

Teaching Programme and Courses

in

M.A./M.Sc. in Environmental Studies

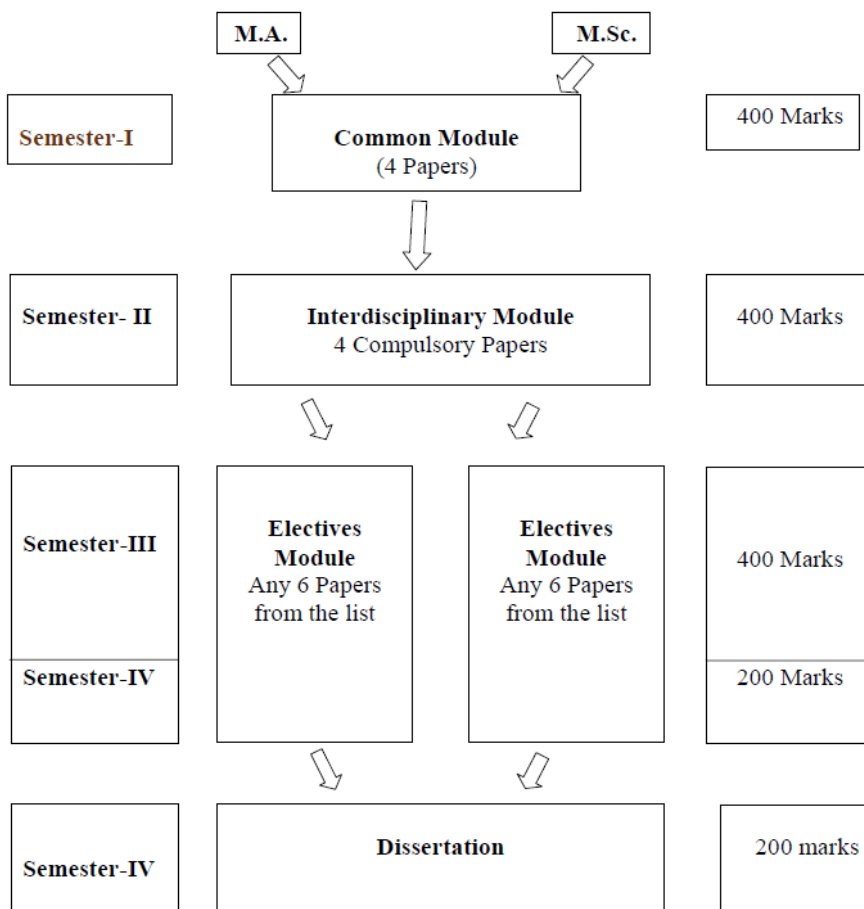


**Department of Environmental Studies
University of Delhi
Delhi – 110007
2011-2013**

Eligibility criteria for admission to M.A./M.Sc. in Environmental Studies

Any undergraduate with 55% marks in B.A./B.Sc./B.A. Sc. (H)/B.Com. (H)/Pass Course (3 year course after 10+2) OR B.Tech. degree from University of Delhi or any other university/institution whose examination is recognized as equivalent and fulfills other conditions of eligibility, but having at least one of these subjects (Physics/ Chemistry/ Biology/ Maths/Geography/Economics) at 10+2 level. The candidate must qualify the entrance test to be conducted by the Department of Environmental Studies. A maximum of 54 students (23 for M.A. and 31 for M.Sc. stream) will be admitted to the Course based on the candidate's preference. **All seats are filled through an entrance examination.**

Structure of M.A./M.Sc. course in Environmental Studies



Note:

- For the first 2 semesters, the semester examination for each paper will be for 70 marks and 30 marks will be for internal assessment, based on at least two assignments.
- For the elective module in III & IV semester, the above system will be in force only for M.A. stream. For M.Sc. stream, 70 marks in each paper will be assigned for semester examination and 30 marks for the Practicals.
- The dissertation, to be completed by all students in semester IV, will be for 200 marks. Out of this 150 marks will be for the thesis and 50 marks allocated for viva voce to be held at the Department by an internal and external examiner who examine the thesis.

Teaching Programme and Courses in M.A./M.Sc in Environmental Studies

Four Semesters (each semester will follow University Calendar)

Semester I

I. Common Module: (Common to both M.A. & M.Sc.)

- Paper I Introduction to Environmental Sciences
- Paper II Social perspectives on environment
- Paper III Environment, development & sustainability
- Paper IV Methodologies for environmental studies

Semester II

II. Interdisciplinary Module (Compulsory for both M.A. & M.Sc.)

- Paper V Environmental impact and risk assessment
- Paper VI Pollution and health
- Paper VII Urban ecosystems
- Paper VIII Natural resources: conservation and management

Semester III

III. Elective Module: (Opt 4 papers out of the 12 papers listed below)

Semester IV

IV. Elective Module (Opt 2 papers out of the 12 papers listed below) + **Dissertation*** (=2 Papers)

Paper No.	M.A	M.Sc.
Paper 9	Environmental and resource economics	Atmosphere and global climate change
Paper 10	Social theory, sociology of development and environment	Natural & managed ecosystems
Paper 11	Indian and international environmental law	Biodiversity and conservation biology
Paper 12	Environmental ethics and philosophy	Soil biology
Paper 13	Environmental history and environmentalism	Ecotoxicology and environmental health
Paper 14	Environmental policies and politics	Environmental biotechnology
Paper 15	Environmental communications and education	Environmental chemistry
Paper 16	Technology, environment and society	Environmental hazards
Paper 17	Natural resource conflicts and choices	Hydrology and water resources
Paper 18	Gender & environment	Environmental geology
Paper 19	Global environmental issues	Systems analysis and modeling
Paper 20	Culture and environment	Environmental engineering

***Dissertation:** to be completed in Semester IV based on field study or organizational attachment.

Syllabus for M.A./M.Sc. Environmental Studies

Paper-1

INTRODUCTION TO ENVIRONMENTAL SCIENCES

Preamble: This paper introduces the students, coming from disparate backgrounds, to the basics of Environmental Science. Major themes and issues confronting our present day environment are introduced in this paper from a scientific perspective. Each theme in the paper is listed in separate paragraphs.

Introduction to the Environment. Acquisition, transformation and utilization of energy: the geochemical, biogeochemical and hydrological cycles. Concept of ecosystem.

Atmosphere: structure and composition. Air pollutants and their emission sources. Aerosols and Smogs. Air quality standards. Tropospheric ozone. Air pollution in Indian cities.

Water: quantity and quality. Parameters and standards; Demands. Rain water chemistry. Surface and subsurface waters in India. Environmental hotspots related to water in India.

Soil and Land use: climate and soil profile, petrography and mineral matters in soil. Soil classification. Soil distribution in India. Land use in India. Impact of soil loss and land cover on biogeochemical cycle.

Biodiversity. Problems and issues in biodiversity and forestry. Conservation and utilization of biodiversity.

Global warming and climate change. Recent records of climate change. Impact of climate change on Indian environment. Measures to cope with climate change.

Mineral and energy resources. Impact of mining and other human activities on the environment.

Environmental impact assessment and environmental audit: an introduction. Environmental policy matters and law.

Suggested Readings:

Anjaneyulu. Y, 2004, Introduction to Environmental Science. B. S. Publications.

D. Daniel Chiras, 2001, Environmental Science, 6th Ed., Jones and Bartlett Publishers.

Mukherji Shormila, 2004, Fragile environment, Manak Publication Pvt. Ltd.

Subramanian. V, 2002, A text book in Environmental Science, Narosa Publishing House, New Delhi.

Wright. R.T, and Nebel. B. J, 2004, Environmental Science, 8th Ed. Prentice Hall India Ltd.

Paper-2

SOCIAL PERSPECTIVES ON ENVIRONMENT

Preamble: This paper introduces students to social thought on environmental issues, from a historical and contemporary perspective. Students are introduced to critical issues in environmental studies, both in an Indian and global perspective.

Introduction to environmental thought.

Traditions of thinking about environment from deep ecology to modernization, reflections on industrial societies and risk. Indian and global thinkers are discussed.

Early issues in Indian environmentalism: land, forest and water.

Looks at historical developments in key areas such as land management, forestry and water management in colonial India, both from the perspective of the state and of communities. Differences across various regions in India are explored.

Environmental politics in contemporary India.

Introduces a range of policy initiatives and popular struggles around contemporary environmental issues such as, forests, wildlife, water, traditional knowledge and environmental resources and pollution.

Issues in global environmentalism.

Explores significant global environmental issues such as acid rain, climate change etc., examining both the nature of the issues and instruments of international environmental negotiations.

Urbanization and environment.

The process of urbanization is explored with respect of consumption of resources; environmental consequences of urban transformation, waste disposal and pollution.

Environment, technology and society.

Examines the interface between specific technologies, including electrification, transport technologies, energy generation etc. and rural/urban environments.

Population and resources.

Explores the historically evolving relationship between population pressures, resource consumption and sustainability. Tragedy of commons Indian and global debates are introduced.

Risk and ecological modernization.

The nature of environmental risk that emerges in the wake of modernity and the responses to the same in select national contexts are introduced.

Regulations and environment. Deals with law and policies to regulate environmental harm in select national contexts.

Communicating environment.

Introduces the media and educational dimensions of environmental awareness in contemporary societies.

Suggested Readings:

- Grove Richard, 1997, Ecology, climate and empire. Colonialism and Global Environmental History, 1400-1900. Cambridge, White House.
- Guha Ramchandra, 1989, Ecological change and peasant resistance in the Himalaya. Unquiet Woods. Oxford University Press, Delhi.
- Harrison Mark, 1999, Climates and Constitutions. Health, Race, Environment and British imperialism in India, 1600-1850. O.U.P., Delhi.
- K.B. Chokkan, Pandya, H and Raghunathan, H (Eds), 2004, Understanding Environment. Sagar publication India Pvt. Ltd., New Delhi, London

Paper-3**ENVIRONMENT, DEVELOPMENT AND SUSTAINABILITY**

Preamble: The paper deals with the human dimension of development and environment. It aims to provide adequate insight on management of natural resources by imparting training in tools and methodologies of ecological and environmental economics.

What is sustainability? Concept of sustainability science, sustainable development and its different constituents. Drivers of ecological changes and its implication for society.

Principles of ecological economics – scope and usefulness. Prey-Predator and supply-demand cycles.

Valuation of ecosystem services and impact of intervention (malign and benign).

Sustainability of society, resources and framework.

