

**SCHEME OF EXAMINATION
AND
COURSE OF STUDY
CHOICE BASED CREDIT SYSTEM**

**M.Sc. Environmental Science
(w. e. f. 2022)**



**SRI DEV SUMAN UTTARAKHAND UNIVERSITY
&
DEPARTMENT OF ZOOLOGY & ENVIRONMENTAL SCIENCES
SWAMI VIVEKANANDA COLLEGE OF EDUCATION, MATLABPUR, ROORKEE
HARIDWAR – 247667**

Curriculum Design Committee, Uttarakhand

S. No.	Name & Designation
1.	Prof. N.K. Joshi Vice-Chancellor, Sridev Suman Uttarakhand University, New Tehri Chairman
2.	Vice-Chancellor, Kumaun University, Nainital Member
3.	Prof. Jagat Singh Bisht Vice-Chancellor, Soban Singh Jeena University Almora Member
4.	Prof. Surekha Dangwal Vice-Chancellor, Doon University, Dehradun Member
5.	Prof. O. P. S. Negi Vice-Chancellor, Uttarakhand Open University, Haldwani Member
6.	Prof. M.S.M. Rawat Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand Member
7.	Prof. K. D. Purohit Advisor, Rashtriya Uchchatar Shiksha Abhiyan, Uttarakhand Member

M. Sc. Environmental Science
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HARIDWAR – 247667

Semester – I (There will be three core courses, two labs and one compulsory foundation course)

Total Credits=24

Course Code	C/E/F	Course Title	Credits		Examination system		Total Marks
			Theory	Practical	ESE	S	
MEN -101	F	Fundamentals of Environmental Science	4		70	30	100
MEN- 102	C	Natural Resource Conservation and Management	4		70	30	100
MEN -103	C	Wildlife Management	4		70	30	100
MEN-104	C	Environmental Pollution	4		70	30	100
MEN- 151	C	Practical I		4	70	30	100
MEN -152	C	Practical II		4	70	30	100

Semester – II (There will be three core courses, two labs and one elective course) Total Credits= 24

Course Code	C/E/F	Course Title	Credits		Examination system		Total Marks
			Theory	Practical	ESE	S	
MEN -201	C	Environmental Monitoring and Instrumentation	4		70	30	100
MEN- 202	C	Environmental Microbiology and Toxicology	4		70	30	100
MEN- 203	C	Environmental Chemistry	4		70	30	100
MEN -251	C	Practical III		4	70	30	100
MEN -252	C	Practical IV		4	70	30	100
ELECTIVE PAPERS:							
MEN- 204	E	Solid Waste and waste water management	4		70	30	100
MEN -205	E	Air pollution management	4		70	30	100

Note: A minimum of six students will be required to run any elective course.

Semester – III (There will be three core courses, two labs and one elective course) Total Credits= 24

Course Code	C/E/F	Course Title	Credits		Examination system		Total Marks
			Theory	Practical	ESE	S	
MEN- 301	C	Environmental Impact Assessment and Disaster management	4		70	30	100
MEN- 302	C	Remote Sensing and GIS in Environmental Management	4		70	30	100
MEN- 303	C	Environmental Biotechnology	4		70	30	100
MEN- 351	C	Practical V		4	70	30	100
MEN- 352	C	Practical VI		4	70	30	100
ELECTIVE PAPERS							100
MEN- 304	E	Sustainable development, eco – tourism, and Env. Economics	4		70	30	100
MEN - 305	E	Himalayan geology and Ecology	4		70	30	100

Note: A minimum of six students will be required to run any elective course.

Semester – IV (There will be two core courses, one dissertation equivalent to one core course and lab course, one foundation course and one lab). Total Credits=24

Course Code	C/E/F	Course Title	Credits		Examination System		Total Marks
			Theory	Practical	ESE	S	
MEN- 401	C	Faunistic Taxonomy and biodiversity	4		70	30	100
MEN- 402	C	Ecological modeling, statistics and research methods	4		70	30	100
MEN - 403	F	Environmental Policies and laws	4		70	30	100
MEN- 451	C	Practical VII		4	70	30	100
MEN- 404	C	Dissertation	8		200		200

Note: A minimum of six students will be required to run any elective course.

SEMESTER-I

MEN-C 101 : Fundamentals of Environmental Science M.M.: 70

UNIT – I

Introduction of ecology (Definition, brief history, scope and branches of ecology). Definition of Environment and Environmental factors: Abiotic factors: medium, substratum, soil, water, humidity, climate and microclimate, light, temperature, current and pressure, atmospheric gases (O₂, CO₂ and N₂), pH and flow of nutrients through biogeochemical cycles (C, N, O, P, S), their role and importance.

UNIT – II

Ecosystem: Definition, structural components of ecosystem. Biotic components of ecosystem: autotrophs and heterotrophs *i.e.*, producers, consumers, decomposers and transformers. Energy flow in an ecosystem, Ecological pyramids of numbers, biomass and energy, concept of primary productivity and secondary productivity. Habitats and Ecosystem Classification, Ecosystem mapping, ecotone, ecotype and edge effect.

UNIT – III

Structure and composition of atmosphere, hydrosphere, lithosphere and biosphere. biomes of earth, study of different ecosystems, characteristics and components of forest ecosystem, grassland ecosystem, desert ecosystem and aquatic ecosystem including wetlands: (classification, origin and their significance).

UNIT – IV

Population ecology: definition, characteristics of population, dynamics & regulation, community ecology concept, community characteristics and, dynamics & interactions (Parasitism, prey-predator relationship, competition, mutualism, symbiosis & commensalism), development of community (ecological succession), ecological adaptations.

UNIT – V

Environmental perception in Vedic literature (air, fire, earth, water and sun in Vedas), Environmental ethics and global imperatives. Mass and energy transfer across various interfaces, Energy budget, Ecological energetics material balance, Law of Thermodynamics, heat transfer processes, and zoo-geographical classification.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Definition and types of natural resources, Renewable and non-renewable resources concept of conservation: Objectives and aims of conservation, Policies and strategies of conservation. Conservation of soil: types of soil, soil components, Land use pattern and planning, reasons of soil degradation, soil erosion and its control measures.

