

# COURSE CURRICULUM AND SCHEME OF EXAMINATION

M. Sc. Environmental Science

Choice Based Credit System (CBCS)

w.e.f Academic Session 2020-21



SEMESTER	CORE COURSE (CC)	ELECTIVE (CEC)	TOTAL	TOTAL MARKS
I	20	4	24	600
II	20	4	24	600
III	16	10	26	650
IV	16	8	24	600
<b>TOTAL</b>	<b>72</b>	<b>26</b>	<b>98</b>	<b>2450</b>

The student have to earn 10% of the programme credit from open elective courses

### M.Sc Environmental science (First Semester)

S.No	Course	Nomenclature	Type (Credit)	Contact Hours		Exam marks		Duration of Exam
				L	PR	TH	Int Assess	
1	EES-101	Earth Processes	NCC	4		70	30	3
2	EES-102	Ecology	CC(4)	4		70	30	3
3	EES-103	Environmental Chemistry	CC(4)	4		70	30	3
4	EES-104	Physical environment	CC(4)	4		70	30	3
5	EES-105(A)	Natural resources	CEC(4)	4		70	30	3
6	EES-105(B)	Environmental awareness & planning	CEC(4)	4		70	30	3
7	EES-106	Lab I-Ecology	CC(4)		(4+4) 2 days & 2 groups	100		6
8	EES-107	Lab II-Env monitoring Soil	CC(4)		(4+4) 2 days & 2 groups	100		6
		<b>Total</b>	<b>CC(20), CEC (4)= 24</b>	<b>24</b>				
				<b>8X2=16x2=32</b>	<b>600</b>			

### M.Sc Environmental science (Second Semester)

S.No	Course	Nomenclature	Type (Credit)	Contact Hours		Exam marks		Duration of Exam
				L	PR	TH	Int Assess	
1	EES-201	Environmental Impact assessment	CC(4)	4		70	30	3
2	EES-202	Analytical techniques	CC(4)	4		70	30	3
3	EES-203	Biodiversity & Conservation	CC(4)	4		70	30	3
4	EES-204	Environmental Pollution	NCC(4)	4		70	30	3
5	EES-205(A)	Biostatistics & Computer application	CEC(4)	4		70	30	3
	EES-205(B)	IPR & Biosafety	CEC(4)	4		70	30	3
8	EES-206	Lab III-Env monitoring water	CC(4)		(4+4) 2 days & 2 groups	100		6
9	EES-207	Lab IV-Env monitoring Air & Noise	CC(4)		(4+4) 2 days & 2 groups	100		6
		<b>Total</b>	<b>CC(20), CEC (4)= 24</b>	<b>24</b>				
				<b>8X2=16x2=32</b>	<b>600</b>			

### M.Sc Environmental science (Third Semester)

S.No	Course	Nomenclature	Type (Credit)	Contact Hours		Exam marks		Duration of Exam
				L	PR	TH	Int Assess	
1	EES-301	Environmental Microbiology	CC(4)	4		70	30	3
2	EES-302	Pollution Control & Management	CC(4)	4		70	30	3
3	EES-303	Environmental Biotechnology	CC(4)	4		70	30	3
4	EES-304(A)	Environmental issues	CEC(4)	4		70	30	3
	EES-304(B)	Environmental Law	CEC(4)	4		70	30	3
5	EES-305	Lab V-Env. Microbiology	CC(4)		(4+4) 2 days & 2 groups	100		6
6	EES-306(A)	Lab VI-Biostatistics & Computer application	CEC(4)		(4+4) 2 days & 2 groups	100		6
	EES-306(B)	Lab VII-Solid waste	CEC(4)		(4+4) 2 days & 2 groups	100		6
8	EES-307	Credit Seminar	CEC(2)		2XN ( Number of faculty members)	50		To be evaluated by faculty members
9	EES-308	Minor Project/Training	CEC(2)					To be evaluated in fourth semester by committee of internal faculty members
		<b>Total</b>	<b>CC(16), CEC (10)= 26</b>	<b>18</b>	<b>8X3=24x2=48</b>	<b>650</b>		

### M.Sc Environmental science (Fourth Semester)

S.No	Course	Nomenclature	Type (Credit)	Contact Hours		Exam marks		Duration of Exam
				L	PR	TH	Int Assess	
1	EES-401	Energy resources	CC(4)	4		70	30	3
2	EES-402	Environmental Health & Toxicology	CC(4)	4		70	30	3
3	EES-403	Remote sensing & Modelling	CC(4)	4		70	30	3
4	EES-404(A)	Natural resource management	CEC(4)	4		70	30	3
	EES-404(B)	Environmental hazards & Disasters	CEC(4)	4		70	30	3
5	EES-405(A)	Lab VIII-Environmental Biochemistry	CEC(4)		(4+4) 2 days & 2 groups	100		6
	EES-405(B)	Lab IX-Energy	CEC(4)		(4+4) 2 days & 2 groups	100		6
8	EES-406	Field Report	CEC(2)			50		To be evaluated by committee of internal faculty members
9	EES-308	Minor Project/Training	CEC(2)			50		To be evaluated in fourth semester by committee of internal faculty members
		<b>Total</b>	<b>CC(16), CEC (8)= 24</b>	<b>16</b>	<b>8X2=16x2=32</b>	<b>600</b>		

### **Open Elective Courses for the Students of M.Sc. Environmental Science**

The student will earn minimum ten percent of the programme credits by choosing open elective courses offered by different departments of the university other than the Department of Energy and Environmental Sciences.

### **Departmental Compulsory (Non-Credit Courses)**

The department of Energy and Environmental Sciences will offer the following Compulsory Non-Credit courses (NCC) for the student of M.Sc. Environmental Sciences. The grades of Compulsory Non-Credit courses will not be counted for the computation of SGPA/CGPA. The student will have to obtain at least P Grade in Compulsory Non-Credit courses.

<b>S. No.</b>	<b>Course</b>	<b>Nomenclature</b>	<b>Type (Credit)</b>	<b>Contact hours</b>		<b>Examination schedule marks</b>		<b>Duration of Exam (Hour)</b>
				L	PR	TH	Int.	
						Assess		
1	EES-101	Earth Processes	NCC	4		70	30	3
4.	EES-204	Environmental Pollution	NCC	4		70	30	3

NCC\*- Non Credit Compulsory course

### **Open Elective Courses for the Students of other departments of the university**

The department of Energy & Environmental Sciences will offer the following open elective course for the student of other departments of the university in both the odd and even semesters.