Natural resources accounting – concepts, methods and empirical evidences. Environment and trade.

Cost of environment, pollution, life cycle assessment. Impact of development on biodiversity. Development indicators and human health.

Suggested Readings:

- Baumol and Oates, 1988, Theory of Environmental Policies, Cambridge University Press, Cambridge, UK.
- Freeman A.M., 2001, Measures of value and Resources: Resources for the future, Washington DC.
- Freeman. A.M., 2003, Millennium Ecosystem Assessment: Conceptual framework. Island Press.
- Shogren, White and Hanley, 2001, Introduction to Environmental Economics, Oxford University Press, New York.
- Tietenberg. T, 2003, Environmental and Natural Resource Economics. Pearson Education, New York.

Paper-4

METHODOLOGIES FOR ENVIRONMENTAL STUDIES

Preamble: This paper introduces the students to various methods used in the collection of data and analysis for environmental studies. Simulation model are increasingly used to investigate the complexity of environmental processors. The paper introduces the students to the basics of modeling along with the application of remote sensing and GIS in different aspects of environmental studies.

Data collection, survey and processing including social and cultural parameters. Statistics: Normal and binomial distribution. Hypothesis testing, t and chi square tests. Correlation and regression. Introductory analysis of variance. Multi-criteria analysis.

Modeling: Types of models: Mechanistic, economic, simulation etc. Fundamentals of building a model. Treatment of 2 or 3 environmental related models: Eutrophication model, global climate change model, wildlife habitat suitability model, air pollution model, ground water pollution model.

Remote Sensing: definition, principles, satellites and sensors. Aerial photography to Satellite Remote Sensing. Digital Image processing and image interpretation. GPS principles and applications. Geographic Information System: concepts, database generation and analysis.

Applications of Remote Sensing-GIS for environmental studies. Case studies, such as,

- a. Land use / land cover change, Forest degradation, Urban sprawling.
- b. Mining Hazards / Impacts.
- c. Forest Fire / Coal Fire Monitoring.

Suggested Readings:

Demers, Michael N., 2005, M.N. Fundamentals of Geographic Information Systems. Wiley & Sons, 2nd Ed.

Freund. R.J., Wilson W.J., 2003, Statistical Methods, Academic Press.

Lillesand. T.M. and Kiefer. R.W., 1999, Remote sensing and image interpretation. 4th Ed. Wiley & Sons.

Wainwright. J. & Mulligan. M., 2004, Environmental Modeling. John Wiley & Sons Ltd.

Paper-5

ENVIRONMENTAL RISK AND IMPACT ASSESSMENT

Preamble: This paper is an introduction to EIA, a systematic process that examines the environmental consequences of development actions, in advance. This process is firmly on the agenda of all environmental agencies as a result of introduction of legislations in various countries.

Introduction: Defining environmental risk in different perspectives.

Principles and procedures: Nature and purpose of environmental impact assessment (EIA). Characteristics of big project. Current issues in EIA. Worldwide spread of EIA. EIA regulations in India. Risk Assessment v/s Environmental Impact Assessment. Life cycles Assessment. Strategic Environmental Assessment.

Process and Methods of EIA: Stages, Scoping, Alternatives, Impact Identification, Establishing the Environmental base line. Impact prediction, evaluation and mitigation. Criteria and standards for assessing significant Impact. Cost- Benefit Analysis and valuation of Environmental Impacts. Public Participation, presentation and review. EIA monitoring and auditing.

Practice: Air quality Assessment; Water Impact Assessment; Social Impact Assessment; Ecological Impact Assessment; Landscape and visual Impact Assessment; Environmental Impact of surface and underground mining of metals, minerals and fossil fuels. Cumulative Effects Assessment.

Issues and problems in environmental assessment.

Suggested Readings:

Glasson J., Therivel R., Chadwick. A., 1994, Introduction to environmental impact assessment- Principles and procedures, process, Practice and prospects. Research Press, Delhi.

Morris. P. & Therivel. R., 2001, Methods of environmental impact assessment, 2nd Ed. Spon Press, New York, With a chapter on GIS and EIA by A.R. Bachiller & G. Wood, p. 381-401.

Petts Judith, 1999, Handbook of environmental impact assessment. Vol. 1, Blackwell Science.

Paper-6

ENVIRONMENTAL POLLUTION AND HEALTH

Preamble: Environmental pollution end results in adverse effect on the health of the people exposed to it. A large number of diseases are caused and spread by contaminated soil, water and air. The paper will deal with the impact of environmental pollution on health and includes the guidelines for pollution control in the context of public health.

Water sources, quality and standards. Water purification and surveillance of drinking water quality. Infections and diseases spread by contaminated water.

Air pollution: composition and sources. Air quality monitoring. National and international standards for monitoring air quality. Diseases caused by air pollution. Quality of indoor air and its effect on health. Ventilation: standards, methods and health hazards. Radiation pollution: sources, biological effects and protection. Meteorological environment monitoring. Air temperature and biological effects.

Noise pollution: source and standards. Noise pollution: health hazard and protective measures.

Housing standards and effect on health. Methods of disposal of solid waste. Diseases related to soil pollution. Problems and methods of excreta disposal.

Arthropods of medical importance. Vector-borne diseases: transmission and control. Impact of fleas, ticks and mites on health. Zoonotic diseases and their prevention and control. Hospital environment in the context of health and disease.

Pollution control in India: Government obligation, mechanism and legislation in the context of public health.

Suggested Readings:

Leslie Collier, Balows Albert and Sussman Max, Topley and Wilson's Microbiology and Microbial infections. Oxford University Press.

Murray J.F. and Nadel J.A., 2000, Text book of respiratory medicine, 3rd Edn., W.B. Saunders & Co.

Park J.E. and Park K., 1994, Text book of preventive and social medicine, Banarsi Das & Bhanot, Jabalpur.

Paper-7

URBAN ECOSYSTEMS

Preamble: Much of environmental policy making and popular struggles in India have the rural scenario as their object of inquiry. This paper looks at the emerging importance of the urban setting as the locus of environmental conflict and governance in India, across a range of urban clusters including metros, cities and towns. Their importance for policy, community mobilization, law and governance are explored.

City, region and modernity

Places the city in its regional context, both in terms of drawing upon resources and transferring waste.

Nature in the city: Parks, Gardens and Public spaces.

Examines the principles and techniques through which green spaces are organized in the city to produce 'controlled nature'.

Infrastructure

A variety of infrastructure from sewage and water to transport and communication are studied from an environmental perspective.

Planning and environment

Town planning Acts and their environmental aspects are studied across a range of Indian cities. Historical and contemporary developments in urban planning and environmental management are addressed.

Slums and neighborhoods.

Examines the housing scenario across large-medium-small cities and the presence of slums as a specific environmental issue in urban contexts.

Occupational environment

Environmental aspects of a variety of informal and formal work spaces are examined.

Pollution and waste

Major forms of urban pollution - air, water, noise and land - are explored historically and across various urban sites. Spatial dimensions of waste circulation are explored.

Consuming nature

Introduce the issue of consumption from a variety of perspectives - materials, symbolic and aesthetic.

Energy and environment

Examines the major techniques for providing energy in urban contexts - generation, transportation, usage, alternatives and environmental impacts.

Sustainability and urban futures

Addresses some key challenges facing urban sustainability in the 21st century.

Suggested Readings:

- D'Monte Darryl, 1985, Industry versus Environment Temples or Tombs. Three controversies, Delhi, CSE.
- T. Veena, 1984, The making of colonial Lucknow Oldenburg. Princeton, Princeton University Press,.
- Verma Dewan Gita, 2002, Slumming India, Penguin Books, New Delhi.

Paper-8**NATURAL RESOURCES: THEIR CONSERVATION AND MANAGEMENT**

Preamble: This paper takes an objective view of the nature of Earth's resources, particularly the non-renewable resources, how and where they are generated, how they are extracted and used, and how these activities impact Earth's environment. It also addresses sustainability by looking into different ways of conservation of the natural resources and their management.

Introduction to natural resources and their consumption patterns. Supply and demand of natural resources. Types of natural resources: renewable and non-renewable resources. Time frame. Approaches to natural resource management.

The nature of soil, characteristics and value. Soil formation, soil profile and soil classification. Soil fertility. Soil conservation and sustainable agriculture: nature of soil erosion; factors affecting soil erosion by water and its control. Alternative agriculture, sustainable agriculture. Land use and environmental problems of soil. Soil surveys and Land use planning.

Minerals resources, their use, mining and sustainability. Genesis of mineral deposits: endogenous and exogenous processes and their time frame. Environmental impact of mineral production. Mineral conservation strategies: the resource cycle.

Non-renewable energy resources: patterns of consumption, issues and options. Global energy source: an overview. Fossil fuels: reserves of coal, its classification and basic geology. Environmental impact of coal mining. Reserves of oil and gas, basic geology. Environmental impact of their production and consumption. Nuclear energy, its sources. Nuclear power plants. Nuclear waste disposal. Geothermal energy: water dominated and vapour dominated systems.

Types of renewable energy source and their environmental significance. Sustainable development of energy resources.

Suggested Readings:

- Craig. J.R., Vaughan. D.J., Skinner. B.J., 1996, Resources of the Earth: origin, use, and environmental impact, 2nd Ed. Prentice Hall, New Jersey.
- Klee. G.A, 1991, Conservation of natural resources.. Prentice Hall Publ. Co., New Jersey.
- Owen. O.S, Chiras. D.D, Reganold. J.P, 1998, Natural resource conservation – management for sustainable future, 7th Ed., Prentice Hall.

M.A. Stream

Paper-9 (M.A.)

ENVIRONMENTAL AND RESOURCE ECONOMICS

Preamble: Economics & ecology must be completely integrated in decision making & law making processes and there should be an effort to increase understanding of intriguing policy problems. Environmental and resource economics makes use of ideas and tools developed in other branches of economics to make significant contribution to valuation techniques, design of policy instruments for pollution control and management of commons.

Introduction: Overview of Central Issues; Refresher on Supply and Demand

Basics of Welfare Economics: Producer and Consumer Surplus, Market failure, Externalities, Public Goods, Pareto Optimality

Cost-Benefit Analysis and Valuation: Discounting, Principles of Cost-Benefit Analysis, Estimation of Costs and Benefits, Techniques of Valuation

Non-Renewable Resources: Economics of Fuels and Minerals, Hotelling's rule and Extensions, Taxation, Recycling, Waste Management

Renewable Resources: Economics of water use, Management of Fisheries and Forests

Pollution Control: Policies for Controlling Air and Water pollution, Disposal of Toxic and Hazardous Waste-Standards vs. Emissions Charges

Regional and Global Concerns: Acid rain, Ozone depletion, Greenhouse Effect, WTO and environment, Natural Disaster Management.

