

MAHARSHI DAYANAND SARASWATI UNIVERSITY

AJMER



SYLLABUS

SCHEME OF EXAMINATION AND COURSES OF STUDY

FACULTY OF SCIENCE

M. Sc. ENVIRONMENTAL SCIENCE

M. Sc. I & II Semester w.e.f. 2013-2014

M. Sc. III & IV Semester w.e.f. 2014-2015

M.SC. ENVIRONMENTAL SCIENCE

SCHEME OF EXAMINATION AND COURSES OF STUDY

1. Candidates for admission to the Master of Science (Environmental Science) degree shall be required to have passed the B.Sc. Degree (pass/honours) with at least one subject of Biological Science.
2. Admission will be given on the basis of Merit. The Merit will be drawn on aggregate marks received in the qualifying examination by the candidate.
3. The duration of the course is for two academic years (four semesters). The course work of the M.Sc. degree in Environmental Science shall be in accordance with the scheme of examinations and syllabus prescribed.
5. The minimum attendance required by a candidate will be as per university rules.
6. A candidate for a pass at each of the part I and part II Examinations shall be required to obtain:
 - a) at least 36% marks in the aggregate of the papers prescribed for the examination and
 - b) at least 36% marks in the practical (s)
7. Wherever prescribed at the examination, provided that a candidate fails to secure at least 25% marks in each individual theory paper at the examination he/she shall be deemed to have failed at the examination notwithstanding having obtained the minimum percentage of marks required in the aggregate for the examination.
8. No division will be awarded for the first three semester examination. Division shall be awarded at the end of the fourth semester examination and combined marks obtained after four semester examinations taken together as noted below:

First Division - 60% of aggregate of above marks taken together

Second Division- 48% of aggregate of above marks taken together

All the rest will be declared to have passed the examination.
9. There will be 4 theory papers in each semester of 50 marks each, out of which 40 marks allotted for theory examination and 10 marks allotted for internal assessment. There will be a practical examination of 100 marks in each Semester.
10. An educational tour may be organized both for M.Sc. Sem. I &II and M.Sc. Sem. III &IV to important places of environmental interest within or outside the State under the supervision of faculty member/s of the department. The expenses will be borne by the participating student. However, the university will provide train/bus travel concessions as per necessity and university rules. Travelling expenses of the teacher/s will be borne by the university as per rules of TA and DA.

SCHEME OF EXAMINATION

M.Sc. I Semester

Paper	Nomenclature		Max Marks (Theory): 200	
			Theory	Internal
ES	101	Concepts of Ecology and Environmental Factors	40	10
ES	102	Energy and Natural Resources	40	10
ES	103	Environmental Management and Legislation	40	10
ES	104	Environmental Pollution and Control -I	40	10
PRACTICAL				100
		Experimental work	75	
		Practical record & scientific material preparation	10	
		Viva Voce (Based on Experiments.)	15	
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M.Sc. II Semester

Paper			Nomenclature	Max Marks (Theory): 200	
				Theory	Internal
ES	201	Ecosystem Science		40	10
ES	202	Environmental Pollution and Control -II		40	10
ES	203	Biodiversity, Wildlife and Environmental Ethics		40	10
ES	204	Occupational Health and Eco toxicology		40	10
PRACTICAL				100	
Experimental work				75	
Practical record & scientific material preparation				10	
Viva Voice (Based on Experiments.)				15	
				Total	300

M.Sc. - III Semester

Paper		Nomenclature	Max Marks (Theory): 200	
			Theory	Internal
ES	301	Environmental Biotechnology and Eco-modeling	40	10
ES	302	Environmental Geo-Science	40	10
Group A				
ES	303	Environment Impact Assessment -I	40	10
ES	304	EIA in Practice - I	40	10

Group B

ES	303	Environment Disaster Management	40	10
ES	304	Natural Disaster Management	40	10
		PRACTICAL	100	
		Experimental work	75	
		Practical record & scientific material preparation	10	
		Viva Voice (Based on Experiments.)	15	
		Total		300

M.Sc. IV Semester

Paper	Nomenclature	Max Marks (Theory): 200	
		Theory	Internal

ES	401	Environmental Microbiology & Waste Treatment	40	10
ES	402	Environmental Geochemistry	40	10

Group A

ES	403	Environment Impact Assessment-II	40	10
ES	404	EIA in Practice - II	40	10

Group B

ES	403	Geological Disaster	40	10
ES	404	Geology and Mining Disaster Prediction	40	10
		PRACTICAL	100	
		Experimental work	75	
		Practical record & scientific material preparation	10	
		Viva Voice (Based on Experiments.)	15	

Total 300

1. In M.Sc. Semester III and IV students have to opt for one group A or B .Minimum five students should opt a particular group to run that specialization.

2. The practical Examinations would be conducted by the board of Examiners consisting of one Internal and one External Examiner; there will be no separate practical Examination for compulsory papers.