### **Open Elective Courses**

S. NO.	COURSE CODE	TITLE	TEACHING HOURS	CREDIT	EXAMINATION SCHEDULE		DURATION OF EXAM
					TH	Int. Assess	
1	<b>EES-OEC-001</b>	Environmental Awareness	OE (4)	4	70	30	3
2	<b>EES-OEC-002</b>	Disaster Management	OE (4)	4	70	30	3
3	<b>EES-OEC-003</b>	Environment and Society	OE (4)	4	70	30	3

### **GENERAL INSTRUCTIONS:**

1. The Training/ minor project (EES-308) of 2 credits will be continued in both the 3<sup>rd</sup> and 4<sup>th</sup> Semester. The evaluation of the Training/ minor project will be done after fourth semester by a committee of internal faculty members.
2. The Field report (EES-308) of 2 credits will be in fourth semester. The evaluation of the Field report will be done after fourth semester by a committee of internal faculty members.
3. The ordinance of Choice Based Credit System (CBCS) of the university will be followed by the department.

4. The departmental elective courses will be allotted to the students on the basis of their preference and percentage of marks in the previous semesters of M.Sc. Environmental Science
5. The evaluation of courses shall be as under:

<b>Theory Courses components</b>	<b>Weightage (4 credits)</b>	<b>Weightage (3 credits)</b>	<b>Weightage (2 credits)</b>	<b>Evaluation</b>
Mid term	20	15	10	Internal
Assignment	05	05	05	Internal
Attendance	05	05	05	Internal
End term exam	70	50	30	External
Total	100	75	50	

## **EES-101**

### **Earth Process**

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### **UNIT I**

Origin of universe; Origin and evolution of earth; Primary geochemical differentiation and formation of crust, mantle and core, atmosphere and hydrosphere; Geological time scale; Geochemical classification of elements; Elements abundance in bulk earth, crust, hydrosphere and biosphere; Geochemical recycling of elements

#### **UNIT II**

Concept of minerals and rocks; Magma generation; Formation, characteristics and types of rock: igneous, sedimentary and metamorphic; Rock cycle; Weathering; Erosion, transportation and deposition of earth's materials by: running water, winds and glaciers.

#### **UNIT III**

Thermal, Magnetic and Gravitational fields of the earth; Concept of plate tectonics; Isostasy; Theory of continental drift; Paleomagnetism; Faults; Sea floor spreading; Mountain building: island arc, andes, himalaya

#### **UNIT IV**

Geological resources: nonmetallic resources and metals; Mineral reserves : ore, coal, petroleum, natural gas; Mine and mining; Geological survey of India; Indian mineral deposits: bauxite, iron ore, manganese, copper, lead-zinc, chromite, tin, gold, silver, platinum and atomic minerals.

#### **Reference**

1. Environmental Geology- Edward A. Keller
2. Physical Geology- C.W. Montgomery
3. Essentials of Geology- Tarback
4. Fundamentals of Geology- A. B. Roy
5. Geology and the Environment- Bernad, Trent, Hazlett & Bierman.
6. Essentials of Physical Geology- Wicander & Monroe
7. Historical Geology- Wicander & Monroe
8. Ore Deposits of India- Gokhale, KVGK and Rao TC

**EES-102**  
**ECOLOGY**

**Credit : 4**

**Marks:100**

**Time: 3Hrs**

**Theory+Internal sssessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

**UNIT I**

Introduction: Definition, aims and scope of Ecology, Application and branches of Ecology, Organization level of biosphere, Ecological factors, Liebig's law of minimum, Shelford's law of Tolerance, other limiting factors.

**UNIT II**

Ecosystem: Structure, Function and Services, Ecological pyramids, Food webs, Tropic levels, Ecological efficiencies, Model of energy flow, Energy budget, Primary and secondary production. Biogeochemical cycle: Gaseous cycles and Sedimentary Cycles, Human impact on biogeochemical cycling.

**UNIT III**

Population Ecology: Demography, Population characteristics, Evolutionary strategy, r and k selection, Population growth and Regulation, Human population dynamics, Age structure, Population interaction, Symbiotic association, Competition, Parasitism, Prey-predator Relations.

**UNIT IV**

Community Ecology: Community Ecology, Analytical and Synthetic characters, Species diversity, Biomes and their types, Concept of niche, Keystone species, Ecad, Ecotype, Ecotone and Edge effect, Endemic species, Ecological succession: Types, trends and models, concept of climax.

Reference

- |    |  |   |
|----|--|---|
| 1. | Element of Ecology-                              | Smith & Smith                           |
| 2. | Text Book of Ecology-                            | Peter Sterling                          |
| 3. | Fundamentals of Ecology-                         | E.P. Odum                               |
| 4. | Ecology-   | Russel, Rolfe, Hertz, Starr & Macmillan |
| 5. | Ecology-   | Miller                                  |
| 6. | Essentials of Ecology and Environmental Science- | S.V.S. Rana                             |
| 7. | Essential of Ecology                             | Townsend, Begon and Harper              |



## EES-103

### ENVIRONMENTAL CHEMISTRY

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

Atmospheric Chemistry: Chemical composition of the atmosphere-particles, ions, and radicals, Formation of particulate matter, Photochemical and chemical reaction in the atmosphere, Smog, Acid rain, Chemistry of Ozone layer depletion, Global warming, and Greenhouse effect.

#### UNIT II

Water Chemistry: Water quality parameters (Physical, chemical & biological parameters); Water quality standards for domestic, drinking and surface water quality ; Chemistry of inland water bodies (lentic system, lotic system); Solubility of gases in water, Carbonate system, Redox potential, Solubility product, Acids- Base reaction.

#### UNIT III

Soil Chemistry: Chemical and mineralogical composition, Soil formation, soil profile, Soil properties (physical, chemical, biological), soil nutrients (Organic and Inorganic nutrients), Ion exchange reactions in soil, soil fertility, soil pollutants (Pesticides, Heavy metals) and their effects.

#### UNIT IV

Thermodynamics: Classification of elements, Stoichiometry; First law of thermodynamics, Enthalpy, Second law of thermodynamics, Carnot's cycle, Entropy. Third law of thermodynamics, Gibb's free energy, Chemical equilibrium and chemical potential.