UNIT – II

Principal forest types in India, causes of forest degradation (forest fires, forest land degradation, Illicit felling, grazing, shifting cultivation etc.), Forest conservation measures– Social forestry (Farm forestry, village forestry, agro forestry, extension forestry), role of forestry in eco-development of rural areas, ethno-botanical studies in India.

UNIT – III

Biological Diversity: Definition, Species diversity, genetic diversity and ecosystem diversity. Types: α , β , γ diversity. Key stone species. Biodiversity hot spots. IUCN categories– Red data book. Biodiversity Conservation Plans in India, Hotspots of Biodiversity, Reasons for its depletion, Scope of Biodiversity.

UNIT – IV

Energy Resources: Sun as a source of energy, nature of its radiation. Fossil fuels: coal, petroleum/ oil and natural gas. Mineral resources. Environmental impacts of exploiting, processing and smelting of minerals. Hydroelectric power, tidal, wind, biomass, geothermal energy, solar and nuclear energy (atomic).

UNIT – V

Conservation of aquatic system: Global water balance, ice-sheets and fluctuations of sea levels, origin and composition of sea-water. water resources of India. Need and strategies of conservation of aquatic resources (Lentic and lotic), conservation of aquatic life. Watershed management, and factors influencing the surface water and runoff process. Rain water harvesting. and water foot prints.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Definition of wildlife, concept of wildlife: Role of wildlife in nature, preservation of breeding stock, artificial stocking, habitat improvement, gene farming, Values of Wildlife, Field observations: Study of signs and symptoms– foot prints, locomotory patterns in tetrapods. Human-wildlife conflict: reasons and remedial measures.

UNIT – II

Types of movement: Tiger pug marks, foot prints of other animals, feeding sign, animal dropping, wildlife census methods (waterhole survey, point count and line transect methods, pug marks count method, King's census method), components of wildlife habitat (cover, food, water and space), common flora and fauna of India specially Himalayan region.

UNIT – III

Sociobiology of wild animals– Territorial behaviour, migratory behavior. Breeding behaviour, animal grouping. Animal communication: Visual, acoustic and olfactory and their socio-biological importance, animal learning and memory.

UNIT – IV

Indian wildlife (Introduction, distribution of wildlife in ecological subdivision of India), IUCN categories, Protected area networks: National parks, Wildlife Sanctuaries, Biosphere reserves and Zoos in India, gene pool. habit, habitat and breeding biology of few mammals (*viz.* Elephant, Tiger) and birds (*viz.* Weaver bird, Oriental Magpie Robin).

UNIT – V

Reasons for wildlife depletion (Habitat fragmentation, Habitat destruction, commercial wildlife exploitation, overgrazing, impacts of developmental projects etc.), measurement for wildlife conservation (Policies and programmes), special projects for endangered species (Project tiger, Gir lion Sanctuary Project, Crocodile breeding project, Hangul project), man and wild life conflicts. International trade of wildlife, animal cruelty: causes and prevention, Wildlife-tourism management.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Air pollution– Sources of air pollutants (Natural sources and manmade sources), types of air pollutants (Primary pollutants– aerosols, gaseous, particulates, metallics, pesticides, radioactive, carcinogens, biological contaminants, secondary pollutants– smog), Effects of air pollutants (Biological, physical and economical) and their control measures.

UNIT – II

Factors affecting air pollutants (Wind, temperature, height, precipitation, topography, turbulent diffusion, separated flows and plume behavior), green house effect, Ozone depletion, acid rain, El-nino and La-nina effect, photo-chemical smog, Bhopal gas tragedy.

UNIT – III

Water pollution: Types of water pollution (Ground water, surface water, lake water, river water and marine water). Sources of water pollution (Sewage and domestic wastes, industrial effluents, agricultural discharges, fertilizers, detergents, toxic metals, thermal pollutants and radioactive materials), Eutrophication, effects of water pollutants and their control, National River Action Plan (NRAP) (Ganga Action Plan & Yamuna Action Plan).

UNIT – IV

Terrestrial pollution (Soil Pollution): Sources of terrestrial pollution (Electronic wastes, Industrial wastes, urban wastes, agricultural practices, chemical and metallic pollutants, sedimentation, biological agents), effects of terrestrial pollutants, bio-indicators of terrestrial pollution. Bio-medical and Hospital Wastes, Radioactive Wastes: Sources, Transport and Disposal. Municipal solid wastes - hazards, disposal and energy production- Case studies

UNIT – V

Radio-active pollution: Introduction, types of radiations (Ionizing and non-ionizing), sources of radiations (natural sources and anthropogenic sources). Biological effects of radiations, noise pollution: Introduction, sources of noise (Industrial, transport, neighborhood), noise exposure levels and standards, effects of noise pollution and its control.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

MEN-C 151: PRACTICAL – I

Time: 6-8 HOURS

M.M. 100

Sessional: 30 ESP: 70

- A. Analysis of soil for the following parameters: 4 marks each= 16**
(Two exercise to be done in examination)
- | | |
|--------------------------------|-----------------------------------|
| 1. Soil texture | 2. Soil pH |
| 3. Soil temperature | 4. Soil humidity/moisture content |
| 5. Soil water holding capacity | 6. Atmospheric humidity |
| 7. Porosity | 8. Bulk density |
- B. (Two exercise to be done in examination)**
- | | |
|----------------------------|---------------------|
| 1. Organic matter in soil | 2. Nitrate nitrogen |
| 3. Phosphate phosphorus | 4. Soil acidity |
| 5. NPK by flame photometer | 6. Soil alkalinity |
- B. Population dynamics and community composition 4 Marks each =16**
(Four exercise to be done in examination)
- To take up marbles of 5-6 different colours mix these in different ratio selecting one colour for one species and find out:
 - Species composition/Diversity
 - Dominant Species
 - Population ratio
 - Species Density with given hypothetical area
 - Ask the students to study community components of the grass land ecosystem by identifying the:
 - Types of species of grasses
 - Types of species of herbaceous plants
 - Types of species of shrubs
 - Types of species of trees
 - Types of species of insects fauna
 - Types of species of bird fauna
 - In the map of India. Show distribution of different types of forests of India with different colours
- C. Determination of primary productivity by following methods: 5+5= 10**
(Two exercise to be given)
- Harvest method (Grassland ecosystem)
 - Chlorophyll content method (Forest)
 - Light and dark bottle method (Aquatic)
- D. Ecosystem Analysis: 5+5=10**
(02 exercise to be given)
- To study and enlist various biotic and abiotic components of forest Ecosystem.
 - To study and enlist various biotic and abiotic components of Desert Ecosystem.
 - To study and enlist various biotic and abiotic components of Grassland Ecosystem
 - To study and enlist various biotic and abiotic components of Aquatic Ecosystem
 - To study ecology of some major invasive weeds
- E. Viva Voce 8**
- F. Practical record 5**
- G. Chart/Model 5**