Growth, Resources and the Environment: Resource Scarcity, Poverty, Sustainable Development, Foreign Aid.

Suggested readings:

Baumol, W.J. and Oates, W.E., 1988, *The Theory of Environmental Policy* Cambridge University Press.

Bhattacharya, R.N. (Ed.), 2001, *Environmental Economics: An Indian Perspective*, O.U.P.

Bromley, D.W. (Ed.), 1995, *Handbook of Environmental Economics*, Blackwell.

Kadekodi, G.K., (Ed.), 2004, *Environmental Economics & Practice*, O.U.P.

Kolstad, Charles, 2000, *Environmental Economics*, Oxford University Press.

Tietenberg, Tom, 2003, *Environmental and Natural Resource Economics* (sixth edition) Pearson Education.

Paper-10 (M.A.)

SOCIAL THEORY, SOCIOLOGY OF DEVELOPMENT AND ENVIRONMENT

Preamble: The concept of development is rooted in a particular view of society and emerged at a particular historical point. This paper introduces the student to theoretical debates about development. A major purpose of this paper is to establish the relationship between development and the environment and explore the extent to which development is beneficial for the environment. The following issues will be taken up:

The relationship between ‘development’, ‘progress’, science, capitalism and industrialism.

Green critiques of industrialism

Post-colonial and post-structuralist critiques of development and the discourse of participation

The impact of development on marginal peoples

Re-evaluation of development in light of sustainability and social equity; contemporary critiques and models.

Suggested readings:

- Agarwal, Anil, et al, Eds., 1984, State of India’s Environment, A Citizen’s Report, Centre for Science and Environment, Delhi.
- Borrie, W.D., 1988, Population, Environment and Society, O.U.P., U.K.
- Chambers, Robert. 1983 Rural Development: Putting the Last First. London, Longman.
- Crush, Jonathan ed., 1995, The Power of Development, New York, Routledge.
- Escobar Arturo, 1995, Encountering Development: The making and unmaking of the third world, Princeton University Press.
- Gadgil, Madhav and Guha, 2001, Ramachandra, Ecology and Equity: The use and abuse of nature in contemporary India, Delhi, Penguin.
- Gorz, Andre, 1980, Ecology as Politics, Boston, South End Press.
- Hobart Mart, 1993, An Anthropological critique of Development: The Growth of Ignorance, Routledge.
- Krishna Sumi, 1966, Environmental politics, People’s Lives and Development choices, Sage Publications, New Delhi.
- Kuper Adam, 1988, The Invention of Primitive Society, Routledge.
- Leacock Eleanor and Lee Richard, 1982, Politics and History in Band Societies, Cambridge University Press.
- O’Connor, Martin Ed., 1994, Is Capitalism Sustainable: Political Economy and the Politics of Ecology, New York, Guilford Press.
- Peets Richard and Watts Michael, 1966, Liberation Ecologies: Environment, development, social movements, Routledge.
- Scott, James, 1998, Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed, New Haven, Yale University Press.

Paper-11 (M.A.)

INDIAN AND INTERNATIONAL ENVIRONMENTAL LAW

Preamble: Environmental law is that branch of law for planetary house keeping, protecting the planet and its people from activities that upset the earth and its life-sustaining capacities. This paper aims to understand and apply a range of regulatory instruments to preserve and protect the environment. It also emphasizes on identifying the strengths and weaknesses in law and its enforcement and develops strategies to overcome the same.

Environmental laws: an introduction. Legal meaning of environment. Forms of pollution-causes and effects. Need for legal control.

International Perspective: Human right to environment. From Stockholm 1972; to Rio 1992 and beyond; Johannesburg Summit 2002, Delhi Summit 2002.

Fundamental principles of environmental protection: sustainable development-Brundtland report 1987. Intergenerational and intra-generational Equity, Polluter pays principle, precautionary principle, Environmental Impact Assessment, Environmental audit, Public Trust Doctrine, Indian judicial response.

Constitutional Perspective: Fundamental right to wholesome environment. Article 14, 19 (1) (g), 21 & 32 of the constitution. Directive principles of state policy-Article 47, 48A of the constitution. Fundamental duty-Article 51A (g) of the constitution. Public interest litigation-Nature, standing and doctrine of Pro Bono Publico, Judicial response.

Environmental Protection Legislations: The Water (Prevention and control of Pollution) Act 1974; The Air (Prevention and Control of Pollution) Act 1981; The Environment (Protection) Act 1986; Forest Act 1927; Forest Conservation Act 1980; The Wild life Protection Act 1972(2002 Amendment); Biodiversity Act 2002; The Noise Pollution (Regulation) 2000.

Legal control of Hazardous waste – Biomedical waste, genetic waste, e-waste. Industrial accidents-principle of ‘no-fault’ and absolute liability. Public liability insurance-Act 1991. National environment tribunal 1995.

National Appellate Environmental Authority-Act 1997. Constitution, Powers, Functions, Roles.

Suggested Readings:

Bell Stuart & Mc Gillvray Donal, 2001, Environmental Law, Universal Law Publishing Co.

Diwan Shyam and Rosencranz Armin, 2002, Environmental Law and Policy.

Hughes David, 1992, Environmental Law, Butterworths.

Jariwala C.M., 2004, Environmental Justice, APH Publishing Corporation, N. Delhi

Leelakrishnan. P, 2004, Environmental Law Case Book , Lexis Nexis, Butterworths

Mohanty. S. K., 2004, Environment and Pollution Law, Universal Law Publishing Co. Pvt. Ltd.

Singh Gurdip, 2004, Environmental Law in India, Mcmillan & Co.

Singh Gurdip, 2003, International Environmental Law, in Gurdip Singh, International Law, Macmillan.

Shastri. S. C., 2005, Environmental Law, Eastern Book Company.

Paper-12 (M.A.)

ENVIRONMENTAL ETHICS AND PHILOSOPHY

Preamble: The main objective of this course will be to familiarise the students with the broad theories and parameters of environmental philosophy, including issues of animal rights, human rights and wilderness ideas. The effort will be to look at the philosophical basis of current conservation theories and competing views of environmentalism.

An Introduction to Environmental Ethics and Philosophy: Ethics in society; Environmental Consequences; Responsibility for Environmental Degradation

Theories of Environmental Ethics and Philosophy: Different types of schools of thought vis-à-vis nature and environmental management. Values in modernity, anti-modernity, eastern and western cultures, nature and religion etc.

Eco Centric Theories of Nature: Deep ecology and animal rights theories, environmental rights, environmental racism.

Cross-cultural views on Nature: The relationship between humans, nature and adaptation. Theoretical frameworks of cultural and social ecology; debates on culture/nature divide.

Environment and Business Ethics: Foundations of Environmental Ethics for Business, Corporate Environmental Ethics, Environmental Disclosure, Social and Ethical Issues for Sustainable Development, Business Ethics and Corporate Environmental Performance.

Environmental Ethics and Issues of National and International Governance: changing nature of environmental ethics in relation to international and national paradigms of environmental governance.

Resource consumption patterns and the need for equitable utilization; Equity disparity in the northern and southern countries; Urban – rural equity issues; Need for gender equities; Preserving resources for future generations; The ethical basis of Environmental education and awareness; The conservation ethics and traditional value system of India.

Suggested Readings:

Aggarwal Anil & Narain Sunita, 1991, Global warming in an unequal world: A case of Environmental colonialism, Centre for Science & Environment.

Cooper, D.E. & Palmer. J.A., (Ed.), 1992, The Environment in question: Ethics & Global Issues, London, Routledge.

Des Jardius, J.R., 2001, Environmental Ethics: An invitation to Environmental philosophy (3rd Ed.), Wadsworth Publ., Belmont, California.

Grim. John. A., 2001, Indigenous Traditions and Ecology (Ed.), Harvard University Press.

Lesourd, J.B. and Schilizzi, S.G. M., 2001, The Environment in Corporate Management: New Directions and Economic Insights, Edward Elgar, UK.

Vandever, D.C.P. and Vandever, D., 2002, The Environmental Ethics and policy book: Philosophy, Ecology, Economics (3rd Ed.), Wadsworth publishing, California.

Paper-13 (M.A.)

ENVIRONMENTAL HISTORY AND ENVIRONMENTALISM

Preamble: The course is a concise history, from ancient to modern times, of the interactions between human societies in relationship to ecosystems. It involves a consideration of present day environmental dilemmas, conflicts and choices that have their roots in the past. The course looks into the ways in which environmental changes, often the result of human actions, have caused historical trends in human societies. These processes have happened in every historical period and in every part of inhabited earth.

Introduction to the ideology of environmentalism and environmental history, Modern environmental movements. The Gaia theory.

History of the development of environmental history as a discipline and its relationship with social and economic history. Methods and Sources of Environmental History: Distributions from other types of history.

Environmental History as Natural History: In the developed and developing nations. Ideas of wilderness and conservation.

Environmental History as a History of Industrialization and Anti-Industrialization: debates on the nature of modernization and industrialization in developed and developing countries. Issues of its links with history of science and technology.

The Rise of European power and its consequences not only for peoples, but also for plants and pathogens, animals and landscapes.

Nature and Empire: Debate on 'colonialism as a watershed'. Colonialism and the unleashing of destructive forces and the threat of general environmental decline.

Environmental History as the History of the State: State and state policy

Environmental History and Marginalized People: Issues of castes, identity politics and ethnicity

Environmental History as a Global History: Challenges posed by globalization

Suggested readings:

- Arnold, David & Guha, Ramachandra (Ed.), 1995, *Nature, Culture, Imperialism: Essays on the Environmental History of South Asia*, Oxford University Press, Delhi.
- Baviskar Amita, 2003, 'Tribal Discourse and Indian environmentalism in Greenough, Paul and Anna Lowenhaupt Tsing (Ed.), *Nature in the Global South: Environmental Projects in South and Southern Asia*, Durham and, London: Duke University Press/Orient Longman.
- Balee William, 1998, *Advances in Historical Ecology*, Columbia University Press, New York.
- Beinart William and Coates Peter, 1995, *Environment and History*, London: Routledge.
- Carson, Rachel, 1962, *Silent spring*. Houghton Mifflin, Boston.
- Crumley (Ed.) Santa Fe, 1994, *Historical Ecology: Cultural knowledge & changing landscapes*, School of American Research Press.
- Gadgil, Madhav & Guha. R.C, 1992, *This Fissured land: An Ecological History of India*, O.U.P.
- Greenough Paul and Anna L Tsing Ed., 2003, *Nature in the Global South*, Delhi: Orient Longman.

