Sharma and Krishna R. Reddy, Geo-Environmental Engineering : Site Remediation, Water Contaminant and Emerging Water Management Technologies, John Wiley & Sons Limited, 2004. • William J. Deutsch, Groundwater Geochemistry : Fundamentals and Applications to Contamination, Lewis Publishers, 1997.	
EVSC 202	Biodiversity, Forestry and Natural Resources	4
	EVSC 202 Biodiversity and Natural Resources **Credits 4** 1. INVENTORY OF BIO – RESOURCES: Global and National. (4 lectures) • An inventory of Global and Indian biological resources and their present and potential uses. • Valuation of bio-resources and current and potential threats • Traditional cultivars of crop species and their evaluation • Traditional livestock resources and their evaluation • Current status of exploitation of wild species (terrestrial) • Current status of marine resources, and trends in their usage pattern • Traditional knowledge systems (including medicine, ethno-botany, water and soil conservation and other cultural practices), their evaluation and protection under IPR regime. 2. GLOBAL AND NATIONAL BIODIVERSITY (4 lectures) • Magnitude and distribution of Biodiversity (global and Indian) and its characterization. • Rapid assessment of biodiversity and its valuation; skills, trained personnel and resources needed for the task. • Evaluating nature, scale and intensity of the threats to biodiversity. • Developing measures for conservation of biodiversity and approaches to its sustainable utilization. 3. PLANT RESOURCES. (6 Lectures) • Role of plants in natural ecosystems and life support systems (terrestrial, freshwater and marine) • Importance of traditional cultivars and wild species in agriculture • Role of plants in modern and traditional medicine • Value of plants in scientific research and technological inventions • Plants in modern lifestyle and economy • Approaches to conservation of plants (*in situ* and *ex situ*) 4. ANIMAL & MICROBIAL RESOURCES (6 lectures) • Role of animals in conservation of natural ecosystems • Role of wild and domesticated gene-pool in human nutrition • Importance of wild species (terrestrial and marine) in medicine • Animals in modern society and economy	

Course no.	Title	Credits
	• Importance of wild species in scientific research and inventions • Value of microbes in medicinal, scientific and technological research, solutions and inventions. 5. ECOSYSTEM RESOURCES (6 Lectures) • Economic value of natural ecosystems and their processes in global and national economies • Understanding the limits to exploitation and sustainability • Developing alternative resources / technologies / usage patterns • Ecotourism in wilderness and protected area network 6. PEOPLE RESOURCES (6 Lectures) • Understanding the growth of human population, its pattern, causes and consequences • Economic development, technological inventions and their impact on lifestyle as well as environment • Environmental cost (direct and indirect) of human conflict • Strategy for constructive involvement of communities (urban and rural) in conservation of biological resources 7. STRATEGY FOR CONSERVATION OF BIO-RESOURCES (6 Lectures) • International conventions and treaties for conservation of bio-resources • (including WCS, CBD, CITES, IPCC, Ramsar Convention, UNCLOS, Montreal Convention and others) • National Laws, policies and action plans for conservation of forests, wildlife, biodiversity, marine resources as well as for people's participation in conservation efforts. • Role of NGOs in conservation of bio-resources and people's participation in such efforts at global, national and grassroots level. 8. CONSERVATION ACTION AT NATIONAL AND LOCAL LEVELS (4 Lectures) • Environmental education at academic and non-formal levels • Role of youth in conservation education and action • Participation in conservation issues and action at national and local levels • Generating, sustaining and implementing conservation action at grassroots levels (eg resource conservation, waste disposal, conservation of wildlife in populated and protected landscapes) 9. FORESTRY (6 Lectures) • Forests and Forestry: Forest types of the world. Champion and Seth's Forest Types of India. Forest diversity of Oriental Region. • Forest Management: Working plans in forestry. Forests Departments and their structure. Conservation and protection of natural forests. Nursery, seed stock and forest plantation. • Community participation in forestry: Joint forest management. Social forestry. Eco-development. Habitat management in wastelands for forestry and national resources conservation. • Traditional knowledge and management practices: Medicinal plants in forestry. Rare and endangered forest species. Future sciences in forestry applications.	
	Reference Books • Chaudhuri AB and Sarkar DD (2003) Megadiversity Conservation, Flora, Fauna and	