Total 70

MEN-C 152: PRACTICAL – II

TIME: 6-8 HOURS

Max. Marks: 100

Sessional: 30 ESP: 70

A. Ecological Adaptations:

05 marks each= 10

(02 exercises to be given)

- | | |
|-------------|------------|
| 1. Arboreal | 2. Volant |
| 3. Desert | 4. Mimicry |
| 5. Aquatic | |

B. Zoo-geographical regions:

06 marks each= 12

(Map studies using Atlas – Three exercises to be given)

1. India – Physiographic Divisions
2. India – Climatic Regions
3. India-Distributions of Animals
4. India- Rainfall and wind
5. Distribution of endangered animals species in Himalayan region

C. Biodiversity studies:

05 marks each= 10

(Map studies using Atlas - Two exercises to be given)

1. Biodiversity Hotspots location in
(a) World (b) India
2. Protected Areas of India (National parks, Wildlife Sanctuaries, Tiger reserves, Biosphere Reserves, Zoos, Conservation Reserves, Community reserves)

D. Wildlife material for identification and comments 6 marks each=

12 (Two exercises to be given)

- | | |
|------------------------|------------------|
| 1. Pug marks and hoops | 2. Bird Nests |
| 3. Bird Eggs | 4. Bird Feathers |
| 5. Antlers and horns | 6. Fish Scale |

E. Listing of threatened , endangered major fauna of National park in Uttarakhand. **06 marks**

F. **Viva Voce** **5**

G. **Practical record** **5**

H **Preparation of Herbarium** **5**

I. **Classroom Seminar** **5**

Total **70**

SEMESTER-II

MEN-C 201 : Environmental Monitoring and Instrumentation M.M. 70

UNIT – I

Air pollution sampling and monitoring: (Air quality standards, sampling methods, instruments, duration of sampling period, location of sampling sites, air sampler operations, stack sampling technique, measurement of SO₂, NO₂, SPM oxidation and ozone, hydrocarbon and particulate matter), control of gases contaminants, combustion, adsorption, adsorption recovery system.

UNIT – II

Physical, chemical, biological and bacteriological sampling and analysis of water quality. Sewage treatment: (pretreatment, primary, secondary & tertiary treatment methods; physical-chemical and biological methods of treatment). Odours and their control, Criteria for the application of aerobic and anaerobic biological treatment; types of biological treatment; separation and grit chambers, velocity control devices, disposal of grit, oil and grease separation.

UNIT – III

Treatment for various industrial effluents with reference to distillery, paper and pulp, textile and dyeing wastes, industrial pollution abatement. Pollution control in petroleum refineries and petrochemical units. threshold concentration, oxidation, water supply management: Introduction, demand of water, need of water supply: Quality criteria of water for drinking, irrigation and industrial uses. Treatment of ground water.

UNIT – IV

Solid-waste management: Waste generation, characterization collection techniques, need for management and planning, solid waste types: Municipal waste, domestic waste, sewage sludge and municipal waste, slaughter house waste, agriculture waste. Integrated solid waste management, solid waste reduction and recycling processes.

UNIT – V

Principles of analytical methods: Microscopy (Scanning & Transmission) Colorimetry, Flame photometry. Spectrophotometry, Chromatography (Gas, TLC, Ion exchange and HPLC chromatography), Atomic Absorption Spectrophotometry, Electrophoresis, X-ray fluorescence, X-Ray diffraction, Radio-immunoassay, ELISA, Polymerase Chain Reaction and Respirable Dust Sampler (RDS).

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Soil microbiology: Introduction, microorganisms in soil, role of microbes in biogeochemical cycles (Oxygen, carbon-dioxide, Nitrogen, Sulphur and phosphorous). Role of microbes in humus formation, Role of microbes in Carbon, Nitrogen and Sulphur cycle, Air microbiology, Introduction, microorganisms in air, role of microbes in atmosphere. Aquatic microbiology; introduction, microorganisms in water, Role of microbes in aquatic system.

UNIT – II

Basics of microbiological analysis, laminar air flow, autoclaving, preparation of culture media, microorganisms and diseases: epidemiology (Introduction, factors affecting epidemiology, modes of transmission, controls of communicable diseases), air-borne diseases (tuberculosis, meningitis, chicken-pox), soil-borne diseases (tetanus and gas-gangrene). Anti-microbial agents and their significance.

UNIT – III

Water and food-borne diseases (Cholera, Typhoid, Amoebiasis, Giardiasis and Hepatitis), Disease causing agents, Contamination of food, microbial spoilage of food, Role of microbes in oil-pollution control and chemical pollution control, Ecological and public health impacts of raw sewage and domestic liquid discharge.

UNIT – IV

Toxicology – Definitions, Classification, Origin and nature of toxicants in Environment. concepts, Toxicity, Acute, sub-acute, chronic, dose effect, LD 50, LC 50 and response safe limits. Dose response relationship, concentration and response relationship, Safe Limits. Biological, chemical factors their influence. Influence of route of administration, abnormal response to chemicals; basis of selective toxicity, Detoxification.