#### Reference

1. Environmental Chemistry- Mannhan
2. Environmental Chemistry- A. K. De
3. Environmental Chemistry- Balram Pani
4. Soil sampling, preparation and analysis- Kim H. Tan
5. Soils: Micheal J. Singer and Donald N. Munns
6. Environmental Engineering and Science: Gilbert M. Masters and W. P. Ela
7. Fundamentals of Soil Sciences: Henery D. Futh
8. Text book of Limnology: G.A. Cole
9. Environmental Chemistry: Sharma and Kapoor

## EES-104

### PHYSICAL ENVIRONMENT

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

**Note for the Paper setter:** The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

**Earth Atmosphere:** Composition of Atmosphere, Atmospheric composition as a function of height, Thermal structure of atmosphere, Lapse rates and its types, Concept of Air Parcel, Vertical stability of atmosphere, Inversions, Mixing Height, Atmospheric stability and Plume behavior, Hydrostatic equilibrium.

#### UNIT II

**Earth Sun Relations:** Relationship between earth and sun, Latitudinal and seasonal distribution of Insolation, Solar radiation, Interaction of solar radiation with atmosphere, Terrestrial radiation, Atmospheric window, Albedo, Planetary Albedo, Heat budget of the earth, History of climate change, Methods for climate change detection, Milankovitch's theory of climatic change, Climatic feedback mechanism,

#### UNIT III

**Meteorology:** Meteorological parameters - pressure, temperature, precipitation, humidity, mixing ratio, saturation mixing ratio, wind velocity, Coriolis force, pressure gradient force, Global pressure belt systems, Cloud formation and classification, Precipitation, South-Westerly and North-Easterly Monsoon and its patterns.

#### UNIT IV

**Aquatic Ecosystems:** Limnology- Physicochemical properties of Water, Types of freshwater bodies lentic and lotic; water mixing in lakes; Oceanography- Origin and Composition of sea water, Variation in Sea water Salinity and pH, Marine Biozones, Ocean waves and currents, Marine geological environment, Marine sediments.

#### Reference

1. The atmosphere: An introduction to Meteorology: F.K. Lutgens and E.J. Tarbuck
2. Atmospheric science: An Introductory Survey: J.M. Wallace and P.V. Hobbs
3. Confronting climate change: I.M. Mintzer
4. Atmosphere, Weather and Climate: Navarraa
5. Essentials of Oceanography: T. Garrison
6. Essentials of Oceanography: H.V. Thurman and A.P. Trujillo
7. Oceanography: G. Gross
8. Oceanography, An introduction to the Marine Environment: Richard Davis

## EES-105 (A)

### NATURAL RESOURCES

**Credit: 4**

**Marks:100**

**Time: 3Hrs**

**Theory+Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

**Biological Resources:**Forest types in India, Importance of Forests, Range lands and their importance. Floral and Faunal resources of the World, Floral and Faunal resources of India, Botanical Survey of India, Forest Survey of India, Zoological Survey of India, Plants of medicinal importance, Ethno botanical importance.

#### UNIT II

**Water Resources:**Water resources types, Surface water: Rivers, Lakes etc, Underground water and aquifers, Current scenario of water related issues.

#### UNIT III

**Land Resources :** Major Soil types of India, Mineral resources and reserves, Ocean ores and recycling of resources, Processing and smelting of mineral, Oceans as need areas for exploitation of mineral resources.

#### UNIT IV

**Energy Resources:**Renewable and non-renewable energy resources, Solar energy, Solar radiations, Fossil fuels classification and composition, Physico- chemical characteristics and energy content of Coal, Petroleum and Natural gas, Wind Energy, Geothermal Energy, Gas hydrates, Tidal energy, Biomass Energy, Hydropower, Nuclear Energy.

#### References

1. Ecology and Environment- P.D. Sharma
2. Essentials of Ecology and Environmental Science- S.V.S. Rana
3. Natural resources conservation: Oliver Owen and Chiras
4. Living in the environment: T. J. Miller
5. Ecology of Natural resources: Ranade
6. Global biodiversity: W.R.L. (IUCN)
7. [www.moef.gov.in](http://www.moef.gov.in)
8. [www.unep.org](http://www.unep.org)

## **EES-105 (B)**

### **ENVIRONMENTAL AWARENESS AND PLANNING**

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### **UNIT I**

Environmental awareness approach, Role of different media in environmental awareness, Role of NGOs, Role of public participation in Environmental awareness.

#### **UNIT II**

Environmental ethics, Ecomark, Basic concepts of environmental planning, Energy resources and water resources planning in India, Urban and rural planning, Landuse planning, Major issues related to Himalayan ecology, Deserts and Mangroves.

#### **UNIT III**

Environmental Economics: Cost and benefit of GHG's controlling, carbon trading and CDM mechanism, Cost benefit analysis-its relevance, concept of consumer surplus, willingness to pay and accept, estimation methods of nonmarket benefits-Contingent valuation, Travel cost approach, Hedonic price approach, Green accounting, Agricultural marketing.

#### **UNIT IV**

Concept of Sustainable development, Principals of Sustainability, Pillars of Sustainability, Ecological and Economic and Social aspects of Sustainability, Ecological Footprint, Natural Capital, Poverty and Environment, Sustainable Development Goals (SDGs), World Summit on Sustainable Development (WSSD).

#### **Reference**

1. Environmental Economics- Charles D Kolstad
2. Environmental Ethics- David R Keller
3. Environmental Studies & Ethics- Gouri Suresh
4. Environmental Awareness- Annette Bogler
5. Living in the Environment: Principles, Connections, and Solutions: Miller & Spoolman

**EES-106**  
**Lab I: ECOLOGY**

**Credit : 4**

**Marks: 100**

**Practical Hrs: 4 + 4**

**Exam duration: 6 hrs**

1. Biomass Estimation of Plant Sample.
2. Determination of minimum size of the quadrat.
3. Determination of minimum numbers of the quadrat.
4. Determination of population density by quadrat method.
5. Species richness and evenness (Biodiversity) by quadrat method.
6. Determination of Frequency of a plant community by quadrat method.
7. Determination of Abundance of a plant community by quadrat method.
8. Determination of Relative Dominance of plant community by quadrat method.
9. Determination of Importance Value Index (IVI) of species by quadrat method.

**EES-107**

**LAB II: ENVIRONMENTAL MONITORING (SOIL)**

**Credit : 4**

**Marks: 100**

**Practical Hrs: 4 + 4**

**Exam duration: 6 hrs**

1. Soil Sampling and Sample processing.
2. Determination of pH in soil sample.
3. Determination EC in soil sample.
4. Determination of Carbonate content in soil sample.
5. Determination of Total Organic Carbon (TOC) in soil sample.
6. Determination of Particle Size Analysis (PSA) in soil sample.
7. Mineralogical analysis of soil and rock samples.
8. Heavy metal analysis of soils.
9. Determination of water holding capacity of soil sample.
10. Determination of different forms of Nitrogen by Kjeidahl method.

