FACULTY OF LIFE SCIENCES

SYLLABUS

FOR

M.Sc. (ENVIRONMENTAL SCIENCES)

(Credit Based Evaluation & Grading System)

(Semester: I - IV)

Examinations: 2019-20

GURU NANAK DEV UNIVERSITY AMRITSAR

M.Sc. (Environmental Sciences) (Semester System)
(Credit Based Evaluation & Grading System)

SCHEME

Note : All Theory Papers having Mid Semester Marks : 20 & End Semester Marks : 80. Total Marks will be 100.

Semester-I

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
BSL401	C	Mathematical Biology	3	0	0	3
ESL403	C	Environmental Chemistry	3	0	0	3
ESL404	C	Air Pollution	3	0	0	3
ESL405	C	Atmosphere and Hydrosphere	3	0	0	3
ESL407	C	Conservation Biology	2	1	0	3
ESP423	C	Environmental Science Lab I (Based on ESL403, ESL404)	0	0	3	3
ESP424	C	Environmental Science Lab II (Based on BSL401, ESL405)	0	0	3	3
Interdisciplinary/ MOOC Course						
	I	To be offered from outside the department	4	0	0	4
		Total Credit	18	1	6	**25**

Semester-II

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
ESL451	C	Environmental Engineering	3	0	0	3
ESL452	C	Environmental Geology	3	0	0	3
ESL453	C	Sanitary Engineering and Environmental Management	3	0	0	3
BSL451	C	Statistical Techniques	3	0	0	3
BSL453	C	Instrumental Methods of Analysis	3	0	0	3
ESP471	C	Environmental Science Lab III (Based on ESL451 and ESL452)	0	0	3	3
ESP472	C	Environmental Science Lab IV (Based on ESL453 and BSL453)	0	0	3	3
ESS473	C	Seminar	0	0	0	0
Interdisciplinary/ MOOC Course						
	I	To be offered from outside the department	4	0	0	4
		Total Credit	19	0	6	**25**

Note : PSL-053 ID Course Human Rights & Constitutional Duties (Compulsory Paper). Students can opt. this paper in any semester except the 1st Semester. This ID Paper is one of the total ID Papers of this course.

M.Sc. (Environmental Sciences) (Semester System)
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Semester-III

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
ESL501	C	Wastewater Treatment Plant Design	3	0	0	3
ESL503	C	Environmental Biotechnology	3	0	0	3
ESL504	C	Environmental Microbiology	3	0	0	3
ESL505	C	Hazardous Chemicals	3	0	0	3
ESL506	C	Ecological Modelling	3	0	0	3
ESP524	C	Environmental Science Lab V (Based on ESL503 and ESL504)	0	0	3	3
ESP525	C	Environmental Science Lab VI (Based on ESL501 and ESL505)	0	0	2	2
ESD523	C	Case Study/Industrial Training	0	0	1	1
Interdisciplinary/ MOOC Course						
	I	To be offered from outside the department	4	0	0	4
		Total Credit	19	0	6	**25**

Semester-IV

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
ESL551	C	Industrial Wastewater Management	3	0	0	3
ESL553	C	Environmental Toxicology	3	0	0	3
ESL554	C	Natural Resource Management	3	0	0	3
ESL555	C	Remote Sensing and GIS	2	0	0	2
ESP576	C	Environmental Science Practical VII (Based on ESL553, ESL554 and ESL555)	0	0	3	3
ESD573	C	Project Report/ Advance Practical /Assignment/Review/Status Report	0	0	2	2
ESF574	C	Field Study/ Industrial visit	0	0	1	1
Elective/MOOC Course						
	E	Elective Course	4	0	0	3
		Total Credit	15	0	6	**21**

List of Elective Courses

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
BSL585	E	Dynamics of Biogeography	3	0	0	3
BSL588	E	Perspectives in Conservation	3	0	0	3
ESL581	E	Urban Planning and Environmental Management	3	0	0	3
ESL583	E	Geoinformatics in Environmental Management	3	0	0	3
ESL584	E	Solid Waste Management	3	0	0	3
ESL585	E	Bioremediation	3	0	0	3
ESL586	E	Environmental Safety and Management	3	0	0	3
ESL587	E	Waste Stabilization Ponds	3	0	0	3
ESL588	E	Water and Wastewater Analysis	3	0	0	3
ESL589	E	Water Treatment Processes	3	0	0	3
ESL590	E	Environmental Laws and Impact Assessment	3	0	0	3
ESL502	E	Software System Analysis in Ecology	3	0	0	3

M.Sc. (Environmental Sciences) (Semester-I)
(Credit Based Evaluation & Grading System)

BSL401 – Mathematical Biology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Linear Function:** $y=ax$ and $y=ax+b$, linear relation, linear programming
2. **Power Function:** $y=ax^n$, polynomials, differences, quadratic equation.
3. **Exponential and Logarithmic Functions:** Exponential function $y=aq^x$, logarithmic function, scaling, Weber's law, spirals- spiral of Archimedes and logarithmic spiral.

SECTION-B

4. **Graphical Methods:** Linear, semi logarithmic and double logarithmic plots, triangular charts.
5. **Limits:** Limits of sequences, Fibonacci sequence.
6. **Differentiation and Integration:** Growth rates, instantaneous rate of change, differentiation of some important functions, product rule and quotient rule of differentiation, chain rule of differentiation.

SECTION-C

7. **Integration:** Integrals, definite integral, rules of integration, second derivative, extremes of a function, mean of a continuous function.
8. **Differentiation and Integration of Exponential and Logarithmic Functions:** $d/dx(e^x)$, $d/dx(\ln x)$, integral of $1/x$, properties of $\ln x$**,** inverse function of $\ln x$, logarithms, $a^x = e^{x\ln a}$, introduction to hyperbolic functions.

SECTION-D

9. **Periodic Function:** Cycloid, polar coordinates, sine and cosine, conversion of polar coordinates into rectangular coordinates, trigonometric relations, polar graphs, trigonometric polynomials.
10. **Ordinary Differential Equations:** $y'=ay$, $y'=ay+b$, $y'=ay^2 + by+c$, $dy/dx=k.y/x$.
11. **Fractal Dimension**: Measurement by divider method, applications in biology.

References:

1. Batschelet, E. (1971). Introduction to Mathematics for Life Scientists. Springer-Verlag, Berlin.

M.Sc. (Environmental Sciences) (Semester-I)
(Credit Based Evaluation & Grading System)

ESL403 – Environmental Chemistry

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Fundamentals of Environmental Chemistry:** Stoichiometry, Gibb's energy, chemical potential, chemical equilibria, acid base reactions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydrocarbons, radionuclides.
2. **Physical Processes of Pollutant Transport and Dispersion:** Transport media, transport of pollutants in air, some important types of reactions which pollutants undergo in the atmosphere.
3. **Dispersion of Pollutants in Water:** Physical transport in surface water, dispersion of pollutants in ground water, biochemical processes in water involving microorganisms.

SECTION-B

4. **Dispersion of Pollutants in Soil:** Adsorption and decomposition of organic pollutants in soil, fate of soil pollutants, sorptive properties of soil, colloids, cation exchange capacity, siltation of lakes.
5. **Major Types of Water Pollutants**: Oxygen demanding wastes, disease causing agents, synthetic organic compounds, plant nutrients, inorganic chemicals and minerals, sediments, oil, impact of water pollution on environment, radioactive and thermal pollution.

SECTION-C

6. **Monitoring and Analysis of Water/Wastewater Parameters:** Turbidity, colour, pH, acidity, hardness, residual chlorine and chlorine demand, chlorides, dissolved oxygen, biochemical oxygen demand, chemical oxygen demand, nitrogen, solids, iron and manganese, fluoride, sulphate, phosphorus and phosphate, oil and grease, volatile acids, gas analysis, trace contaminants, biological examination of water.
7. **Soil Chemistry:** Inorganic and organic components of soil, rocks, weathering, processes of soil formation, soil micro-organisms and their functions, nitrogen pathways and NPK in soils, physico-chemical, bacteriological sampling and analysis of soil quality.

SECTION-D

8. **Soil Pollution and Control:** Soil pollutants, detrimental effects of soil pollution and soil erosion, degradation of pesticides in soil, different kinds of synthetic fertilizers and their pollution, methods to minimize soil pollution, soil pollution monitoring.

9. **Environmental Geochemistry:** Concept of major, trace and REE, classification of trace elements, mobility of trace elements, geochemical cycles, biogeochemical factors in environmental health, human use of trace elements and health, possible effects of imbalance of some trace elements, diseases induced by human use of lead.