- Grove, R.H., V. Damodaran and S. Sangwaned, 1998, Nature and the Orient. Essays on the Environmental, History of South and South East Asia, O.U.P., Delhi.
- Guha Ramachandra, 2000, Environmentalism, A Global History, Delhi, O.U.P.
- McNeill, Robert, 2002, Something New Under the Sun, an Environmental History of the 20th Century, Penguin Press, Allen Lane.
- Rangrrajan, Mahesh, 2001, India's Wildlife History, An Introduction; Permanent Black, Delhi.
- Simmons. I.G., 1993, Environmental History: A Concise Introduction, Blackwell, Oxford.

Paper-14 (M.A.)

ENVIRONMENTAL POLICIES AND POLITICS

Preamble: The paper introduces the student to the politics of environmental issues at the national and international levels. It also familiarizes the student with the debates on environmental policies and regulations and environmental movements in India.

Introduction to Environmental Politics: Nature of environmental politics at both the global and national level. The different paradigms of environmental politics

Environmental Politics and the Path of Development Debate: Critiques of modern development and proposed alternatives to it in the contemporary world.

Varieties of Environmentalism and Environmental Movements in Developing Countries: Nature of environmental movements and their material basis in some selected developing countries.

The Indian Environmental Movement and its Ideologies: Emergence of environmental issues on the political agenda and its relationship with the Indian environmental movement in different sectors.

Environmental Politics and Issues of Governance in India: Issues of local governance, decentralization and nature of local participation and state control.

Methods and Forms of Environmental Regulations and Policies: Evolution of environmental regulation in selected countries, the debates that surround them and the responses to them.

Global Environmental Politics: Selected global environmental issues; Global politics between developed and developing nations in IUCN, WTO etc.

Suggested Readings:

- Allay Kelly, 2002, On the Banks of the Ganga, University of Michigan Press.
- Bryant, Bunyan & Mohai, Paul (Ed.), 1992, Third World Political Ecology, Routledge, London.
- Centre for Science and Environment, Global Environment Governance Series (Green Politics, Poles Apart, Global Warming in an Unequal World), Delhi, CSE.
- Demobowski, Hans, 2001, Taking the State to Court. Delhi: O.U.P.
- Donahue, John & Johnston, Barbara (Ed.), 1998, Water, Culture and Power: Local struggles in a Global context, Island Press, Washington D.C.
- Fortune, Kim Advocacy after Bhopal – Environmentalism, Disaster, New Global Orders, 2003, University of Chicago Press.
- Patterson, M., 1996, Global warming and global politics, London, Routledge.
- Mukund Rajan, 1997, Global Environmental Politics: India and the North-South Politics of Global Environmental Issues, O.U.P, Delhi

- Peets Richard and Watts Michael, 1996, Liberation Ecologies: Environment, development, social movements, Routledge.
- Persoon, G. And A. Kalland, 1998, Environmental Movements in Asia, London, Curzon press.
- Sainath, P., 1996, Everybody Loves a Good Drought, Delhi, Penguin.
- Singh, C. 1986, Common Property, Common Poverty. Delhi: ILI
- Sabarwal V., 1999, Pastoral Politics: shepherds, bureaucrats & conservation in western Himalayas, O.U.P.
- Sundar, N., R Jefferey and N Thin, 2001, Branching Out: Joint Forest Management in India, Delhi, O.U.P.
- Sundar, N. et al, 2005, "Land and Identity in Jharkhand." Special Section on laws and Natural resources in Economic and Political Weekly, XI (41), October, 8th 2005, pp. 4430-4462.

Paper-15 (M.A.)

ENVIRONMENTAL COMMUNICATIONS AND EDUCATION

Preamble: This paper focuses on methods of communication to the masses and consumers for environmental issues. It also provides an overview of the scenario of environmental education and communication at the national and international levels.

Environmental education and environmental literacy: Need for public awareness.

Fundamentals of Mass communication: What is communication? Defining Communication; Types of Communication; Mass Communication: an introduction; Role of Mass media.

Basics of Science & Technology (S&T) Communication: Role of Communication in Modern Science; 'Public' nature of science; Science and Public: Historical overview; Why communicate S&T; When public meets science

Channels of S&T Communication: What are channels; Broadcast media and S&T; Print media and S&T; Telecast Media and S&T; Science through little media; Use of group media for S&T communication.

Pragmatic aspect and contexts of science & environmental communication: Strategies for Communication; Use of analogies; Metaphor and Simile; Human and With Examples and illustrations; Anecdotes and personalizing; Context for science and environmental communication; Human interest; Cultural needs; Survival needs; Sources of information; ethics in reporting & fundamentals of media laws.

Educating Consumers: Consumer Behavior and Environment: Role of Information, Eco- Labeling
Environmental communication Today: Introduction; Over view of the scenario in the country; International scenario; Canonical texts (Critical reading of Books on Environmental communications such as Silent spring); case studies of media reports that had impact; Analysis of mass media coverage of complex environmental issues and the media's effects on public opinion and government environmental policies.

Suggested Readings:

- Greenough, Paul et al., 2003, Nature in the Global South: Environmental Projects in South and South-East Asia, Orient Longman.
- Krarup, S. and Russell, C. S., 2005, Environment, Information and Consumer Behaviour (Ed.), Edward Elgar, UK.
- Orr. D., 1994, Earth in mind: on education, environment and the human prospect, Island Press, Washington, D.C.

Saberwal, Vasant et al., 2001, People, Parks, Wildlife: Towards Co-Existence, Orient Longman.
Valdiya, K.S., 2004, Geology, Environment and Society, Universities Press.

Paper-16 (M.A.)

TECHNOLOGY, ENVIRONMENT AND SOCIETY

Preamble: A study of the relationship between technology and environment with the aim to understand the role and contribution of different types of economic and social mechanisms that the contemporary societies have been able to evolve to shape the technological changes in the direction of sustainable development and to achieve ecological and social justice.

Understanding the relationship of technology with environment through the analysis of shifts in the perceptions of societies in the countries of technologically advanced and developing world.

Study of “technological innovation as a solution/ remedy for environmental problems”, “technological impacts / innovation and technology adoption effects of environmental policies”;

Environmental policy assessment for the evaluation of impact on environmental costs, assessment of the effectiveness of alternate policy instruments in containing environmental damage, the encouragement to technology transitions and environmental technology innovations for the achievement of ecological and social justice.

Assessments of the developments within the relevant fields of science and technology for the achievement of sustainable development in the world in general and in India in particular; the management of transition to environmentally and socially just futures for energy, transportation, climate change, handling of toxics, agriculture, water, forests, etc.

Impacts of social movements for the achievement of ecological and social justice in India; corporate responsibility movement, appropriate technology movement, environmental groups and movements, citizen groups, etc.; developments within the field of integrated technology assessment, innovation policy tools, pathways creation for sustainable development, etc.

Suggested Readings:

- Elliot David, 2003, Energy, Society and Environment, Technology for a Sustainable Future, Routledge
Jasanoff Sheila, 2002, New Modeenities: Reimagining Science, Technology and Development, In Environmental values.
Jasanoff Sheila, 2003, Technologies of Humility: Citizen participation in governing science, In Minerva.
Juma. C, Konde. V, 2002, Technical change and sustainable development, Developing country perspectives, American association for the advancement of sience (AAAS).
Makofske, W.J. and Karlin, E.F., 1995, Technology and Global Environmental issues, Addison Wesley Longman, Toronto.
Mawasley. E, 2004, India’s middle classes and the environment development and change.
Vernon W. Ruttan, 2000, Technology, Growth, and Development: An Induced Innovation Perspective, Oxford University Press, New York.
Visvanathan Shiv, 2000, Environmental values, Policy and conflict in India, Carnegiecouncil.org

Paper-17 (M.A.)

NATURAL RESOURCE CONFLICTS AND CHOICES

Preamble: This paper focuses on contemporary conflicts, struggles and policy choices around natural resources. Often, conserving nature is also about defining who controls it and how. Similarly, there is often a variety of explanations for who degrades nature and why. The initial introduction will be to major approaches towards natural resource issues that privilege particular factors such as population/economic growth, technology, culture and religion and specific property regimes. Looking at these ideal types critically will sharpen the ability to think creatively about conflict and concord in general. There will be special emphasis on the roles of ideas and institutions in environmental politics. Case studies could include issues such as big dams and endangered fauna, industrial pollution and global warming, the role of gender and empire.

Forests: Who saves forests is closely linked to who controls them and for what. The ecological implications of different kinds of forest choices are critical to the study of nature in conflict. The section takes up debates on forest protection and management, the use of NTFPs, and conflicts over commons.

Water: Water, vital for life but a source of conflict over use and abuse, is a related theme. Again, the hydrology is central to systems of renewal or of disrepair. This section will look at large dams which may mean energy and irrigation, but can also mean displacement or denudation; the problems involved in river sharing; conflicts between different stakeholders in water use (industry or agriculture, towns' people or farmers, fishers or factories); water wars and the prospects for peace via water harvesting and water sharing.

Land Use: Land use conflicts range across many productive activities related to mining, industry, agriculture and also conservation, afforestation and wasteland development. How far are such conflicts evitable and to what extent can they be minimized? Debates over common property, open access resources and privatization.

Wildlife and Biodiversity: Wildlife conservation, management and policies regarding National Parks, conservation and community conflicts; regulations and practices of (il) legal trade in wildlife products. Debates over the ownership of biodiversity and links to traditional knowledge; gender and biodiversity management, the implications of the introduction of genetically modified crops.

Policy Issues: Overview of the policies and institutional innovations across the range of themes discussed above and their critiques as offered from within policy circles, by communities and by environmentalists and activists. Similarities and differences between policy options considered by India and other international bodies such as the United Nations and World Bank. Contrasts between different states in India.