## **EES-201**

### **ENVIRONMENTAL IMPACT ASSESSMENT**

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### **UNIT I**

Aims and objectives of Environmental impact assessment (EIA), EIA process- project screening, scoping, base line data, impact identification, and prediction, evaluation, monitoring and auditing and mitigation, public participation, presentation, review and decision making in EIA process; Environmental impact statement (EIS); Impact assessment methodologies.

#### **UNIT II**

EIA guidelines, EIA notification of 2006; EIA amendment from time to time; Environmental planning as a part of EIA; Environmental impact of mining industries; Environmental impact of Nuclear power plants; Environmental impact of Coal Fired Thermal Power plant, EIA of Environmental impact of Hydroelectric Projects-Tehri dam, Sardar sarovar and Almetti dam.

#### **UNIT III**

Environmental Management Systems; Environmental Management plan; environmentally sound technologies; concept of cleaner production; clean development mechanism (CDM), Environmental management plan ISO-14000, Life Cycle Analysis (LCA), Strategic Environmental Assessment (SEA).

#### **UNIT IV**

Environmental Risk: Definition of risk, nature of risk (voluntary and in voluntary risk), risk perception, important environmental risk, risk assessment- hazard identification, hazard accounting, exposure assessment Dose-response assessment and risk characterization; ecological risk assessment; uncertainty; risk management- risk identification, risk estimation, risk evaluation

#### **Reference**

1. Environmental impact assessment: John Glasson
2. Methods of Environmental impact assessment: Morris & Therivel
3. Environmental impact assessment: L.W. Canter
4. Introduction to Environmental Engineering and Science: Gillbert masters.
5. Soil and Environmental Quality: G. M. Pierzynski, J. T. Sims and G. F. Vance

## EES-202

### ANALYTICAL TECHNIQUES

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

**Note for the Paper setter:** The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

**Spectroscopy:** Principles of spectroscopy, UV-Visible spectrophotometry, Flame photometry, Atomic Absorption Spectroscopy, Inductively Coupled Plasma-Atomic Emission Spectroscopy (ICP-AES), Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS).

#### UNIT II

Fourier Transform Infrared spectroscopy (FTIR), Scanning Electron Microscopy (SEM), X-Ray Diffraction (XRD), X-Ray Fluorescence (XRF), Fluorometry

#### UNIT III

**Chromatographic technique:** Theory and Principle, Paper chromatography, Thin layer chromatography (TLC), Column chromatography, Ion exchange chromatography, Gas chromatography (GC), High Pressure Liquid Chromatography (HPLC).

#### UNIT IV

Titrimetry: Complexometry, Neutralization titrations, Oxidation-Reduction Titrations.; Gravimetry, Electrophoresis

#### Reference

1. Textbook of Quantitative Chemical Analysis: J. Mendham, R.C. Denney, J.D. Barnes
2. Instrumental Methods of Chemical Analysis: G.R. Chatwal, S.K. Anand
3. Undergraduate instrumental analysis: James W. Robinson
4. Model method of chemical analysis: Robert, Shields, Carins, Willim.



## EES-203

### BIODIVERSITY AND CONSERVATION

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

Biodiversity: Definition, Significance, Threats, Genetic variability, global status of biodiversity , status of biodiversity India, Floral, Faunal and Microbial diversity in India, Agro-diversity in India. Forest wealth of India, Biogeographical zones of India. Status of biodiversity in Haryana.

#### UNIT II

IUCN, Concept of Red Data Book, and Red list Categories, concept of species extinction, Mega diversity regions of the world, Concept of Biodiversity Hotspot, Global Biodiversity Hotspots, Biodiversity Hotspots in India.

#### UNIT III

Biodiversity conservation strategies: *In-situ* conservation, Protected Area Network (PAN), National Parks, Sanctuaries and Biosphere reserves in India, Ramsar wetland sites in India of international importance and *Ex-situ* conservation, Botanical garden, Zoological Garden, Aquarium, Concept of gene bank, Gene banks in India.

#### UNIT IV

Sustainable Development:- concept and goals associated with biodiversity, National initiatives for the conservation of biodiversity. National Biodiversity Authority, Bioprospecting, Biopiracy. Concept of Exotic Species, concept of invasive species, concept and significance of e

ndemic species. Restoration of biodiversity.

#### Reference

1. Natural resources conservation: Oliver Owen and Chiras
2. Living in the environment: T. J. Miller
3. Ecology of Natural resources: Ranade
4. Handbook of climate change and diversity Filho, Barbir & preziosi
5. Global biodiversity: W.R.L. (IUCN)
6. <http://www.enfor.nic.in>.
7. <https://www.iucn.org/>

**EES-204**

**ENVIRONMENTAL POLLUTION**

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

**UNIT I**

**Water pollution:** Sources, Consequences, Ecological and Biochemical aspects of water pollution, Characteristic of domestic, industrial, and agricultural wastes, their effect on water bodies, Water quality parameters, Criteria and standards. Marine pollution, Thermal pollution.

**UNIT II**

**Air pollution:** sources, Classification and properties of air pollutant, Behavior fate of air pollutant, Effect of air pollution on human health and materials, Air pollution meteorology.

**UNIT III**

**Soil pollution:** Soil pollution form the use of Fertilizers, Pesticides, Heavy metals, Industrial effluent and surfactant. Detrimental effects of soil pollutant, Soil sediment as pollutant, Remedial measures for soil pollution.

**UNIT IV**

**Noise pollution:** Definition, Sound pressure level, noise spectra, Octave band. Frequency, Weighting network, noise monitoring and sound level meter, equivalent continuous noise level, Effects of noise pollution.

**Reference**

1. Industrial Noise Control – Bell & Bell
2. Introduction to Environmental Engineering and Science- Gillbert Masters
3. Geoenvironment- V. Aswathanarayan
4. Soil chemistry – Bolt & Buggenwert

## EES- 205(A)

### BIOSTATISTICS AND COMPUTER APPLICATIONS

**Credit : 4**

**Marks:100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

Basic concepts of computer; History of computer evolution; Computer hardware; Operating systems: windows, unix and linux; Use of common application software in biology: word processing, spreadsheets, graphics and data base; Introduction to web browsing software and search engines with special reference to online environmental resources.