References:

1. Alloway, B. J., Ayres, D.C. (1997). Chemical Principles of Environmental Pollution. Blackie Academic and Professional, London.
2. Hemond, H.F. and Fechner, E. (1994). Chemical Fate and Transport in the Environment. Academic Press, San Diego.
3. Karikalan, V.L. (2002). Environmental Engineering. Dhanpati Rai & Co. (P) Ltd., Delhi.
4. Manahan, S.E. (1991). Environmental Chemistry. Lewis Publishers, Chelsea, Michigan.
5. O' Neill, P. (1993). Environmental Chemistry. Chapman and Hall, London.
6. Peavy, A.S., Rowe, D.R., Tchobanoglous, G. (1985). Environmental Engineering. McGraw Hill, Singapore.
7. Rao, C.S. (1991). Environmental Pollution Control Engineering. Wiley Eastern, New Delhi.
8. Richardson, M.L. (ed.)(1991). Chemistry, Agriculture and the Environment. Royal Society of Chemistry, Cambridge.
9. Rowell, D.L. (1994). Soil Science: Methods and Applications. Longman Harlow.
10. Sawyer, C.N., Mc Carty, P.L. and Parkin, G.F. (1994). Chemistry for Environmental Engineering. McGraw Hill Inc., New York .
11. Schwarzenbach, R.P., Gschwend, P.M. and Imboden, D.M. (1993) Environmental Organic Chemistry, Wiley Interscience, New York.
12. Sharma, B.K. and Kaur H. (1998). Environmental Chemistry. Goel Publishing House, Meerut.
13. Tchobanoglous, G. and Burton, F.L. (1979). Waste water engineering: Treatment, Disposal, and Reuse. Tata McGraw Hill, New Delhi.
14. Wild, A. (1993). Soils and the Environment. Cambridge University Press, Cambridge.

M.Sc. (Environmental Sciences) (Semester-I)
(Credit Based Evaluation & Grading System)

ESL404 - Air Pollution

Credits 2-1-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. 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.
2. Thermo-chemical and photochemical reactions in the atmosphere. Oxygen and ozone chemistry, chemistry of air pollutants, Photochemical smog.
3. Natural and anthropogenic sources of air pollution. Primary and Secondary pollutants, Transport and diffusion of pollutants.

SECTION-B

4. Methods of monitoring and control of air pollution SO_2, NO_x, PM_{10} & $PM_{2.5}$. Effect of pollutants on human beings, plants, animals, materials and on climate. National Ambient Air Quality Standards (NAAQS), Air Quality Index (AQI).
5. First and second law of thermodynamics, heat transfer processes. Scale of meteorology, pressure, temperature, precipitation, humidity, radiation and wind. Atmospheric stability, inversion, and mixing height, wind rose.

SECTION-C

6. Effect of lapse rate on plume behaviour. Maximum mixing depth, Gaussian dispersion model, Effective stack height.
7. 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.

SECTION-D

8. Stack sampling (with special emphasis on isokinetic sampling) and analysis of temperature, flow velocity, composition.
9. Global environmental problems: ozone depletion, global warming and climate change. Green belt design. Control of air pollution by process change. Management strategies for air pollution abatement. Vehicular pollution and urban air quality.

References:

1. Nevers, N. D. (1995). Air Pollution Control Engineering. McGraw-Hill Publishing Company, New York.
2. Peavy, H. S., Rowe, D. R. and Tchobanoglous, G. (1985). Environmental Engineering. McGraw-Hill Book Company, Singapore.
3. Rao, M. N. & Rao, H. V. N. (1989). Air Pollution. Tata McGraw-Hill Publishing Company Limited, New Delhi.
4. Stern, A. C. & Boubel, A. (2000). Fundamentals of Air Pollution 3/e, Academic Press, New York.

M.Sc. (Environmental Sciences) (Semester-I)
(Credit Based Evaluation & Grading System)

ESL405 - Atmosphere and Hydrosphere

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Seasons and Time:** Foucault pendulum, rotation and revolt earth, perihelion and aphelion, solstice and equinox, sun's declination, local and standard time, daylight saving time, time zones, International Date Line.
2. **Cartography:** Meridians and parallels, longitude and latitude scales, Map projections: zenithal, conic, cylindric, stereographic, secant conic, mercator, homolographic, sinusoidal, homolosice, universal transverse Mercator, multipurpose and thematic, planimetric and flow maps, importance of third dimension on maps.
3. **The Earth Systems and Biosphere:** Conservation of matter in various geospheres, Energy budget of Earth, Ecosystems flow of energy and matter, Coexistence in communities-food webs, Earth's major ecosystems: terrestrial and aquatic.

SECTION-B

4. **Atmosphere:** Composition of the atmosphere, atmospheric pressure and temperature, ozone layer, magnetic atmosphere, Effects of primary and secondary pollutants.
5. **Global Wind Circulation:** Winds, anemometer, pressure gradient force, sea and breezes, Coriolis effect, cyclones and anticyclones, surface pressure systems, monsoon, local winds, geostrophic wind, meridional winds, Hadley cell circulation, Westerlies, Rossby winds, jet stream, ocean currents.
6. **Air Masses and Cyclones:** Climates of India, Indian monsoon, El Nino, Droughts, Tropical cyclones, air masses and warm fronts, tornadoes, Western disturbances.

SECTION-C

7. **Oceans:** World ocean, Oceans as new areas for exploration of mineral resources, Ocean pollution.
8. **Water Resources and Environment:** Global water balance, Ice sheets and fluctuations at sea levels, composition of sea water, hydrological cycle, factors influencing surface water, ground water and its pollution.
9. **Runoff and Streams:** Drawdown and cone of depression, salt water intrusion, Overland flow nterflow, base flow, drainage system, stream channel geometry (flow, discharge, gauging), floods, hydrologic effects of urbanization, lakes and ponds.

10. **Atmospheric Water:** Water states and heat, humidity, adiabetic process, cloud particles and forms, fog, precipitation, stable air, thunderstorms, hail and lightening, orographic precipitation, global balances of energy and water, convective storm, low and upper level inversions, Pollution dome and acid deposition.

SECTION-D

11. **Radiation Balance:** Electromagnetic radiation, solar constant, energy spectrum of sun and earth, Stefan – Boltzmann law, insolation and its losses, world latitude zones, radiation balance, albedo, man's impact on radiation balance, temperature inversion, land and water temperature contrasts, global climate changes.

12. **World Climates:** classification based on net radiation, air temperature, precipitation, air masses and frontal zones, climate types, Koppen system of climate classification.

References:

1. Strahler, A.N. and Strahler, A.N. (1992). Modern Physical Geography, John Wiley & Sons, Inc., New York.
2. Dlij, H.J. and Muller, P.O. (1996). Physical Geography of the Global Environment. John Wiley & Sons, Inc. New York.
3. Skinner, B.J. and Porter, S.C. (1987). Physical Geology John Wiley & Sons, New York.
4. Donn, W.L. (1972). The Earth, John Wiley & Sons Inc., New York.

M.Sc. (Environmental Sciences) (Semester-I)
(Credit Based Evaluation & Grading System)

ESL407 –Conservation Biology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Background, Terminology and Concepts:** An introduction to biological diversity (Species diversity, naming and classification, genetic diversity, eco diversity), conservation biology, its origin, ethical principals, importance of conservation Biology
2. **Habitat Destruction, and Global Climate Change:** Human population growth and its effect, Habitat destruction (threatened rain forests, other threatened habitats, marine coastal areas, desertification); habitat fragmentation , edge effect, habitat degradation and pollution, global climate change (changes in temperate and tropical climates; plants and climate change, rising sea levels and warmer waters, overall effect of global warming)

SECTION-B

3. **Threats to Biological Diversity:** Spatial pattern of biological diversity in the world, Variation in climate, environment, topography and habitat size, Ecological Succession and ecosystem dynamics, Principals of community organization, Extinctions (Past mass extinctions and current human caused extinction, extinction rates on islands, extinction rates in aquatic environments, local extinctions, estimating extinction rates with island biogeography model), Vulnerabilty to extinction (Endemic species and extinction, species vulnerable to extinction).
4. **Invasive Species and Disease**: Over exploitation, International wildlife trade, commercial harvesting; Invasive species on islands, GMOs and conservation biology, Implications of invasive species and diseases for human health.

SECTION-C

5. **Conservation at the Population and Species Level**: Problems of small populations (Minimum Viable populations, loss of genetic variability, consequences of reduced genetic variability, factors that affect the persistence of small populations, Demographic variations, Environmental variation and catastrophes, Extinction vortices,

6. **Applied Population Biology and Conservation Strategies**: Methods for studying populations (gathering ecological info and monitoring populations), population viability analysis, metapopulations, long term monitoring of species and ecosystems, Establishing new populations (various approaches) status of populations, Ex-situ conservation strategies

SECTION-D

7. **Protected Areas and Restoration Ecology**- Protected areas, classification and their establishment, designing network of protected areas, protected area size and characteristics, Researve design and species preservation, minimizing edge effects and fragmentation effects, landscape ecology and park design, management of protected areas, conservation outside protected areas (conservation in urban areas, agricultural areas), ecosystem management, Ecological restoration techniques, case studies, restoration in urban areas.
8. **International Approach to Conservation:** International agreements to protect species and habitats, funding for conservation, funding sources and programs, Role of Conservation Biologist, Ongoing Problems and solutions, Challenges for conservation biologists.
5. **Genetic Monitoring and Management**: Admixtures, Role of genetic management in conservation breeding and ex-situ conservation, The appropriate geographic scale of management, Identification of Management Units, systematic and conservation units

References:

1. Soulé, M. E.(1996). Conservation Biology: The Science of Scarcity and Diversity. Sunderland, MA: Sinauer & Associates.
2. Frankham et al. (2010). Introduction to Conservation Genetics, 2nd Edition, Cambridge Univ. Press
3. Allendorf F.W., Luikart G. (2007). Conservation and the Genetics of Populations. Blackwell, Oxford.

