UNIVERSITY OF PUNE

M. Sc. Environmental Sciences
Revised Syllabus for University Department and Affiliated Colleges from July 2013
M. Sc. Part I

Course Number	Title of Course	Credits
Semester I		
EVSC 101	Environmental Biology	4
EVSC 102	Environmental Chemistry	4
EVSC 103	Environmenal Geosciences	4
EVSC 104	Environmental Statistics	4
EVSC 105	Practicals 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	Practicals II	6

44 Credits – Part I

M. Sc. Environmental Sciences Part II for University Department and Affiliated Colleges
Proposed Structure for M. Sc. Part II from July 2014

Course Number	Title of Course	Credits
Semester III		
Compulsory Courses		
EVSC 301	Environmental Impact Analysis and Environmental Audit	4
EVSC 302	Environmental Pollution II**:** Air, Noise and Radiation	4
EVSC 303	Water and Wastewater Technology	4
EVSC 304	Environmental Law, Ethics and Policy	4
EVSC 305	Practicals III	6
EVSC 306	In-plant training + Seminars	3
Elective Courses (Any One)		
EVSC 307	Man and Environment	4
EVSC 308	Environmental Education	4
EVSC 309	Environmental Biotechnology	4
EVSC 310	Environmental Resource Monitoring	4
Semester IV		
Compulsory Courses		
EVSC 401	Environmental Toxicology, Health and Safety	4
EVSC 402	Restoration Ecology and Watershed Management	4
EVSC 403	Waste and Hazardous Waste Management	4
EVSC 404	Renewable and Non-Renewable Energy	4
EVSC 405	Dissertation and Project Work	7
Elective Courses		
EVSC 406	Forestry and Habitat Management	4
EVSC 407	Environmental Economics	4
EVSC 408	Sustainable Agriculture and Organic Farming	4
EVSC 409	Wild Life Management and Conservation	4

29 + 27 = 56 Credits = Part II
44 Credits (Part I) + 56 Credits (Part II) = 100 Credits

M. Sc. Environmental Sciences Part II for University Department and Affiliated Colleges
Proposed Structure for M. Sc. Part II from July 2014

Course Number	Title of Course	Credits
	Semester III	
	Compulsory Courses	
EVSC 301	**Environmental Impact Analysis and Environmental Audit** (44 lectures) – Equivalence – ENV 302	4
	Introduction (5 lectures) Definition, aims and objectives of EIA. Concept of EIA and Scope of EIA. Hierarchy. Evolution of EIA. Terminologies used in EIA – Environmental inventory / baseline data study / environment setting / environmental impact assessment, environmental impact statement. EIA and sustainable development. Benefits of EIA. Drawbacks in EIA process. **Legislation and Procedures (5 lectures)** National Environmental Policy Act (NEPA) of 1969, USA. EIA notification 1994, 2006 for India and implementation, EIA Guidelines. EIA legislative requirements and administrative procedures in India / States of India. Accreditation of EIA consultants by Quality Control of India – requirements and guidelines. **Methodology (5 lectures)** Methods of impact analysis. Description of the environmental setting. Baseline data collection for EIA procedure of baseline data collection. Guidelines used for collection of baseline data for different environment e.g. water, air, soil, hydrogeology, climate, micro-climate etc. Environmental risk assessment. **Prediction and assessment of impacts (2 lectures)** Air, water, noise, biological, cultural and socio-economic, mining, blasting. **Preparation and writing of EIA report (3 lectures)** **Public participation (1 lecture)** Public participation in environmental decision making, regulatory requirement, techniques, advantages and disadvantages of public participation. **Case studies of EIA (10 lectures)** Industries like oil, petrochemical, iron and steel, fertilizer, sugar and distillery, projects of road /dams and housing etc. **Environmental management plan (5 lectures)** Planning and selection of appropriate resource management procedures for – Water, air, land, soil, solid wastes. Resources recovery and reuse. Ecology and biodiversity. Noise and vibration. Occupational safety and health. Risk assessment. Disaster management plan. Prevention, maintenance and operation of environment control systems. Socio-economic factors – human settlements, culture, occupation, water, electricity supply, transport systems, education, communication, health care facilities. Environment Cell. Environmental budgets, to minimize environmental impacts.	

Course Number	Title of Course	Credits
	Semester III	
	Compulsory Courses	
	Environmental Audit (8 lectures) Definition of environmental audit and its importance for industries. Environment Compliance Audit. Types of audits. Audit tools and technology /general audit methodology and basic structure of audit. Elements of an audit process and its importance. Environment Audit in India – Development of environmental auditing in India, Concept of ISO 14000, requirements of Rule 14 for environmental audit under Environmental Protection Act, 1986. Definitions – signatory, consumption audit, pollution audit, hazardous audit, solid waste audit, disposal audit, cost audit, investment audit, voluntary.	
EVSC 302	**Environmental Pollution II: Air, Noise and Radiation** (44 lectures) – Equivalence – ENV 301	4
	Air Pollution (2 lectures) Chemical composition of atmosphere. Greenhouse effect and global warming. Air pollution disasters. Atmospheric reaction. Ozone depletion. Quality and emission standards. **Classification and effect of air pollution (4 lectures)** Sources, classification and effects of air pollutants. Effects of gaseous and particulate air pollutants on plant, animal and human health. Economic effects of air pollution. Particulates, NOx, Sox, and Oxides of Carbon and hydrocarbons, wet and dry deposition on plants, animals and properties. Acid rain. **Vehicular pollution (4 lectures)** Automobile emissions, dispersion of vehicular pollutants. Carcinogenic potential, prevention and control of vehicular pollution, Emission, air fuel ratio, combustion chamber. Surface-volume ratio, combustion chamber deposits. Control of exhaust emissions. Catalytic converters. Alternative fuels, SPM pollution. Path of a particulate particle. Lead pollution. **Industrial air pollution (5 lectures)** Point and non-point sources of air pollution, principle causes of industrial pollution, environmental problems of some industries – mining and metallurgy industry, cement industry, thermal power plants, nuclear power plants. Preventive measures for industrial pollution. **Analytical methods for air quality analysis (2 lectures)** Air monitoring instruments and techniques. Monitoring of sulphur dioxide, CO2, SO2, NOx, hydrocarbons and particulate matter, SPM, trace metals. **Prevention and control of air pollution through different technologies (7 lectures)** Control of air pollution by fuel selection, principle and working of – cyclones, scrubbers, settling chambers and electrostatic precipitators. Control of gaseous pollutants – absorption, adsorption, condensation, vapor incineration. Equipments for control of air pollution – Cyclones, Wet scrubbers, Electrostatic precipitators, fabric filters, absorption.	