SEMESTER I

PAPER: ES 101 CONCEPT OF ECOLOGY & ENVIRONMENTAL FACTORS

Duration: 3 hrs

Max. Marks 40

Note: the question paper will be divided into three parts- A, B & C

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All questions carry equal marks. Each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks. Each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks. Each question is of 8 Marks.

Unit: I

Environmental factors: Atmosphere, Hydrosphere, Lithosphere and biosphere and their interrelationships. Holistic concept, Environmental complex, Tolerances, ecological amplitude, limiting and inhibiting effects. Climatic (light and temperature) factors. Edaphic factors - soil - physical, chemical and biological characteristics. Biotic factor, relationship between organisms - competition, symbiosis, parasitism, prey predator, neutralism, commensalism, mutualism, proto cooperation, antibiosis, allelopathic interactions.

Unit: II

Population characteristics - density, natality, age distribution, biotic potential, growth rate. Adaptations - genecological differentiation, species analysis and evolutionary entities, ecads and ecotypes. Types of ecotypes.

Unit: III

Genetic model for range extensions. Population change - k and r selections. Concept of community, methods of study of plant communities. Characters of communities - Analytical (quantitative and qualitative) and synthetic characters. Raunkiaer's life forms and biological spectrum diversity indices.

PAPER: ES 102 ENERGY & NATURAL RESOURCES

Duration: 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks. Each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks. Each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks. Each question is of 8 Marks.

Unit: I

Renewable and Non-renewable energy sources. Fossil fuels-classification, composition, physico-chemical characteristics and energy content of coal, crude oil, natural gas, hydroelectric power. Forest resources of India, Causes of forest degradation, Forest conservation measures-social forestry (farm forestry, agroforestry), Ethnobotanical aspects of forest flora with special reference to Rajasthan.

Unit: II

Nuclear Energy-fission and fusion, Radioactive waste management, Energy conservation, Alternative energy sources-Geothermal energy and environment. Sun as a source of energy-spectral characteristic solar collectors, photovoltaic, tidal and wind energy. Magneto-hydrodynamic power. Biomass production, Energy plantations, Energy and microbes-cellulosic raw material, methane production through anaerobic fermentation, sugar crop producing system, microbial ethanol and laboratory type, Biogas from waste, Hydrogen gas. Alternative biofuels-biodiesel, alcohol, biogas. Microbial fuel cell.

Unit: III

Land classification and use, causes of soil degradation, soil erosion, soil conservation methods, formation and reclamation of Usar and Saline soil. Agriculture land and agro ecology-impact of canal irrigation on characteristics of land and soil, soil fertility problems, salinity problems with special reference to Rajasthan. Biofertilizers. Wasteland and their reclamation.

PAPER: ES 103

ENVIRONMENTAL MANAGEMENT AND LEGISLATION

Time 3 hrs

Max Marks - 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit: I

Overview of the ISO 14000 family. Key aspects of the International Standard ISO 14001. Environmental Management Systems: Benefits , Principles and elements of successful environmental Management. Auditing of EMS . Occupational Health and Safety Management System (OHSMS), OHSAS 18001. , Environmental Labeling, Life Cycle Assessment, Ecological Foot printing, Ecotourism- its components and principles. Present Status of Ecotourism in Rajasthan and Future prospects. Environmental education. Clean Development Mechanism- Process, Validation & Case Studies.

Unit: II

Environmental Impact Assessment (EIA): Definition, benefits & general structure of the EIA, Procedure of EIA. Overview of the variety of impact identification methodologies and their strengths and weaknesses as tools for identifying different impacts and their sources/causes.

Definition, function, Benefits & Cost of Environmental Auditing, Auditing Stages, The report structure, setting up environmental audits & Requirements Concerning Environmental Auditing.

Unit: III

Forest (Conservation Act), 1980, Air(Prevention and Control of Pollution)Act - 1981, Water (Prevention and Control of Pollution) Act - 1974, Wildlife Protection Act 1972, , Environmental (Protection) Act - 1986, Bio- Medical Waste (Management and Handling rules - 1998, Hazardous Waste Management and Handling rules - 1989, Plastic Waste (Management and Handling) Rules 2011. Provision in the Constitution of India regarding Environment (Article 48A and 51G).

PAPER: ES 104 ENVIRONMENTAL POLLUTION & CONTROL- I

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight question are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit: I

History and episodes of air pollution. Sources of pollution, nature, effects and classification of air pollutants, Meteorological measurements, plume behaviour and wind rose. Fly ash utilization, Vehicular air pollution. Photochemical reactions in the atmosphere, measurement and control (SO_x, NO_x, SPM) of air pollution.

Unit: II

Global consequences of air pollution (acid rain, global warming and ozone depletion), Air quality standards. Air sampling techniques. Biochemical Aspects of Arsenic, Cadmium, Lead, Mercury, Carbon Monoxide, O₃ and PAN Pesticides, Insecticide, MIC, Carcinogens in the air.