UNIT – V

Xenobiotics in the environment. Pesticides – Classification of pesticides – Pest surveillance, resistance, residual effects, Bioaccumulation, Biotransformation, toxic effects of insecticides on man, fishes and mammals. Mutagenesis and carcinogenesis - selective important case studies. Environmental health risk assessment.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Fundamentals of environmental chemistry: Stoichiometry, Gibbs' energy, Henry's law, chemical potential, chemical equilibria, acid base reactions, carbonate system, solubility product, solubility of gases in water, carbonate system, unsaturated and saturated hydrocarbons, radionuclides in environment.

UNIT – II

Chemical composition of Air: Classification of elements, chemical speciation, particles, ions and radical in the atmosphere, transport of pollutants in air. chemical processes for formation of inorganic and organic particulate matter. Thermo-chemical and photochemical reactions in atmosphere. Oxygen and ozone chemistry of air pollutants, Air Quality index.

UNIT – III

Water chemistry: Chemistry of water, concept of DO, BOD, COD, coagulation, filtration, physical transport in surface water, dispersion of pollutants in ground water, biochemical processes in water involving microorganisms. Oxygen demanding wastes, Water quality index, synthetic organic compounds, inorganic chemicals and minerals, sediments, impact of oil on water pollution and environment, radioactive pollutants in water.

UNIT – IV

Inorganic and organic components of soil, Nitrogen pathways, NPK in soil and their interaction. Physico-chemical analysis of soil, SAR, Soil pollution control, Soil health index. Industrial waste/ effluents and heavy metals in soil and their interactions. Reactions of different types of insecticides, fungicides and weedicides in soil systems.

UNIT – V

Toxic chemicals in the environment: Metals, inorganic contaminants and organic contaminants; pesticides in water, Biochemical aspects of Arsenic, Cadmium, Lead, Mercury, Carbon-monoxide, O₃ and PAN, pesticides, insecticides, Radioactive substances, MIC, carcinogens in the air.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

MEN-C 251: PRACTICAL – III

TIME: 6-8 HOURS

Max. Marks: 100

Sessional: 30, ESP: 70

A. Water analysis of the following parameters: 28 marks

- a.
- | | |
|--|----------------------------------|
| 1. Preparation of standard solution in lab | 2. Preparation of standard curve |
| 3. Sampling procedure | 4. Dissolved oxygen |
| 5. Free CO ₂ | 6. Total Hardness: (a) Ca (b) Mg |
| 7. Total Alkalinity | 8. Transparency |
| 9. Turbidity | 10. pH |
- b.
- | | |
|---|---|
| 1. Chlorides | 2. Total dissolved solids |
| 3. Conductivity | 4. Phosphate phosphorous |
| 5. Sulphate | 6. Composition of solid waste |
| 7. Chlorophyll content estimation in road side plants | 8. BOD of sewage and industrial waste water |
| 9. COD of sewage and industrial waste water | 10. Acidity |
| 11. Na and K- by flame photometer | |

B. Principle and functioning of following instruments: 12 Marks

(Three exercises to be given for comments)

- | | |
|-----------------------------------|----------------------------|
| 1. pH meter | 2. DO meter |
| 3. Conductivity meter | 4. Jackson turbidity meter |
| 5. Nephelometer | 6. Spectrophotometer |
| 7. Flame photometer | 8. Lux meter |
| 9. Anemometer | 10. Sound meter |
| 11. TDS Meter | 12. AAS |
| 13. (RDS) Respirable Dust Sampler | 14. HPLC |
| 15. Weather Monitoring station | 16. Water Samplers |

C. Determination of lead, Cobalt and Cadmium from the sample using AAS: 4

D. To study the different methods of air monitoring 04

Ambient air monitoring for SO₂, NO_x, CO, & SPM

E. To study the different methods of water sampling 04

Visit to nearby Sewage/effluent treatment plants (ETP/CTP)

F. Viva Voce: 10

G. Practical record 4

H. Chart/Model 4

Total 70

MEN-C 252: PRACTICAL – IV

TIME: 6-8 HOURS

M.M. 100
Sessional: 30, ESP: 70

A. Study of plankton	7+7=14
(Two exercise to be given)	
1. Collection, Preparation of slides, identification and quantification of plankton (Phytoplankton, Zooplankton and benthos) of pond and river water using Sedgwick – Rafter counter method.	
2. Study of permanent slides Identification and comments (four slides to be given)	8
Phytoplankton, Zooplankton, periphyton and benthos	
B. Microbial studies	8
(Four slides to be given)	
Identification and comments on Bacteria, Fungi and Protozoa	
C. Experiments to perform	6+6=12
(Two exercise to be given)	
1. Preparation of nutrient broth/Glucose broth	
2. Inoculation of inoculum (Any polluted water)	
3. Preparation of nutrient agar medium (NAM)	
4. Preparation of potato agar medium (PAM)	
5. Demonstration of pouring and streaking techniques	
6. Grams staining of <i>Lacto bacilli</i>	
7. Faecal coliform	
8. SPC, MPN	
D. Comments on the following water and food borne diseases:4+4=8	
Cholera, Typhoid, Amoebiasis, Giardiasis and Hepatitis, microbial spoilage of food.	
E. Classroom seminar	10
(On the basis of his/her performance and attendance in the seminar held during the semester/year)	
F. Practical record/Chart/Model:	5
G. Viva Voce	5
Total	70

ELECTIVE PAPER

MEN-E 204 : Solid Waste and waste water management

M.M.: 70

Unit I

Solid Waste – collection, Storage, segregation- transportation and disposal methods-sanitary land fills and their types, composting, aerobic digestion, incineration, types of incineration, pyrolysis and medical waste, technology options for biomedical waste treatment. Hazardous waste-Introduction, characteristics, resource conservation and recovery act, Classification of hazardous waste and handling of hazardous solid wastes. Radioactive wastes- sources, pollution, types of radioactive waste and their control and management.

