

CURRICULUM OF SENIOR SECONDARY COURSE IN ENVIRONMENTAL SCIENCE (333)

RATIONALE

Rapid growth of population coupled with increasing industrial development and all around increase in consumerism throughout the world are posing a serious threat to the environment. People in almost all nations of the world are becoming increasingly conscious of the danger of deteriorating environmental conditions. In view of the critical importance of the environmental issues, it is necessary to introduce Environmental Science as a full-fledged subject at the Senior Secondary level. Environmental Science deals with the relationships between environment and humans and draws upon physical sciences, biological sciences and social sciences.

Humans have been concerned with environment since the beginning of civilization. Even our ancient scriptures have emphasized the virtues and values of environmental conservation. Now, it is even more critical than ever before for mankind to have a better understanding of environmental issues to promote sustainable development practices. Environmental science embraces problems related to conservation of natural resources, deforestation, loss of biodiversity, environmental pollution, deterioration of life support systems and issues like global warming, ozone depletion etc. All this and much more is dealt within the subject.

The course covers all the major components of the environment including natural resources, ecological principles and population dynamics, pollution, wildlife conservation, and impact of industrialization. In

addition, it also addresses environment related socio-economic, cultural and ethical aspects, which are important to ensure a sustainable future for humans. The course also provides practical insight into environmental management to enable an appreciation of the issues related to sustainable livelihood and human welfare.

OBJECTIVES

The course is designed to enable the learner:

- to know about origin of earth and evolution of life, and appearance of human species;
- to develop concerns for environmental problems;
- to understand ecological principles.;
- to harmonize environmental concerns with technological and socio-economic issues;
- to develop respect for nature and living beings and to help maintain ecological balance;
- to take active part in protecting and conserving the environment and to assume the responsibilities for change of society;

COURSE STRUCTURE

The present curriculum contains 7 Core modules and 2 Optional modules. The Core modules are compulsory for all learners, whereas the learner can choose any one of the two Optional modules. Thus, each learner goes through eight modules in all. Each module has been divided further into units and then into lessons. The number of lessons, suggested study time and marks allotted for each unit are as follows:

Unit wise Distribution of Core Modules	Number of lessons	Study hours	Marks allotted	
			Unit	Module
Module 1 : Environment through Ages 1.1 Environment-Origin, Evolution of Environment and its uses by Humans	3	15	5	05
Module 2 : Ecological Concept and Issues 2.1 Principles of Ecology : Composition and various types of Ecosystem	4	30	12	12
Module 3 : Human Impact of Environment 3.1 Human Settlements and their impact on Environment	2	20	07	07
Module 4 : Contemporary Environmental Issues 4.1 Environmental Pollution and Natural Disasters 4.2 National and Global Environmental Issues	3 2	25 15	10 05	15
Module 5 : Environmental Conservation 5.1 Conservation of Biodiversity and other Natural Resources (Soil, Land, Water, Energy etc.)	4	35	14	14
Module 6 : Sustainable Development 6.1 Sustainable development with regard to Agriculture and Cleaner technology	4	20	07	07
Module 7 Environmental Management 7.1 Environmental Ethics 7.2 Legislation for Environmental Improvement 7.3 Organization devoted to Environment	1 2 1	5 10 5	2 4 2	8
Optional Module 8A : Water Resource Management 8.1 Water as a Resource 8.2 Conservation of water Or Optional module 8B : Energy and Environment 8.1 Energy use and its Impact on Environment 8.2 Energy Conservation	3 2	18 12	07 05	12
Theory examination	31	3 hrs	1 paper	80
Practical Examination		3 hrs	1 paper	20
Total				100

Module–1: Environment through Ages

Time: 15 Hours

Marks: 05

Approach

This module is intended to enable the learners to visualize the origin of earth and the development of conditions for support of life.

They will also learn about the use of natural resources by primitive humans and evolution of the socio-cultural environment. The learner will also visualize how industrial development has led to environmental degradation and realise that such degradation poses a threat to human well being and survival of other living beings.