Course no.	Title	Credits
	Medicinal Plants of India's Hotspots. Daya Publishing House, New Delhi. • Gary K Meffe and Ronald Carroll C (1994) Principles of Conservation Biology. • Sinauer Associates Inc., Massachusetts. • Groombridge B (Ed.) (1992) Global Biodiversity Status of the Earths Living • Resources. Chapman & Hall, London. • IUCN (1992) Global Biodiversity and Strategy. • Sharma PD (2000) Ecology and Environment. Rastogi Publications, Meerut, • India. • Singh MP, Singh BS and Soma S. Dey (2004) Conservation of Biodiversity and • Natural Resources. Daya Publishing House, New Delhi. • Virchow D (1998) Conservation and Genetic Resources, Springer-Verlag, Berlin. • Singh B, Social Forestry for Rural Development, Anmol Publishers, New Delhi (1992). • Murthy J.V.S., Watershed Management in India, (1994). • Raymond F Dasmann, Environmental Conservation, John Wiley (1984). • Kato, M. The Biology of Biodiversity, (1999), Springer Verlag, Tokyo. • Kotwal, P.C. and S. Banerjee. Biodiversity Conservation – In Managed forest and Protected areas, (2002). Agrobios, India. • Krishnamurthy, K.V. An Advanced Textbook on Biodiversity – Principles and Practice, • (2003). Oxford and IBH Publishing, New Delhi.	
EVSC 203	Atmospheric Sciences	4
	EVSC 203 Atmospheric Sciences (Credits 4) 1. Atmospheric science: (8 lectures) Atmosphere as part of the Biosphere Ecosystem; Evolution of atmosphere; Composition and structure of the atmosphere; Need of atmospheric studies in environmental sciences; Elements of weather and climate; weather parameters (temperature, wind, pressure, relative humidity, rainfall), climatology of weather parameters, long-term and short-term climatic effects. 2. Insolation and Energy Balance: (8 lectures) Insolation, Basic laws of radiation, black body radiation, multiple scattering, factors affecting the distribution of Insolation, geographical and seasonal distribution of Insolation, The energy system, Flux of solar energy in the biosphere, Earth's radiation budget, Net radiation and latitudinal heat balance, Greenhouse effect and Human influence on radiation balance. 3. Temperature measurements and controls: (4 lectures) Temperature measurements, horizontal and vertical distribution of temperature, Temperature inversion, Types of inversion, temperature gradients, urban heat island effect. 4. Atmospheric pressure and winds: (4 lectures) Pressure measurement and distribution, Wind observations, Factors affecting wind, pressure and wind belts, local winds, Geostrophic and gradient winds. 5. Atmospheric moisture: (6 lectures) Condensation, Forms of precipitations, Hydrological cycle, Indian monsoon, Inter-tropical convergence zone (ITCZ), Models of general circulation of the atmosphere, El-Nino, La-Nina phenomena, Walker circulation.	

Course no.	Title	Credits
	6. Stable and unstable atmosphere: (3 lectures) Atmospheric stability, Dry adiabatic lapse rate and moist adiabatic lapse rate, Environmental lapse rate. 7. Air masses and Fronts: (4 lectures) Air masses, Classification and modifications of air masses, Analysis of air mass back trajectories, Characteristics and types of fronts, the jet stream. 8. Atmosphere hazards: (6 lectures) Introduction to thunderstorm and lightening, Tropical cyclone, hurricanes, Global warming, Ozone depletion, Droughts, Ocean Atmosphere, sea surface temperature, ocean currents. 9. Environmental Meteorology: (5 lectures) Introduction to the atmospheric chemical transport models, emission inventory, aerosol and gases pollutants, national air quality standards and index, dry and wet deposition fluxes of gases and aerosol pollutants, Intercontinental and hemispheric transport of air pollutants.	
	Reference Books: • Atmospheric Sciences – Wallace, J. M. and Hobbs, P. V. • An Introduction to Dynamic Meteorology, James R. Holton and Gregory J. Hakim • Environmental Meteorology- B. Padmanabha Murthy • Introduction to boundary layer meteorology-Stull, R. B. • Atmospheric chemistry and physics from air chemistry to climate change- Seinfeld, J. H. and Pandis, S. N. • Introduction to atmospheric chemistry – Daniel Jacob • Short course in cloud physics –Rogers, R. R. • Micro-physics of clouds and precipitation by Pruppacher, H. R. and Klett, J. D. • Studies of clouds, precipitation and thunderstorm electricity, Vul'fson, N. I. Ed., Levin, L. M. Ed.	
EVSC 204	Remote Sensing and GIS	4
	EVS 204 Remote Sensing, image processing and GIS Credits 4 1. Basics of remote sensing: (4 lectures) Definition, EMR spectrum, Radiation laws, Active and passive remote sensing: Optical, Thermal, Microwave, Resolution of Remote sensing data: Spatial, Spectral, Radiometric and Temporal, Spectral signatures, Hyper-spectral sensing 2. Interaction of EMR with the earth's surface and atmosphere: (6 lectures) Energy response mechanism: Reflection, Absorption, Transmission, Scattering, Refraction, Reflectance, Emission and scattering, Bi-directional Reflection Distribution Function (BRDF), Atmospheric windows. 3. Platforms, Orbits, Sensors: (4 lectures) Types of platform; Geostationary orbit and Sun-synchronous Polar orbit; Multi spectral scanning, Scanning Systems (Push broom and Whiskbroom); sensors- LISS III, LISS IV, PAN, WIFS, Cartosat, Landsat, IKONOS, SRTM, ASTER GDEM 4. Aerial photography and Air Photo Interpretation: (5 lectures)	