Unit: III

Types, sources and consequence of water pollution, types of water pollutants, physico-chemical and bacteriological sampling and analysis of water quality. sewage and waste water treatments and recycling, water purification and carrying/assimilation capacities, indices of pollution, water quality standards.

SEMESTER I
Practical Exercises for M.Sc. Environmental Science

Max Marks 100

Parameters to be studied :

Climate

1. Wind Monitor- Temperature, Relative Humidity, Wind Direction and Wind Speed.
2. Paterson week indices for climatic study.

Water Analysis

1. Dissolved Oxygen by Azide modification and Oximeter.
2. pH
3. Chloride by titration.
4. TDS using Conductivity meter
5. Total residual Chlorine
6. Conductivity using Conductivity meter.

Soil Analysis

1. pH of Soil using pH Meter
2. Soil composition/ Soil Texture.
3. Soil moisture, WHC, wilting coefficient, hygroscopic coefficient, colloidal matter of soil samples
4. Percentage Organic Carbon of Soil

Ecology

1. Floristic survey of area and ecological adaptations
2. Least size of quadrat for community study.
3. Determine frequency, density and abundance of various plant species in a community
4. Study of population age structure and growth.

Ecophysiological

1. Determination of water relation indices of plant- moisture content, water saturation deficit and relative water content.

SEMESTER -II

PAPER: ES 201 ECOSYSTEM SCIENCE

Duration: 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit: I

Concept of ecosystem, ecosystem as a dissipative structure, food chain and food webs, grazing and detritus food chains, ecological pyramids-number, biomass, energy. Ecological Energetics and cybernetics : principles of thermodynamics. Energy flow, Lindemann's and Odum's energy flow models, energy. Concept of productivity, solar energy and production, estimates of primary production, relation, between GPP and NPP, Energy budget, efficiency of energy.

Unit: II

Biogeochemical cycles, pools and flexes, basic types of cycles, hydrological, carbon, oxygen, nitrogen, phosphorus and sulphur, Nutrient cycling in forests ecosystem and in nutrient-poor soils. Integrated principles of ecosystem structure and function. Homeostasis self organization : Biodemographic regulation, Mcarthur's hypothesis, stability index; Biogeochemical regulation. Ecosystem and development. Succession-Models of ecosystem development-microcosm and Tubular. Macro versus Microevolution.

Unit: III

Ecosystem type - Aquatic (fresh water, marine) and terrestrial (grassland, forest) ecosystem. Desert ecosystem with reference to flora and fauna of Rajasthan desert. Modified ecosystem with reference to the Impact of canal irrigation. Aravalli ecosystem characteristics-community and biological spectrum of aravallis. Waterbodies and their management strategies. The role of ecotones (transition zone) in the conservation and management of tropical inland waters.

PAPER: ES 202 ENVIRONMENTAL POLLUTION & CONTROL- II

Duration: 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit: I

Chemical nature and composition of soil and rocks, sources of soil pollution, chemical and metallic soil pollutants, soil pollution control. Physico-chemical and bacteriological sampling and analysis of soil quality. Degradation of different insecticides, fungicide, and weedicides in soil. Different kinds of synthetic fertilizers (N, P and K) and their interaction with different components of soil.

Unit: II

Basic concept and definition, sources of noise pollution, RMS sound pressure, intensity level, power levels and sound pressure levels, decibels, measurements of noise-sound level meters, noise exposure levels and standards. Impacts of noise on human health, control of noise. Comprehensive Environmental Pollution Index (CEPI)

Unit: III

Radioactive pollution - sources, types, effects of radiation, major episodes of radioactive pollution, management and disposal of radioactive wastes. Measurement of radioactive pollution and control of radioactive pollution. Thermal pollution- Sources, types, effects of thermal pollution,

PAPER: ES 203 Biodiversity, Wildlife and Environmental Ethics

Duration: 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight question are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit: I

Definition and importance of Biodiversity conservation and Agenda 21, Causes of biodiversity reduction and strategies for biodiversity conservation. Critical issues related to biodiversity conservation. Hotspots of Biodiversity. National Biodiversity Authority and its role in Biodiversity Conservation. Biodiversity Heritage Sites. Biological Diversity Act in 2002 UN role in Biodiversity conservation: conventions and policies.

Unit: II

Endangered and Threatened Species (Flora and fauna) of India and Rajasthan, Endemic species, Wild life-causes of depletion, Biosphere reserve, National parks and Sanctuaries in India. Gene pool. National Board of Wildlife (NBWL). CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora).

Unit: III

Definition and scope of Environmental Ethics. Environmental Values, Value education. Deep Ecology, Environmental Thinkers. Contribution from Religious books and authors. Role and need of Environmental Ethics in present scenario. Movements related to Environment. Conservation efforts by communities.