Unit III

Recycling of Wastes , waste for Industrial, Agricultural and Domestic Purposes; Recycling of Metals, Reuse, recovery and ,reduction of paper and plastics; Recycling in Food Manufacturing, Beverages, Apparel, Leather, Paper, Pulp, Chemical and other industries; Fly Ash utilization. Waste Disposal Methods – composting, incineration, pyrolysis, medical waste disposal strategies.

Unit III

Water purification, Screening (coarse screen, medium screen, fine screen) . Treatment systems (sedimentation, coagulation, filtration – rapid sand filter, slow sand filter) , advantages and disadvantages. Disinfections – Methods of disinfections, chlorination, water softening process. Water quality- Drinking water quality standards-Irrigation standards- effluent standards – Minimal National Standards (MINAS). International standards as described by WHO and EPA.

Unit IV

Waste water treatment: Characteristics of waste water, primary treatment – sedimentation and flocculation, equalization, neutralization, secondary treatment – Aerated lagoons, Trickling Filters, Activated Sludge process, Oxidation pond, Aerobic and Anaerobic decomposition of sewage- A note on reverse osmosis. Tertiary treatment,- biological processes and sludge treatment.

Unit V

Economics of waste treatment: Benefits of pollution abatement, Primary, secondary and intangible benefits, Capital and operating cost of different treatment processes for industrial waste. Management of industrial wastewater through Volume reduction, Strength reduction, Neutralization, Equalization,

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

ELECTIVE PAPER

MEN-E 205 :

Air pollution management

M.M.: 70

Unit I

Chemical composition of air: Classification of elements, chemical speciation, Particles, ions and radicals in the atmosphere. Chemical processes for formation of inorganic and organic particulate matter. Thermo-chemical and photochemical reactions in the atmosphere.

Unit II

Natural and anthropogenic sources of air pollution. Primary and Secondary pollutants, Transport and diffusion of pollutants. Laws governing the behaviour of pollutants in the atmosphere. Methods of monitoring and control of air pollutants, SO₂, NO_x, CO, SPM. Effect of pollutants on human beings, plants, animals, materials and on climate. Acid rain, Air Quality standards.

Unit III

Heat transfer processes. Scale of meteorology: pressure, temperature, precipitation, humidity, radiation and wind. Atmospheric stability, inversion, and mixing height, wind rose. Effect of lapse rate on plume behaviour. Maximum mixing depth, Gaussian dispersion model, Effective stack height.

Unit IV

Control devices for particulate matter: Principle and design of gravitational settler, centrifugal collector, wet collector, fabric filters and electrostatic precipitator. Control of gaseous contaminants through adsorption, absorption, condensation and combustion including catalytic combustion.

Unit V

Stack sampling (with special emphasis on isokinetic sampling) and analysis of temperature, flow velocity, composition. Green belt design. Control of air pollution by process change. Management strategies for air pollution abatement. Vehicular pollution and urban air quality management.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

SEMESTER-III

MEN-C 301 : Environmental Impact Assessment and Disaster management M.M.: 70

UNIT – I

Environmental impact assessment: Introduction, aims, objectives, constraints in EIA, environmental assessment process (impact prediction, evaluation, mitigation and monitoring), environmental impact statement (EIS), methods of impact analysis (check lists, overlays, matrices, models, comparative studies), environmental items in Leopold's identification matrix, questions for impact identification, impact interpretation, impact communication, impact statements.

UNIT – II

EIA Guidelines of GOI (2015). Prediction, evaluation, assessment and monitoring of impacts of different developmental activities on the air environment, water environment, noise environment, biological environment, cultural environment, socio-economic environment.

UNIT – III

Impacts of urbanization, socio-economic and environmental impacts of tourism, impact of coal mining and stones, Types of dams, impact of hydroelectric development projects, impact of fly ash, impact of sewage and other effluents, impact of leather tanning.

UNIT – IV

Introduction to catastrophic geological hazards. Type of disasters (Natural and manmade), Casual factors of disasters, phases of disasters. Study of floods, droughts and their types, earthquakes, Tsunami, landslides, volcanism and avalanche., Uttarkashi (1991), Latur (Killari-1993) & Nepal (2015) earthquakes, Kedarnath aapda (2013), Kerala flood (2018): implications and lessons.

UNIT – V

Action plan for earthquake disaster mitigation, flood mitigation practices in India, drought management through anticipatory multidimensional approach. controlling the landslides. Flood management, monitoring of avalanches. Man made Disasters and Hazards- Improper Irrigation, deforestation, Industrial hazards- safety in industry. Management of dangerous materials in Industry, Safety system in industry. Disaster and accident prevention. National Disaster management act (2005).

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Introduction to Remote Sensing: Definition, Necessity and Application and Scope. Electromagnetic radiation, energy source and radiation principles. Atmospheric effects on radiation: (Interaction of EMR with atmosphere and earth surface features, Spectral reflectance of soil, water and vegetation). Real Remote Sensing System and its characteristics.

UNIT - II

Sensors and platforms used in Remote sensing. Aerial Photographs, Aerial photo-classification based on altitude of camera lens, distortions caused due to flight irregularities, overlaps, scale, relief displacement and its effects. Photo recognition elements. Different types of photographs., aerial photography and its characteristics, photogrammetry, Elements of image interpretation

UNIT - III

Elements of photographic systems. Land stat, IRS and other satellite systems- satellite data. Principals involved in thermal IR image and microwave image interpretation. Spectral reflectance, Digital image processing (DIP), Multi-spectral classification (supervised and un-supervised).

UNIT – IV

Applications of Remote Sensing and Aerial photographs in environmental monitoring, forestry mapping of forest types, landscape analysis, urban development, water resources, habitat suitability analysis, species analysis, wildlife habitat management,

UNIT - V

Introduction to Geographical Information Systems and GIS software, Fundamentals of GIS: Layers and features, Raster/Vector- Geo-referencing and projection, Spatial data and GIS basics; Data attributes and spatial topology, Projection / Image registration, Digitization and data attributes -map data representation, GPS.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Introduction, History of vermiculture, ecology and distribution of earthworms, Types of earthworms, vermiculture techniques: Selection and suitable characteristics of Earthworm for Vermicomposting, vermicomposting methods. Vermiculture biotechnology and waste management, Waste management and resource recovery, Types of Vermiculture plants, Vermi filters, Nutrient value of worms and Vermicompost, Maintenance and limitations of vermi composting, Economics of vermiculture, Vermiwash, *In-situ* application of vermiculture for crop productivity, land improvement and soil reclamation.