Course no.	Title	Credits
	Basic geometric characteristics of aerial photographs. Scale, resolution, overlaps, flight planning, Measurement of height on aerial photograph, Principle of relative tonality, minimum mapping unit, Photo interpretation elements for visual interpretation 5. Digital Image Processing and Interpretation: (5 lectures) Factors governing Interpretability, Elements of image interpretation. Image correction, rectification and enhancement technique, Image fusion, image contrast stretching and image filtering. Image classification. 6. Basics of GIS: (6 lectures) Definition and Objectives of GIS, Concept of space and time, components of GIS, basic entities of GIS: line point and polygone. Map Projection: Conical, Azimuthal and Cylindrical. LCC Projection, UTM and Polyconic projections. Types of Datum. 7. Data structures in GIS – Spatial: (3 lectures) Raster data, Vector data, comparative overview. Non-spatial data - Hierarchical, Network and relational data. 8. Acquisition of spatial data: (3 lectures) Scanning, Georeferencing, concept of layer, digitizing, error detection and correction, concept and type of topology. 9. Spatial Analysis: (6 lectures) Vector based: Overlays operations- point in polygon, line in polygon, polygon in polygon; single layer operations and Multilayer operations. Raster based: Map algebra, Grid based operations, Local, Focal, Zonal and Global functions. Buffering, Network Analysis, Terrain Analysis, Digital Terrain Models and generation of Thematic maps. 10. Applications of RS and GIS in Environmental Issues: (6 lectures) Landuse-land cover changes: Natural hazards and hazard management, floods, landslides and other natural hazards, monitoring water quality and soil quality, mineral exploration, lithological and structural mapping, Use of GIS to represent environmental status and highlight environmental issues.	
	Reference Books • Lillisand, T. M. and Keifer, R. W. (1990): Remote Sensing and Image interpretation, John Willey and Sons, New York • Joseph G. (2003): Fundamentals of Remote Sensing, Universities Press, Hyderabad. • Haywood, Ian (2000): Geographical Information Systems, Longman • Chang, Kang-taung (2002): Introduction to Geographic Information Systems, Tata McGraw-Hill. • Burroughs, P. A (1986): Principles of Geographical Information Systems for land Resource Assessment, Oxford University Press. • Gupta, R. P. 2003. Remote sensing geology, Springer, New York • Barrett, E. C. and Curtis, L. F. 1999. Introduction to environmental remote sensing. Chapman and Hall	
EVSC 205	Practical Courses II	6
	EVSC 205 Practicals II **Credits: 6** **<u>Practical based on Environmental pollution I</u>**	

Course no.	Title	Credits
	• Determination of COD in given water sample • Determination of Do and BOD of given water sample • Determination of Nitrate and nitrites in a water sample. • Determination of TS and TSS of water sample • Estimation of oil and grease from a water sample. • Removal of heavy ions by different processes • Estimation of MPN and standard plate counts from a water sample. • To estimate organic carbon and water holding capacity od soil sample • Find out water holding capacity of soil • To estimate cation exchange capacity of soil. • To determine sodium adsorption ratio of soil **<u>Practicals based on Biodiversity, Conservation and Natural Resources</u>** • Plant species diversity in a sacred grove or forest area (one season data only) • Species wise population count of birds in a wetland • List of minor forest produce used by a community living inside or in the proximity of a • Protected area • Establish micro-plan and action programme for village-level joint forest management committee and local communities • Develop a biodiversity register at village level near or within Protected Areas • Do flora species counts with local forest guards /forest officials in development or verification of forest working plan • Develop and maintain a herbarium of flora species along a water stream in the hill areas of Pune, Nashik and Ahmadnagar Districts • Develop or verify or monitor and evaluate the conservation action plan for a protected area in collaboration with the forest department and the local village-level community • Develop or verify or monitor and evaluate the eco-tourism action plan near a protected area in collaboration with the forest department and the local village-level community **<u>Practicals based on Atmospheric Sciences</u>** • Estimation of distribution of solar radiation/ insolation over Earth's surface • Exercises based on incoming and outgoing solar radiations • Estimations of dry and wet deposition fluxes of gases and aerosol pollutants • Global average temperature estimations with & without Greenhouse effect • Plume dispersion model (case studies) (optional) • Exercises based on adiabatic lapse rates • Climatic maps and diagrams – circular, graph, wind roses • Air-mass back trajectory analysis (optional) • Calculation of ventilation coefficients for the fate of air pollutants (optional). **<u>Practicals based on GIS and Remote sensing</u>** • Installation of GIS Software • Introduction of the software • Georeferencing • Base layer preparation / Digitization • Preparation of Geodatabase • Mosaicing	

Course no.	Title	Credits
	• Subsetting • Classification of Satellite Image • Preparation of Layouts • Point interpolation techniques like IDW and Krigging • Handling of GPS and use of expert GPS software • Applications of Google Earth in calculating ground distance, aerial distance, path and area of given features • Study of different layers in Google earth • Interpretation of aerial photographsusing mirror stereoscope and pocket stereoscope • Use of Arc- Scene.	