Course Number	Title of Course	Credits
	Semester III	
	Compulsory Courses	
	Noise Pollution (10 lectures) **The physics of sound and hearing:** Sound transmission, the auditory mechanism **Noise sources, national standards** **Effects of noise:** Reactions to noise- auditory effects, PTS, acoustic trauma, psychological effects- speech interference, annoyance, sleep interference, effects on performance, subjective response, acoustic privacy. **Noise measurements:** Basic definitions and terminology. Frequency, loundness **Noise assessment and evaluation** **Noise control at source:** Sound path reciver concept, control by design, control by redress **Noise control in the transmission path:** Accoustical separation, physical barriers, Isolators and Silencers **Protecting the receiver:** personal protection devices **Radiation pollution (10 lectures)** Radioactivity – types and measurement. Detection of nuclear radiations – G. M. counter, scintillation counter, semi-conductor detector. Radiation hazards and safety – natural and manmade. Types of radiations. Internal and external radiation hazards, safe handling methods, personal dosimetry, reactor safety. Interaction of radiation with matter. Units of measurements, half-life period, radiation dose measurement. Biological effects and health hazards associated with radiation. Interaction of radiations with biological cells, somatic and genetic effects. Classification of radio-active wastes – gas, solid, liquid. Control measures – treatment and disposal of radio-active waste, generation of waste from various sources. ICRP recommendations. AERB classification, maximum permissible dose. Three miles and Chernobyl accidents.	
EVSC 303	**Water and Wastewater Technology** (44 lectures) – Equivalence – ENV 202	4
	Water (6 lectures) Water Requirements for Domestic Consumption. Population forecasting by the following methods. Demographic method, Arithmetical progression method, Geometrical progression method, Logistic methods, Graphical projection method, Final prediction. Quality of water required for – (a) Domestic, (b) Institutional (Schools, Hostels, Hospitals), (c) Fire fighting, (d) Commercial (Shopping complex, Hotels, Restaurant), (e) Industrial (Dairy, Sugar, Pulp and Paper, etc.) (f) Specific requirement at pilgrimage place and recreation activities. **Impact of future growth and development and change in quality of life on water requirements. (5 lectures)** Types of solid in water and their impact on water quality. Need of water quality standards for domestic & industrial purpose. Specifications for drinking water (physical, chemical & bacteriological) by Bureau of Indian Standards & World Health Organization. Packaged drinking water. **Water Sources (5 lectures)** – Availability & quality of Surface water (River, stream lake, dam) & Ground water (Open well & Borewell). Water source, quality of raw water, solids in water & treatment process.	

Course Number	Title of Course	Credits
	Semester III	
	Compulsory Courses	
	Water Treatment (3 lectures) – Principal, Application & Designing of following Unit Operation in water treatment. a. Collection & pumping, b. Aeration, c. flocculation, d. Sedimentation, e. Filtration, f. Disinfections (Chlorination, UV, Ozonization), g. water softening. **Advance treatment methods (3 lectures)** e.g. a. Demineralization, b. Ultra filtration, c. Reverse osmosis, d. Color & odor removal by activated carbon, e. Iron removal. Selection of appropriate unit operations for the treatment and flow chart of water treatment plant. **Wastewater technology (4 lectures)** for Preliminary & Primary Treatment: Quantity & Quality of sewage generated, Impact of Future growth & development & change in quality of life on sewage quality & quantity. **Specification of treated wastewater (4 lectures)** for disposal into surface water, on land & for treatment. a. Collection & pumping, b. Screen chamber, c. Grit chamber, d. Oil & grease removal, e. Dissolve air floatation. **Wastewater engineering for Biological Treatment (6 lectures)**: Principal, role of microorganisms, ecosystem & designing of following biological Unit Operation in waste water treatment. a. Stabilization pond, b. Aerated lagoon, c. Activated sludge process, d. Trickling filter, e. Anaerobic treatment. **Industrial Wastewater (3 lectures)**: Selection of appropriate unit operations for the treatment and flow chart of wastewater treatment plant for a. Dairy, b. Pulp & Paper, c. Galvanizing. **Biotechnology & Waste Management (5 lectures)**: Application of biotechnology for the Treatment of followings:a. High strength waste e.g. whey & spent wash, b. Primary & secondary sludge, c. Phenol & cyanide removal. Different models of anaerobic digestion by combination of attached & suspended growth.	
EVSC 304	**Environmental Law, Ethics and Policy** (44 lectures) – Equivalence – ENV 204	4
	Law and Policy (3 lectures): Introduction to Law, Policy; Meaning, Basic difference and Importance. **Indian Constitution and Environment (5 lectures)** Role of Constitution in Environment Protection, Fundamental Rights and Duties, Article 48A, 51A (g) and 58A **Environmental Laws in India (10 lectures)** The Water (Prevention and Control of Pollution) Act – 1974 The Air (Prevention and Control of Pollution) Act – 1981 Indian Forests Act (Revised) 1982. The Environment (Protection) Act, 1986 The Indian Wildlife (Protection) Act – 1972 amended 1991 The Public liability Insurance Act, 1991	

Course Number	Title of Course	Credits
	Semester III	
	Compulsory Courses	
	The National Environmental Tribunal Act, 1995 The Biological Diversity Act, 2002 **Rules and Regulations (4 lectures)** Hazardous waste management and Handling rules, Solid waste management and Handling rules, biomedical waste regulations, Motor Vehicle rules **Environmental Policies in India (4 lectures)** National Environmental Policy, National Forest Policy, National Water Policy, Policies on Renewable and Non renewable energy resources. **International Environmental Laws and Policies (6 lectures)** Stockholm conference, Nairobi Declaration, Rio Conference, Kyoto Protocol, World Summit on Sustainable Development (Rio + 10), Convention on Biological Diversity, Convention on Climate Change, Role of UN authorities in protection of Global Environment. **Environmental Ethics (6 lectures)** Introduction, concept, ethical theories applied to the environment. The ethical dilemma, Environmental ethics and population, pollution. Human life and its environment – The art of ethics and an ethical dilemma, Challenges of world environmental ethics. **Sustainable Development (6 lectures)** Definition and concepts of sustainable development, Integration of – a. Economic, Social and Environmental sustainability, b. Biodiversity and c. Availability of natural resources in development. Parameters and Issues of Sustainable Development.	
EVSC 305	**Practicals III**	6
	EVSC 301 EIA and Environmental Audit Content of EIA studies and collection of secondary data for at least 3-4 developmental projects and preparation of the report. Environmental audit : protocols and data collection and analysis Field work for rapid EIA studies and environmental audit (3-4 days duration). **EVSC 302 Environmental Pollution II: Air, Noise and Radiation** Comparative analysis of air sampling from clean and polluted area using key parameters. (2 P) Collection and Interpretation of weather data (Calculation of stability and wind rose diagrams, field visit to observatory) (2 P) Measurement of sounds by DB meter in silent, industrial, residential and commercial zones. (2 P) Carbon sequestration in vegetation and soil (4 P) Estimation of above and below ground biomass Calculation for total carbon sink Estimation of soil organic carbon Estimation of dead wood and litter for carbon	