#### UNIT II

Concept of sample and population; Sampling; Sampling techniques: Random and Non-random; Qualitative and quantitative data; Discrete and continuous data; Scales of measurement: nominal, ordinal, ratio, interval; Collection and scrutiny of data; Data representation: line chart, bar chart, pie chart, histogram, frequency polygon, frequency curve, ogive curve; Measures of central tendency: mean, median, mode, geometric mean, harmonic mean.

#### UNIT III

Absolute and relative measures of dispersion: range, quartile deviation, mean deviation, standard deviation, variance, coefficients of dispersion; Concept of moment; Standard error; Quartiles; Box plot; Lorenz curve; Skewness and Kurtosis

#### UNIT IV

Correlation: scatter diagram, principle of least squares, karl pearson's correlation coefficient, coefficient of determination, correlation ratio, rank correlation; Linear regression: simple linear regression and multiple regression; Basic concept of probability theory; Basic concept of distributions: normal, log-normal, binomial, poisson; Testing of hypothesis and its significance; "t" test; Chi-square test: goodness-of-fit, test of independence, test of homogeneity; ANOVA: one way and two way.

#### Reference

1. Elementary statistics- Neil A. Weiss
2. Statistics for Environmental Science & Management- Bryar F.J. Manly
3. Introduction to Statistics- Kapoor & Sanchita.
4. Statistics for Earth and Environmental Science- Schuenemeyer & Drew
5. Biostatistics- Daniel
6. Principals of Biostatistics- Pagaro & Gauvrear

## **EES-205 (B)**

### **IPR & BIOSAFETY**

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory+ Internal assessment:70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### **Unit I**

Introduction to Intellectual Property Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of GMOs IP as a factor in R&D. Agreements and Treaties History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments

#### **Unit II**

Basics of Patents and Concept of Prior Art Introduction to Patents; Types of patent applications: Ordinary, PCT, Conventional, Divisional and Patent of Addition; Specifications: Provisional and complete; Forms and fees Invention in context of “prior art”; Patent databases; Searching International Databases; Country-wise patent searches (USPTO, esp@cenet(EPO), PATENTSCOPE(WIPO), IPO, etc.)

#### **Unit III**

Patent filing procedures National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation.

#### **Unit IV**

Introduction to Biological Safety Cabinets; Primary containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines - Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

#### **Reference**

1. P. Narayanan, Intellectual Property Laws, Eastern Law House.
2. Meenu Paul, Intellectual Property Laws, Allahabad Law Agency.
3. Intellectual Property Law containing Acts and Rules, Universal Law Publication Company.

**EES-206**

**LAB III: ENVIRONMENTAL MONITORING (WATER)**

**Credit : 4**

**Marks: 100**

**Practical Hrs: 4 + 4  
hrs**

**Exam duration: 6**

1. Determination of pH in a given water sample.
2. Determination of various form of alkalinity in a given water sample
3. Determination of Total hardness, calcium and magnesium hardness in a given water sample.
4. Determination of Total solids, suspended solid and dissolved solids in a given water sample.
5. Determination of conductivity in a given water sample.
6. Determination of Turbidity in a given water sample.
7. Determination of DO in given water sample.
8. Determination of BOD 5 day and ultimate BOD in sewage sample.
9. Determination of COD by open and closed reflux method in given waste water sample.
10. Determination of mineral contents in a given water sample (Calcium, Sodium, Potassium, Fluoride, Chloride, Phosphate and Sulphate).

**EES-207**

**Lab VI: ENVIRONMENTAL MONITORING (AIR & NOISE)**

**Credit : 4**

**Marks: 100**

**Practical Hrs: 4 + 4**

**Exam duration: 6 hrs**

1. Air Sampling
2. Determination of Suspended particulate matter using high volume sampler in Residential area.
3. Determination of Suspended particulate matter using high volume sampler in Institutional area.
4. Determination of SO<sub>x</sub> in ambient air.
5. Determination NO<sub>x</sub> in ambient air.
6. Estimation of Atmospheric Dust fall.
7. Estimation of Noise in Residential area.
8. Estimation of Noise in Institutional area.

## **EES-301**

### **ENVIRONMENTAL MICROBIOLOGY**

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### **UNIT I**

Microbial world: Introduction of environmental microbiology, relation of environmental microbiology with other allied sciences, Major groups of micro-organisms, Microbial interactions- neutralism, commensalism, synergism, mutualism, competition, ammensalism, parasitism, predation; interaction of microorganisms with plant and animals.

#### **UNIT II**

Air microbiology: Microflora of air: Outdoor and indoor microflora, Transmission of Microflora in air, enumeration and assessment of microorganisms in air, sources of contaminations of air: Outdoor and indoor, control mechanism of airborne microorganisms.

#### **UNIT III**

Water microbiology: Microbes in aquatic system, pathogens in water, Biofilms, bacteriological analysis of water and tests for indicator organisms, standard plate count method (SPC), most probable number count method (MPN), membrane filter method (MF), Role of microbes in wastewater treatment.

#### **UNIT IV**

Soil microbiology: distribution of different types of soil microorganisms, factors influencing microbial population, Rhizosphere effect, microbes in decomposition, mineralization and recycling process, Bioremediation, Solubilization of phosphate (PSB).

#### **Reference**

1. Microbiology: J.G. Black
2. Environmental and applied Microbiology: K.C. Agrawal
3. Microbiology: Pelzar
4. Microbial Botechnology: A.N. Glazer
5. Microbial Ecology: R.M. Atlas and Barthas

## EES-302

### POLLUTION CONTROL & MANAGEMENT

**Credit: 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

**Waste water treatment:** Drinking water treatment: Coagulation and flocculation, Sedimentation and Filtration, Disinfection and Softening. Primary treatment methods-screening, grit removal, primary sedimentation; Secondary treatment methods-activated sludge process, trickling filters, rotating biological contactors, oxidation ponds and lagoons, Advanced waste water treatment methods- removal of nutrients and solids; waste water reuse and sludge treatment and disposal.

#### UNIT II

**Air pollution control:** Control methods for particulates-gravitational settling chambers, centrifugal collectors, wet collectors/scrubbers, fabric filters, electrostatic precipitators, Control of gaseous pollutants through adsorption, absorption, condensation and combustion including catalytic combustion

#### UNIT III

**Solid waste management:** Types and sources of Municipal Solid waste, Characterization (Physical and Chemical), Collection, Transportation, Handling, Treatment, Disposal and Recycling of solid waste, composting, Vermicomposting, incineration and Sanitary landfills; Hospital waste management; e-waste: classification, methods of handling and disposal.