PAPER: ES 204 OCCUPATIONAL HEALTH AND ECOTOXICOLOGY

Duration: 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit: I

Definition of Occupational Health, Health of a worker and interactions in a working environment, Occupational Hazards, Occupational diseases, Pneumoconiosis: Silicosis, Anthracosis, Byssinosis, Bagassosis, Asbestosis, Farmers's Lung. Lead poisoning, Occupational Cancer, Occupational Dermatitis, Radiation Hazards.

Unit: II

Occupational Hazards of agriculture workers, Accidents in Industry, Health problems due to Industrialization, Measures for Health protection of workers, Prevention of Occupational diseases. Role of World Health Organisation (WHO) in Occupational Health., WHO Declaration on occupational health for all (1994), Stresa Declaration on Workers Health (2006) , Global Occupational Health Network (GOHNET), Occupational Health in India.

Unit: III

History and scope of toxicology. Principles of ecotoxicology. Role of Environmental Chemistry in Ecotoxicology. Spectrum of Toxic dose: Approximate acute LD50 of some representative chemical agents. The use of biomarkers in assessing the impact of environmental contaminants. Aquatic toxicology: Requirements for ecotoxicological measures in the aquatic Environment. Terrestrial Toxicology: Acute and Chronic. Toxicity testing, field testing, Enclosure studies. Trophic level transfer of contaminants. Role of modelling and GIS in ecotoxicology. Ecological risk assessment.

SEMESTER II

Practical Exercises for M.Sc. Environmental Science

Max Marks 100

Parameters to be studied :

Climate

1. Calculation of water balance indices: heat index potential, evapotranspiration, ecoclimate formula
2. Relative humidity, precipitation, temperature (ombrothermic representative)

Water Analysis

1. Chemical Oxygen Demand (COD)
2. Biochemical Oxygen Demand (BOD)
3. Total Hardness
4. Phosphate by Spectrophotometer
5. Carbonate and Bicarbonate Alkalinity by Titrimetry

Soil Analysis

1. Salinity of Soil using WTW instrument
2. Sodium , potassium by flame photometer
3. Calcium, Magnesium by titrimetric method

Air Quality

1. Respirable dust using High Volume Sampler, Fine Particulate Sampler APM 550
2. Working knowledge of Cyclone collectors, fabric or bag filters, Electrostatic precipitators, Scrubbers.
3. Determination of noise levels using noise level meter and comparing with ambient standards

Ecology

1. Study of diversity indices of plant/organisms
2. Determination of IVI of various plant species.
3. Frequency classes in a community compared with Raunkiers normal values

Eco-physiological

1. Productivity by harvest and chlorophyll method of terrestrial community
2. Energy content of given biomass by Bombs calorimeter

Taxonomy

1. Representative Flora of Rajasthan
2. Representative Fauna of Rajasthan

SEMESTER -III

PAPER: ES 301 ENVIRONMENTAL BIOTECHNOLOGY AND ECO-MODELLING

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit: I

A brief idea of genetic engineering - Restriction endonucleases, properties of restriction engineering, plasmids, isolation of plasmid. DNA. Cloning of DNA fragments. Clong of single stranded DNA, Shuttle Vectors and their environmental applications, Recombinant DNA Technology and Development of Genetically Engineered Microorganisms (GEMs), Polymerse Chain Reaction (PCR) and development of Gene Probes for environmental remediation, Use of GEMs in bioremediation. Release of GEMs in Environment.

UNIT II

Emerging technologies for environmental bioremediation - Microelectromechanical systems (MEMs) Genosensor technology, Gene Probes - nah operon. Integrated Treatment System with special reference to biodegradation of Polychlorinated biphenyls (PCBs), PCB treatment process and Design. Enzymes contributing to sustainable industrial development - Starch processing, detergents. Textile, leather, pulp and paper manufacturing, baking. Biochemical measures of stress and Mixed Function Oxidise enzyme (MFOs), protein induction and SFG. Fermentation technology.

UNIT III

Complexity of systems. Objectives of system ecology, analysis of system processes and conditions, Model for steady state conditions, Lotka voltara, leslics matrix model, box model, microcosm model, Gaussian plume model, models for population growth and interactions.

PAPER: ES 302 GEO SCIENCE

Duration: 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidate have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

UNIT 1

Environmental Geoscience; fundamental concept. The earth system and biosphere conversion of matter in various geospheres-lithosphere, hydrosphere, atmosphere and biosphere. Earth processes: cycle in the earth system, Concept of residence, time and rates of Natural cycles.

Unit II

Water as a natural source, Types of water. Hydrological cycle. Water balance, porosity, permeability, runoff processes. Global water balance. Ground water pollution. Ice sheets and fluctuations in sea levels. Geochemical cycles. Biogeochemical factors in environmental health. Human use, trace elements and health. Possible effect of imbalance of some trace elements. Diseases induced by human use of land. Land use planning. Soil survey in relation to landuse planning.

UNIT III

Mineral resources-distribution major steps of extraction of common metals and their recycling. Concept of major, trace and Rare Earth Elements (REE). Environmental impact of exploitation of minerals and mining activities with reference to Rajasthan. Minerals and population. Ocean as new areas for exploitation of mineral resources.