Course Number	Title of Course	Credits
	Semester III	
	Compulsory Courses	
	Estimation of Carbon dioxide from air sample (2 P) Radio-active beta-decay. Energy of beta particles. Neutron activation. (3-4 P) **EVSC 303 Water and Wastewater Technology** Field visit to river/lake and water and wastewater treatment plants. One day tour. Physico-chemical analysis soil. Physico-chemical analysis water. Types of solid in water and their impact on water quality. Water source, quality of raw water, solids in water & treatment process. Visit to waste-water treatment plant. Quality of sewage. Visit to operative waste water treatment through Stabilization pond and aerated lagoon. Models of anaerobic digestion. **EVSC 304 Environmental Law, Ethics and Policy** Assignments and seminars.	
EVSC 306	**In-plant training + Seminars**	3

Course Number	Title of Course	Credits
	Semester III	
	Elective Courses (Any One)	
EVSC 307	**Man and Environment** (44 lectures)	4
	Man and environment relationship (7 lectures) General relationship between landscape, biomes and climate. Concept of sustainable development. Scope of Human Ecology, its importance in understanding conservation issues; Different modes of resource use and differences with respect to technology economy, social organization, ideology, and nature of ecological impact; **Human population and growth (8 lectures)** Population growth - biological growth curves and carrying capacity, Human population growth and environmental constrains, Effects of environment on human culture and livelihood; Human impact on ecosystems. Implications for the natural environment. Population dynamics: Concept of population, population regulation – biotic potential and environmental resistances; Factors of population regulation – density dependent and density independent; Population crash and carrying capacity; The laws of population growth. **Human settlements (3 lectures)** Size and distributions. Settlement hierarchy. Primacy of cities. Evolution and growth of rural settlements. Spatial distribution and dispersion. House forms and types. **Human ecology and environmental geography (8 lectures)** Evolution and objectives. Man-environmental relationships – hunting gathering, fishing, mining, acquiring forestry. Environmental systems. Environmental degradation – Causes, resulting effects, remedies. Land uses – Types of land use, agriculture, urbanization, changes in land use during historical times. Earth, Man and Environment. Ecosystem, pathways in ecosystems, physico-chemical and biological factors in the Environment. Definition, principles and scope of ecology, human ecology and human settlements, Energy flow, food chain, food web, Population ecology – density, natality and mortality. **Limiting Factors (6 lectures)** Limiting Factors of Environment for Man: Concept of limiting factors, Laws of limiting factors – laws of minimum and tolerance; Combined concept of limiting factors; Earth's carrying capacity. Human food requirements, Food production and its environmental significance. Food chain losses; effects of pesticides on non-target organisms, effects on predator, pollution. **Urban and Rural Planning (8 lectures)** Demographic considerations, national and regional planning parameters for urban and rural areas. Development indices, industrial and business growth pattern, indigenous assets and liabilities, natural resources and exploitation patterns, accessibility and transportation development, industrial development and growth prospects, human resources, services levels and social aspirations, willingness to pay, rehabilitation and resettlement issues.	

Course Number	Title of Course	Credits
	Semester III	
	Elective Courses (Any One)	
	Rural Communities: Rural ecosystem structure, organisation and function; Characteristics of rural subsistence economy, role of wilderness and wildlife areas in rural sustainability, and the impact of market economy. **Equity, Environment and Development (6 lectures)** Equitable development and its principles, Importance of critical review of plan with respect to local and regional levels, Immediate and long term gains and effect of development. Comparison between exploitation and safe guards for conservation, rates of utilization and regeneration, natural and manmade growth, and survival need of mankind and protection of environment. Agenda 21: Role of various stakeholders in environmental planning and development process	
EVSC 308	**Environmental Education** (44 lectures)	4
	Introduction to Environmental Education (EE) and Education for Sustainable Development (ESD) (8 lectures) Importance of EE and ESD as essential tool for achieving sustainable development. Evolution of the concepts of EE and ESD at the international level through UNESCO conferences on EE; Agenda 21 and Earth Charter; Traditional and community based approaches of teaching and learning; *Nai Taleem* Guiding Principles of Environmental Education **EE in Formal Education (8 lectures)** Current policies and status of EE and ESD in Indian school systems and that of selected countries (Sweden, Germany, UK, etc). Evolution of EE in Indian school systems, the importance to Environment in India's National Policy on Education, EE in the National Curriculum Framework; Quality Education and ESD; The linkage of *Sarva Shiksha Abhiyan* to ESD. Curricular and extra-curricular approaches; the whole-school, whole-systems approach: textbooks and EE; school infrastructure and habitat; school in community; eco-clubs; project-based learning EE at college and university level. Teacher orientation for EE and ESD - pre-service and in-service teacher preparation **ESD and Communication, Education and Public Awareness (CEPA) (8 lectures)** Policies and approaches to public awareness. EE/ ESD/ CEPA as elements of multilateral environmental agreements, national programmes, and civil society efforts in the areas of environmental conservation, natural resource management, health and sanitation, waste reduction and management, pollution abatement, consumption and lifestyles. Collaborative learning approaches to address 'wicked' problems. **Educator Competence (8 lectures)** The role of the educator and facilitator. Understanding advocacy, communication, facilitation, collaborative and action learning. Framework of competence for Education for Sustainable Development.	