M.Sc. (Environmental Sciences) (Semester-II)
(Credit Based Evaluation & Grading System)

ESL451 - Environmental Engineering

Credits 2-1-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Water Chemistry**:** Chemistry of water, concept of DO, BOD, COD, sedimentation coagulation, filtration, Redox potential
2. BOD test procedure, determination of BOD_5 and modelling of BOD_5. Calculation BOD constants using Least square and Fujimoto methods. Interrelationship between BOD, COD and TOC.

SECTION-B

3. Box model, point source stream pollution, Dissolved oxygen model (oxygen sag curve). Basic design of Screening, sedimentation, Filtration, Softening. Break point chlorination.
4. Physico-chemical and bacteriological sampling including MPN test and analysis of water quality. Standards for water quality BIS 10500:2012 and wastewater discharge.
5. Methods of Sampling: Grab, Composite and integrated. Sample volumes, Selection of sampling points.

SECTION-C

6. Tests performed in the laboratory for raw sewage, primary sedimentation tank, aeration tank, secondary settling tank, sludge digester and stabilization ponds.
7. Flow Measurements: Notches and Weirs, Flumes, Venturi meters, Drops, Current meter. Flow Equalization
8. Treatment plant operation and maintenance for screens, grit chamber, sedimentation tank, aeration tank, trickling filters, sludge digestion tanks, sludge drying beds and stabilization ponds.

SECTION-D

9. Chemical precipitation for the removal of Heavy metals and dissolved inorganic substances.
10. Adsorption (Freundich & Langmuir isotherm), Advanced Oxidation Process, Multiple Effect Evaporator
11. Flow sheets of water and wastewater treatment plant.

References:

1. Eckenfelder, W. W. Jr. (1989). Industrial Water Pollution Control. McGraw-Hill Book Company, New York.
2. Garg, S. K. (2003) Sewage Disposal and Air Pollution Engineering, Khanna Publishers, Delhi.
3. Manual of Water Supply and Treatment. (1999). Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development, New Delhi.
4. Manual on Sewerage and Sewage Treatment. (1993). Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development, New Delhi.
5. McGhee, T. J. (1991). Water Supply and Sewerage. McGraw-Hill, New York.
6. Metcalf & Eddy Inc. Revised by Tchobanoglous, G., Burton, F. L. and Stensel, H. D. (2002). Wastewater Engineering Treatment and Reuse 4/e. Tata McGraw-Hill Publishing Company Limited, New Delhi.
7. Peavy, H. S., Rowe, D. R. and Tchobanoglous, G. (1985). Environmental Engineering. McGraw-Hill Book Company, Singapore.

M.Sc. (Environmental Sciences) (Semester-II)
(Credit Based Evaluation & Grading System)

ESL452 - Environmental Geology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Earth's Crust:** Composition, rocks and minerals, magma, igneous rocks, weathering, clastic and non clastic sediments and sedimentary rocks, metamorphic rocks.
2. **Earth's Processes and Geological Hazards:** Earth's processes, catastrophic geological hazards, prediction and perception of the hazards and management of geological hazards.
3. **Lithosphere and Plate Tectonics:** Earth's interior and crust, lithosphere and asthenosphere, continents and ocean basins, earth's relief features, geologic time scale, second order relief features of continents, alpine chains, second order relief features of ocean basins, plate tectonics, subduction tectonics, orogeny, continental drift, tectonic system.

SECTION-B

4. **Volcanic and Tectonic Landforms:** Initial and sequential landforms, volcanic activity, composite volcanoes, calderas, flood basalts and shield volcanoes, cinder cones, volcanic activity and land forms, geothermal energy sources, landforms of tectonic activity.
5. **Landforms of Weathering and Mass Wasting:** Wasting of slopes, geometry of rock breakup, effects of physical and chemical weathering, lime stone caverns, karst landscapes, mass wasting, geomorphic aspects of arctic tundra.
6. **Landforms Made by Running Water:** Fluvial processes and landform, normal and accelerated slope erosion, land use and sediment yield, accelerated soil erosion, stream erosion and transport, landforms of flood plains, flood abatement measures.

SECTION-C

7. **Denudation:** Available land mass, tectonic uplift, landmass rejuvination, desert climate process system, hill slope evolution, savanna.
8. **Landforms and Rock Structure:** Dip and strike, interior shield covers, ground water in sedimentary strata, coastal plains, deformed strata, sedimentary domes, black hills dome, syncline, anticline, plunging folds, types of faults, exposed batholiths.
9. **Landforms Made by Waves and Currents:** Water waves, waves in deep water, shoaling waves and breakers, marine erosion of coasts, beaches, beach profile, littoral drift, wave refraction, tidal currents and tidal power.

SECTION-D

10. **Glacial Landforms and the Ice Age:** Glaciers, alpine glaciers, glacial erosion, landforms made by glaciers, ice sheets, sea ice, iceberg and ice islands, ice age, causes of ice ages, Holocene, climate cycles.
11. **Soil Forming Processes and World Soils:** Concepts of pedon and polypedon, soil colour, texture, consistence, structure, soil horizons, soil temperature and water regimes, pedogenic processes salient features of Marbut System of soil classification and Comprehensive Soil Classification System.
12. **Biogeography:** Water requirements of plants, temperature and other climatic factors, biomes, geomorphic and edaphic factors, succession, major biomes.

References:

1. Strahler, A.N. and Strahler, Arthur, N. (1992). Modern Physical Geography, John Wiley & Sons, Inc., New York.
2. De Dlij, H.J. and Muller, P.O. (1996). Physical Geography of the Global Environment. John Wiley & Sons, Inc. New York.
3. Skinner, B. J. and Porter, S. C. (1987). Physical Geology. John Wiley & Sons, New York.
4. Donn, W.L. (1972). The Earth. John Wiley & Sons Inc., New York.

M.Sc. (Environmental Sciences) (Semester-II)
(Credit Based Evaluation & Grading System)

ESL453 Sanitary Engineering and Environmental Management

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Concepts of Sanitary Engineering:** History and importance, Layout of sanitary engineering, relationship between water supply engineering and sanitary engineering, sanitary works, Principles of sanitation, Necessity of collection and disposal of waste, sewage disposal, layout of sewage disposal system, waste and its types.

2. **Quantity of Sewage:** Classification of sewage, sanitary sewage or dry weather flow (D.W.F), Sources of dry weather flow, Factors effecting dry weather flow, Determination of dry weather flow, Storm sewage, necessity of storm sewers, factors affecting storm sewage, determination, time of concentration, design of sewers, design of distribution systems.

SECTION-B

3. **Sewerage System:** Methods of collection as sanitation, dry or conservancy method, water carriage method, sewerage system, sewers and their types sewer joints, Spigot and socket point, collar joints, mechanical joint, bandage joints, flush joints, manholes, drop holes, lamp holes, filled and poured type joints.

4. **Building Drainage:** Principle of house/building drainage, plumbing system, sanitary fitting and fixtures, wash basin, kitchen sinks, bath tubs, drinking fountains, traps and types.

5. **Maintenance of Sewage System:** Maintenance and purpose of inspection, causes of damage to sewer, problems in sewer maintenance, breaking and clogging of sewers, hazards and preventions, precautions during cleaning and maintenance of sewers, safety equipments.

SECTION-C

6. **Sewage Treatment:** Quality of sewage, physical, chemical and biological examination of sewage, composition of sewage, exothermal, endothermal and biochemical reactions, primary, secondary and tertiary treatment methods, (sedimentation process, sedimentation with coagulation, filteration, trickling filters: low rate and high rate, activated sludge process, aeration of sewage, drying and disposal, oxidation ponds.

ECTION-D

7. **Sewage Disposal:** Methods of sewage disposal, sewage disposal by dilution, land treatment methods, sewage pumping and air ejectors.
8. **Sewage farming and Problems**: Sewage sickness and mitigation measures, Problems related to contaminated soil and water.

References

1. Sharma, J.L. (2000). Public health Engineering, Satya Prakashan, New Delhi.
2. Gupta, N.L. (1994). Urban Water Supply, Rawat Publications, New Delhi.
3. Bijlani, H.U. and Rao, P.S.N. (1990). Water supply and sanitation in India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Shah, C.S. (1998). Water supply and Sanitation. Golgotia Publishing Company, New Delhi.