(GROUP A)

PAPER: ES 303 ENVIRONMENTAL IMPACT ASSESSMENT -I

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit- I

Introduction & Overview of EIA: - The concept of EIA, History & evolution of EIA, Purpose Principle and Process of EIA, Generalized EIA Process Flowchart. Cost and Benefits of Using EIA Process.

Public Involvement:- Objectives and purpose of public involvement, levels & forms of public involvement, Role and contribution of public involvement in EIA, Public involvement in Key stages of EIA process. Factors affecting the effectiveness of Public Involvement. Benefits of Effective Participation.

Unit- II

Screening:- Purpose and outcome of screening, Methods used in screening proposals,

Scoping:- Role and Purpose of Scoping in EIA, Guiding principle and objectives of scoping, Steps involved in scoping, outline of Terms of References, Identification and consideration of alternatives. Impact Identification Methods: - Checklists, Matrices, Networks, Overlays and Geographic information system (GIS), Professional Experience. Advantages and Disadvantages of Impact Identification Methods.

Unit- III

Impact Analysis & Prediction: - Importance of impacts in prediction and decision making, Methods of Impact Prediction, types of Uncertainty in Impact Prediction. Evaluation of Impact Significance: - Importance of determining impact significance, Principles, Impact Significance criteria. Mitigation: - objectives & principles, elements of mitigation, proponents responsibility for implementing mitigation. A framework for Impact Management, Objectives of Impact Management & components of EMP.

(GROUP A)

PAPER: ES 304 EIA IN PRACTICE- I

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit: I

Status of EIA in India, Capacity Building, Quality and Quality Control in EIA, The Convention of Environmental Impact Assessment in a Trans-boundary Context. Law policy and Institutional Arrangements for EIA systems. EIA notification 2006. EIA legislation of USA, New Zealand, Canada, Australia and European Union.

Unit: II

Prediction and Assessment of Impact on: the Air Environment, Surface-Water Environment, Soil and Groundwater Environments, Noise Environment, Biological Environment, Cultural (Architectural, Historical, and Archaeological) Environment. Prediction and Assessment of Visual Impacts. Prediction and Assessment of Impacts on the Socio-economic Environment, Health Impact assessment.

Unit III

Strategic Environmental Assessment:- Concept of SEA, Comparison between EIA & SEA, Aims & Objectives of SEA, Institutional benefits from the use of SEA, Guiding principles, Scope of application of SEA to different level of decision making. Generic forms of SEA.

Cumulative Impact Assessment- Definition, its need and methodology.

(GROUP- B)

PAPER: ES 303 ENVIRONMENTAL DISASTER MANAGEMENT

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight question are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

UNIT I

Fundamentals of Disasters, Causal Factors of Disasters, and Phases of Disaster: Rapid Onset Disasters, Slow Onset Disasters Nature of Responses to Geo- hazards, Trends in Seismic Activity, UN Draft Resolution on Strengthening of Coordination of Humanitarian Emergency Assistance.

UNIT II

Flood Management Model, Integrated Flood Management Information System (IPMIS). Flood Control in India. Tropical Cyclone, Water Related Hazards, Tsunamis: Physical Characteristics, Causes, Mitigation of Risk and Hazards.

UNIT III

Changes in the Coastal Zone, Coastal Erosion and Beach Protection, Wave Erosion, Erosion due to near shore Currents, Coastal Erosion Caused by Natural Features, and Coastal Erosion Caused by Man-Made Structures.

PAPER: ES 304 NATURAL DISASTER MANAGEMENT

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit I

The UN International Decade for Natural Disaster Reduction (IDNDR) , Policy for the Reduction of Disaster Consequences, Problems of Financing and Insurance, Role of the civil defence during disasters, Training of emergency measures

UNIT II

Causes of Floods, River systems, River Flooding, Hazard associated with Flooding, Flood Forecasting, Methods of Flood Forecasting, Disaster Management and Mitigation Measures, Cyclonic Storms in Bay of Bengal, Tropical Cyclone Warning Strategy in India.

UNIT III

Oil Spills: Sources and Nature of Oil, Behaviour of Oils Spills, Countermeasures, Effects, Measures to Prevent Accidental Spills, Accidental Discharges.

**Practical Exercises for M.Sc. Environmental Science
SEMESTER III**

Air Quality Monitoring Techniques for defined Parameters :

1. Sulphur dioxide by Colorimetric method.
2. Respirable Suspended Particulate Matter (RSPM) by Respirable suspended particulate matter sampler (RDS APM 460).
3. Formaldehyde (HCHO) by Colorimetric method.
4. Dust retaining capacity of plants.