Suggested Readings:

- Agarwal, Anil, Ravi Chopra and Kalpana Sharma ed, 1982 and later reports, State of India's Environment, A Citizens's Report, Delhi, CSE.
- Agrawal, Arun and C. Gibson (Ed.), 2001, Communities and the Environment: Ethnicity, Gender and the State in Community-based Conservation, New Jersey: Rutgers University Press.
- Baviskar, A. (Ed.).2007. Waterscapes, Delhi, Permanent Black.
- D'Monte, Darryl, 1985, Temples or Tombs? Delhi: CSE.
- Greenough, Paul and Anna Lowenhaupt Tsing (Eds.) Nature in the Global South: Environmental Projects in South and Southeast Asia. Durham and London: Duke University Press: pp. 201-230.

- Mc Neill, Robert, 2002, *Something new under the sun, an environmental history of the 20th century*, Penguin, Allen Lane: NY.
- Omvedt, Gail. 1993, *Reinventing Revolution: New Social Movements and the Socialist Tradition in India*. New York: ME Sharpe.
- Peluso, N. and M. Watts (Eds.) 2001, *Violent Environments*, Cornell, Cornell University Press.
- Prasad, A., 2004, *Environmentalism and the Left*, Delhi.
- Saberwal, Vasant. K and Mahesh Rangarajan (Eds.), 2003, *Battles over Nature: Science and the Politics of Conservation*, New Delhi: Permanent Black.
- Sundar, A., 1999, *Sea Changes: Organising around the Fishery in a South Indian Community*. In Jonathan Barker ed., *Street level Democracy*, Toronto, Between the Lines Press.
- Tucker, Richard, 2000, *Insatiable Appetite, America's impact on the tropical world*, Berkeley: Univ. of California Press.

Paper-18 (M.A.)

GENDER AND ENVIRONMENT

Preamble: This paper focuses on gender differences in human relationships with the environment and the differential impact of environmental change on men and women. In particular, it explores how the gendered division of labour and gender inequalities in access to economic resources can make for differences in the ways women and men depend on the environment, their knowledge of the environment, how they are affected by environmental degradation and their responses to environmental change. It focuses both on conceptual issues and on empirical case studies in the Indian context. The course will encourage students to examine all environmental issues from a gender perspective.

Gender Differences, Hierarchies and inequalities: The historical construction of Gender, including the gendered division of labour; Cultural, social and economic perspectives; Evolution of gender hierarchies in a materialist perspective; Nature, Culture, Gender debates.

Conceptual and theoretical perspectives: Ecofeminism, Feminist environmentalism, feminist ecology.

Natural Resources, Sustainable Development and Women: Gender differences in dependence on environmental resources and the gender division of labour in use of forests and water; gender and knowledge about the environment; gender, environment and globalization

Gender implications of environmental degradation and poverty: gender/class/poverty links with the environment, the domestic energy crisis, the crisis of water and sustainability

Women and Environmental movements: Women's perspectives of environmentalism; Women's participation in environmental movements and conservation.

Suggested Readings:

Agarwal, Bina, 1992, "The Gender and Environment Debate: Lessons from India", *Feminist Studies* (Minnesota).

Agarwal, Bina, 1997, "Gender, Environment and Poverty Interlinks: Regional Variations and Temporal Shifts in Rural India: 1971-1991", *World Development* (Washington DC), 25 (1).

- Agarwal, Bina, 1986, *Cold Hearths and Barren Slopes: The Fuel wood Crisis in the Third World*, London: Zed Books.
- Braidotti, R. et al., 1994, *Women, the Environment and Sustainable Development: Towards a Theoretical Synthesis*, Zed Books, UK
- Elson, Diane, 1991, *Male Bias in the Development Process*, Manchester University Press.
- Jackson, Cecile, 1993, *Questioning Synergism: Win-Win with Women in Population and Environmental Policies*. *Journal of International Development*, 5 (6): pp. 651-68
- Kabeer, N., 1994, *Reversed Realities: Gender Hierarchies in Development Thought*, Delhi: Kali for Women; London: Verso Press.
- Krishna, Sumi, 2004, *Livelihood and Gender*, New Delhi, Sage.
- Miller, Barbara, 1993, *Sex and Gender Hierarchies*, Cambridge University Press
- Rocheleau, Dianne et al, 1996, *Feminist Political Ecology: Global issues and Local experiences*, New York Routledge.
- Nanda, M., 1991, 'Is Modern Science a Western, Patriarchal Myth? A Critique of the Populist Orthodoxy', *Social Science Bulletin*, 11 (1 and 2): 32-60.
- Vishwanathan, Nalini, 1997, *The Women, Gender and Development Reader*, London: Zed Books.

Paper-19 (M.A.)

GLOBAL ENVIRONMENTAL ISSUES

Preamble: This paper introduces the students to some of the important environmental issues that have become a matter of global policy making, international negotiations and trade disputes. It will also provide an understanding of the links between environment, property regimes, trade and information economies.

Climate Change: Key concerns in the climate change debate, scientific and political conflicts concerning their impacts on natural resources, food production etc. and the techno-economic measures being used to reduce greenhouse emissions.

Impact on War and Terrorism on the Environment: Nuclear Winter: Environmental Consequences of Nuclear War; Chemical & Biological Warfare; Impact of Nuclear Weapon Tests; Use of Depleted uranium shells; Impact of Destruction of Nuclear power plants; Burning of oil wells; Destruction of Chemical plants. Use of Incendiary Bombs (Napalm).

Wastes: Regional and international frameworks for regulating trade in wastes, especially toxics. Policies and environmental activism around trade in toxic wastes such as asbestos, PVCs, lead, mercury, electronic wastes and other chemicals.

Biodiversity: Approaches to understanding of biodiversity, case studies of strategies for conservation and sustainable use of biological resources, case studies of conflicts (and their possible resolution) between conservation and local community practices, links between conservation, local knowledge and intellectual property and issues of biopiracy.

Biotechnology and Genetic Engineering: Scientific, social, ethical and political issues related to the modification of a gene from one species to another for purposes of food productivity, medical advance etc. The environmental and human impacts of genetic modification and the various regulations that guide the testing and marketing of genetically modified materials. Case studies that have special implications for India (e.g. Bt cotton).

Energy: The energy sector and environment including historical studies of coal and pollution in select countries; policies relating to sustainable energy use through select case studies (e.g. Germany, the Netherlands, Brazil, India) and their implications for global and local economies. Nuclear energy as an environmentally friendly/ degrading source of energy, again through select case studies (e.g. France, England, India and China).

Global Environmental Issues in Industry: Business – Environment Debate: Ozone Depletion and Environment Change, International Business, Globalization and Sustainable Development, Environmental Management Norms and Certification, International Environmental Management Systems, Kyoto Protocol and CDM.

International Conventions and Protocols: The treaties and conventions guiding the use of resources, disposal of waste and international cooperation in the fields of conservation and sustainability will be studied. Students will be introduced to a range of international protocols such as The Kyoto Protocol to the UN Convention on Climate Change, Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal, The Convention on Biological Diversity, Convention on Long-Range Transboundary Air Pollution, The Montreal Protocol on Substances That Deplete the Ozone Layer and the United Nations Convention to Combat Desertification.

Suggested Readings:

- Cartimes J. Jepma and Mohan Munasinghe, 1998, Climate change Policy, Cambridge University Press.
- Ehrlich, Paul et al: Long Term Biological consequences of Nuclear War, 1983 (Stanford University).
- Howes, R.; Skea, J. and Whelan, B., 1997, Clean & Competitive? Motivating Environmental Performance in Industry
- Kemp, D.D., 1990, Global Environmental issues: A climatologized approach, Taylor and Francis, London.
- Makofske, W.J. and Karlin, E.F., 1995, Technology and Global Environmental issues, Addison Wesley, Longman, Toronto.
- Russo, M. V., 1999, Environmental Management: Readings and Cases, ed., Houghton Mifflin Company, Boston, NY.
- Shiva Vandana, 2005, Earth Democracy. Justice, sustainability and Peace, South End Press.
- Smith, P. and Warr, K., 1991, Global Environmental issues, Hodder and Stoughton, London.
- Susskind et. al. Lawrence (Ed.), 2002, Trans-boundary Environmental Negotiation: New Approaches to Global Cooperation.
- Toman (Michael) (Ed.), 2002, Climate change, Economics and Policy, Cambridge University Press.
- Welford, R., 2000, Corporate Environmental Management: Towards Sustainable Development, Book 3, Earthscan Publications Ltd, London.

Paper - 20 (M.A.)

CULTURE AND ENVIRONMENT

Preamble: Different cultural traditions conceive of the environment in different ways, and enjoy different attitudes towards it. Defining a sphere as environmental is itself a cultural choice. Religions have played a role both in environmental destruction and conservation. This course focuses on these aspects as also on the various cultural formations through which humans have adapted to the environment.

Introduction: Concepts and Theories: Concept of Culture, Material Culture, technology; role of culture in adaptation of human populations,

Basic Forms of Human adaptation to environment: Hunting and Food gathering Pastoralism; Shifting Cultivation; Agriculture; Transition to Market economy and Industrialization

Social and Cultural implications of various forms of adaptation: Evolution of political organizations, distribution and exchange of resources; Political economy of the state (land and forest policies: colonial to post-colonial)

Environmental Culture in Business Organizations: Development of environmentally aware corporate cultures, Linkage between Organizational Environmental Culture and Environmental Strategy.

Development and Environment: Current debates; How development policy defines degradation in largely physical terms, and not in terms of access inequities and exploitation.

Landscapes: how landscapes are invested with cultural meaning, changes in landscape over time and their cultural and ecological implications.

Suggested Readings:

- Baruah, Sanjib, 2005, *Durable Disorder: Understanding the Politics of Northeast India*, O.U.P.
- Gadgil Madhav and Guha Ramachandra, 1992, *This Fissured land: An Ecological History of India*, O.U.P.
- Gold, Ann and Bhoju Ram Gujar, 2002, *In the Time of Trees and Sorrows: Nature, Power, and Memory in Rajasthan*, Durham, Duke University Press.
- Guha, Ramachandra, *Social Ecology*, 1998, Oxford University Press.
- Ingold Tim, 1994, *Companion Encyclopedia of Anthropology*, Routledge.
- Kelley Alley, 2002, *On the banks of the Ganga: when waste water meets a sacred river*, University of Michigan Press, Ann Arbor.
- Leach, M. and R. Mearns (Ed.), 1996, *The Lie of the Land: Challenging Received Wisdom on the African Environment*, London and Oxford: The International African Institute and James Curry.
- Milton, Kay, 1993, *Environmentalism: The view from Anthropology*, Routledge
- Mehta, Lyla, 2001, *The Manufacture of Popular Perceptions of Scarcity: Dams and Water related Narratives in Gujarat, India*. *World Development* 29 (12), pp. 2025-2042.
- Schama, Simon, 1995, *Landscape and Memory*, London, Harper Collins.
- Savyasachi, 1994, *The Tiger and the Honeybee*. *Seminar* 423: 30-35
- Thorner, Daniel ed, 1996 *Agricultural Atlas of India , 1920*, Karachi, Oxford University Press.
- White, Leslie A., 1959, *The Evolution of Culture*, McGraw-Hill, New York.
- Zimmerman, F. 1982, *The Jungle and the Aroma of Meats*, Berkeley, University of California Press.