Unit 1 Environment- Origin, Evolution of Environment and its use by Humans

1.1.1 Origin of Earth and Evolution of Environment

- Conditions on earth prior to the origin of life
- Origin and evolution of life on earth
- Abiotic (physical) environment
- Biotic environment

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- Origin of earth
- Evolution of life on earth

1.1.2 Human Society and Environment

- Interaction between primitive society and environment
- Use of primitive tools
- Beginning of settled life
 - (i) Beginning of agriculture
 - (ii) Domestication of animals
- Settled life
- Industrialization and Environment
 - (i) Beginning of industrialization
 - (ii) Exploitation of natural resources
 - (iii) Impact of industrialization
 - abiotic resources (air, water and soil)
 - biotic resources (plants and animals)

1.1.3 Degradation of Natural Environment

- Concept of environmental degradation
- Population growth
- Deforestation
- Urbanization
- Mining and environmental degradation

- Use and exploitation of fossil fuels
- Impact of modern agriculture
- Environmental backlash
 - i. Local backlash – Bhopal gas tragedy, Minamata disease, species extinction
 - ii. Regional backlash – Flood, drought, acid rain, oil spills, collapse of marine fisheries.
 - iii. Global backlash – Biodiversity loss, global warming, ozone depletion.
- Environmental degradation – A threat to survival

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- Impact of industrialization on natural resources
- Environmental degradation

Module–2: Ecological Concepts and Issues

Time:30 Hours

Marks: 12

Approach

This module aims to introduce the learner to the principles of ecology and functioning of nature.

Unit 1 Principles of Ecology – Composition and Types of Ecosystems

2.1.1 Principles of Ecology

- Definition of ecology
- Organism, habit, habitat and ecological niche
- Organism and environment – species concept – adaptation, evolution, extinction
- Biosphere – ecosystem – community – interspecific interaction-ecological succession
- Organism – population, size, growth, density and dispersion

2.1.2 Ecosystem

- Components of ecosystem (non-living and living)
- Energy flow

- Food chain and food web
 - i. trophic levels – producer, consumer, decomposer
 - ii. ecological pyramids
 - iii. energy flow in a food chain
- Energy efficiencies
- Nutrient cycles (water, carbon, nitrogen)

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- Ecological pyramids
- Nutrient cycles

2.1.3 Natural Ecosystems

- Terrestrial ecosystems
- Threatened ecosystems and causes thereof
- Aquatic ecosystem with Indian examples
 - i. fresh water
 - ii. marine
- Ecotones and edge effect

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- Ecosystems – natural and human modified
- India's threatened ecosystems

2.1.4 Human Modified Ecosystem

- Agro-ecosystems
- Plantation forests
- Dams and reservoirs
- Aquaculture ponds
- Urban and industrial ecosystem

Module–3: Human Impact on Environment

Time: 20 Hours

Marks : 07

Approach

This module is designed to enable the learner to understand the varieties of problems that have

arisen due to increasing human habitations in the form of cities. The module also covers the highly important aspects of deforestation, loss of biodiversity.

Unit 1 Human Settlements and their impact of Environment

3.1.1 Human Societies

- Rural settlements
 - i. Characteristics of rural settlement
 - ii. Land use changes
 - iii. Effect of modern technology on agriculture
 - iv. Environmental problems of rural areas
- Urban settlements
 - i. Urban settlement – its occurrence, push and pull factors
 - ii. Life style – changing life patterns
 - iii. Slums and urban planning
 - iv. Increased resource consumption
 - v. Increased waste generation (liquids, solid and gases)

3.1.2 Deforestation

- Causes of Deforestation
 - i. Increase in human population
 - ii. Transformation forests into agricultural fields
 - iii. Overexploitation of forest resources
 - iv. Urbanization and industrialization
- Consequences of Deforestation
 - i. Soil erosion
 - ii. Depletion of wildlife
 - iii. Floods
 - iv. Effect on climate
 - v. Desertification

- Loss of Biodiversity
 - i. Causes of biodiversity loss
 - ii. Threatened/endangered/rare species
 - iii. Invasion of exotic species
 - iv. Consequences of biodiversity loss
- Effect on tribal societies

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- Biodiversity
- Deforestation
- Desertification
- Wildlife conservation

Module–4: Contemporary Environmental Issues

Time: 40 Hours

Marks: 17

Approach

This module brings about awareness of the contemporary environmental issues related to natural and man-made problems. Major national and global environmental issues have been described in this module to familiarize the learner with environmental pollution and natural disasters. Environment related human health problems are also highlighted in this module.