#### UNIT IV

**Hazardous waste management and Noise pollution control:** Hazardous waste – Definition, sources and categorization, characteristics and health impacts. Hazardous waste management: Treatment Methods – neutralization, oxidation reduction, precipitation, solidification, stabilization, incineration and final disposal.Noise pollution control:Absorbing materials, barrier materials, damping materials, Active noise control methods.

#### Reference

1. Environmental Pollution Control Engineering: C.S. Rao
2. Management of Municipal Solid waste: T.V. Ramchandra
3. Prospects and Perspectives of Solid Waste Management: B.B. Hosetti
4. Air pollution: Rao & Rao
5. Environmental Engineering: Peavy
6. Introduction to Environmental Engineering and science: Gilbert M. Masters
7. Industrial Noise Control: Bell & Bell



## **EES-303**

### **ENVIRONMENTAL BIOTECHNOLOGY**

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### **UNIT I**

An Introduction to Environmental biotechnology, Fundamentals of Environmental biotechnology. Concept of Genetic Engineering, Recombinant-DNA Technology, Genetically Modified Organism, Bt Cotton, Concept of Biosensor, types and its applications in environmental monitoring.

#### **UNIT II**

Application of biotechnology in environmental management, Bioremediation, Phytoremediation, Biotechnological approaches for preserving biodiversity: Gene banks, Germplasm bank, Microbial culture banks.

#### **UNIT III**

Green revolution, Environmental Issues related to agrochemicals, Concept of Sustainable Agriculture, Organic farming and its Ecological significance, Integrated Nutrient Management (INM), Integrated Pest Management (IPM), Allelopathy, Biofertilizer, Biopesticide, Fermentation Technology, Composting, Vermicomposting.

#### **UNIT IV**

Significance of Agriculture in Indian Economy, Role of Indian Council of Agriculture Research (I.C.A.R.), Concept of Crop rotation, Silviculture, Agro-forestry, Social Forestry, Joint Forest Management (JFM).

#### **Reference**

1. Environmental Biotechnology- S.N. Jogdanel
2. Text book of Environmental Biotechnology- P. K. Mohapatra
3. Environmental Science & Biotechnology:- Murugesan & Rajakumari
4. Environmental Biotechnology- Indu Shekhar Thakur
5. Environmental Microbiology - Maier, Pepper & Gerba

## EES-304 (A)

### ENVIRONMENTAL ISSUES

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

**Note for the Paper setter:** The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

**National Issues and Initiatives:-**Issues related to surface (Eutrophication, Heavy Metal, Pesticides etc ) and Ground water (Arsenic, Fluoride), Desertification, Deforestation. Mass movement for Environmental conservation: Narmada Bachao Andolan, Tehri Movement, Chipko Movement, Appiko Movement, Silent Valley.

#### UNIT II

National River Conservation Directorate, National Ganga River basin authority, Capacity Building for Industrial Pollution Management. Project Elephant, Project Tiger, Rain water harvesting, Wetland conservation

#### UNIT III

**International Issues and Initiatives:-** Climate Change, Transboundary Movement of Pollutants, The Club of Rome report, United Nations Conference on the Human Environment (Stockholm Declaration 1972), Agenda 21, WCS (World Conservation Strategy), IGBP(International Geosphere Biosphere Programme) Outer Space treaty, Vienna convention & Montreal Protocol, Kyoto Protocol, united nations Conference on Environment and Development- Rio Convention ( Earth Summit 1992), Antarctic Treaty, IPCC (Inter-governmental Panel for Climate change-), UNFCCC(United Nations Framework Conventions of Climate Change),.

#### UNIT IV

IUCN (International union for Conservation of Nature and Natural Resources), CITES (Convention on international Trade of Endangered Species of Wild Flora and Fauna), Man and Biosphere Programme (MAB). Convention on Biodiversity (CBD), Ramsar Convention on wetlands

Reference

<http://www.enfor.nic.in>, <http://www.ipcc.ch>

<https://www.iucn.org>, <http://www.ramsar.org/>

<http://www.cbd.int>, <http://www.cites.org>

<http://unfccc.int.>, <http://www.igbp.net>

## EES-304(B)

### ENVIRONMENTAL LAW

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

**Note for the Paper setter:** The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

Environmental legislation in India, India's Ancient Traditions for Protection of Environment, Constitutional Provisions for Protection of Environment. National conservation strategy and Policy statement on Environment and Development 1992.

#### UNIT II

Wildlife Protection Act, 1972, & 1991; Indian Forest Act, 1982 Forest Conservation Act, 1980 Indian Forest act, 1982; National Forest Policy, 1988; Biodiversity Conservation Act, 2002.

#### UNIT III

The Water (prevention and Control of Pollution) Act, 1974; The Air (prevention and Control of Pollution) Act, 1981; ; Ozone depleting Substances Regulation and Control rules 2000; Environmental Protection Act, 1986; Noise Pollution Regulation and Control Rules, 2000. Environmental Audit Notification 1992; Environmental Impact Assessment Notification 1994, Ecomark.

#### UNIT IV

Biomedical Waste Management and Handling Rules, 1998, Hazardous Waste Management and Handling rules, 1989. Municipal Solid Wastes (Management and Handling) Rules, 2000, Energy Act 2002, Public Liability Insurance Act, 1991, Disaster Management Act 2005, National Green Tribunal Act 2010, Green Bench.

#### Reference

1. Environmental Law- Sumeet Malik
2. Environmental Law - S. C. Shastri
3. International Environmental Law- Sethi & Kulkarni
4. Environmental Noise Pollution-V. Mahandiyani
5. Environmental Laws in India- A. K. Tiwari
6. Environmental Law and Policy in India- Diwan & Armin
7. Environmental Policy & Law- Garg, Bishnoi & Mallik

**EES-305**

**Lab V: ENVIRONMENTAL MICROBIOLOGY**

**Credit : 4**

**Marks: 100**

**Practical Hrs: 4+4**

**Exam duration: 6 hrs**

1. Concept and preparation of different culture media.
2. Isolation of fungi from soil sample.
3. Isolation of bacteria from soil sample.
4. Isolation of fungi from water and waste water samples
5. Isolation of bacteria from water and waste water samples.
6. Slide preparation of fungal and bacterial samples for microscopic studies.
7. Gram staining of bacterial isolates
8. Estimation of fungal biomass in liquid media
9. Estimation of bacterial biomass in liquid media
10. Calculation of Fungal colony by Colony Forming Units (CFU).