M.Sc. Stream

Paper - 9 (M.Sc.)

ATMOSPHERE AND GLOBAL CLIMATE CHANGE

Preamble: This paper introduces the student to the development of the Earth's atmosphere, its dynamic nature and variability in terms of the global energy balance. It also deals with elements of the climate, climate change and human impacts on climate initiative policies.

Earth Systems: Atmosphere, Hydrosphere, Lithosphere, Biosphere and their linkage. Earth's geological history and development and evolution of the atmosphere; Gaia Hypothesis.

Atmosphere and climate. Basic atmospheric properties, climatic controls. Climatic classifications and variability. Movement in the atmosphere: global scale, regional scale, local scale.

Oceans: General circulation patterns. Air- Sea interaction.

Global Energy balance: Source, transfer, distribution. Energy balance of the atmosphere.

Wind, stability and turbulence; Monsoons; El Nino, Southern Oscillations, cyclones. Natural climate changes: Records of climate change (glacial cycles, ocean sediments, corals, tree rings).

Human Impacts on climate:

(i) Causes and consequences of Global warming: Greenhouse effect; Global and regional trends in greenhouse gas emissions; Sea level rise; role of oceans and forests as carbon sinks (ii) Ozone depletion-stratospheric ozone shield; Ozone hole.

Impacts of Climate change: Effects on organisms including humans; effects on ecosystems and productivity; species distribution ranges; spread of diseases; Extinction risk for temperature-sensitive species; UV effects

Climate change and Policy: Montreal Protocol; Kyoto Protocol; Carbon trading; clean development mechanisms.

Practicals:

Project reports based on any of the above topics. Out of these one should be based on long term data collected from India Meteorological Department (IMD) and National Physical Laboratory (NPL) on various atmospheric parameters and their analysis.

Visit to IMD to learn about real time monitoring and prediction of weather.

Viva-Voce based on the above two project reports/practicals.

Suggested Readings:

Barry, R. G., 2003. Atmosphere, weather and climate. Routledge Press, UK

Critchfield, Howard J., 1998, General climatology, Prentice Hall India Pvt. Ltd., New Delhi.

Firor, J., and J. E. Jacobsen, 2002. The crowded greenhouse: population, climate change and creating a sustainable world. Yale University Press.

Glantz, M. H., 2003. Climate Affairs: a primer. Island Press.

Harvey D., 2000, Climate and Global Climate Change, Prentice Hall.

Kump, L. R., Kasting, J.F., and Carne, R. G., 2004. The Earth System. 3rd Ed. Prentice-Hall

Paper-10 (M.Sc.)

NATURAL & MANAGED ECOSYSTEMS

Preamble: This paper deals with some important aspects of Ecology. The course also emphasizes the distinction between natural and managed ecosystems which calls for different management approaches and strategies for sustainable development.

Introduction to Ecosystems: concepts; components; flow of energy; productivity, cycling of materials and nutrients, Food chain.

Communities: concept; development; structure; niche; regulation of community structure.

Ecosystem dynamics and functioning: role of biodiversity in patterns and processes of communities and ecosystems; stability, disturbance and resilience.

Ecosystem types and their distribution. Classification; Major ecosystems of the world (forests, grasslands, wetlands, oceans, rivers and lakes, deserts). Managed Ecosystems; Agri-Ecosystems, Aquaculture, Urban Ecosystems and Community Forests.

Ecosystems and Human well-being: Ecosystem services; Natural and Human induced changes in Ecosystems and their consequences on human well-being.

Sustainable Management: Concept of sustainability; Mechanisms to ensure sustainability of Ecosystems – Changes in institutional and Environmental governance framework; Economic and financial interventions; Social and Behavioral changes; Technological options; Design of effective decision making process; Vision for an ecologically sustainable future.

Practicals:

Projects/Practicals based on field visits to:

Natural ecosystems, one or two managed ecosystems.

Viva-Voce based on these two project reports.

Suggested Readings:

Clapham Jr., W.B., 1983, Natural Ecosystem: Chapters I, II, III and IV. Macmillan Publishers, London
Gadgil Madhav, 2004, Ecological Journeys. The Science and Politics of conservation in India, Permanent black, Delhi.

Heywood, V.H. (Executive Editor), 1995, Global Biodiversity Assessment: Chapters 5 and 6. UNEP, University Press, Cambridge

Jennifer, A., Burch. W.R., Conover, B. and Field, D., 1998. Ecosystem Management: Adaptive strategies for Natural Resources organizations in the 21st Century. Taylor and Francis, London.

Reid, W.V. et al (Ed.), 2005, Ecosystems and Human well-being: Synthesis. p.1-37. Millennium Ecosystem Assessment, World Resource Institute, Island Press, Washington DC.

Samson, B.F, and Knoff, F.L., 1996, Ecosystem Management. Springer-Verlag, New York.

Paper-11 (M.Sc.)

BIODIVERSITY AND CONSERVATION BIOLOGY

Preamble: This course entails the study of diversity existing at different levels of Biological organization and understanding the essential ecological and biological processes which ensures long terms stability of ecosystems. The course highlights the values of biodiversity and scientific approaches to conservation which only can lead to sustainable development and safeguard the interests of future generations.

Section A. Biodiversity:

Concepts: Organic Evolution through geological time scale. Ecosystems, Biomes etc.

Levels of Biodiversity: Community diversity (alpha, beta and gamma biodiversity), Gradients of Biodiversity (latitudinal, insular), Ecosystems diversity: biomes, mangroves, coral reefs, wetlands and terrestrial diversity (equilibrium mix of *G* and *W*).

Species diversity: richness and evenness, loss of species. Magnitude of biodiversity (Global and Indian data). Direct and indirect benefits, Bioprospecting (molecular techniques like RAPD, RFLP, AFLP, DNA sequencing etc).

Genetic diversity: sub species, breeds, race, varieties and forms. Variation in genes and alleles at DNA sequence levels (selected case studies). Microbial diversity and useful prokaryotic genes. Speciation (amount of genetic variation is the basis of speciation). Consequences of monotypic agricultural practice (Detailed case studies).

Threats to Biodiversity: Habitat loss and fragmentation; Disturbance and pollution; introduction of exotic species; extinction of species.

Human intervention and Biodiversity loss: Global Environmental changes, land in water use changes.

Section B. Conservation Biology.

History of Conservation movements: International and National. Ecologically relevant parameters (viable population, minimum dynamic area, effective population size, metapopulations); reproductive parameters in conservation (breeding habitats, mating systems, inbreeding depression, genetic bottlenecks, genetic constraints).

IUCN categorized-endangered, threatened, vulnerable species. Red data book and related documentation.

Methods of conservation. *In situ* (Biosphere reserves, National Parks, Sancturies, Sacred groves etc) & *ex situ* (Botanical gardens, Zoological gardens, Gene banks, Pollen, seed and seedling banks, tissue culture and DNA banks etc) modes of conservation.

Benefits of conservation: Biodiversity as a source of food and improved varieties; source of drugs and medicines; Aesthetics and cultural benefits. Sustainable development. Ecosystems services (maintenance of gaseous composition of the atmosphere, climate control by forests and oceanic systems, Natural pest control, pollination of plants by insects and birds, formation and protection of soil, conservation and purification of water, nutrient cycling).

Practicals:

Measurement of species diversity (calculation of Diversity Indices from data collected on plant species in the ridge forest.

Measurement of biodiversity at molecular level by RFLP, RAPD, AFLP analyses.

Blast analyses of selected DNA sequences from the International Gene Banks.

Suggested Readings:

- Daily, G.C., Ed., 1997, Nature's Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, D.C.
- Dobson, A.P., 1996, Conservation and Biodiversity. Scientific American Library, New York, NY.
- Gaston, K.J. and J.I. Spicer, 1998, Biodiversity: An Introduction. Blackwell Science, London, UK.
- Groombridge, B., and M. Jenkins, 2000, Global Biodiversity: Earth's Living Resources in the 21st Century. World Conservation Press, Cambridge, UK.
- IUCN, 2004, Red list of threatened species. A global species assessment. IUCN, Gland, Switzerland
- Loreau, M., and P. Inchausti, 2002, Biodiversity and Ecosystem functioning: Synthesis and Perspectives. Oxford University Press, Oxford, UK.
- Primack, R.B., 2002, Essentials of Conservation Biology, 3rd Edn., Sinauer Associates, Sunderland, Ma. USA
- Wilson, Edward O., 1993, Diversity of Life. Harvard University Press, Cambridge, MA.

Paper-12 (M.Sc.)

SOIL BIOLOGY

Preamble: Soil, the thin film at the interface of the lithosphere and the atmosphere is a reservoir of organic and mineral matter, which is a regulator of exchanges in the ecosystem. This course covers the fundamentals of general soil science, the processes of its development and the major principles of its classifications and mapping. Importance of Applied soil science is in the practice of composting, and the fight against pollution or erosion of soils.

Soil genesis and provenance, Pedosphere, Soil organic matter: sources, composition, microbial decomposition of organic matter, Humus formation

Soil as a habitat for organisms: micro flora and soil fauna, ecological interactions. Taxonomy and biology of soil organisms, Position and role of soil fauna in soil, ecological niche. Economic importance of soil microbes.

Role of soil biota in nutrient cycles: Carbon, Nitrogen, Sulphur, Phosphorous cycles.

Soil mutualistic symbioses – Structure of plasma membrane and fluxes across it. Mycorrhizal symbioses and Nitrogen fixing symbioses, Underground interactions: Rhizosphere, root exudates

Environmental problems related to soils in India: desertification, salinization, erosion.

Bioremediation of contaminated soils and ground water, Fate of plant allelochemicals in soil, Composting, a value addition to our wastes.