Unit 1 Environmental Pollution and National Disasters

4.1.1 Pollution – Its causes, consequences and prevention

- Air and Noise pollution
- Water pollution
- Soil pollution
- Thermal pollution
- Radiation pollution

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- Pollution-air, water, noise, soil
- Uses and effects of pesticides and insecticides

4.1.2 Environment and Health

- Water borne diseases
- Air pollution and health
- Environmental carcinogens
- Heavy metals (arsenic, mercury and lead) toxicity
- Occupational health

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- Environment and human health

4.1.3 Disasters and their Management

- Types of disasters – natural and human-made
- Causes and management of the following types of disasters
 - i. Water and climate related disasters – Flood, cyclone, drought
 - ii. Earthquake
 - iii. Accident related disasters – Forest fire, oil spill,
- Biologically related disasters – Epidemics (Dengue, SARS, HIV, mad cow disease and bird flu), pest attacks, cattle epidemics

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- Disaster-its causes and management

Unit-2 National and Global Environmental Issues

4.2.1 National Environmental Issues

- Growth of human population – size, growth, density, dispersion, age (shift in the population growth curve with special reference to ageing population) and sex ratio, natality and mortality, immigration, emigration

- Problems of urbanization – Energy, water scarcity, water pollution, waste disposal, congestion and transport

- Man-wildlife conflicts

4.2.2 Global Environmental Issues

- Major Global Environmental issues
 - i. Global warming
 - ii. Ozone layer depletion
 - iii. Biodiversity loss
 - iv. Nuclear disasters
 - v. Marine pollution (including dumping of hazardous wastes)

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- Global warming
- Ozone layer depletion

Module–5: Environmental Conservation

Time: 30 Hours

Marks : 14

Approach

This module introduces the importance of and methods of conservation of biodiversity, soil, water, energy and natural resources.

Unit 1 Conservation of Biodiversity and Other Natural Resources (Soil, Water etc.)

5.1.1 Biodiversity Conservation

- Methods of biodiversity conservation

In situ approaches

- i. National parks
- ii. Sanctuaries
- iii. Biosphere Reserves
- iv. Wildlife conservation projects – tiger, elephant and crocodile
- v. Wetlands conservation

Ex-situ approaches

- i. Botanical gardens
- ii. Zoological parks
- iii. Seed Banks/Gene Banks
- iv. National Genetic Resources Centres :
 - National Bureau of Plant Genetic Resources, New Delhi
 - National Bureau of Animal Genetic Resources, Hissar
 - National Bureau of Fish Genetic Resources, Lucknow
 - Tissue Culture techniques

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- Wildlife conservation
- National parks and sanctuaries

5.1.2 Conservation of other Natural Resources

- Non-renewable resources (Primary energy resources and their consumption, fossil fuels, minerals)
- Renewable resources (water, wood, natural pastures)

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- Conservation of natural resources

5.1.3 Soil Conservation

- Causes of soil erosion
- Methods of prevention and control of soil erosion
- Fertilizers and manure

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- Soil Erosion
- Conservation of soil

5.1.4 Land Conservation

- Causes, consequences and control of land degradation
- Methods of land reclamation and conservation

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- Conservation of land

5.1.5 Energy Conservation

- Conventional and non-conventional sources of energy
- Efficient use of energy – in home, place of work, transport and industry
- Renewable energy programme in India

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- Conservation of energy

5.1.6 Water Conservation

- Causes of water degradation and scarcity
- Methods of conserving water resources
- Methods of preventing water degradation and control of water pollution

Module–6: Sustainable Development

Time: 20 Hours

Marks: 07

Approach

This module aims to inform the learner about the concept of sustainable development for integrating environmental conservation with developmental objectives. This module elaborates the concept of sustainable agriculture including crop rotation, genetic control, organic agriculture, integrated pest management and cleaner technology.

Unit 1 Sustainable Development with regard to Agriculture and Cleaner Technology

Concept of Sustainable Development

- Our common resources and tragedy of commons
- Development without destruction
- Safeguarding resources for future generations

- Ensuring equity and transgenerational consideration

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- Sustainable development-concept

Modern Agriculture

- Green revolution
- Agricultural impacts and environmental degradation (pesticides, fertilizers)
- Animal husbandry
- Management of livestock and their environmental consequences- examples (foot and mouth diseases)
- Consequences of practices used for enhancing animal and plant production – hormones, steroids, and fish culture

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- Green revolution
- Animal husbandry

Concept of Sustainable Agriculture

- Approaches of sustainable agriculture
- Crop rotation
- Genetic improvement including GMOs
- Integrated Pest management (IPM)
- Biofertilizers (Cyanobacteria)
- Organic Farming

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- GMOs
- Crop rotation
- Organic farming
- Biofertilizers : uses and effects

6.1.2 Cleaner Technology

- The concept of cleaner technology
- Agriculture life cycle analysis

- Waste management
 - i. Industrial wastes : reduce, recycle and reuse
 - ii. Domestic wastes : reduce, recycle and reuse

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- Cleaner Technology and Waste Management

Module-7: Environmental Management

Time: 25 Hours

Marks: 08

Approach

This module aims to inform learner about the concept of environment impact assessment and its relevance for promoting environ-friendly development. The learner will also be introduced to various national and international legislation promulgated for environmental improvement and conservation. This module also highlights the need to respect all life forms, ethics and Gandhian approach towards environment conservation.