Reference

- |    |   |                      |
|----|---|----------------------|
| 1. | Microbiology: A laboratory manual                 | Cappuccino & Sherman |
| 2. | Microbiological applications: A laboratory manual | Brown & Smith        |
| 3. | Manual of Environmental microbiology              | Yates et al          |

**EES-306(A)**

**Lab VI: BIOSTATISTICS & COMPUTER APPLICATION**

**Credit : 4**

**Marks: 100**

**Practical Hrs:4 + 4**

**Exam duration: 6 hrs**

1. Environmental Sampling by different methods
2. Plot various statistical curves (histogram, frequency polygon, frequency curve, ogive curve) using computer software.
3. Estimation of central tendency (mean, median and mode) using computer software.
4. Estimation of dispersion (range, standard deviation and variance) using computer software.
5. Estimate the skewness and kurtosis using computer software.
6. Plot the scatter diagram and estimate the coefficient of correlation value using computer software.
7. Perform the linear regression analysis using computer software.
8. Perform the ANOVA (one way) using computer software.
9. Computer application in Environmental Science
10. Application of MS-Word in Environmental Science
11. Application of MS-Excel in Environmental Science
12. Application of Power Point in Environmental Science
13. Application of internet resources in Environmental Science

**EES-306 (B)**

**Lab VI: Solid Waste**

**Credit : 4**

**Marks: 100**

**Practical Hrs: 4 + 4**

**Exam duration: 6 hrs**

1. Characterization of Solid Waste
2. Composition of Solid waste in Rural settlement
3. Composition of Solid waste in Urban settlement
4. Estimation of Bulk Density of solid waste
5. Estimation of Moisture Content of Solid waste
6. Estimation of Volume of Solid waste
7. Field Visit to sanitary land fill site (Report)

**EES-401**  
**ENERGY RESOURCES**

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

Note for the Paper setter: The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

**UNIT I**

Introduction of energy sources; Energy sources- renewable & non-renewable, conventional & non-conventional, primary, secondary & substantial energy sources; Energy consumption pattern in India, Energy; Rural Energy consumption pattern in India; Rural Energy Programmes in India; conservation strategy of energy resources, environmental impacts of energy resources on environment,

**UNIT II**

Non-renewable Energy; Fossil fuel -Coal, Petroleum, Natural gas; Classification, composition and characterization Coal, Petroleum, Natural gas; energy content and calorific value of Coal, Petroleum, Natural gas, other energy sources- shale oil, coal bed methane, gas hydrates.

**UNIT III**

Renewable energy; Sun as a source of energy - Solar energy, solar radiation and its spectral characteristics, Solar radiation measurement, solar collectors, Photo-Voltaic modules, Solar pond; Different Type of nuclear reactors and Nuclear energy in Indian scenario

**UNIT IV**

Principles of generation of Wind energy, Geothermal energy, Ocean energy: Tidal energy, wave energy and Ocean Thermal Energy Conversion (OTEC), solar energy and Bioenergy: Biomass conversion Technologies, Biogas, Producer gas, Energy Plantations/Petrocrops.

Reference

1. Natural resources conservation - Oliver S. Owen and Chiras
2. Living in the Environment - T.J. Miller
3. Environmental science - Cunningham Saigo
4. Non-conventional energy sources - G.D. Rai

## EES-402

### ENVIRONMENTAL HEALTH AND TOXICOLOGY

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

**Note for the Paper setter:** The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

Introduction and Principles of Toxicology, Toxic chemicals in the environment and their effects, Xenobiotic Compounds, Toxic responses of xenobiotic compounds in animal and plant system, Pesticide: classes and types, Toxic effects of DDT, Endosulphan, 2, 4 D on humans. Mode of entry of Toxic substances in human body and Detoxification sites in human body, Bioaccumulation, Biotransformation. Toxic effects of heavy metals : Lead (Pb), Cadmium (Cd), Chromium (Cr), and Mercury (Hg).

#### UNIT II

Occupational Health Hazards, Major occupational Diseases, protective and safety measures for occupational health hazards, International and National organizations in the field of occupational health: NIOH, IITR, Industrial disasters: Bhopal gas tragedy.

#### UNIT III

Epidemiological Issues- Goiter, Fluorosis and Arsenic poisoning. Concept and significance of trace elements, deficiency and disorder related to trace elements. Water borne diseases and Food borne diseases. Malaria: Life cycle of *Plasmodium* species, Tuberculosis and AIDS.

#### UNIT IV

Radioactive pollution: Natural and anthropogenic sources of radiation in Environment, Concept of Radioactivity, Radioactive waste. Effect of Radioactive pollution on Plants, Animals and Humans, Chernobyl disaster.

#### Reference

1. Introduction to Environmental Toxicology- Landis, Sofield & Hoyu
2. Pesticides: Methods and their residue estimation- Kumari & Kathpal
3. Text Book of Toxicology- Balram Pani
4. Environmental Toxicology- Trivedi , Jaiswal, Pandey & Shukla
5. Trace elements as contaminants and nutrients- M V Prasad
6. Fundamental of Toxicology- P K Gupta



## EES-403

### REMOTE SENSING AND MODELLING

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

**Note for the Paper setter:** The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

Basic concepts and principals of remote sensing, Sensors and platforms, Physical Basis of remote sensing, Photo interpretation, Digital image processing and ground truthing, Geographical Information System (GIS) and Global Positioning System (GPS).

#### UNIT II

Application of remote sensing and GIS in: Environmental management, Forestry, Land cover / Landuse planning, Natural disasters, Vegetation studies, Natural resources, Climate Change, Urban Sprawling

#### UNIT III

Role of modelling in environmental sciences, Model classification: Deterministic model, Stochastic model, Steady state model, Dynamic model, Different stages involved in model building. Methods for the formulation of dynamic balance equation- Mass balance procedures, Energy balance procedures.

#### UNIT IV

Streeter Phelps Oxygen Sag model, Box model, Gaussian Plume model, Two Species population growth model of competition, Lotka-Volterra Prey predator model, Logistic Growth Curve, Maximum sustainable yield, Carrying capacity, Leslie's matrix model.