UNIT – II

Biological waste and fish farming: Definition and types of biological wastes and their nutrient values, wastes recycling methods, Use of wastes as fertilizer and feed. Application of wastes in cultures of micro-algae, use of sludge, slurry and livestock wastes in Biogas formation, Intensive aquaculture: sewage fed fish culture (monoculture and polyculture), Integrated fish farming system.

UNIT – III

Environmental Biotechnology : Introduction and application, Biofertilizer technology: Rhizobium culture, Blue-green algae culture, *Azolla* culture, and *Micorrihizea* culture. Benefits and significance of biofertilizers in agriculture. Fermentation technology. Role of microorganisms in production of alcohol, and pharmaceutical products, biomass (*Spirulina* culture) production and bio-fuel production.

UNIT – IV

Biopesticides: definition, types (Plants, Biochemical, Bacterial Virus, Fungal and Entomopathogenic nematodes) Mode of application of biopesticides, Integrated pest management, Biological and ecological intensive IPM. Bioleaching: types of bioleaching, mechanism of bioleaching and significance.

UNIT -V

Genetically modified microorganisms (GMO) concepts and technology, Transgenic plants and vegetables, Transgenic and hybrid fishes, Tissue culture technology: micro propagation, somatic hybridization and clonal propagation, Intellectual property right (IPR) and protection, Plant breeder rights (PBR).

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

MEN-C 351: PRACTICAL – V

TIME 6-8 HOURS

M.M. 100

Sessional: 30, ESP:70

A. Hypothetical EIA of following: (Two exercises to be given)	6+6=12	
1. Urbanization		
2. Dam construction		
3. Hydroelectric power generation		
4. Tourism		
5. Sugar mills		
6. Road construction		
7. Industry		
8. Railway track		
9. Bridge		
B. Management practices of following Natural disasters:5+5=10 (Two exercise to be given)		
1. Earth quake	4. Volcanic eruption	7. Famine
2. Land slides	5. Tsunami	
3. Floods	6. El Nino & La Nina	
D. Environmental and Green audit	8	
(One exercise to be given) Prepare an environmental audit of hostel/institutes/industrial area/city. Prepare the Green cover, land use of University campus		
E. Experiments on Remote sensing	5+5=10	
(Two exercises to be given)		
1. Reading of topo maps and geological maps.		
2. Study of satellite imageries.		
3. Interpretations of remotely sensed data.		
4. Study of 3-D vision test cards with the help of pocket stereoscope.		
F. Class room seminar	10	
(On the basis of his/her performance and attendance in the seminar held during the semester/year)		
G. Viva Voce:	10	
H. Chart/Model:	5	
I.. Practical record:	5	
Total	70	

MEN-C 352: LAB COURSE – VI

TIME: 6-8 HOURS

M.M. 100

Sessional: 30, ESP:70

- A. Experiments on Biotechnology: 8=8**
(One exercises to be given)
1. Estimation of earthworm biomass from:
 - (a) Forest soil
 - (b) Agriculture soil
 - (c) Garden soil
 2. Types of vermicast/collection
 3. Study of Vermicomposting Unit.
- B. Experiments to be performed: (Any one): 5**
1. Separation of *Anabaena* from *Azolla*
 2. Root nodule bacteria
- C. Comments upon the principle and functioning of following: (Any one): 5**
1. Ferment model
 2. Aquaculture practice/aquarium model
- D. Experiments on phytoremediation (Any two): 3+3=6**
Using water hyacinth, lemna, azolla, water lettuce
- E. Experiments on Himalayan Ecology 6+6+6=18**
(Three exercises to be given)
1. To study the internal structure of earth.
 2. Diagrammatic representation of different layers of atmosphere, their characteristics and temperature relationships.
 3. Types of rocks.
 4. Himalayan Horizontal/vertical division (Map studies)
 - (a) Climatic
 - (b) Physio-geographic
 - (c) Position and location of glaciers, lakes, rivers, streams
- F. Listing or map representation of following: (Any two): 4 +4=8**
1. Endangered species of flora in the Himalayan region.
 2. Endangered species of Himalayan fauna.
 3. Study of National parks, sanctuaries and Biosphere reserves in Himalayan region.
 4. Studies on wet lands of India
- G. Viva voce 10**
- H. Chart/Model 5**
- I. Practical record 5**

Total

70

ELECTIVE PAPER

MEN-E 304: Sustainable Development, Eco – Tourism and Env. Economics M.M.: 70

Unit I

Sustainable Development – scope & definition, parameters of sustainability, Population stabilization, integrated land use planning, conservation of biological diversity, control of pollution, development of non-polluting renewable energy systems. Recycling of wastes/residues, ecologically compatible human settlement and slum improvement, environmental education and awareness.

Unit - II

Sustainability of Water Resources, Sustainable Management of Forests, sustainable agricultural rotation of crops, organic farming. Environmental movements and role of NGOs in sustainable development. Global policy for sustainable development – world summits. Urbanization and its impact on Environment. Rural and Urban planning for sustainable development.

Unit III

Concepts of Tourism - Classification – Religious Tourism – Cultural Tourism – Heritage Tourism – Monumental Tourism – Adventure Tourism – Mass Tourism – Sustainable Tourism – Core indicators, Consumptive and Non-Consumptive Tourism. Principles of Ecotourism –Concepts of Ecotourism – Origin of Ecotourism – Objectives of Ecotourism – Benefits of Ecotourism – Trends affecting Ecotourism. Infrastructural Facilities for Ecotourism – Maintenance of Ecological Centers Target group of Ecotourism – Ecotourism and Conservation.