M.Sc. (Environmental Sciences) (Semester-II)
(Credit Based Evaluation & Grading System)

BSL451 - Statistical Techniques

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Statistical Methods:** Basic principles of statistical techniques with numericals for analysis of ecological data. Measures of central tendency and dispersal; sampling distribution; confidence interval; errors; levels of significance.
2. **Central Tendency:** Arithmatic mean, geometric mean, harmonic mean, median, mode.
3. **Dispersion:** Range, quartile deviation, mean deviation, variance, standard deviation, standard error, coefficient of variation.

SECTION-B

4. **Skewness, Moments and Kurtosis:** Measures of skewness, moments about mean, measures of kurtosis.
5. **Probability:** Events, concept of probability, conditional probabilities, multiplication rule, permutations and combinations.
6. **Probability Distributions:** Binomial, Poisson and Normal distributions
7. **Normal Distribution:** Mathematical equation for normal curve, confidence limits, hypothesis testing, null hypothesis, comparing the mean of a sample with a known standard, comparing the means of two samples, Student's *t*-test.

SECTION-C

8. **Binomial Distribution:** Comparison of percentage with a known standard, comparison of two percentages.
9. **Poisson Distribution:** Comparing two Poisson distributions.
10. **Chi square Distribution:** Goodness of fit.
11. **Regression and Correlation:** Computation of correlation coefficient and regression equation.
12. **Partial Correlation and Multiple Regression:** Partial correlation, multiple regression with two independent variables**.**

SECTION-D

13. **Elements of Path and Principal Component Analysis**.
14. **Analysis of Variance:** F-test, one way analysis of variance, multivariate statistics
15. **Non-Parametric and Distribution –Free Tests:** Wilcoxon's signed rank sum test for single sample Wilcoxon's signed rank sum test for two samples, rank correlation coefficient.
16. **Time Series Analysis:** Seasonal, cyclic and irregular variations, trend analysis, Index numbers and their classification.

References:

1. Bailey, N.T.J. (1995). Statistical Methods in Biology. Cambridge University Press, Cambridge.
2. Ludwig, J. and Reynolds, J.F. (1988). Statistical Ecology. John Wiley & Sons, New York.
3. Sokal, R.R. and Rohlf, F.J. (1995). Biometry. W.H. Freeman & Co. San Francisco.

M.Sc. (Environmental Sciences) (Semester-II)
(Credit Based Evaluation & Grading System)

BSL453 - Instrumental Methods of Analysis

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Principles of Analytical Methods:** Chromatography, GLC, HPLC, GC-MS, LC-MS, Atomic Absorption, Spectrophotometry and Flame Photometry.
2. **Histochemical and Immunotechniques:** Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ*localization by techniques such as FISH and GISH.

SECTION-B

3. **Biophysical Methods: a**nalysis of biomolecules using UV/visible, fluorescence, UV, circular dichroism, NMR and ESR spectroscopy, molecular structure determination using X- ray fluorescence and X-ray diffraction and NMR; Molecular analysis using light scattering surface plasma resonance methods.

SECTION-C

4. **Microscopic Techniques:** Visualization of cellular and sub cellular components by light microscopy, resolving power of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and stating techniques for EM, freeze-etch and freeze fracture methods for EM image processing methods in microscopy.

SECTION-D

5. **Radiolabeling Techniques:** Detection and measurement of radioisotopes normally used in biology; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

References:

1. Brown TA (2010) Gene cloning and DNA analysis, An Introduction, 6th Edition, Blackwell Scientific Publication, Oxford, UK
2. Goldsby RA, Kindt TJ and Osborne BA (2000) Immunology, 4th Edition, WH Freeman and Company, NY
3. Kostic, T., Butaye, P., Schrenzel, J. (2009). Introduction to Microarray Based Detection Methods. In: Detection of Highly Dangerous Pathogens: Microarray Methods for the Detection of BSL 3 and BSL 4 Agents. Edited by TanjaKostic, Patrick Butaye, and Jacques Schrenzel.Wiley-VCH Verlag GmbH & Co. KGaA.
4. Sheehan, D. (2000). Physical Biochemistry: Principles and Applications, John Wiley

ESL501 - Wastewater Treatment Plant Design

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Characteristics of Wastewater: Classification of organic impurities of wastewater. Types of Biological processes for wastewater treatment: Suspended and Attached growth processes.
2. Oxygen Transfer: Oxygen transfer coefficient, Oxygen transfer in clean water and wastewater, Effect of temperature on oxygen transfer, Alpha and Beta correction factor, Application of correction factors.
3. Aeration System: Diffused air systems, Mechanical aerators, High purity oxygen system. Energy requirements for mixing in aeration systems.

SECTION-B

4. Activated Sludge Process: Mathematical modelling, Kinetic relationships and formulation of continuous biological reactor.
5. Biokinetic parameters for aerobic biological reactors: Y, Y, k_d, a and b. Basic concepts of HRT, SRT, F/M, MLSS and, recycling ratio.
6. Material balance for determination of oxygen utilization and net yield of biomass and recycle ratio. Concepts of mean solids residence time and sludge age. Relationship between recycle ratio r and sludge age (θc).

SECTION-C

7. Michaelis-Menten Relationship: Derivation, Corollaries, Relationship in terms of specific growth rate. Comparison of Plug Flow reactor and Continuous Flow Stirred Tank Reactor (CFSTR).
8. Trickling filters: Basic design considerations (NRC and First order).
9. Rotating Biological Contactor: Basic design parameters and operation.

SECTION-D

10. Anaerobic Treatment of Wastewater: Advantages, Disadvantages, General design considerations for wastewater characteristics, solid retention time, expected methane production. Conversion process in anaerobic systems: Hydrolysis, Acidogenesis, Methanogenesis.
11. Design of anaerobic suspended growth process. Design of Upflow Anaerobic Sludge Blanket Reactor: Design consideration, Start up, Operational problems.
12. Attached growth anaerobic processes. Fermentation Technology.

References:

1. Malina, J. F. Jr. and Pohland, F. G. (1992) Design of anaerobic processes for the treatment of industrial and municipal wastes, Technomic Publishing Co. Inc., Lancaster.
2. Manual on Sewerage and Sewage Treatment. (1993). Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development, New Delhi.
3. Metcalf & Eddy Inc. Revised by Tchobanoglous, G., Burton, F. L. and Stensel, H. D. (2002). Wastewater Engineering Treatment and Reuse 4/e. Tata McGraw-Hill Publishing Company Limited, New Delhi.
4. Ramalho, R. S. (1983). Introduction to Wastewater Treatment Processes. Academic Press Inc., San Diego.

M.Sc. (Environmental Sciences) (Semester-III)
(Credit Based Evaluation & Grading System)

ESL503 - Environmental Biotechnology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Waste Water Treatment with Aquatic Macrophytes:** Introduction, concepts of aquatic macrophyte - based waste water treatment systems, economics, thin film techniques for waste water treatment using aquatic plants, algal treatment system.
2. **Treatment of wastes with Anaerobic Digestion:** Process and low rate digesters, high rate digesters, anaerobic digestion of high-solid wastes.

SECTION-B

3. **Waste Management with Microorganisms:** Types of bioremediation, use of fungi, algae and bacteria in biosorption, cautions for using bioremediations, biodegradation of oilspills, TNT wastes, dye stuff wastes, pesticides and xenobiotics.
4. **Polymers and Plastic Degradation:** Introduction, polymer synthesis, polymer degradation, photochemical degradation, biodegradation of naturally occurring polymeric substances, disposable synthetic polymers, polymer recycling, carry bags – a menace, role of microorganisms in degradation of polymers and plastic.

SECTION-C

5. **Biofertilizer**: Bacteria, bacterization, mass cultivation of microbial inoculants, green manuring, the blue green algae, algalization, *Azolla*, present status and improvements.
6. **Solid Waste Management with Vermicomposting:** Resource recovery or reclamation, organic waste processing, composting, anaerobic digestion, vermiculture and vermicomposting, essential precautionary steps in vermicomposting, vermiculturing and protein production, vermiwash, overall benefits, economics and marketing.

SECTION-D

7. **Biomass Production Technology:** Introduction, plant biomass, sources of biomass, forest biomass, crop residues, aquatic biomass, wastes as a source of energy, composition of plant biomass, biomass conversion, useful products of biomass (ethyl alcohol, methanol, methane), applications and future prospects.
8. **Tissue Culture Technology:** Micropropagation, somatic hybridization, clonal propagation, production of genetically variable plants, production of useful biochemicals through tissue culture technology, resistance to drought and flooding, importance of tissue culture technology.