Course Number	Title of Course	Credits
	Semester III	
	Elective Courses (Any One)	
	Teaching-Learning Approaches (8 lectures) Introduction to teaching-learning processes and techniques in the context of EE and ESD; developing and using different approaches. Roles and use of traditional and new media. Films, websites, exhibitions. Experiencing nature/ nature camps. Communication campaigns, mass media. Deliberative and participatory techniques. Techniques to enhance systems thinking, critical thinking, values clarification, empathy. Evaluation of EE and ESD programmes **Readings and references** Tbilisi to Ahmedabad – Centre for Environment Education Green Teacher - Centre for Environment Education Green Action Guide - Centre for Environment Education UNECE Strategy for Education for Sustainable Development National Curriculum Framework – NCERT ESD Toolkit – UNESCO Engaging People in Sustainability (IUCN, Gland, Switzerland) - Tilbury, D. and Wortman, D. (2004) Power: A practical guide for facilitating social change - Raji Hunjan and Jethro Pettit Wals, A. (ed.) (2007). *Social learning towards a sustainable world*. Wagening: Academic Publisher Ison, R. (2010) *Systems Practice: How to Act in a Climate Change World*. Dordrecht: Springer.	
EVSC 309	**Environmental Biotechnology** (44 lectures)	4
	Introduction to Environmental Biotechnology (8 lectures) The scope of environmental biotechnology; Concept and broad outlines of various application areas – waste treatment, biodegradation, hydrocarbon degradation, bio-fuel production, bio-fertilizer, bio-pesticides production, and bioleaching. Bioremediation: Concept, role of bioremediation in controlling various pollution problems – solid water, sewage water, industrial effluents, heavy metals, radioactive substances, oil spillage. Biodegradation of macromolecules; Biosensors to detect environmental pollutants. Microorganisms and organic pollutants; Fermentation technology (Bioreactors). **Applications in environmental biotechnology (7 lectures)** Phytoremediation and biopesticides – Abatement of different types of pollution using plants, types of phytoremediation, mechanism involved with case studies. Alternate fuels: source and mechanism of various biofuel productions. Integrated pest management: concept, technology involved in agriculture & forestry. Biopesticides. Biocomposting. Biomining. Biomethanation (Agro industrial wastes). Air borne microbes and allergic disorders. **Environmental microbiology (7 lectures)** Diversity of micro-organisms. Prokaryotes versus eukaryotes- Eukaryotic and Prokaryotic cell structure, three domains of life. General characters, important uses and harmful effects of a) Protozoa b) algae, c) fungi, d) bacteria, e) virus. Classification, nomenclature and identification. General Concepts of microbial	

Course Number	Title of Course	Credits
	Semester III	
	Elective Courses (Any One)	
	taxonomy, phenetic classification, numerical taxonomy, Phylogenetic classification-polyphasic taxonomy of prokaryotes, Ecological, Morphological, Physiological, biochemical, genetic and molecular characterisation classification and identification schemes. **Microbes (7 lectures)** Nutritional requirements, macronutrients, micronutrients, trace metals and growth factors, Nutrient media (selective, differential, enriched, enrichment and special purpose media) and growth condtions, Nutritional types based on energy source, principal carbon source, electron donor. Proto and auxotrophs, copio and oligotrophs, phago and osmotrophs. Isolation, cultivation (aerobic & anaerobic) and preservation of microorganisms, Physiology of growth, bacterial growth curve, methods for determining bacterial numbers, mass and cell constituents. Exponential growth and generation time. Bacterial growth in batch and continuous culture, synchronous growth. **Micro-organisms and the natural environment (7 lectures)** Effects and microbial adaptations to environmental conditions – Temperature, oxygen, desiccation, extreme cold, ionic effect, osmotic pressures, radiant energy, hydrostatic pressures. Basic concept of genetic engineering of plants and its applications- herbicide and stress tolerant plant. Biotechnology strategies in forestry and wasteland management. Biotechnology in biodiversity conservation: gene banks, germplasm conservation and DNA Banks.Genetically modified organisms and Biosafety- a general account. **Bioindicators and biosensors (8 lectures)** What are bioindicators? Plankton community as indicators of water pollution; use of diversity index in evaluation of water quality. Determination of micro-biological quality of recreational and potable waters, indicator organisms, coliforms and E.coli, fecal streptococci, clostridia, heterotrophic plate counts etc. lichens as air pollution indictors. What is a biosensor? Components, Advantages and limitations, biocatalysis based, bioaffinity based and microorganism based biosensors; Transducers-potentiometric, conductometric, amperometric, optical, piezoelectric, and thermoelectric based biosensors. Glucose, ammonia gas, alcohol, BOD, methane and mutagen sensors. Applications of biosensors in environmental monitoring. Manahan, S.E. 1997. Environmental Science and Technology. Lewis, New York. Environmental Biotechnology – A.K. Chaterjee Environmental Biotechnology (second edition) – Alan Scragg Environmental Biotechnology – Bimal C. Bhattacharyya, Rintu Banerjee	
EVSC 310	**Environmental Resource Monitoring** (44 lectures)	4
	Introduction (4 lectures) Introduction to environmental monitoring; Basics of resources to be monitored.	

Course Number	Title of Course	Credits
	Semester III	
	Elective Courses (Any One)	
	Air Quality Parameters (10 lectures) a. weather monitoring - includes light, rainfall, wind direction, wind velocity, temperature, pressure, humidity, etc. broad significance of each of the parameter, monitoring tools/instruments and its work principle, data reporting/presentation method(s), etc. b. ambient air – national standards for ambient air quality, site and parameter selection, monitoring of important ambient air components such as particulate matter (PM) of 10 micron or less in size and 2.5 micron and less in size, oxides of sulfur and nitrogen, etc limits/standards for these parameters under OSHA, ambient air and work zone monitoring techniques; monitoring tools/instruments used for the same and its work principle, stack gases monitoring technique; limits for different industries for stack gases, stack height determination, criteria for sampling port (Indian Standard (IS) and/or international standards linked with these elements need to be familiarized to student) c. Noise & vibration monitoring: Introduction of noise & vibration; measuring techniques, national standard for noise, noise monitoring methods, A-weighted Sound Level: The Basic Noise Unit; Maximum Sound Level (Lmax) During a Single Noise Event; Sound Exposure Level (SEL): Exposure from a Single Noise Event Hourly Equivalent Sound Level (Leq(h)); Day-Night Sound Level (Ldn): 24-Hour Exposure from All Events; A Noise-Exposure Analogy for Leq and Ldn ; d. Noise Impact Criteria: investigation and assessment of impact of noise; Considerations in Applying the Noise Impact Criteria; Mitigation Policy Consideration; Determining the Need for Noise Mitigation e. Odour monitoring: basics, technique/methodology **Methods for monitoring/sampling of water and its analysis (10 lectures)** Monitoring of Water, purpose/objectives of monitoring, selection of method suitable to fulfill monitoring objective; Water Quality Monitoring Protocol, frequency and parameters for ground water & surface water, collection of sample (types of sample, chain of custody, sampling method, number of samples, sample containers, sample volume, etc), sample preservation, handling & storage guidelines/criteria, water quality monitoring on field test parameters, off-field test parameters, water quality criteria for different designated best uses; general effluent standards, drinking water standard (IS 10500 and WHO standards); Safety practices Monitoring of pollution of water bodies (rivers, streams, creaks, seas, oceans, etc), monitoring methods, tools/instruments, impact prediction and analysis **Monitoring of Soil (10 lectures)** Objectives of soil monitoring/testing, sampling and sample units; sample number, frequency and timing; Sampling methodology; a. Site selection b) In-field sampling technique c) Describing the soil profile d) Site description e) Setting a transect instruments / Equipments used,	