Unit IV

Impact of Ecotourism – Economic Impacts (Fiscal Impacts, Concept and Methods) – Types and Degree of Impacts from Ecotourism activities – Socio-cultural Impacts – Ecotourism related organization – Ecotourism Research-Disasters and Ecotourism-Role of ethics in ecotourism, professional certification and accreditation, Rules & regulation for Eco- tour operators and tourists. Wild life tourism in India, PAN-Environmental services, Indigenous- sensitive ecotourism. Advantages and Disadvantages of Ecotourism- Eco-branding and Eco-labeling of Ecotourism Products - Marketing of Ecotourism. World ecotourism summit, 2002.

Unit V

Fundamentals and theories of environmental economics: Principles of cost-benefit analysis, cost effective analysis, environmental issues in the Five-Year Plans, Joint Forest management for optimal property rights, economic value of India's forest stock and economics of forest products in India. Environmental Statement (ES), ES of Government of India and its contents, Introduction to environmental audit: Guidelines and methodology, purpose and needs; Natural resource accounting for Indian condition:

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

ELECTIVE PAPER

MEN-E 305 : Himalayan Geology and Ecology

M.M.: 70

UNIT I

Geological features of rocks (in brief): Introduction, Folds and foldings, Faults and faulting, Types of mountains and their physiographic features with special reference to Himalayas, Seismicity and Neotectonics in the Himalayas and their effect on environment.

UNIT II

Climate of the Himalayas and the influence of the Himalayas on the climate of India, Forests and Forestry in Himalayan region (Introduction, Floristics, Forest influences, forest destruction and denudation), Forest types and productivity, Carbon sequestration, Forest base industries, Shifting cultivation, Migratory grazing). Economically important flora of Himalayan region with special reference to food, fodder, fibre, timber and medicinal importance.

UNIT III :

Crop resources and their genetic upgrading in the Himalayan region (Crop resources, Problems of crop improvement, Genetic upgrading of crop resources), Plant genetic resources (Introduction, botanical wealth, Plant genetic resources, inventory and present status, Vertical distribution of genetic diversity, conservation of resources), Glacier resources of the Himalayas and their importance to environmental studies, Total ice cover, Distribution of ice cover, Ice as a water resource, Cooling effects of glaciers, Debris and Glaciers).

UNIT IV

Land-capability; classification for Himalayan region (Introduction, texture, slope, erosion, climate), Soil erosion & sedimentation (Introduction, Sedimentation in small reservoir, Sedimentation in big erosion and flood), Resources and development of aquatic life of the Himalayas (Introduction, the salient feature of watershed, Resources of aquatic life, Conservation and development).

UNIT V

Ecotourism: Tourism in the Himalayan region and its impact, agriculture system and problems of agriculture in the Himalayan region, problems of water resource development, agro-based industries, socio-economic aspects of resource mobilization in the Himalayan region.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

SEMESTER-IV

MEN-C 401 : Faunistic Taxonomy and biodiversity conservation M.M.: 70

UNIT- I

Definition and basic concepts of biosystematics and taxonomy, Importance of applications of bio-systematics, Recent trends in biosystematics: (Chemotaxonomy, cytotaxonomy and molecular taxonomy), Taxonomic procedures, collection, preservation, correcting, process of identification, taxonomic keys, taxonomic characters, theories of biological classification, origin of reproductive isolation, biological mechanism of genetic incompatibility.

UNIT –II

General characters, classification and affinities of Main faunistic groups: Protozoa, Platyhelminthes, Aschelhelmithe Annelida, Arthropoda, Mollusca up to class level giving suitable Classification of chordates: Pisces, Amphibia, Reptilia, Birds and Mammalia up to order level giving suitable examples of Indian Himalayan region only.

UNIT-III

Concepts of Biodiversity in Indian Himalayan regions, IUCN categorizations of major endemic and exotic species in groups: Pisces, Reptiles, Birds and Mammals. Value of their biological diversity, loss of biological diversity, causes of species extinctions. Public participation in biodiversity conservation.

UNIT- IV

Biodiversity indices: α , β , γ diversity, Shannon-Weiner index, Simpson index, Similarity and dissimilarity index, Associated index. Calculating various biotic indices through given data. Dimension of speciation and taxonomic characters, species concept: Species category, different species concepts, sub-species and other intra-specific categories, mechanism of speciation in panmictic and apomictic species, International Code of Zoological Nomenclature (ICZN), Interpretation and application of important rules

UNIT-V

Conservation and Management – National Legislation – Protection of Wild flora and Fauna -Protection of National Habitats - National and International Protected Areas – Current Practices in Conservation - in *situ* Conservation and *ex situ* Conservation of Threatened Species — Patent Act (1970) –Biodiversity Conventions — NBSAP – Megadiversity zones and Hot Spots: Concepts, Distribution and Importance – Use of Biodiversity: Source of food, medicine, raw material, aesthetic and cultural – Biodiversity Prospecting.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Introduction to Mathematical Modeling (Definition and Terminology), Basic principles, advantages and limitations for modeling. Basic models for environmental research (Mass balance: Eulerian models, Lagrangian model, point source stream pollution model, Gaussian plume model), Role of modeling in environmental research.

UNIT – II

Introduction to Biostatistics: Development, Definition, Characteristics, importance and limitations, Preliminary concept (Variables and constants) sources and presentation of data and its graphical representation, measures of central tendencies: Mean, median and mode, Standard deviation, elementary knowledge of probability, correlation and linear regression.

UNIT – III

Distribution– Normal, Binomial and Poisson, analysis of variance, test of significance (Introduction, procedure of testing hypothesis), t-test, Chi-square test, F-test, Standard deviation (SD), ANOVA. Lotka-Volterra model of population growth.

UNIT – IV

Computer organizations, Applications of computer, MS office, MS excel, Power Point presentation, Components of computer, Types of computers; Computer generations, Concept of operating system, Computer graphics. Basic concepts of networking and its applications, Internet connection, Website, Internet browsing, Applications of Internet, E-mail, GIS-scope.