References:

1. Alexander, M. (1999). Biodegradation and Bioremediation. Acadamic Press, San Diego.
2. Abbasi, S.A. and Ramasami, E. (1999). Biotechnological Methods of Pollution Control. Universities Press, Hyderabad.
3. Manahan, S. E. (2000). Environmental Science and Technology, Lewis Publishers, New York.
4. Rittmann, D.E., McCarty, P.L. (2001). Environmental Biotechnology: Principles and Applications. McGraw Hill, New York.

M.Sc. (Environmental Sciences) (Semester-III)
(Credit Based Evaluation & Grading System)

ESL504 - Environmental Microbiology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Introduction to Environmental Microbiology:** Microorganisms in the environment, general characteristics of microorganisms, porous media, microbial activities in porous media.
2. **Microbial Environment:** Microorganisms in surface soils, shallow subsurface environments, deep subsurface environments and deep saturated zone, sampling techniques, identification of microorganism, diseases caused by microorganism.

SECTION-B

3. **Microbiology of Wastewater:** Sewage (waste water) treatment, ecological impact of raw sewage on receiving water, public health impact of raw sewage discharge, primary waste water treatment, secondary treatment, microbial treatment problems, tertiary waste water treatment, drinking water treatment, total coliform bacteria analysis, fecal coliform bacteria analysis.
4. **Bioremediation:** Biodegradative organisms, relationship between contaminant structure, toxicity and biodegradability, environmental factors affecting biodegradation, biodegradation of organic pollutants, problems associated with bioremediation, future of bioremediation.

SECTION-C

5. **Microorganisms and Metal Pollutants:** Metal bioavailability in the environment, metal toxicity effects on the microbial cell, mechanisms of microbial metal resistance and detoxification, method for studying metal-microbial interactions.
6. **Aeromicrobiology:** Important airborne plant, animal and human pathogens, important airborne toxins, nature of bioaerosols aeromicrobiological pathways, sampling devices for the collection of bioaerosols, microbial survival in the air, extramural aeromicrobiology, intramural aeromicrobiology, bioaerosol control, microbial habitats in the aquatic environment.

SECTION-D

7. **Industrial Microbiology:** The microbe, primary and secondary metabolites, major industrial products, foods, flavouring agents and food supplement, vitamins and beverages, organic acids, enzymes and microbial transformation, inhibitors, genetically engineered microorganisms–Human insulin and human growth hormones and vaccines.
8. **Control of Microorganisms:** Fundamentals of control, physical agents, high temperature, low temperature, desiccation, osmotic pressure, radiation, surface tension and interfacial tension, filtration, characterization of an ideal antimicrobial chemical agent, selection of a chemical agent for practical application, major groups of antimicrobial agents.

References:

1. Pelczar, M. J., Chan, E. C. S., Krieg, N. R. (1993). Microbiology-Concepts and Applications. McGraw Hill Inc.
2. Tortora, G.J. Funke, B. R., Case, C. L. (2001). Microbiology-An introduction (7^{th} ed.) Addison Wesley longman, Inc.
3. Taussig, M. J. (1984). Microbiology (2^{nd} ed.) Blackwell Scientific Publications. Oxford London.
4. Maier, R.M., Pepper, I.L. and Gerba, C.P. (2000). Environmental Microbiology, Academic Press.

M.Sc. (Environmental Sciences) (Semester-III)
(Credit Based Evaluation & Grading System)

ESL505- Hazardous Chemicals

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Toxic Chemicals in the Environment - Air, Water and Soil:** Pesticides, Biochemical aspects of Arsenic, Cadmium, Lead, Mercury, carbon Monoxide, O_3, PAN, MIC and other carcinogens.

2. **Sources and Generation of Solid Wastes:** Characterization, chemical composition and classification of solid waste. Different methods of disposal and management of solid wastes Hospital Wastes and Hazardous Wastes, Waste minimization technologies.

3. **Marine Pollution and Control:** Criteria employed for disposal of pollutants in marine system-coastal management, Soil pollution and nuclear waste.

SECTION-B

4. **Physical Properties of Hazardous Chemicals:** Vapour pressure, Vapour density, Solubility, Octanol/ water partition coefficient, Odor.

5. **Combustible and Explosive Properties**: Flashpoint and Autoignition temperature of some chemicals, explosive properties.

SECTION-C

6. **Toxic Chemicals and their biochemical aspects:** Aldehydes, Alkaloids, Amines, Azodyes, Chlorohydrins, Nitriles, Cyanides, Organic isocyanates, Dioxins, Epoxy compounds, Esters, Haloethers, Halogenated hydrocarbons, Halogens, Aromatic hydrocarbons, Polynuclear aromatics.

SECTION-D

7. **Toxic Gases:** Arsine, Mustard Gas, Sarin, Soman, VX, Tabun, Phosgene.

8. **Explosives:** Nitroexplosives - Nitroglycerine, dynamite, Nitrocellulose, 2,4,6- Trinitrotoluene, Picric acid.

9. **Hazardous Waste Management:** Hazardous Waste Handling Rules, 1989, Resource Management, Disaster Management and Risk Analysis.

References

1. Karm, W. and Sehwederski, B.C. (2001). Bioinorganic Chemistry: Inorganic elements in Chemistry of Life. An Introduction and Guide. John Wiley and Sons. New York.
2. Patnaik, P. (1999). A comprehensive Guide to the Hazardous Properties of Chemical Substances. Wiley, New York.
3. Shaw, I.C. and Chadwick, I. (1998). Principles of Environmental Toxicology. TJ International Ltd. Padstow, U.K.
4. Smith, A.G. (2004). Toxicology of organochlorine Insecticides. In: Pesticide Toxicology and International Regulations (Eds. T.C. Marrs and B. Ballantyne) John Weily and Sons Ltd. USA.

ESL506 - Ecological Modeling

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Exponential Population Growth:** Finite rate of increase, population doubling time, life tables, life expectancy, net reproduction rate, generation time, intrinsic rate of natural increase, stable age distribution.
2. **Matrix Model for Population Growth:** Matrix operations, addition, subtraction, multiplication, inversion, latent roots of a matrix, Leslies matrix model for population growth in unlimited environment, finite rate of increase with stable age distribution.

SECTION-B

3. **Logistic Population Growth:** Differential and matrix models for population growth in limited environment.
4. **Dispersal:** Empirical models, random walk model.
5. **Dispersion:** Poisson, random, uniform and aggregate patterns, Morisita's index of aggregation.

SECTION-C

6. **Interaction Between Two Species:** Competition – Differential equations, Leslie-Gower Model, Lotka-Volterra model for predator – prey interaction, Leslie model, deterministic models for simple and general epidemics.
7. **Association Analysis and Community Classification:** Chisquare, Cole's measures and point correlation coefficient for association, information analysis, ordination, continuum concept.

SECTION-D

8. **Species Diversity:** Species area relationships, species abundance relationships – Log normal distribution, information measures of diversity. Brillouin's measure, Shannon-Wiener measure, Simpson's measure. Extinction and formation of single populations, McArthur – Wilson theory of biogeography.
9. **Production and Energy Flow:** Production efficiency. Bertalanffy's growth equation, measurement of production in plants, litter decomposition – differential equations, Gompertz curve – differential equations, Energy flow. Ecological energetic.
10. **Applied Ecology:** Lake classification, Industrial water management, Water quality indices, Technological disasters.

References:

1. Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plant Ecology. Benjamin/Cummings Publication Company, California.
2. Batschelet, E. (1971). Introduction to Mathematics for Life Scientists. Springer-Verlag, Berlin.
3. Begon, M., Harper, J.L. and Townsend, C.R. (1996). Ecology. Blackwell Science, Cambridge.
4. Chapman, J.L. and Reiss, M.J. (1988). Ecology: Principles and Applications. Cambridge University Press, Cambridge.
5. Curran, P.J. (1988). Principles of Remote Sensing. E.L.B.S., Longman Scientific and Technical, Harlow.
6. Heywood, V.H. and Watson, R.T. (1995). Global Biodiversity Assessment. Cambridge University Press, Cambridge.
7. Kormondy, E.J. (1996). Concepts of Ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.
8. Krebs, C.J. (1989). Ecological Methodology. Harper and Row, New York, USA.
9. Ludwig, J. and Reynolds, J.F. (1988). Statistical Ecology. John Wiley & Sons, New York.
10. Magurran, A.E. (1988). Ecological Diversity and its Measurement. Chapman & Hall, London.
11. Misra, R. (1968). Ecology Work Book. Oxford & IBH, New Delhi.
12. Moldan, B. and Billharz, S. (1997). Sustainability Indicators. John Wiley & Sons, New York.
13. Moore, P .W and Chapman, S.B. (1986). Methods in Plant Ecology. Blackwell Scientific Publications, Cambridge.
14. Muller-Dombois, D. and Ellenberq, H. (1974). Aims and Methods of Vegetation Ecology, Wiley, New York.
15. Muller-Dombois, D. and Ellenberg, H. (1974). Aims and Methods of Vegetation Ecology, Wiley, New York.
16. Odum, E.P. (1971). Fundamentals of Ecology. Saunders, Philadelphia..
17. Odum, E.P. (1983). Basic Ecology. Saunders, Philadelphia
18. Pielou, E.C. (1984). The Interpretation of Ecological Data. Wiley, New York.
19. Poole, R.W. (1974). An Introduction to Quantitative Ecology. McGraw Hill Book Co., New York.
20. Sabbins Jr, F.F. (1986) Remote Sensing: Principles and Intrepretation. WH Freeman & Co., New York.
21. Smith, R.L. (1996). Ecology and Field Biology. Harper Collins, New York.
22. Sokal, R.R. and Rohlf, F.J. (1995). Biometry. W.H. Freeman & Co. San Francisco.