Water Quality Monitoring : Advanced Instrumental Analysis

1. Flame photometry
2. Total, organic and inorganic carbon.
3. UV-Visible Spectrophotometry.

Biological Monitoring

1. Fish
2. Macrophytes.
3. Phytoplankton & Zooplankton.

Solid Waste Analysis

1. Physical composition (by weight)
2. Calorific value by calculation
3. Moisture content
4. pH and Conductivity

Data handling and Management

1. Knowledge of Statistical software which processes numerical data and performs statistical tests and analysis
2. Different modes of graphical representation of data
3. Working knowledge of Internet
4. Model for steady-state conditions of hypothetical system.

Statistics

1. Calculation of standard deviation, correlation, regression
2. T-test, Chi-test, ANOVA,
3. Basic elements & tools of statistical analysis: Probability, sampling, measurement and distribution of attributes; Distribution- Normal, t and χ^2 , Arithmetic, Geometric and Harmonic means; tests of hypothesis and significance.
Study of different Ecological sampling methods: - Data collection methods, Species abundance measures, sampling pattern (in space and time) and sample size.

Ecomodeling

1. Compartment/Box model of forest ecosystem.
2. Determine steady state conditions (ecosystem analysis).
3. Determine transfer rates between various trophic level.

SEMESTER IV

PAPER : ES 401 ENVIRONMENTAL MICROBIOLOGY AND WASTE TREATMENT

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

UNIT I

Geomicrobiology: Biogeochemical cycles of Carbon, Nitrogen, Phosphorus, Sulfur Cycles. Geomicrobiology of Iron, Magnesium, Manganese and Calcium. Bioleaching and biomining. Fossil fuel microbiology-Petroleum prospecting, migration, MEOR. Petroleum degradation.

Soil Microbiology: Soil, its formation, physical and chemical characteristics. Microflora of various soils. Rhizosphere and phyllosphere. Biofertilizers versus fertilizers. Biological nitrogen fixation. Nitrogenase and its regulation. Symbiotic and non symbiotic nitrogen fixation. Mycorrhiza. PGPR. Process, structure, biochemistry and genetics of Rhizobium-legume, Frankia-nonlegume, and Anabaena-Azolla symbiosis.

UNIT II

Aquatic microbiology: Freshwater (Ponds, lakes, streams) and marine habitats (estuaries, mangroves, deeps sea, brackish water, hydrothermal vents, salt pans, coral reefs). Zonations of aquatic ecosystems. Upwelling. Potability of water. Microbial assessment of water quality. Water purification. Water borne diseases. Eutrophication. Algal/cyanobacterial blooms and toxic algae. Subterranean microbes. Ground water contamination.

Biofilms in natural and manmade environments. Biodeterioration: Paper, leather, wood and textile. Metal corrosion, Bioaccumulation of metals and detoxification, biosorption, scavenging. Biodegradation of Xenobiotics (Pesticides and dyes). Biological alternatives: biopesticides, biosurfactants, biocolours and biofuel. GMO and their impact.

UNIT III

Bioremediation and Bioaugmentation: Wastes, their types and characterization. Methods of treatment-Physical, chemical, biological-aerobic and anaerobic (Oxidation ponds, HRABP, ASP, Trickling Filter, Fluidized Bed Reactor, Biogas, Rotating contactor).

Solid waste treatment (Agricultural/urban): Saccharification, gasification, composting, vermicompost, mushroom compost, ensilage. Utilization of solid wastes- food (SCP, mushroom, yeast), fuel (ethanol, methane-biogas plant), manure (composting). Non biodegradable solid waste and its management.

Flue Gas Management: Treatment strategies and microbiological options. Fuel desulfurization.

PAPER: ES 402 ENVIRONMENTAL GEOCHEMISTRY

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight question are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

Unit: I

Geographical classification and zones of India, General relationship between landscape, biomes and climate. Energy budget of the earth. Climate of India. Indian Monsoon. El Niño ,La Niña. Drought, Tropical cyclones and Western disturbances.

Unit: II

Catastrophic geological hazards : Study of floods, landslides, earthquakes, volcanoes and avalanche. Prediction and perception of the hazards and adjustment to hazardous activities. Origin and composition of sea water. Resources of oceans. Ocean pollution by toxic wastes. Water crisis as current environmental issue, conservation of water. OTEC (Ocean Thermal Energy Conversion) and GTEC (Geo-thermal Energy Conversion).

Unit: III

Method of site-selection and evaluation. Application of GIS and remote sensing in Environmental Sciences. Environmental impact of exploitation of minerals and mining activities with reference to Rajasthan. Aravallis mining lands types of mine reclamation practices. Revegetation of mine spoils through plants fertilization and related practice.

(Group-A)

PAPER: ES 403

ENVIRONMENTAL IMPACT ASSESSMENT - II

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

UNIT I

Reporting: - Features & purpose of EIA Reports, Main elements of EIA Report, Shortcoming encountered in preparing EIA reports. Review of EIA Quality:- Role & purpose of the Review process, Aspects for consideration, EIA Review- Types of Procedures, Steps involved in EIA Review, EIA review criteria, EIA review methods, Four steps approaches for EIA review. Environmental Management plan (EMP) or Impact management Plan.