Unit 1 Legislations for Environmental Improvement and Conservation

7.1.1 Environmental Legislation

- Need for legislation
- National legislation
 - i. Pollution related Acts
 - Water Pollution Act
 - Air Pollution Act
 - Environment Act
 - ii. Biodiversity related Acts
 - Forest Act
 - Biodiversity Act
 - iii. International legislations/conventions
 - i. Wetland Convention

- ii. Montreal Protocol
- iii. Climate Convention
- iv. Biodiversity Convention

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- Environmental legislation – national and international

7.1.2 Environmental Impact Assessment (EIA)

- Negative impact of development projects – concept of externality
- Development without destruction
- Anticipation and mitigation of negative impact of development projects
- Requirement for environment impact assessment
- Methods of carrying out environment impact assessment
- Environment impact assessment practices in India
- Evaluation of alternative scenarios

Unit 2 Organisation related to Environment

7.2.1 Environment related Institutions and Organizations

- National Environmental Agencies
 - i. Ministry of Environment and Forests (MoEF)
 - ii. State Environment Bodies
 - iii. Central Pollution Control Board (CPCB)
 - iv. State Pollution Control Board (SPCB)
 - v. Indian Board for Wildlife (IBW)
- International Environmental Agencies
 - i. United Nations Environmental Programme (UNEP)
 - ii. World Health Organisation (WHO)

- iii. Food and Agricultural Organisation (FAO)
- iv. Commission on Sustainable Development (CSD)
- v. United Nations Framework Convention for Climate Change (UNFCCC)
- International NGOs
 - i. International Union for conservation of Nature and National Resources (IUCN)
 - ii. World wide Fund for Nature (WWF)
 - iii. Green peace
 - iv. TERI
- National NGOs
 - i. Centre of Science and Environment (CSE)
 - ii. Kalpavriksha
 - iii. Development Alternative
 - iv. Sulabh International

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- Role of WHO, FAO, UNEP, CSD for conservation of Environment

Unit- 3 Environmental Ethics

7.3.1 Environmental Ethics and Gandhian Approach

- Environmental thought in ancient scriptures
- Respect for nature and heritage
- Respect for all life (animal and plants)
- Indian Culture – Environmental values

respect for plants (banyan, peepal, tulsi, banana, kadamba etc.) and animals (cow, bull, elephant, lion, monkey snake, owl, swan, peacock etc.), sacred groves.

- Gandhian philosophy and environmental sustainability
 - i. self-help
 - ii. self sufficiency
 - iii. minimize need
 - iv. sustainable consumption pattern
 - v. promote cottage industries
 - vi. small scale village (ecofriendly)

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- Environmental ethics
- Indian Culture

OPTIONAL MODULE– 1

Water Resource Management

Time: 30 Hours

Marks: 12

Approach

Fresh water is a costly commodity required not only by humans but also by other living beings. A good deal of fresh water is also required for agricultural and industrial uses. The hard fact is that the fresh water resources are limited thereby warranting careful management of fresh water resources by avoiding wastage. Emphasis of this module is on fresh water management including ground water resource. Steps to be taken by individuals and communities are highlighted not only to conserve fresh water but also to prevent its wastage and pollution. The learner is also told about the traditional as well as modern methods of water conservation.

Unit 1 Water as Resource

8.1.1 Global Circulation of Water

- Importance of water
- Hydrological cycle (Evaporation, precipitation balance)

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- Hydrological cycle

- Importance of water

8.1.2 Ground Water Resource

- Use and management
- Importance of ground water
- Ground water recharging – natural and human made depletion of ground water
- Depletion of water resources

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- Depletion of ground water resources

8.1.3 Fresh Water Resource and Distribution

- Distribution of fresh water resources
- Domestic, agricultural and industrial use of water
- Obtaining, processing and distribution of drinking potable water at community levels-water supply

Unit-2 Conservation of Water

8.2.1 Methods of Water Harvesting

- Need of water harvesting
- Traditional methods of water harvesting
- Modern methods of water harvesting

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- How can we conserve our water resources for future generations

8.2.2 Conservation at different levels

- Water shed management (prevent wastage and control of pollution)
- Role of an individual in water conservation

OPTIONAL MODULE – 2

Energy and Environment

Time: 30 Hours

Marks: 12

Approach

This module exposes the learner to the vital area of energy and both its renewable and non-

renewable sources. The learner is also exposed to the concept of alternative sources of energy apart from the traditional ones. The learner is also told about the impact of energy use on environment. A good deal of emphasis is laid on the need and methods of conservation of energy.