#### Reference

1. Fundamentals of Remote Sensing- G. Joseph
2. Remote Sensing and Image Interpretation- T.M. Lillesand, R.W. Kiefer, J.W. Chipman
3. Dynamics of Environmental Bioprocesses- Modeling and Simulation: Snaps and Dunn
4. Introduction to Environmental Remote Sensing- Curtis

## **EES-404(A)**

### **NATURAL RESOURCE MANAGEMENT**

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

**Note for the Paper setter:** The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### **UNIT I**

Natural Resource: Definition, Principle of natural resource conservation, types of natural resources, major issues related to natural resources.

#### **UNIT II**

##### **Biological resource management**

Forest and their significance, Range lands and their importance. Management of tropical and temperate forest, effects of de-forestation on ecological setup, desertification- International and national initiatives, Management of Wetlands, Wildlife Management, Forest management.

#### **UNIT II**

##### **Water Resource management**

Water resources management- initiatives for the management of watersheds, Rehabilitation of Eutrophicated lakes and polluted water bodies, rehabilitation of polluted rivers- Ganga action plan, Yamuna action plan; rain water harvesting.

#### **UNIT III**

##### **Land Resource management**

Soil conservation; Watershed Management, wasteland management, Wetland Management strategies, Reclamation of usar, alkaline and saline soil.

#### **Reference**

1. Conservation Ecology – G.W. Cox
2. Restoration of degraded lands (Ed)-J.S. Singh
3. Natural Resource Conservation- Owen & Chiras
4. Biotechnology Environmental Management-Biotol Series
5. Environmental Chemistry- B K Sharma
6. Wetland Ecosystem- Mitsch, Gosselink, Anderson & Zhang

## EES-404(B)

### ENVIRONMENTAL HAZARDS AND DISASTERS

**Credit : 4**

**Marks: 100**

**Time: 3Hrs**

**Theory +Internal assessment: 70+30**

**Note for the Paper setter:** The question paper will consist of nine questions in all. The first question (5X2 =10 marks) will be compulsory and will consist of five short questions of 2 marks each covering the whole syllabus. In addition eight more questions will be set unit-wise comprising of two questions (15 marks each) from each of the four units. The candidate is required to attempt four questions of 15 marks each, selecting at least one question of 15 marks from each unit.

#### UNIT I

**Natural Hazard:** Preparedness, Zoning, Prediction and Mitigation; Human and hazard, Global climate and hazard, Natural vs. Man-made Disaster.

#### UNIT II

**Geological hazards and disaster:** Earthquake and Seismic hazards, Earthquake intensity and scales, Impacts, Himalayan Seismicity, Avalanches; Landslides, Volcano, Tsunami. Uttarakhand Disaster.

#### UNIT III

**Climatic hazards and disaster:** Tropical Cyclones, Western disturbances and Winter Rains in India, Anticyclones, Blizzards, Windstorms, Hail storms, Cloud burst, Floods, Drought, El-Nino, La-Nina.

#### UNIT IV

**Chemical and Biological hazards:** Outbreak of epidemic and pandemic diseases: Bird Flu, Biological warfare, Biological terrorism: Anthrax. Radioactive hazards, Chernobyl Disaster, Bhopal gas Tragedy, Exxon Valdez Oil spill. National and International efforts for disaster management.

#### Reference

1. Environmental Geology: Edward A. Keller
2. Confronting climate change: I.M. Mintzer
3. Atmosphere, Weather and Climate: Navarraa
4. Climatology- Rohli & Vega
5. Natural hazards and Disasters- Hyndman & Hyndman
6. Disaster management- Jagbir Singh
7. Geology and the Environment- Pipkin, Trent, Hazlett & Bierman

**LAB VII EES-405(A)**

**PRACTICAL: ENVIRONMENTAL BIOCHEMISTRY**

**Credit : 4**

**Marks: 100**

**Practical Hrs: 4+4**

**Exam duration: 6 hrs**

1. Principle and working of spectrophotometer
2. Spectrophotometric estimation of Chlorophyll a, Chlorophyll b, Total Chlorophyll
3. Spectrophotometric estimation of Total Carotenoid in plant sample.
4. Concept and preparation of standard curve
5. Spectrophotometric estimation of Total Carbohydrate in plant sample
6. Spectrophotometric estimation of Total Phenol in plant sample.
7. Spectrophotometric estimation of Proline in plant sample
8. Spectrophotometric estimation of Protein in plant sample

Reference

1. Manual of Environmental analysis

N C Aery

**EES-405(B)**

**LAB IX: PRACTICAL ASPECTS OF ENERGY**

**Credit : 4**

**Marks: 100**

**Practical Hrs:4 + 4**

**Exam duration: 6 hrs**

1. To determine the Calorific value of given materials.
2. To understand the principle and working of solar power panel.
3. To understand the principle and working of solar cooker.
4. To understand the principle and working of solar heater.
5. To determine the total shining hour using sunshine recorder.
6. To understand the principle and working of biogas plant.
7. To understand the principle and working of solar pond.
8. Field visit to Energy harvesting system: Solar /Windmill / Tidal energy/ OTEC/  
Geothermal /Hydro Electricity (Report)

## **EES- 406**

### **Field visit**

**Credit:2**

**Marks:50**

Every enrolled student of M.Sc. (Environmental Sciences) programme, shall have to visit any field or area's related to environment i.e. aquarium/ botanical garden/ zoological garden/ solid waste management plant/ solar park/ landfill site/ water treatment plant/ Hydrological power plant/ Refinery/ Thermal power plant/biodiversity park/ conservation reserve/ wildlife sanctuary/ national park/ aquatic ecosystem/ Ramsar site of national and international importance/ desert ecosystem/ biosphere reserve/ geological site) in third or fourth semester and will submit a 10-15 page original report both in hard copy and soft copy in fourth semester focusing on the environmental significance and issues of the visited field/ area. He/She will also prepare and deliver a power point presentation of the visit conducted in a viva voce before the committee comprising of departmental faculty in fourth semester for evaluation. Every student shall be required to submit the topic of his/her field visit to the chairperson so that the same may be displayed on the notice board for the presentation schedule.

## **EES- 308**

### **Training/ Minor project**

**Credit:2**

**Marks:50**

Every enrolled student of M.Sc. (Environmental Sciences) programme shall have to undergo training for the period of 21 days or three weeks in any governmental /nongovernmental / industrial organizations working on various aspects of environment and will submit a report (hard copy and soft copy) along with training certificate issued by the organization. After completing training programme he/she will also prepare and deliver a power point presentation of the training attended in the department .The power point presentation will be of 10-15 minutes duration during which question will be raised by the committee comprising of faculty of the department. Every student shall be required to submit the topic of his/her training to the chairperson so that the same may be displayed on the notice board for the presentation schedule.