UNIT II

Decision Making: - concepts and its importance, responsibilities f decision makers in EIA process, Decision Making Process. Implementation & Follow up:- Need & purpose, Its components, Guiding Principles and elements, Aspects and Issues needs to be considered in EIA implementation & follow up.

UNIT III

EIA Project Management: - its concepts, Role of Project Manager, Characteristics & Attributes of an interdisciplinary of EIA team, Project Managers Responsibilities. Social Impact Assessment:- concept, role & purpose of SIA, Benefits of SIA, Steps & principles of SIA, Methods used for predicting Social Impacts.

(Group-A)

PAPER: ES 404

EIA IN PRACTICE- II

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six question are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

UNIT I

EIA for Mining Projects, EIA for Building Construction and townships, EIA for Highways, EIA for Nuclear Power, EIA for Thermal power. EIA for River valley and Hydropower , EIA of Cement Plant. Knowledge of Form -1 and related documents.

UNIT II

National Accreditation Board for Education and Training (NABET) Criteria for Registration of EIA Consultant Organizations including Need, Eligibility, Skills and Knowledge of Experts. EIA Coordinators, Functional Area Experts, Work Experience of Functional Area Experts and procedure of Registration. Case Studies: Tehri Hydro-Electric Project, Sardar Sarovar Dam, Almetti Dam, Indira Gandhi Canal Project and Bisalpur Dam.

UNIT III

EIA for Pulp and Paper, EIA for Oil refineries, EIA for man made fibre. EIA for common hazardous waste disposal, storage and treatment facilities. Knowledge of EIA related organizations including International Association of Impact Assessment (IAIA), Established EIA Centers of India and abroad. Important Consultants and NGOs working in the field of EIA

(GROUP- B)

PAPER: ES 403 GEOLOGICAL DISASTERS

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

Part B- This part is of 8 Marks. Four questions are to be set, at least one from each unit. All questions are compulsory. The answer for each question should not exceed fifty words. All questions carry equal marks, each question is of two marks.

Part C- This part is of 24 Marks. Six questions are to be set, that is two from each Unit. The candidates have to answer any three questions choosing at least one question from each Unit. The answer for each question should not exceed four hundred words. All questions carry equal marks, each question is of 8 Marks.

UNIT I

Causes, Characterization of Ground-Motion, Earthquakes Scales: Magnitude and Intensity, Earthquake Hazards and Risks, Description of Phenomenon, Volcanic Landforms, Eruption Early Warning from Satellites, Volcanic Hazards, Reducing Structural Vulnerability, Risk Mitigation and Training.

UNIT II

Types of Mass wasting process, Factors influencing the Slope Stability, Landslides, Rock falls, Avalanches, Mudflows and Glaciers, Landslide Information, Snow Avalanches, Event Modification Surface subsidence and Collapse, Removal of Solids and Mine-Related Collapse, Subsidence Caused by Fluid Withdrawal, Other Causes of Subsidence

UNIT III

Mining and Environment, Environmental Impacts of Mining in India, Disasters Due to Mine Subsidence Open-Cast Mining: Environmental Impacts, Land Degradation, Hydrology and Water Pollution, Air Pollution, Noise Pollution.

PAPER: ES 404
GEOLOGY AND MINING DISASTER PRIDITION

Time 3 hrs

Max Marks 40

Note: the question paper will be divided into three parts- ABC

Part A- This part is of 8 Marks. Eight questions are to be set, at least 2 from each unit, All questions are compulsory. The answer for each question should not exceed twenty words. All question carry equal marks, each question is of one mark.

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UNIT I

Perception and Prediction of Earthquake, Earthquake Disaster Mitigation Programme Components, and Disaster Mitigation Programme in India. Monitoring and Warning, Volcano Monitoring using Satellite Images, Detection and Monitoring of Eruption Plumes,

UNIT II

Vulnerability Modification. Types of Glacier Hazard. Landslide Hazard Potential Map (LHPM), Landslide Hazard Grading (LHG). Carbonate Dissolution, Karst Topography, Predicting and Mitigating Subsidence Hazards.

UNIT III

Land Degradation and Reclamation, , Calamities of Fire and Explosion in Coal Mines, Hazards of Fire in Mines, Disasters of Mine Fire and Its Diagnostics, Case Study of some Major Open Cast Mining Activity in Rajasthan.

SEMESTER IV
Practical Exercises for M.Sc. Environmental Science

Air Quality Monitoring Techniques for defined Parameters :

1. Nitrogen oxides by Colorimetric method
2. Polycyclic Aromatic Hydrocarbon (PAHs) by Gas chromatographic/ FID Detector
3. Air pollution tolerance index and related parameters

Water Quality Monitoring :

Physical and chemical Analysis for few parameters. (Those which can be done in the field.)/using microprocessor based instruments.