UNIT – V

Scientific documentation: Methods of literature collection, design, planning and execution of investigation, Preparation of scientific documents, general articles, research papers, review articles, editing of research papers, methods of citation, Plagiarism and copy right act. Presentation techniques, Effective communication skill, discussion and critic.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

UNIT – I

Fundamental articles for environment and natural resources, constitutional and legislative provisions: Primary and secondary laws, Fundamental concepts of environmental laws, Introduction to National Law (Constitution and other relevant statutes). Public nuisance, the writ jurisdiction, statutory remedies, public interest litigation, class action, freedom of information and the right to know.

UNIT – II

Air (Prevention and control of pollution) Act 1981, Water (Prevention and control of pollution) Act 1974, as amended in 1988 and rules 1975. Forest Act 1927, Forest conservation Act 1980, Environmental Case studies to be taken up: M.C. Mehta Vs Union of India: Ganga pollution case of Tanneries, AIR-1988 SC 1037 (1987), M.C. Mehta Vs Union of India, Ganga Pollution (Municipalities) AIR 1988 SC 1115 (1988),

UNIT- III

Environmental Protection Act 1986 and Rules 1986, Wildlife (Protection) Act 1972, Public liability insurance Act, 1991, National Environmental Tribunal Act 1995, National Bio-diversity Act 2002. National Green Tribunal(NGT), R.L. and E. Kendra Dehradun Vs State of U.P. (Dehradun quarrying case, AIR 1985 SC 652 and Banwasi Sewa Ashram Vs State of U.P. AIR, 1987, SC 374.

UNIT – IV

Environmental policies and laws: Introduction to International environmental law (Stockholm to Rio). Convention of International Trade in Endangered Species of Wild fauna and flora (CITES), Convention on biodiversity and convention on climate change, Kyoto protocol, Convention on conservation of Antarctic marine mineral and living resources (1980), The citizens convention on biodiversity (1992), United Nations Framework Convention on Climate Change (UNFCCC) 1992.

UNIT – V

Environmental planning, trends in planning, concepts and approaches and strategic environmental planning and management. International Environmental laws - hazardous wastes-Basal convention – Necessity for International Environmental Court. United Nations Environment Programme [UNEP], Role on international environment laws. Case studies for International environmental disputes.

NOTE: The question paper shall consist of two sections (A & B). Section A shall contain ten short answer type questions of six marks each and student has to attempt any five questions in about 150 words each. Section B shall consist eight long answer type questions of ten marks each and student shall be required to attempt any four questions in detail. Questions shall be uniformly distributed from the entire syllabus. The previous year paper can be used as a guideline and the following syllabus should be strictly followed while setting the question paper.

Time: 6-8 hrs

- | | |
|---|-----------|
| 1. Bio-statistics Exercise | 12 |
| (Two exercise to be given) | |
| 1. To calculate the standard deviation of given samples. | |
| 2. To find out association between two species using Chi-Square method. | |
| 3. To find out association between two species using F-test. | |
| 4. To find out association between two species using T-test. | |
| 5. To calculate correlation coefficient of given samples. | |
| 6. To find out the linear regression. | |
|
 | |
| 2. Listing of extinct, endangered, vulnerable and rare species of groups (Pisces, ambhibian, reptiles, birds and mammals) as per IUCN categories. | 8 |
|
 | |
| 3. Morphometric and meristic characteristics of freshwater fishes (Any two be given):
<i>Labeo, Catla, Schizothorax, Tor, Barilius, Puntius, Hypophthalmix molitrix, Notopterus, Heteropneutis, Cypirus carpio</i> | 6 |
|
 | |
| 4. Identification, classification and morphometric characters, habitat of selected Reptiles of Uttarakhand.
King cobra (<i>Ophiophagus hanna</i>), Crocodile or Mugger (<i>Crocodylus palustris</i>), Gharial (<i>Gavialis gangeticus</i>), Russell's viper (<i>Daboia russelii</i>), Monitor lizard (<i>Varanus</i>), Common garden lizard (<i>Calotes versicolor</i>), Himalayan ground skink (<i>Asymblepharus himalayanus</i>), Python (<i>Python molurus</i>), Indian Pangolin (<i>Manis crassicaudata</i>). | 6 |
|
 | |
| 5. Identification, classification and morphometric characters, habitat of selected Mammals of Uttarakhand.
Indian Elephant (<i>Elephas maximus indicus</i>), Himalayan black bear (<i>Ursus thibetanus laniger</i>), Tiger (<i>Panthera tigris tigris</i>), Snow leopard (<i>Panthera uncial</i>), Musk Deer (<i>Moschus moschiferus</i>), Himalayan Tahr (<i>Hemitragus jemlahicus</i>), Sambar Deer (<i>Rusa unicolor</i>), Sloth bear (<i>Melursus ursinus</i>), Langur (<i>Semnopithecus entellus</i>), Rhesus monkey (<i>Macaca mulatta</i>). | 6 |
|
 | |
| 6. Identification, classification and morphometric characters, habitat of selected Birds of Uttarakhand.
Himalayan woodpecker (<i>Dendrocopos himalayensis</i>), Speckled wood pigeon (<i>Columba hodgsonii</i>), Brown wood owl (<i>Strix leptogrammica</i>), Red junglefowl (<i>Gallus gallus</i>), Himalayan vulture (<i>Gyps himalayensis</i>), Rose-ringed parakeet (<i>Psittacula krameri</i>), Black kites (<i>Milvus migrans</i>), River lapwing (<i>Vanellus duvaucelli</i>), Himalayan monal (<i>Lophophorus impejanus</i>), Koklass pheasant (<i>Pucrasia macrolopha</i>). | 6 |
|
 | |
| 7. Identification, classification and morphometric characters of selected groups of insects
Hymenoptera (Bees): Lepidoptera (butterflies) Coleoptera (lady bird beetle) Hemiptera (Bugs) and Orthoptera (Grass hopper) | 6 |
|
 | |
| 6. Field visits/excursion as per theory paper. | 5 |
|
 | |
| 9. Viva voce | 10 |
|
 | |
| 10. Practical records and charts/models. | 5 |

Total= 70

MEN-C 461 DISSERTATION

M M: 200

Dissertation	100
Presentation	50
Viva Voce	50
Total	200