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL551 - Industrial Wastewater Management

Credits 3-1-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Characteristics of industrial wastewater, types of industrial pollutants. List of green, orange and red industries.
2. Characteristics of wastewater from different industries along with their discharge standards. Waste water generation standards for different industries.
3. Tests performed in the laboratory for raw sewage, primary sedimentation tank, trickling filters, aeration tank, secondary settling tank, sludge digester and stabilization ponds.

SECTION-B

4. Treatment plant operation and maintenance for screens, grit chamber, sedimentation tank, aeration tank, trickling filters, sludge digestion tanks, sludge drying beds and stabilization ponds.
5. Economics of waste treatment: Benefits of pollution abatement, Primary, secondary and intangible benefits, Capital and operating cost of different treatment processes for industrial waste.
6. Management of industrial wastewater through Volume reduction, Strength reduction, Neutralization, Equalization, Removal of suspended solids, Removal of colloidal solids, Removal of inorganic dissolved solids, Removal of organic dissolved solids, Treatment and disposal of sludge solids.

SECTION-C

7. Manufacturing process, Sources of waste, Characteristics and treatment of waste water for the following industries:
   a. Brewery and distillery
   b. Chlora alkali
   c. Corn Starch
   d. Dairy
   e. Fertilizer
   f. Oil refinery
   g. Pulp and Paper
   h. Sugar
   i. Tannery
   j. Textile

SECTION-D

8. Environmental Management Systems (EMS): Scope, Definition, Environmental Policy, Planning, Implementation and operation, Checking and corrective action, Management review with special reference to IS/ISO 14001: 2004. EMS principles and elements: Commitment and policy, Planning, Implementation, Measurement and evaluation, Review and improvement with special reference to IS/ISO 14004: 2004.
9. Guidelines for Environmental Auditing: Scope, Definitions, Requirements, General principles, Audit objectives, Role and responsibility of Lead auditor, Auditor and Audit team. Initiating audit, Preparing the audit, Conducting the audit with reference to IS/ISO 14010: 1996 and IS/ISO 14011: 1996. Guidelines for Environmental Auditing by Central Pollution Control Board,

References:

1. Eckenfelder, W. W. Jr. (1989). Industrial Water Pollution Control. McGraw-Hill Book Company, New York.
2. Manual on Sewerage and Sewage Treatment. (1993). Central Public Health and Environmental Engineering Organisation, Ministry of Urban Development, New Delhi.
3. Metcalf & Eddy Inc. Revised by Tchobanoglous, G., Burton, F. L. and Stensel, H. D. (2002). Wastewater Engineering Treatment and Reuse 4/e. Tata McGraw-Hill Publishing Company Limited, New Delhi.
4. Nemerow, N. L. (1978). Industrial Water Pollution: Origin, Characteristics and Treatment. Addison- Wesley Publishing Company, New York.
5. Pollution Control Acts, Rules and Notifications Issued Thereunder (2001) Pollution Control Law Series, PCLS/02/1002, 4th Edition, Central Pollution Control Board, Delhi.
6. Qasim, S. R. (1999). Wastewater Treatment Plant: Planning, Design and Operation. Lancaster Technomic, New York.
7. Willig, J. T. (Ed.), (1994). Environmental TQM. McGraw-Hill, Inc. New York.

ESL553 - Environmental Toxicology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Toxic Substances and Risk Assessment:** Introduction, Toxic substances, xenobiotics, Acceptable Daily Intake (ADI), Procedure for estimating ADI, Potential Daily Intake (PDI), Relationship between ADI and PDI, Models for estimating risk.
2. **Conventional Toxicity Studies:** Acute toxicity studies, Short term and Long term toxicity studies, Importance of conventional toxicity studies, Examples for acute, short term and long term toxicity studies.
3. **Toxic Effects:** Spectrum of toxic effects: Quantal and graded effects, idiosynchratic and allergic effects, immediate and prolonged effects, Target organs: liver, kidney, intestine, central nervous system, Molecular targets: DNA, RNA, Proteins, Enzymes.

SECTION-B

4. **Modifying Factors of Toxic Effects:** Host factors, Social factors, Environmental Factors.
5. **Absorption, Distribution, Excretion of Toxicants:** Passive diffusion, Filtration, Carrier mediated Transport, Engulfing by cell, Gastrointestinl tract, Respiratory tract, skin, Barriers, Binding and storage organs, Urinary and biliary excretion, Lungs and other routes of excretions.
6. **Biotransformation of Toxicants:** Levels of toxicants in body, Phase I (Degradation) reactions: Oxidation, Reduction and hydrolysis; Phase II (Conjugation) reaction: Glucuronide formation, Sulfate conjugation, methylation, acetylation, aminoacid conjugation, glutathione conjugation.
7. **Bioactivation:** Epoxide formation, N-Hydroxylation, free radicals and superoxide formation, Activation in gastrointestinal tract.

SECTION-C

8. **Sources of Natural and Artificial Radiations:** Dosimetry, types of dosimeters, radioactive substances, applications and handling of isotopes and other radionuclides in environment, Nuclear industry: benefits and harmful effects.
9. **Effects of Radiations on Plants and Animals Including Human Beings:** Cytotocicity, Mutagenicity, Genotoxicity, Teratogenicity and Carcinogenicity, Radiation episodes, Protection and control from radiation.

SECTION-D

10. **Bioassays for Mutagenicity/ Genotoxicity Testing: Microbial:** Ames *Salmonella* mutagenicity assay, Disc diffusion assay, **Plant:** *Allium cepa* root chromosomal aberration assay, *Allium cepa* chromosomal aberration and micronuclei assay in pollen mother cells, *Tradescantia* stamen hair mutation assay, Tradescantia/ Vicia faba micronuclei assay; **Mammalian:** Comet assay, Rattus micro nuclei assay, **Cell lines**: MTT assay.

References

1. Frank C. L.and Sam K. (2002). Lu's Basic Toxicology: Fundamentals, Target Organs and Risk Assessment; 4th edition. Taylor and Francis, London.
2. Tambrell, J. (2002).Introduction to Toxicology. Taylor and Francis, London.
3. Rana, S.V.S. (2011). Environmental Pollution: Health and Toxicology. Narosa Publishing House, New Delhi.
4. Shaw

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL554 - Natural Resource Management

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Natural Resource Conservation and Management:** Population explosion and resource crunch, classification of natural resources, approaches to natural resource management.
2. **Wildlife Extinction:** Wildlife, extinction of wildlife, understanding population – dynamics, causes of extinction, methods of preventing extinction,
3. **Conservation of Biological Diversity:** *In situ* conservation, *Ex situ* conservation, protected areas network and biosphere reserves.

SECTION-B

4. **Freshwater Fisheries Management:** The lake ecosystem, the stream ecosystem, the reproductive potential of fish, environmental resistance encountered by fish, fisheries management.
5. **Coastlands, Estuaries and Oceans:** Coastal erosion problems, estuaries, the ocean and marine fishery industry.
6. **Introduction to Energy Sources:** Energy consumption as a measure of prosperity, world energy future, energy sources and their availability, new energy technologies, prospects of renewable non conventional energy, applications of solar energy, wind energy, basic components of wind energy conversion system, applications of wind energy and environmental aspects..

SECTION-C

7. **Biomass as a Source of Energy:** Energy plantation, advantages of energy plantation, plants proposed for energy plantation, **b**iomass conversion technologies, wet processes, dry processes, advantages and disadvantages of biological conversion of biomass.
8. **Biogas Plants:** Biogas generation and factors affecting biodigestion or generation of biogas Classification of biogas plants, constructional details of some main digesters, biogas from plant wastes, material used for biogas generation, selection of site for a biogas plant, digester design considerations, methods of maintaining biogas production, problems related to biogas plants, starting a biogas plant, filling a digester for starting, fuel properties of biogas, utilization of biogas.
9. **Biomass Gasification:** Classification of biomass gasifiers, chemistry of gasification process, applications of the gasifier, problems in development of gasifiers.