Unit-1 Energy use and its impact on Environment

8.1.1 Importance of Energy in Society

- Importance of energy of doing work
- Interrelationships between energy and development
- Laws of energy
- Impact of energy use on environment along with case studies
- Constraints in energy generation, supply and transmission

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- Uses of energy in daily life

8.1.2 Non-renewable Sources of Energy

- Definition
- Fossil fuels : coal, petroleum, natural gas
- Nuclear plant
- Naphtha
- Lignite
- CNG as a cleaner fuel

8.1.3 Renewable Sources of Energy – 1

- Definition
- Solar energy : solar cooker, solar heater, solar cell
- Wind energy
- Hydro energy
- Thermal energy

8.1.4 Renewable Sources of Energy –2

- Biomass
- Biogas energy
- Animal energy
- Geothermal energy
- Hydrogen energy
- Fuel cell technology

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- Various sources of energy

Unit – 2 Energy Conservation

8.2.1 Energy Conservation

- At household level
- At community level
- At work place, in transportation and building construction
- Design of energy efficient new towns
- Energy efficient devices
- Concept of energy auditing

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- Energy conservation at various levels

PRACTICAL WORK

The purpose of teaching Environmental Science is not only to acquaint the learner with theoretical knowledge but also to develop practical skills. Development of these skills leads to better understanding of the environment through hands-on experience and mutual reinforcement of theory and practice. Field exercises and laboratory work develop psychomotor skills. The present course involves field work, laboratory exercises and short innovative projects to exercise creative thinking and problem solving skills. The list of practical exercises to be carried by a student as part of this course on Environmental Science is given below:

A. FIELD STUDIES (ANY THREE)

1. Study a simple ecosystem (suggested habitats-pond, river, estuarine, lake, grassland, forest, and desert) and describe the biotic and abiotic components of the ecosystem.
2. Study of the effect of human interactions with the natural environment.
3. Survey of vegetation, birds, insects and other animals in your locality.
4. Choose five common tree species plants from your neighbourhood and list their common names. Describe each plant in terms of its height and leaf characteristics.
5. Describe the environmental problem of your locality and suggest their remedy.
6. Visit to different water bodies in your village/ locality and describe their uses and source of water pollution. If any
7. To segregate domestic solid waste into biodegradable and non-biodegradable components.

LABORATORY EXERCISES (ALL)

1. Study of water quality.
2. Soil texture and analysis of components.
3. To estimate dust (particulate) deposition on the leaves of road side plants.
4. To study the effect of light intensity on the growth of plants.

C. CREATIVE ACTIVITIES (ANY TWO)

1. Set up an aquarium.
2. To study the biodiversity birds and insects in your locality.
3. To prepare a list of plants and animals which are used as food for humans and to comment on their habit and habitat.

4. Make herbarium sheets of 10 different plants/trees. Consult your teacher how to make a herbarium sheet.
5. To describe: a) climate of an urban areas; b) yearly variation in suspended particulate matter in the same area.
6. To make an audit of the electrical energy consumption by various house hold appliances of your home.

PRACTICAL EXAMINATION

There will be a practical examination of 3 hours duration and maximum mark 20. The distribution of marks is as follows:

1. Field Studies:	05
2. Laboratory exercises:	03+02
3. Creative activity:	05
4. Practical record and Viva-voce:	03+02

SCHEME OF EVALUATION

The learners will be evaluated through Public Examination and through continuous and comprehensive evaluation in the form of Tutor Marked Assignments (TMAs).

Mode of evaluation	Duration	Marks	Paper
Public examination	3 hrs	80	1
Practical	3 hrs	20	1
TMA-I, TMA-II and	Self-paced	25	
TMA-III (Compulsory)	Self-paced	25	

The awards/grades of TMA will be reflected in the mark sheet separately. The award will not be considered for inclusion in overall grading in the Public Examination.