Course Number	Title of Course	Credits
	Semester III	
	Elective Courses (Any One)	
	Quality Parameters (testing contaminants/polluting elements), important soil quality indicators - soil acidity (pH); EC; carbon (C); total nitrogen (N) and carbon to nitrogen ratio; extractable phosphorous (P); extractable potassium (K) and magnesium (Mg); micro nutrients and potentially toxic elements; useful soil microbes. Basic concepts in analysis, Guidelines for handling and storage of samples; Safety practices **Forest resource monitoring (10 lectures)** Definition and scope. Measurement of individual trees: a) Measurement of diameter and girth of trees b) Measurement of heights of trees c) Measurement of form of trees d) Measurement of volume of felled trees e) Measurement of volume of standing trees f) determination of age of trees g)) determination of increment of trees, increment percent, Sample plot, forest inventory, kinds of sampling, sampling units, sampling intensity, errors of sampling, methods of determination of past growth of stands, method of predicting growing stock of stands, its increment during any future period, stand density, yield tables, stand tables Wild life monitoring: scope, methods/ techniques a) census for invertebrates, fish, amphibian, reptiles, birds and mammals Monitoring of other resources such as wetlands, pasturelands, coastal areas, lakes, river, sea, oceans, etc. techniques for monitoring including remote sensing/aerial photography techniques **Reference** • Guidelines for the Measurement of Ambient Air Pollutants - Volume-I - Guidelines for Manual Sampling & Analyses by CENTRAL POLLUTION CONTROL BOARD (Ministry of Environment & Forests, Govt. of India), Delhi - May, 2011 • GUIDE MANUAL: WATER AND WASTEWATER ANALYSIS by CENTRAL POLLUTION CONTROL BOARD (Ministry of Environment & Forests, Govt. of India), Delhi - May, 2011 • Guidelines for Water Quality Monitoring by CENTRAL POLLUTION CONTROL BOARD (Ministry of Environment & Forests, Govt. of India), Delhi - MINARS/27/2007-08 • Guidelines for Water Quality Management - by CENTRAL POLLUTION CONTROL BOARD (Ministry of Environment & Forests, Govt. of India), Delhi • Horizontal Guidance Note IPPC H3 (part 2) - Noise Assessment and Control - Version 3 June 2004 Environment Agency Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol BS32 4UD • Handbook of Forestry by Khanna LS and Chaturvedi AN; Publiched by Khanna Bandhu, Dehradun ISBN 81-85933-24-3 • Land and Soil Monitoring: A guide for SoE and Regional Council Reporting; New Zealand Published by the Land Monitoring Forum, New Zealand. 2009	

Course Number	Title of Course	Credits
	Semester IV	
	Compulsory Courses	
EVSC 401	**Environmental Toxicology, Health and Safety** (44 lectures)	4
	Safety, Health and Environment (4 lectures) Perspectives and concerns, interrelationship and interactive approach, development projects and related aspects of safety and health, environment as the ultimate beneficiary / loser. **Safety and Health Hazards (4 lectures)** Identification of potential safety and health hazards in industrial and development projects, reduction strategies, policies and legislation, international and national perspective, safety standards and management systems, ISO 18000. Industrial health safeguards and implementation mechanisms. **Health and Safety Risk Management (6 lectures)** Risk identification, allocation and mitigation strategies, responsibilities and authority, potential of health risks in industrial and development processes, local and national policies, public awareness and participation in prevention procedures. Industrial environmental conditions, emissions and noise abatement. **Toxicology (8 lectures)** Basic concepts, toxicity and its impacts, industrial toxicants and hazardous materials, toxic and hazardous waste management, measurement of toxicity, TLM and lethality studies, physiological and metabolic effects on flora and fauna. **Evaluation of toxicity (8 lectures)** Methods used to assess toxicity classification of toxic materials. Physiological and metabolic effects of toxicants, such as VOC and organic solvents, used in industry heavy metals such as Mg Cl, Cu, Pb, Al, AS, Zn, Mutagenic and carcinogenic compound. Anti cancer drugs. **Water and airborne Diseases (8 lectures)** Potential and widespread effects, water and airborne bacteria and viruses, human immune-system and its vulnerability to these bacteria and viruses, preventive and curative measures, epidemics and their containment, biological warfare and protective measures. Safeguarding water sources and ambient air quality, disaster management. **Human Environment and Health Status in Urban and Rural India (6 lectures)** Water and sanitation situation in urban and rural context, historical perspective, WHO and other bodies and their role in public health projects development, eradication programs and their efficacy, development impacts in urban and rural sectors, psychological impacts, public awareness of sanitation and hygiene issues and role of NGOs.	