SECTION-D

10. **Range Land Managements:** The growth characteristics of range grasses, rangeland abuse, range condition, range management and desertification.
11. **Forest Management:** Forest ecology, forest management, harvest methods, reforestation, monoculture controversy, developing genetically superior trees, the logging plan, the logging operation, control of forest pests. Fire control, use of controlled fires, forest conservation by efficient utilization, meeting future timber demands. Removal of tropical rain forests, causes of deforestation, effects of deforestation and what can be done to save tropical forests.
12. **Management of Agro Industrial Wastes:** Agricultural crop residues, forest residues and fruit byproducts. Animal wastes and their recycling and vermiculture.

References:

1. Oliver, S. O. and Daniel, D. C. (1990). Natural Resource Conservation: Management for a Sustainable future. Prentice Hall International, New Jersey.
2. Rai, G. D. (1993). Non Conventional Energy Sources, Khanna Publishers, Delhi.
3. Ramijhan, S.K. (1990). Agro Industrial By Products and Non Conventional Feed for Live Stock. Indian Council for Agriculture Research, New Delhi.

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL555 - Remote Sensing and GIS

Credits 2-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Electromagnetic Energy:** Electromaganic spectrum, image characteristics, remote sensing systems.
2. **Aerial Photographs:** Interaction between light and matter, film technology, characteristics of aerial photographs, stereopairs of aerial photographs.
3. **Black and White Photography:** Panchromatic, IR and UV photography.

SECTION-B

4. **Multispectral Images:** colour photography, normal colour, IR and multispectral photography, multispectral scanner images.
5. **Thermal Infrared Images:** Thermal processes and properties, IR detection and imaging technology, characteristics of IR images.
6. **Radar Images:** Aircraft and satellite Radar systems.

SECTION-C

7. **Imaging System**, Multispectral scanner, return beam vidicon, thematic mapper, high resolution visible imaging system.
8. **Digital Image Processing:** Image structure restoration and enhancement, information extraction, image processing system.
9. **Remote Sensing Satellites**: Specifications of Landsat, SPOT and IRS satellites.

SECTION-D

10. **Applications of Remote Sensing:** Landuse and landcover analysis, resource exploration and environmental monitoring.
11. **Geographical Information System**: GIS techniques, Data representation, Raster, Vector, data capture, spatial analysis with GIS, data modelling, topological modelling, networks, cartographical modelling, map overlays.

References:

1. Curran, P.J. (1988). Principles of Remote Sensing. E.L.B.S., Longman Scientific and Technical, Harlow.
2. Sabbins Jr, F.F. (1986). Remote Sensing: Principles and Intrepretation. WH Freeman & Co., New York.

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

BSL585 - Dynamics of Biogeography
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Biogeography and its History:** Basic principles, its relationship to physiography and other modern sciences, biology, geography, biodiversity, and landscape ecology, age of exploration, biogeography of 18^{th} , 19th and 20^{th} centuries, biogeographic distribution of globe., vegetation types and classification of floristic regions.
2. **Geological History of the Earth:** The geological time scale, Wegner's theory of continental drift, tectonic history of the planet, patterns of continents, Gondwanaland, Laurasia, assembly and breakup of Pangaea, Development of marine basins and island chains, Epeiric, Mediterranean and Red seas, glaciations and biogeographic dynamics of the Pleistocene.

SECTION-B

3. **Ecological Biogeography: habitats, environment and niches,** Climate and life, physical setting of the planet, climatic zones of the world and life, solar energy and temperature regimes, winds and rainfall, soils and successions, formation of major soil types, Topography and Life, Aquatic environments, stratification and oceanic circulation
4. **Island Biogeography**: Types of islands, islands as model systems, MacArthur-Wilson theory of island biogeography, Effects of size and distance, equilibrium equation, modifications caused by selective nature of immigration and extinction and interspecific interactions.

SECTION-C

5. **Distributions of Single Species:** The geographic range projections and geographic coordinate systems, mapping and measuring range, distribution of individuals, populations and ecosystems, Hutchinson's multidimensional niche concept, relationship between distribution and abundance.
6. **Historical Biogeography** Dispersal and Immigration**,** Mechanisms of active and passive dispersal, Physiological, ecological and psychological barriers, biotics, exchange and dispersal routes: corridors, filters, sweepstakes routes, dispersal curves within and among species, establishment of colony and habitat selection, Dispersal & Vicariance in distant past and past community change, Ecosystem theories (Wedge effect, Bergmann's rule, Allen's rule, Gloger's rule, Jordon's rule and Merriam's classification).

SECTION-D

7. **Species Introductions:** Intentional and accidental, effects of non-native (invasive) species on the local flora, magnitude of the problem, concept of invasibility.
8. **Conservation Biogeography** Roots, relevance, aims and values, prospects and challenges, Biological invasions and homogenization of floras and faunas

References:

1. Brown, J.H. and Lomolino, M.V (1998). Biogeography. Sinauer Associates Inc., Sunderland, Massachusetts.
2. Cox, C. B. and Moore, P.D. (2000). Biogeography – An Ecological and Evolutionary Approach. Blackwell Scientific Ltd. pp. 298. London.
3. Fahrig, L., and K. Freemark. (1994). Landscape-scale effects of toxic events for ecological risk assessment. In J. Cairns and B.R. Niederlehner (eds.), Ecological Toxicity Testing, Scale, Complexity, and Relevance. Lewis Publishers, Boca Raton, FL.
4. Weinstein, D.A., and H.H. Shugart. (1983). Ecological modeling of landscape dynamics. In H.A. Mooney and M. Godron (eds.), Disturbance and Ecosystems. Springer-Verlag, New York.

BSL588 - Perspectives in Conservation
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Biogeographical Classification of the World and India, Definition of Biodiversity and its relation to biogeography, Global Magnitude of Biodiversity, Levels and Gradients of Biodiversity and their measurements, Indices of biodiversity, Species -area relationships.
2. Economic and Ecological uses of biodiversity, Direct Use Value, Indirect Use Value, Aesthetic Value, Ethical Value, Option Value.

SECTION-B

3. Loss of Biodiversity, Causes of Loss, Conventional and modern, anthropogenic and natural Man- Wildlife Conflicts, Indian Scenario.
4. Species Extinction, Characters of Species Susceptible to Extinction, The IUCN Red List Categories, Top Ten Most Wanted Species Announced by WWF, Threatened Animal and Plant Species of India, Red Data Books.

SECTION-C

5. *In situ* Conservation of Biodiversity, Protected Areas, National Parks, Wildlife Sanctuaries, Biosphere Reserves, Preservation Plots, Project Tiger, Project Elephant, Sacred Forests and Sacred Lakes.
6. *Ex situ* Conservation, Botanical Gardens, Zoos or Zoological parks, Aquaria, National Bureau of Plant Genetic Resources (NBPGR), National Bureau of Animal Genetic Resources (NBAGR).

SECTION-D

7. Bio-Wealth of India, Mountains as Repositories of Biodiversity, The Indian Deserts, Indian Wetlands, Indian Mangroves, Indian Coral Reefs, Indian Lakes, Hot Spots of Biodiversity, Hot Spots of India, The Status of Wildlife in India.
8. International and National Efforts for Conservating Biodiversity, Biodiversity Treaties, Role of Environmental Institutions in Biodiversity Conservation, India's Efforts in Biodiversity Conservation, Group of Like-minded Megadiverse Countries, Biological Diversity Act 2002, The Cartagena Protocol on Biosafety, The Genetic Engineering Approval Committee, GEF-World Bank Capacity Building Project on Bio safety.

References:

1. Misra S.P. and Pandey S.N. (2011), Essential Environmental Studies (3rd Edition), Ane Books Pvt. Ltd. New Delhi, pp 722-742.
2. Pandey B. N., D. Sadhana and Joshi B.D.(2007) Biodiversity, A.P.H. Publishing Corporation, New Delhi.

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL581 - Urban Planning and Environmental Management
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Historical Perspectives:** The roots of planning, Classic planning, Islamic planning, medieval planning, Indian Indus valley, Later planning theories: Haussman's Boulevards, Sitte's artistic planning, Howard's garden city.

2. **Economy in Urban Systems Models:** Causes and effects in urban development, Growth models: economic base-multiplier model, input-out model, trend model, gravity model, intervening opportunity model, land market model.

SECTION-B

3. **City Planning:** Principles of city planning, types of cities & towns, Model building byelaws, eco-city concept.

4. **Housing:** Concept of housing, housing typology, housing standards, housing infrastructure, housing policies, housing programs in India, self help housing.

SECTION-C

5. **Environmental Studies in Building Science:** Climate responsive design, energy efficient building design, thermal comfort, solar architecture, principles of lighting and styles for illumination.

6. **Building Services:** Water supply, sewerage and drainage systems, principles of electrification of buildings, intelligent buildings, elevators & escalators: their standards and uses, building safety and security systems.

SECTION-D

7. **Materials and Structural Systems:** Characteristics of all types of building materials: mud, timber, bamboo, brick, concrete, steel, glass, FRP, different polymers, composites.