Practical:

Soil Physics: texture, bulk density, porosity and water retention.

Soil Chemistry: organic matter, pH, salinity, CEC/AEC, Nitrogen and Phosphorus.

Soil Biota: analysis of soil sample and identification of major groups of organisms.

Suggested Readings:

- Alexander, M., 1977, 2nd Edn., Introduction to Soil Microbiology, Wiley John.
- Alexander, M., 1994, Biodegradation and Bioremediation, Academic Press.

Coleman and Crossley, 2004, 2nd Ed., Fundamentals of Soil Ecology, Academic Press.
Killham, K., 1994, Soil Ecology, Cambridge University Press.

Paper-13 (M.Sc.)

ECOTOXICOLOGY AND ENVIRONMENTAL HEALTH

Preamble: This paper discusses the source, origin and effect of various toxic materials and heavy metals that adversely affect environmental health. In addition, the lectures would focus on the methods to detect and estimate the concentration of toxic chemicals and other contaminating substances that are polluting the environment with an adverse effect on it.

Section A: Ecotoxicology

Ecotoxicology as a Synthetic Science;

Major classes of Environmental Pollutants; Inorganic, Heavy Metals, Organics, Organometalics, Radioactive Isotopes, Gases

Routes of Entry into Ecosystems – Surface waters, Land, Atmosphere; Long-range movement and global transport of pollutants. Fate of pollutants in Ecosystems: Biotransformation, Bioaccumulation & Biomagnification. Test organisms used in Bioassays. Biomonitoring: Definition of toxicity, F, As, Hg problems

Toxicity Testing, Concept of Dosimetry: lethal, sub-lethal & chronic tests, dose response curves, LC50, MATC-NOEC, Brief statistical methodology

Toxicant Effects: - Cellular, organismic, population & Ecosystem-Level Effects; Global Effects – Acid rain etc.

Section B: Environmental Health

Toxicology & Epidemiology and occupational health

Sources: Solid & Hazardous wastes, untreated sewage, Automobile exhausts, Industrial Effluents, Industrial emissions into atmosphere, Agricultural run-off of Pesticides

Environmental Carcinogens, Mutagens, Asbestos issues

Human adaptation to cold and hot climates, high altitude environment and man-made environments.

Water pollution – Caused diseases (Gastroenteritis, Hepatitis etc.). Air pollution caused diseases (allergies, respiratory diseases). Food-borne diseases (Food poisoning, parasites etc). Vector transmitted diseases. Radioactive effects. Risk assessment.

Practicals:

Air quality assessment

Potable water quality assessment

Analysis of toxic heavy metals in soil and water.

Suggested readings:

Ecotoxicology:

Newman, M.C, Lawrence, C.A., and Unger. M.A., 2002. Ecotoxicology: Fundamentals of Ecotoxicology, 2nd Ed., CRC Press, Boca Raton, Florida.

Walker, C.H., Hopkin, S.P., Sibly, R.M., and Peakall, D.B. 2001. Principles of Ecotoxicology. 2nd Ed. Taylor & Francis, London.

Environmental Health:

Moore, G.S., 2002, Living with the Earth: concepts in Environmental Health Science (2nd Ed.), Lewis publishers, Michigan.

Selinus, Alloway, Centeno, Finkelman, Fuge, Lindh, Smedley; 2005, Essential of Medical Geology; Elsevier Academic Press.

Paper-14 (M.Sc.)

ENVIRONMENTAL BIOTECHNOLOGY

Preamble: The course is aimed at providing comprehensive training in investigating the natural environment and to develop potential solutions to remedy its damage using chemical, biochemical and molecular technologies.

Structure and perpetuation of nucleic acids: Pioneering experiments leading to development of molecular genetics, Fine structure of gene, DNA replication models, mechanism of replication, enzymes involved in replication.

Introduction to nature of genetic information and gene expression: Transcription of DNA; RNA polymerase, initiation, chain elongation, termination, post-transcriptional modifications. The genetic code; protein synthesis: tRNA as adaptor molecule, ribosome structure, ribosomal genes, initiation, elongation and termination of protein synthesis. Inhibition of protein synthesis.

Recombinant DNA technology: Early discoveries, restriction endonucleases, ligases, modification enzymes, DNA and RNA markers, cloning and expression vectors (plasmids, bacteriophage, phagmids, cosmids, artificial chromosomes), selection of recombinant clones, DNA sequencing, gene probes. CDNA synthesis and cloning (mRNA enrichment, reverse transcription, DNA promoters, linkers, adaptors and their chemical synthesis, library construction and screening). Nucleic acid microarrays.

Wastewater Treatment: Water as a scarce natural resource, Measurement of water pollution, sources of water pollution. Wastewater treatment: anaerobic, aerobic process, methanogenesis, bioreactors, cell and protein (enzyme) immobilization techniques. Treatment schemes for waste water, dairy, distillery, tannery, sugar, antibiotic industries.

Solid waste treatment: Sources and management (composting, wormiculture and methane production, landfill. Hazardous waste treatment. Biofuels.

Bioremediation: Remediation of degraded ecosystems, degradation of xenobiotics in environment, decay behaviour & degradative plasmids, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides, heavy metals degradative pathways.

Practicals:

Ames tests for mutagenicity in microbes. Demonstration of the use of *lux*-reporter genes in monitoring environmental toxicity.

PCR-based assays to detect microbes in sewage water and contaminated soil samples collected during field trips.

Biotoxicity assays to evaluate effectiveness of Bt spores against pests & beneficial insects.

A web-based project on multiples sequence alignments of putative environmentally useful gene families from plants and/or microbes.

Suggested Readings:

- Gardner, Simmonds, Snustad, 1991, Principles of Genetics. John Wiley, Eighth Edition.
- Mohapatra. P. K., 2006, Text Book of Environmental Biotechnology. I K International.
- Olguin, E., Sanchez, G. and Hernandez, E., 1999, Environmental biotechnology and cleaner bioprocesses, Taylor & Francis, London.
- Rittman, B. E., and McCarty, P. L., 2001, Environmental Biotechnology. Principles and applications. McGraw-Hill, New York.
- Scragg, A. H., 2005, Environmental Biotechnology. Oxford University of Press.
- Wainwright, M., 1999, An introduction to environmental biotechnology. Springer Verlag, New York.

Paper-15 (M.Sc.)**ENVIRONMENTAL CHEMISTRY**

Preamble: The course introduces the students to some basic chemistry relevant to the course, and to the general chemistry of the lithosphere, hydrosphere and atmosphere. Emphasis is also placed on understanding the chemistry of various anthropogenic pollutants and basic analytical techniques.

Basic Chemistry: Structure of atoms, their properties, their nuclear stabilities and their arrangement in the Periodic Table; fundamentals of chemical thermodynamics and solution formation; basic organic chemistry and biochemistry.

Geochemistry: Structure and chemistry of silicate and ore minerals; bulk composition of the earth, crust, & oceans; rock weathering, clay minerals and soil formation; cycling of chemical elements in the earth system.

Chemistry of waters: properties of water; sources of water and their linkages – hydrologic cycle; concepts of pH, Eh and their variations in waters; metal solubility, complexation and chelation; aquatic life and water chemistry; organic and inorganic including radioactive water pollutants and their removal methods.

Atmospheric Chemistry: Physical and chemical properties of atmospheric air and their variation with latitude and altitude; chemical reactions in air and the residence time of CO₂ and the greenhouse gases aerosols, their chemistry, sources and transport; organic compounds in air and their sources; physical and health effects of air chemistry changes, global warming and acid rain.

Chemistry of waste substances: Nature and types of various wastes such as mining, industrial, agricultural, municipal, medical and nuclear; chemical and biological treatment of wastes before disposal; chemistry of toxic inorganic and organic compounds in the environment and their interactions with living system.

Practical:

Sample preparation methods: Types & calibration of standards for soil & water analysis.

Chemical analysis of water & waste water; Analyses of wastes & solids; Air & gas analysis; Analysis of biological materials.

Familiarity with instrumental techniques for basic Chemical analysis: chromatography, spectrophotometer, fluorometry.

Suggested Readings:

- Manahan. Stanely E, 2000, 7th Edn., Environmental Chemistry, Lewis Publishers.
- Stumm, W.; Morgan, J. J., 1996, Aquatic Chemistry: Chemical Equilibria and Rates in Natural Waters; Wiley Interscience: New York,.

Wayne, R. P., 2000, Chemistry of Atmospheres: An Introduction to the Chemistry of the Atmospheres of Earth, the Planets, and their Satellites (3rd Ed.), Oxford University Press,
Williams Ian, 2001, Environmental Chemistry –a modular approach, Willey John & Sons
Williams. R.J.P and Frausto da. J.J.R, 1996, The Natural Selection of the Chemical Elements, Oxford University Press, Oxford, UK /New York, NY
Willard & Others, 1988, Instrumental Methods of Analysis, Wadsworth.

Paper-16 (M.Sc.)

ENVIRONMENTAL HAZARDS

Preamble: This paper introduces the students to various environmental hazards, their causes, nature, preparedness and assessment of loss. It teaches them to model hazards and familiarizes them with methods of disaster management.

Concept of hazard, disaster, risk, vulnerability, exposure and response. Distinction between natural hazards and anthropogenic environmental disturbances, Hybrid hazards.

Environmental Hazards: Classification, Causes and Distribution.

Natural Hazards:

Geological Hazards: Earthquakes, Volcanoes, Mass-movement; Tsunami.

Hydrological Hazards: Floods, Droughts, Water Quality, Contamination, Arsenic problem, Cyclones, Hurricanes

Atmospheric/Climatic Hazards: Extreme weather events, Global Climatic change.

Man made Hazards:

Biophysical Hazards: Frost Hazards in agriculture, epidemics, wildfires

Technological Hazards: Nature and significance. Lessons from Bhopal and Chernobyl disasters.

Modelling of Hazards: Hill slopes and landslides.

Disasters and Hazard Management: Human and ecological impacts; Risk assessment and vulnerability analysis; National preparedness and adaptation strategies; Hazards policies and agencies; Land use classification. Role of GIS and remote sensing in surveillance, monitoring, risk assessment, estimation of losses and planning.

Practicals:

Preparation of Hazard Zonation map of India for land slides, earthquakes, floods etc.

Earthquake-loss estimation using remote sensing and GIS

Preparation of master plan for any Environmental Hazard mitigation

Suggested Readings:

Bell. F.G, E & FN Spon, 1999, Geological Hazards: Their Assessment, Avoidance and Mitigation, e Books der ULB Darmstadt.