Course Number	Title of Course	Credits
	Semester IV	
	Compulsory Courses	
EVSC 402	**Restoration Ecology and Watershed Management** (44 lectures)	4
	Restoration Ecology (4 lectures) Eco Restoration: definition, principles, significances, guidelines, etc. **Applications of eco-restorations (6 lectures)** **Restoration of urban eco-system –** e.g. ponds, lakes, river banks, avenue trees, biodiversity restoration through gardens, park, restoration of dumping grounds, restoration of eco system on hills, restoration of soil in urban areas, ground water resource – replenishment, sewage or wastewater – recycling for supporting ecosystems **Eco-restoration and industrial environment (2 lectures)** Eco-restoration of mines (open cast), restoration of solid waste dumping sites, Improving aesthetics by partial restoration at industrial sites **Restoration of other natural habitats/eco-systems (2 lectures)** Mangroves, grasslands, wetlands, restoration of streams, degraded forest patches, coastal ecosystems, etc. **Watershed Development** **Concept of watershed management (8 lectures)** Definition, principle, objectives, Water shed morphology and characterization (with respect to size, elevation & slope, aspects & orientation, watershed shape, drainage network), **Watershed functions and surveys (8 lectures)** Collection, storage, dispersal, habitat, Attenuation response, flushing, etc. Engineering surveys involved in watershed development: Topographical survey, drainage line survey, contour survey, common instruments used for survey. Hydrological survey: Methodology for groundwater investigation, investigation of surface springs, vertical distribution of ground water **Water balance studies and harvesting methods (8 lectures)** Water balance and hydrologic equation, inflow to the watershed, outflow from the watershed. Water harvesting methods: traditional water harvesting structures such as *nadis*, *Khadin*, *Rapats*, Lakes, etc. contour bunding, graded bunds /field bunds, land leveling or terracing, farm ponds; Water harvesting in streams: Biological measures, check dam, gully plug, Gabion structure, Overflow weir, earthen dam, Underground *bandhara*. Soil and water conservation aspects: contour trenches, continuous contour benches, live hedges, infiltration pit, *in situ* conservation through appropriate cultivation practices **Watershed management (6 lectures)** Factors, problems associated with watershed management, project monitoring and result indicators, repair and maintenance, etc. Success stories of watershed management/water harvesting projects in India	

Course Number	Title of Course	Credits
	Semester IV	
	Compulsory Courses	
	Reference Restoration of Nature by Prakash Gole Restoration Ecology the new frontier – edited by Jelte Van Andel and James Aronson – Wiley-Blackwell publication ISBN 9781444336368 A source book for Ecological Restoration by Foundation for Ecological Security 2008 Foundations of Restoration Ecology (The Science and Practice of Ecological Restoration Series) - Donald A. Falk, Margaret Palmer, Joy Zedler, Richard J. Hobbs Watershed manual by BK Kakde (BAIF and LEAD India publication) Water Harvesting and Sustainable Supply in India by RN Athavale Centre for Environment Education ISBN: 8170337526 Watershed Hydrology by Peter Black ; Lewis Publishers: ISBN 1575040271 Soil and water conservation engineering by R. Suresh – Standard Publishers and Distributors ISBN 8180140008	
EVSC 403	**Waste and Hazardous Waste Management** 44 lectures	4
	Introduction (6 lectures) Definition, Historical development, Source and type based classification, chemical and physical composition, Environmental and health impacts due to solid waste and handling of it. Characterization: physical & chemical characteristics, implications for solid waste management. Factors affecting solid waste management: Climate, financial, cultural constraint, quality and quantity of waste **Municipal Solid Waste management in India (8 lectures)** Generation, Collection, segregation, Transportation, Transfer stations, processing and disposal. Assessment of existing situation & possible areas for improvement. **Industrial solid waste management (6 lectures)** Pulp and paper, sugar, thermal power station, textile, food processing, mining, Agriculture **Resource Conservation and recovery (2 lectures)** Reduction, separation and recycling **Treatments and disposal (6 lectures)** Waste processing, Recovery of biological and chemical conversion products-composting, biogasification, RDF system, hydrolysis, Pyrolysis, plasma gasification, incineration, sanitary landfills. Role of NGO, local, state and national level authorities in solid waste management. Designing of municipal solid waste management system a case study. **Biomedical waste management (4 lectures)** Define, scope, categorization, segregation, packaging/colour coding and container used, treatment, transport and disposal, status in India.	

Course Number	Title of Course	Credits
	Semester IV	
	Compulsory Courses	
	Hazardous waste management (10 lectures) Identification and sources, characteristics and categorization, Collection, segregation, packaging, labelling, transportation, processing (3R), risk assessment and waste management treatment and disposal, storage and leak detection, Site selection criteria, manifest system and records, Indian scenario, Responsibilities of various authorities, E-waste, Radioactive waste. **Electronic waste management (2 lectures)** A growing problem, Sources and disposal methods	
EVSC 404	**Renewable and Non-Renewable Energy** (44 lectures)	4
	Energy and Environment (6 lectures) Human energy requirement, Energy use pattern in different parts of the world and its impact on the environment; Energy use pattern in India; Sources of energy and their classification; Energy forms and transformation. Sun as source of energy: Source of sun's energy, Solar spectrum, solar radiation – absorption, reflection, scattering and diffusion in the atmosphere, Renewable Energy Integration and Decentralized Generation Systems, Energy Modeling and Project Management, Professional Skills and Energy Project. **Fossil Fuels (6 lectures)** Classification, composition, physiochemical characteristics; Energy content of coal, petroleum and natural gas; Formation, reserves, exploration/ mining and uses of Coal, Oil and Natural gas; Environmental problems associated with exploration / mining, processing, transportation and uses **Bio-energy (6 lectures)** Biomass composition and types; Conversion processes – pyrolysis, charcoal production, compression, gasification and liquefaction; Energy plantation; Biogas – production and uses, anaerobic digestion; Environmental constrains; Energy from solid Wastes – Sources, types, energy production. Bio-energy and Waste to Energy Conversion Systems, Energy Conservation and Management and Energy Laboratory. **Nuclear energy (5 lectures)** Fission and fusion, Nuclear fuels, – Mining and processing of Uranium – concentration, refining, enrichment, fuel fabrication and fuel cycle; Nuclear reactors and radioactive waste; Environmental implications. **Solar Energy (5 lectures)** Harnessing of solar energy, Photovoltaics, Solar collectors and concentrators, Solar thermal energy, Solar electricity generation, Solar heaters, dryers, and cookers; Energy Storage Systems and Fuel Cells, Energy in Buildings, Energy Planning and Economics and Energy Field Visits/Industrial Training.	