Principles of Advanced Instrumental Analysis

1. Gas chromatography
2. Ozone generator
3. Trtrimetry,
4. Gravimetry
5. Colourimetry
6. Spectrophotometry
7. Chromatography
8. Atomic Absorption Spectrophotometry
9. HPLC
10. Electrophoresis
11. X-ray fluorescence
12. X- ray Diffraction
13. Flame Photometry

Microbiological Analysis

1. IMViC tests
2. Heterotrophic plate Count
3. Multiple fermentation tube technique - MPN index for polluted and unpolluted waters.
4. Study of soil microorganisms.
5. Presence Absence Test

Biological Monitoring

1. Benthic Macroinvertebrates
2. Periphyton
3. Diversity indices – Shanon Index
4. Measurement of Pigments

Solid Waste Analysis

1. Total Organic Carbon
2. Nitrogen, Phosphorus and Potassium (NPK)
3. Carbon – Nitrogen ratio (C:N ratio)

Data handling and Management

1. Knowledge of EIA related software
2. Computer aided assessment for Environmental Impact study.
3. Study of Data collection methods including, plot sampling (using quadrates), Plot less sampling (using transects)

Case Study:

1. Study of a given Case and to determine the key facts and issues. List the impacts for each of the three phases of the project: construction, operations and expansion. Then prepare an Activity/Impact Matrix.

Practicals

Books recommended for M.Sc. Previous:

- APHA , Standard Methods for the Examination of Water and Wastewater, 18th edition, American Public Health Association (APHA). 1992
- Water Quality Monitoring/edited by Jamie Bartram and Richard Balance a book published by E & FN SPON Press London on behalf of UNEP and WHO. 1996
- Guidelines for drinking- water Quality Vol1-3. WHO 1985
- Essential Environmental Science- Methods and Techniques/ edited by Simon Watts and Lyndsay Halliwell , Routledge Press, London.1996
- Environmental Management Training/edited by R.G.A.Boland Sterling Publishers (P) Ltd., New Delhi.1993
- Practical Methods in Ecology and Environment – R.K. Trivedi and P.K.Goel, EnviroMedia publications, Karad.
- Handbook of Methods in Environmental Studies Vol – I Water and Waste Water Analysis S.K. Maiti A.B.D. Publications Jaipur.

Books recommended for M.Sc. Final

- Methods of Environmental Impact Assessment /edited by Peter Morris and Riki Therivel - 2nd edition Spon Press, London. 2001.
- APHA , Standard Methods for the Examination of Water and Wastewater, 18th edition, American Public Health Association (APHA). 1992
- Water Quality Monitoring/edited by Jamie Bartram and Richard Balance a book published by E & FN SPON Press London on behalf of UNEP and WHO. 1996
- Guidelines for drinking- water Quality Vol.3. WHO 1985
- Essential Environmental Science- Methods and Techniques/ edited by Simon Watts and Lyndsay Halliwell , Routledge Press, London.1996
- Environmental Management Training/edited by R.G.A.Boland Sterling Publishers (P) Ltd., New Delhi.1993
- Bureau of Indian Standards IS: 9235-1979 Method for Physical analysis and determination of moisture in solid wastes (excluding industrial solid wastes)
- Bureau of Indian Standards IS: 9234-1979. Method for preparation of solid waste sample for chemical and microbiological analysis
- Bureau of Indian Standards IS:10158-1982 Methods of analysis of solid wastes (excluding industrial solid wastes)
- Bureau of Indian Standards IS:1350 (Part II) – 1970. Calorific value

Theory:

Text Books for Final

1. Alexander M 1971. Microbial Ecology. John Wiley & Sons Inc., New York.
2. Alexander M. 1977. Introduction to Soil Microbiology. John Wiley & Sons New York.
3. Eldowney Ec S., Hardman DJ. and Waite S 1993. Pollution: Ecology and biotreatment. Longman Scientific Technical.
4. Baker KH and Herson DS 1994. Bioremediation. Mc Graw Hill Inc., New York.

5. Erneasst WC 1982. The environment of the deep sea. Vol.II J.G. Morin Rubey.
6. Marshall KC 1985. Advances in Microbial Ecology. Vol.8 Plenum Press.
7. Burns RG and Slater JH 1982. Experimental Microbial Ecology. Blackwell Scientific Pub, Oxford.
8. Norris JR and Pettipher GL 1987. Essays in agricultural and food microbiology. John Wiley & Sons, Singapore.
9. Burges A and Raw F 1967. Soil Biology. Academic Press, London.
10. Vanghan D and Malcolm RE. 1985. Soil Organic Matter and Biological Activity. Martinus Nighoff W. Junk Pub.
11. Buckman H. and Brady N.C. The nature and properties of soil. Eurasis Pub. House (P.) Ltd. New Delhi.
12. Brock TD and Madigan. Biology of Microorganisms. Prentice Hall Int. Inc.
13. Michel R. 1999. Introduction to environmental microbiology.
14. Ehrlich. Geomicrobiology.