Burton. I, Kates. R.W and White. G.F, 1993, Environment as Hazard Guilford Press.

Casale. R and Margottini. C. (Ed.), Springer, 2004, Natural Disasters and Sustainable Development

Hewitt. K., 1997, Regions of risk, Longman Press.

Henry J.G. and Heinke, G.W., 2004, Environmental Science and engineering, Pearson education, Delhi, India.
Keller. Edward A, 1996, Introduction to Environmental Geology, Prentice Hall, Upper Saddle River, New Jersey
Smith Keith, 2001, Environmental Hazards: Assessing Risk and Reducing Disaster, Routledge.

Paper-17 (M.Sc.)

HYDROLOGY AND WATER RESOURCES

Preamble: The course introduces the student to the hydrologic cycle and various characteristics of surface and groundwater resources including different techniques of water management. It also introduces them to basic analytical methods to quantify water quality and determine hydrological parameters.

Introduction: The hydrologic cycle; Structure and properties of water, Inventory of Earth's water, quality and quantity. Limits of cations and anions in portable water including fluoride and arsenic, phosphate, nitrate and heavy metals. Application of isotopes in hydrology. Hydrogeology of India.

Surface water resources: precipitation, infiltration, water balance, Evapo-transpiration and runoff, Drainage basin.

Groundwater resources: rock properties affecting ground water, vertical distribution of ground water, zone of saturation. Darcy's law: permeability, transmissivity and storage coefficient. Viscous character of groundwater flow. Geologic formations as aquifers, type of aquifers. Distribution of water - local, regional and global. Ground water exploration.

Environmental Influences on water resources: surface and groundwater resources of arid and semiarid regions, Snowmelt hydrology from glaciers, fluctuations due to urbanization, Evapo-transpiration and tides. Recent development in surface and groundwater resources monitoring and assessing processes. Salinity ingress in ground water. Water logging and soil salinity-conjunctive use of surface water and ground water.

Water resource management: Flood and flood plain management; Water-shed management, water harvesting and artificial recharge to ground water; water pollution and water treatment. Wetland and riparian management; forest management on water resources. Environmental issues: River linking debate.

Practicals:

Estimation of physico-chemical properties of water: Turbidity, Light penetration, Conductivity, Total suspended solids, Alkalinity, Hardness, Dissolved oxygen, BOD, COD, pH, Eh,

Analysis of water quality on Tri-linear diagram,

Evaluation of hydrologic parameters; catchment delineation and water balance. Hydrograph analysis.

Suggested Readings:

Aggarwal, A., 1991, Floods, Floodplains and Environmental Myths. Centre for Science and Environment, New Delhi.

Andrew D. Ward and Stanley Trimble, 2004, 2nd Ed., Environmental Hydrology, Lewis Publishers.

Karant, K.R.C., 1988, Ground Water: Exploration, Assessment and Development. Tata-Mcgraw Hill, New Delhi.

Mahajan, G., 1989, Evaluation and Development of Groundwater. Ashish Publishing House, New Delhi.

Rao, K.L., 1982, India's water wealth. Orient Longman, Delhi.

Subramaniam V., 2002, Text Book of Environmental Science, Narosa Publishing House, Delhi.

Timothy, Davie, 2003, Fundamentals of Hydrology. Rowledge, Taylor and Francis Group, U.K.
Todd, D.K., 2004, Groundwater Hydrology, John Wiley & Sons Inc.
Vijay P. Singh, 1995, Environmental Hydrology. Kluwer Academic Publications, The Netherlands.
Wright. R.T and Nebel. B.J., 2002, Environmental Science: toward a sustainable future, Prentice Hall India Ltd, 8th Edition.

Paper-18 (M.Sc.)

ENVIRONMENTAL GEOLOGY

Preamble: All human activities take place on earth using a large variety of its resources. How do we live here and use these resources, so that not only sustainable society but also life itself is sustained, need the knowledge of the science of the earth (= Geology) for all its citizens. The subject Environmental Geology is an applied one, wherein basic geologic knowledge is used to maximize the utilization of all natural resources, minimize their degradation as well as minimize the destructive potential of natural processes and to sustain a healthy biosphere on earth.

Planet Earth: Earth in the solar system; differentiation of the earth into core, mantle, crust, hydrosphere and atmosphere; rock-forming, ore-forming and soil-forming minerals; energy, mineral, water and soil resources.

Earth processes: Plate-tectonic processes, rock-forming and ore-forming processes, hydrologic, weathering and erosional processes; development of large-scale physiographic features such as oceans, land, mountains, plateau, floodplains and deltas. Rivers and their relation to geology and climate; erosional, transportational and depositional processes of water, air, waves and glaciers.

Resources: Concepts of resources and reserves in energy, mineral and water resources; geological constraints in their availability and use; environmental consequences of their exploitation to air, water, soil, climate and life.

Natural hazards: Floods, landslides, earthquakes-tsunami and volcanism, cyclones, coastal erosion and sea level changes; impact of urbanization on the rate of these processes; general methods to identify the hazard potential, to mitigate and to cope with natural processes.

Land use: Land evaluation and land use planning for construction and waste disposal; landscape geochemistry and human health; Desertification and associated problems.

Practicals:

Identification of common minerals & major rock types in hand specimens and under petrological microscope.

Geomorphological, Land use, LISS mapping,

Plate tectonics and hazard zonation maps.

Suggested Readings:

Keller. Edward A, 1996, Introduction to Environmental Geology, Prentice Hall, Upper Saddle River, New Jersey

Kesler, S. F. 1994, Mineral resources, economics and the environment. Upper Saddle River, NJ: Prentice Hall.

Owen., Oliver S, Chiras. Daniel D, Reganold. John P., 2002, Natural Resource Conservation, 7th Ed., Prentice Hall, Upper Saddle River, New Jersey

- Skinner, Brian J., Porter, Stephen C., 1995, *The Dynamic Earth: An Introduction to Physical Geology*, Casebook, 3rd Edition (Paperback), John Wiley, New York
- Skinner, B. J., and Porter, S. C., 1995, *The Blue Planet, An Introduction to Earth System Science*, John Wiley & Sons, Inc.
- Slaymake, Olav, (Editor), 2000, *Geomorphology, Human Activity and Global Environmental Change*. John Wiley, New York.

Paper-19 (M.Sc.)

SYSTEMS ANALYSIS AND MODELLING

Preamble: The paper introduces the student to the concept of systems and sub-systems, and modelling and simulations as well as computational techniques. These concepts are used to model various environmental systems, particularly those dealing with ecology and ecosystems and study of environmental pollution in modelling air and water quality.

Introduction: Definitions and concepts of system, sub-system, variables and parameters, systems analysis, modeling and simulation. Linear vs. non-linear models; Non-linear forecasting. Prey-predator systems, Environmental systems. Time series analysis.

Types of systems: open and cybernetic systems; feedback; Ecosystem as a cybernetic system; Critical points of a system; stability of critical points. Limitations of modeling.

Models in Ecology: Stochastic and Deterministic model; Development of Ecological models. Fundamental interactions in ecology: predator-prey, competition, mutualism and interference.

Models in Ecosystem Analysis, Synthesis and forecasting: statistical regression approach, differential equation approach and computational approaches, Lotka-Volterra model.

Air and water quality modelling

Introduction to computational technology: Fuzzy logic; artificial neural networks; Genetic algorithms; Evolutionary algorithm, Natural Distribution functions.

Practical:

Computer lab: Introduction to computational techniques.

Simulations based on various environmental models.

Suggested Readings:

- Gallager R., 1996, *Discrete Stochastic Processes*, Kluwer Academic Publishers.
- Grant, W.E., Pederson, E.K. and Sendra, L.M., 1997, *Ecology and Natural Resource Management: Systems Analysis and Simulation*, John Wiley, New York.
- Jorgensen, S.E. Miller, F., (Ed.), 2000, *Hand Book of Ecosystem Theories and Management*, Section-I and 11.4 of Section II. CRC press, Florida.
- Recknagal, F., (Ed.), 2003, *Ecological Informatics*, chapters I, II, III and IV. Springer, Germany.
- Wainwright, John (Editor), Mulligan, Mark (Editor), 2004, *Environmental Modelling: Finding Simplicity in Complexity*. John Wiley, New York
- Zannetti, P., 1990, *Air pollution modeling, theories computational methods and available softwares*. Van Nostrand Rheinhold, New York.

Paper-20 (M.Sc.)

ENVIRONMENTAL ENGINEERING

Preamble: This paper provides an overview of the basic concepts of environmental engineering. It covers various treatment technologies and their application to water and waste water, liquid and solid wastes, and gaseous materials and their management.

Introduction to Engineering Fundamentals: Principles of environmental quality objectives, standards and guidelines; Environmental processes: Engineered systems and policies; Professional directions in environmental engineering; Material Balances and Separations. Science of environment: physical & chemical processes, Environmental Biology, Basics of Microbiology

Treatment technology and control: Aerobic and anaerobic processes; aeration, coagulation and flocculation, sedimentation, filtration, disinfection. Tertiary treatment technologies.

Technological considerations and Engineering applications

Water Treatment Processes; Water transmission, distribution, storage. Wastewater Flow rates & Collection; Wastewater Treatment Processes. Constructed wetlands.

Air Pollution Control: Treatment of Emissions; Dispersion; Control of Moving Sources; Air Pollution control costs.

Solid waste management: Characteristics and collection system. Separation, processing and conversion. Land filling. Future opportunities.

Hazardous Wastes: nuclear waste, biomedical waste, chemical waste. Hazardous waste management.

Waste Minimization; Pollution Prevention and control strategies

Practicals:

Report on the visits to water treatment, waste water treatment and sewage treatment plants.

Report on the visits to Air pollution monitoring station; making flow sheets.

Viva-Voce based on the above reports.

Suggested Readings:

Henry Glya, J. and Heinke, 2004, Gary W. Environmental Science and Engineering. Pearson low priced edition.

Kiely, G., 1998, Environmental Engineering, Irwin McGraw Hill, Boston.

Masters, M.G., 1998, 2nd Edition, Introduction to Environmental Engineering and Science, Prentice Hall, London.

Peavy, H.S., Rowe, D.R. and George, T., 1987, Environmental Engineering, McGraw Hill, New York.

Vesilind, P.A., 1997, Introduction to Environmental Engineering. PWS publishing, Boston.