Course Number	Title of Course	Credits
	Semester IV	
	Compulsory Courses	
	Wind energy (5 lectures) Wind power, Harnessing of wind energy, Power generation – wind mills, concentrators, wind characteristics and siting, environmental considerations; Wind energy potential in India. Numerical Methods and Computational Techniques, Wind Energy Conversion. **Hydroelectricity (5 lectures)** Principles of generation of hydroelectric power, hazard related to hydropower generation and distribution, environmental impact **Geothermal and Hydrothermal energy (6 lectures)** Sources – crust, high temperature aquifers, low temperature aquifers, reserves; Harnessing of geothermal energy – problems and prospects; Geothermal energy prospect in India. Hydrothermal energy; Tidal and wave energy, Problems and prospects. Small-Hydro and Other Renewable Energy Systems. Recommended Books 1. Renewable Energy – Environment and Development: M. Dayal; Konark Pub. Pvt. Ltd. 2. Alternative Energy: S. Vandana; APH Publishing Corporation 3. Nuclear Energy – Principles, practice and prospects: S. K. Agarwal; APH Publishing Corporation 4. Bio-Energy Resources: Chaturvedi; Concept Pub. 5. National Energy – policy, crisis and growth: V S. Mahajan; Ashis Publishing House 6. Geography and Energy – Commercial energy systems and national policies: J. D. Chapman	
EVSC 405	**Dissertation and Project Work**	7

Course Number	Title of Course	Credits
	Semester IV	
	Elective Courses	
EVSC 406	**Forestry and habitat management** (44 lectures) - Equivalence – ENV 411	4
	Forestry (2 lectures) Definition of forestry and habitat management, Concepts, terms and terminologies, need, scope of the subject **Forest Ecology and Ethnobotany (4 lectures)** Forest as a ecosystem, Biotic and abiotic components, productivity, nutrient cycling, stresses, Forest types in India and conservation initiatives. Role of Ethnobotany **Silviculture (6 lectures)** General Silvicultural Principles, ecological and physiological factors influencing vegetation, nursery system, Silvicultural systems – wood selection, felling, establishment and and management of standards, technical methods and constraints, Silviculture practices in specialized ecosystems like Mangroves and Cold desert: Silviculture of trees -Traditional and advance methods, Silviculture of some of the economically important species in India **Agroforestry, Social Forestry, Joint Forest Management and Forest dwellers and their socio-economics. (4 lectures)** Scope and necessity; objectives, techniques, participatory approach, Research and Extension needs, stages of tribal economy, education, cultural tradition, customs, ethos and participation in forestry programmes. **Forestry and Environmental Conservation (4 lectures)** Soil and water Conservation through Forestry**,** Environment; components and principles of conservation, impact of deforestation; forest fires and various human activities like mining, construction and developmental projects, population growth on environment, pollution. **Tree Improvement and Seed Technology (2 lectures)** General concept of tree improvement, methods and techniques, variation and its use, problems, forest genetic resources and gene conservation in situ and ex-situ. Cost benefit ratio, economic evaluation. **Forest Management Systems (8 lectures)** Objective and principles; techniques; stand structure and dynamics, sustained yield relation; rotation of growing stock through management, Forest Working Plan**,** integrated approach, Forest Mensuration - Methods of measuring - diameter, girth, height and volume of trees; form-factor; volume estimation of stand, annual increment. Sampling methods and sample plots. Yield calculation; yield and stand tables. Forest cover monitoring through remote sensing, Geographic Information Systems, management and modelling. Surveying and Forest Engineering General principles, objects, types, methods	

Course Number	Title of Course	Credits
	Semester IV	
	Elective Courses	
	Forest Resources and Utilization (6 lectures) Direct and indirect, Environmentally sound forest harvesting practices, logging and extraction techniques and principles, transportation system, storage and sale, Need and importance of wood seasoning and preservation; Non-Timber Forest Products (NTFPs) definition and scope, collection; processing and disposal. **Forest Protection (4 lectures)** Injuries to forest, Susceptibility of forests to damage, chemical and biological control, protection against fire and other natural disasters. Role of afforestation and forest regeneration, shifting cultivation and control. **Forest Economics and Legislation (4 lectures)** Fundamental principles of forest economics, Socio-economic analyses of forest productivity and attitudes, cost benefit analyses; estimation of demand and supply, valuation of forest goods and service. Legislation – History of forest development; Indian Forest Policy of 1894, 1952 and 1990. National Forest Policy, 1988 of People's involvement, Joint Forest Management, Involvement of women; Forestry Policies and issues related to land use, timber and non-timber products, sustainable forest management; industrialization policies; institutional and structural changes. Decentralization and Forestry Public Administration. Forest laws, necessity; general principles, Indian Forest Act 1927; Forest Conservation Act, 1980; Wildlife Protection Act 1972 and their amendments; Application of Indian Penal Code to Forestry. Scope and objectives of Forest Inventory. **Suggested Readings:** Principal and Practices of Silviculture by LS Khanna Silviculture of Indian Trees (Revised Ed.) Vol 1-7 Editorial Board of Forest Research Institute, Dehradun (original 3 vol. by RS Troup) Forestry in India by AP Dwiwedi Forest and forestry by KP Sagaraya Handbook of Forestry by SS Negi Introduction to Forest Genetics by Wright Foresters Companian by AR Malsekar Social Forestry by KM Tiwari Forest Ecology by AS Puri Revised Survey of Forest Types of India by Champian and Seth Forest Mensuration by LS Khanna Forest Utilization by Tribhuwan Mehta Manual of Joint Forest Management Training Manual Minor Forest Products of India by T Krishnamoorthy India's Forest Policies: analysis and Appraisal by LK Jha	
EVSC 407	**Environmental Economics** (44 lectures) – Equivalence ENV 201	4
	Environmental Economics (10 lectures with essay and seminar assignments) The Economy and the Environment: Two Parts of a Whole – Interlinkages	

Course Number	Title of Course	Credits
	Semester IV	
	Elective Courses	
	between the economy and the environment. Micro Foundations of Environmental Economics - Theory of Public goods, Externalities and Market failure – The Problem of Social Cost - Design of Environmental Policy. **Economic Instruments for Environmental Protection (10 lectures with essay and seminar assignments)** Command & Control versus Incentives and Subsidies - Available Policy Options - Effectiveness of these instruments, International Comparisons. **Economics of Natural Resource Exploitation (10 lectures with essay and seminar assignments)** Renewable and Non-Renewable Resources – Methods of valuation of Environmental Costs and Benefits. Economic Growth and the Environment: Foreign Direct Investment Inflow and the Environmental quality **Sustainable Development (10 lectures with essay and seminar assignments)** Concept of and issues in Sustainable Development, Strategic Planning for Sustainable Development, Economic reforms and sustainable development. **Climate Change and India (4 lectures with essay and seminar assignments)** Vulnerability of regions and populations – Adaptation options. Texts/References: Hanley, Nick, Jason F. Shogren & Ben White: ***Environmental Economics in Theory and Practice***, New Delhi: Macmillan –India, 1997. James, D.E., ***Economic Approaches to Environmental Problems: Techniques and Results of Empirical Analysis***, Elsevier Scientific Publishing Co., 1978. Nash, R.F., ***The Rights of Nature: A History of Environmental Ethics***, University of Wisconsin, 1989. Whytte, Anne, V. and Ian Burton (eds), ***Environmental Risk Assessment***, John Wiley & Sons, 1980. Arrow, K.J. and Scitovsky, T., ***Readings in Welfare Economic***s Part III, 1969. Coase, R.H., The Problem of Social Cost in ***Readings in Micro Economics*** by Breit and Hochman, 1951 Allen V. Kneese and James L. Sweeney, eds. ***Handbook of Natural Resource and Energy Economics***, Chapters 2,12,14,17, North Holland, 1985. Fisher, A.C., Environment and Resource Economics, Selected readings***, New Horizon in Environmental Economics***, Ed. W.E. Oates, 1995. Oates, W.E., ***Economics of the Environment***, 1992. Field, B.C., ***Environmental Economics: An Introduction***, McGraw Hill, 1994 Baumol, W.J. and W.E. Oates, `***The Theory of Environmental Policy***', Cambridge University Press, 1988. Bohm, P. and Russell, C., `Comparative Analysis of Alternative Policy Instruments', Chap. 10 in ***Handbook of Natural Resource and Energy Economics***, Vol.I Ed. A.V. Kneese and J.L. Sweeney, 1985. Mehta, S., S. Mundle and U. Sankar, `***Incentives and Regulation for Pollution Control***', Sage, 1997. Sankar, U. (ed.) Environmental Economics, New Delhi: Oxford University Press, 2001.	

Course Number	Title of Course	Credits
	Semester IV	
	Elective Courses	
EVSC 408	**Sustainable Agriculture and Organic Farming** (44 lectures)	4
	Introduction to sustainable agriculture (6 lectures) Definitions, Pre and Post Green Revolution in India, The "Green Revolution", Monocultures in crop and livestock production, Sustainability concepts, Traditional sustainable agricultural concepts, Global concerns. Sustainable agriculture and precision farming. Livestock and sustainability **Sustainable agriculture in India (5 lectures)** Public policy. Biodiversity issues. Organic agricultural production. Low-Input Sustainable Agriculture (LISA). Sustainable Agriculture Research and Education (SARE). Agro-Ecology. Permaculture and sustainable horticulture in India. Vermiculture and composting – creating the resource and the medium. Incentives. Concepts and misconceptions. **Creating stakeholders for sustainable agriculture (5 lectures)** Agronomy (crop rotations), Nutrient management, Weed control, Insect control, Water quality, Livestock production, Societal traders and institutions, Economic stakes, National Security - Food Production at Stake. **Livestock and sustainable agricultural systems (5 lectures)** Domestic livestock ecosystems. Agropastoralism - The role of grazing herbivores in sustainable systems. Intensive v Extensive livestock keeping. Holistic Resource Management. Energy conversion. Marketing **Habitat issues for sustainable agriculture and organic farming (5 lectures)** Irrigation problems, waste lands and their development; Habitat for organic farming: definition, principles and components; Farming systems: definition, principles and components, wetland, irrigated dryland and dryland situations. **Organic Farming (6 lectures)** Introduction, concept, relevance in present context; Organic production requirements; Biological intensive nutrient management-organic manures, vermicomposting, green manuring, recycling of organic residues, biofertilizers; Soil improvement and amendments; Integrated diseases and pest management – use of biocontrol agents, biopesticides pheromones, trap crops, bird perches; Weed management; Quality considerations, certification, labeling and accreditation processors, marketing, exports. **Nutrients for organic farming (6 lectures)** Raising of vegetable crops organically through nutrient, diseases and pest management; vermi-composting; vegetable and ornamental nursery raising; macro quality analysis, grading, packaging, post harvest management. **Organic farming and its diversity (Assignments and seminars – 6 lectures)** Preparation of cropping scheme for irrigated situations; Preparation of cropping scheme for dryland situations; Study of existing farming systems in nearby villages;	

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	Semester IV	
	Elective Courses	
	Preparation of integrated farming system model for wetlands; Preparation of integrated farming system model for drylands; Preparation of enriched Farm Yard Manure; Preparation of Vermicompost; Visit to urban waste recycling unit; Study of profitable utilization of agricultural wastes; Visit to poultry and dairy units to study resource allocation, utilization and economics; Visit to an organic farm to study various components and utilization; Study of degraded lands.	
EVSC 409	**Wild Life Management and Conservation** (44 lectures)	4
	Wildlife and zoogeographical regions of the world (6 lectures) Wild flora and fauna, macro and micro flora and fauna, wild habitats and wilderness, zoogeography of the world, zoogeographical regions. **Wildlife and zoogeography of India and the Indian Subcontinent (6 lectures)** Wild flora and fauna of India. Zoogeography of India. The convergence of zoogeographical regions in the Indian Subcontinent. Our neighbouring zoogeographical regions. **The various sciences in wildlife studies (6 lectures)** Mammalogy, Ornithology, Ichthyology, Herpetology, Entomology, Population ecology, Animal ethology, Phenology. **Wildlife management (7 lectures)** Introduction to wildlife management. Laws, Acts and rules for wildlife conservation and management. Protected Areas of India. National Parks and Wild Life Sanctuaries. Community Conservation Areas. Biodiversity Registers. The Indian Forest Service. State Forest Services. **Major wildlife habitats and conservation areas in India (7 lectures)** The major conservation zones for wildlife in India – the Himalayas, the North-East, the West and East Coast, the Islands in the Indian Ocean, the deserts and semi-arid regions, the Western Ghats and the Eastern Ghats, the Satpuras and the Vindhyas, the Rivers of India. **Major National Parks and Wildlife Sanctuaries in India (6 lectures)** Corbett, Kanha, Bandavgarh, Tadoba, Nawegaon-Nagzira, Mudumalai, Bandipur, Namdapha, Keoladeo Ghana, Mundanthurai, Point Calimere, Periyar and the Chambal among others. **Conservation breeding and zoo management (6 lectures)** Captive breeding, *in situ* vs *ex situ* conservation, major zoological parks of India, the Central Zoo Authority. Role of modern genetics and biosciences in captive breeding of endangered species.	

29 + 27 = 56 Credits = Part II
44 Credits (Part I) + 56 Credits (Part II) = 100 Credits