8. **Traffic and Transportation Planning:** Principles of traffic engineering and transportation planning, traffic survey methods: roads, intersections, grade separators and parking areas, traffic and transport management in urban areas, intelligent transportation system, mass transportation planning, para-transits and other modes of transportation, pedestrian & slow moving traffic planning.

References

1. Broadbent, G. (1990). Emerging Concepts in Urban Space Design. Van Nostrand Reinhold (International) London.
2. Helly, W. (1975). Urban System Models. Academic Press. New York.
3. Hambleton, R. (1978). Policy Planning and Local Government. Hutchinson of London, London.
4. Sain, M. (1982). Urban Planning in Third World. Mansell P Publishing Limited, London.

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL583 - Geoinformatics in Environmental Management
(Elective Paper)

Credits 3-0-0
Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Introduction:** Geoinformatics and geographic information sciences, components of geoinformatics, applications of geoinformatics, approach to the study of geoinformatics, legal implications, geoinformatics and environmental modelling, GIS data collection, concept and techniques of geoinformatics.
2. **Surveying Technology:** Introduction, surveyors, datum and reference systems, survey operations classification of surveys, principles of surveying, methods of surveying, stages in surveying, modern trends in surveying and mapping.
3. **Cartography:** Introduction, task of cartographer, model of cartographic communication, cartographic symbolization, cartographic generalization, cartographic design, thematic cartography, digital cartography, conventional mapping Vs. Digital mapping, layout and numbering of topographical maps, classification of maps and map projections.

SECTION-B

4. **Photogrammetry:** Introduction, brief history of photogrammetry, stereo photogrammetry, stereoscopic parallax, aerial photography: classification, geometry and scale of vertical aerial photographs, aerial triangulation, digital or soft copy photogrammetry.
5. **Global Positioning Systems (GPS) and Satellites:** Introduction, GPS elements, GPS satellite constellation and signals, GPS measurements, GPS instrumentation, earth resources satellites, meteorological satellites, satellite carrying microwave sensors, OCEANSAT-1(IRS-P4) and Ikonos satellite series.
6. **Geodesy:** Definition, problems of geodesy, the ellipsoid of revolution, coordinate system of rotational ellipsoid, spatial ellipsoid coordinate system, computations on the ellipsoid and satellite geodesy.

SECTION-C

7. **Geographic Information Systems:** Introduction, roots of GIS, overview of information system, the four Ms, GIS architecture, theoretical models of GIS, theoretical frame work for GIS, GIS softwares, GIS applications and GIS operations.
8. **Forest Resources Management:** Geomatics in forestry, forest cover mapping and change detection, forest inventory (stock mapping), parameters of forest inventory, development of working plan, Forest Management Information system(FMIS), forest fire forecasting and risk area mapping, biodiversity characterization, wildlife habitat mapping.
9. **Watershed Management:** Introduction, concept of watershed, GIS database for watershed management, model watershed, landuse and landcover, slope analysis, soil mapping, hydrogeomorphological mapping, groundwater prospects map and drainage mapping.

SECTION-D

10. **Water Quality Mapping and Modeling:** Introduction, role of GIS and remote sensing in water quality mapping and modeling, case study of Hyderabad city, correlation between water quality and groundwater level, correlation between water quality index and landuse, groundwater quality studies using SPANS and evaluation of impact of landuse / land cover changes on groundwater quality.
11. **Management of Natural Disaster (Landslides):** Introduction, types and features and causes of landslides, landslide analysis, remote sensing for landslide mapping, landslide analysis in GIS, hazard mapping of landslides, case study of Kohima area.
12. **Urban Planning and Management:** Introduction, role of GIS and remote sensing in urban planning and management, issues in urban planning, urban land use and infrastructure identification and delineation, urban transport network identification and mapping, urban city guide map change detection and updation.

References:

1. Curran, P.J. (1988). Principles of Remote Sensing. E.L.B.S., Longman Scientific and Technical, Harlow.
2. Reddy, M.A. (2004).Geoinformatics for Environmental Management. BS Publications, Hyderabad.
3. Smith, K. (1996). Environmental Hazards. Routledge Publishers, London.
4. Ustin, S.L. (Ed.) (2004). Remote Sensing for Natural Resource Management and Environmental Monitoring. John Wiley & Sons, U.S.A.

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL584 - Solid Waste Management
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Types, sources of solid waste, Physical and Chemical composition of solid waste. Solid waste management: Material flow in society, materials and energy recovery, Day to day solid waste management

SECTION-B

2. Solid waste generation, On site handling, storage and processing of solid waste. Collection of solid waste, Transfer and transport of solid waste, Laws and rules for solid wastes in India.

SECTION-C

3. Processing of solid waste: mechanical volume reduction, Thermal volume reduction. Composting and Vermicomposting, Anaerobic digestion, Refuse Derived Fuels, Gasification, Pyrolysis.

4. Landfilling, Design and operation of Landfills, Landfarming, Deep well injection. Methane emission estimates from Landfill sites. Overview of LandGeM software by USEPA.

SECTION-D

5. Fly ash disposal techniques, E-waste management, Biomedical waste management, Plastic waste management, Industrial Waste, Agricultural waste

References:

1. Freeman H, Standard Handbook for Hazardous Waste Management, McGraw Hill (1989)
2. Jagbir Singh & AL. Ramanthan. Solid Waste Management: present and Future Challenges, IK International Publishing, New Delhi.
3. Kreith F and Tchobanoglous G, Handbook of Solid Waste Management, McGraw Hill (2002)
4. LaGrega M, Buckingham P and Evans J, Hazardous Waste Management, McGraw Hill (1994)
5. Municipal Solid Wastes (management and Handling) Rules, 2000.
6. Peavy, H. S., Rowe, D. R. and Tchobanoglous, G. (1985). Environmental Engineering. McGraw-Hill Book Company, Singapore.
7. Pichtel J, Waste Management Practices: Municipal, Industrial and Hazardous, CRC Press (2005)

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL585 - BIOREMEDIATION
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Bioremediation:** Introduction, Major environment contaminants, Microbial transformation of chemical contaminants, Phytoremediation, Criteria for Bioremediation as an option, Advantages of Bioremediation approaches to environment safety.

SECTION-B

2. **Biodegradation and Bioremediation of Petroleum and organic pollutants**: 4 soil treatment technologies (Phytoremediation technologies), optimizing environmental conditions, addressing other potential limitiations. Insufficient number of Hydrocarbon degrading microorganisms, lack of Cometabolism, Risk assessment and environment acceptability.

SECTION-C

3. **Bioremediation of Pesticide contaminants:** Organochlorines, Organophosphates, Carbamates, s-Triazines and other pesticides.

SECTION-D

4. **Biodegradation and Bioremediation of Explosives:** Structural properties and biodegradation of cyclic nitramine, TNT etc. and safety procedures.
5. **Biological treatment of Metallic pollutants**: Definition and scope, technologies used, microorganisms as remediation tool for suboxic environment.

References:

1. Singh A. and Ward O.P. (2004). Applied Bioremediation and Phytoremediation. pringer, U.S.A.
2. Bioremediation its Applications to Contaminated Sites in India - Ministry of Environment and Forests, Govt. of India (moef.nic.in/downloads/public Information/ Bioremediation Book.pdf) (2010).
3. Fulekar MH (2010). Bioremediation Technology, Capital Publishing, 1st ed.
4. Ronald LC and Donald LC (1996). Bioremediation Principle and Application, Cambridge

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL586 - ENVIRONMENTAL SAFETY AND MANAGEMENT
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Need for integration of Safety, Health and Environment (SHE), General instructions for safety, Policy, Planning, Implementation and Operation, Hazardous materials: Definition and classification; Material safety data sheets; Handling of hazardous materials. Regulations: Rules and regulations pertaining to the management and handling of hazardous chemicals, hazardous wastes, biomedical wastes, hazardous microorganisms, genetically engineered organisms or cells, municipal solid wastes, E-wastes, batteries and plastics.

SECTION-B

2. Hazard Identification: Assessment of risk; Risk management; OSHAS 18001 and Occupational health and safety management systems.

3. Principles of Accident Prevention: Accident recording, analysis, investigation and reporting; On-site and off-site emergency preparedness and response plans; rules and regulations dealing with chemical accidents.

SECTION-C

4.Protection from Hazardous Materials: Personal protective equipment and clothing; Fire safety; Noise and vibrations; and Principles of noise control.

5.Hazardous Material – Storage, Disposal and Safety: Notification of sites; Safety reports; and safety audits.

SECTION-D

6.Laboratory work: Material safety data sheets (MSDS); On site and off-site emergency plans; Environmental risk analysis; Safety audits; Preparation of safety reports and notification of sites.

References:

1. Central Pollution Control Boards. Pollution Control Acts, Rules and Notifications Issued Thereunder. Pollution Control Law Series (PCLS/02/2006)
2. Gustin JF, Safety Management: A Guide to Facility Managers, Taylor & Francis (2003) http://moef.nic.in/modules/rules-and-regulations

ESL587 - Waste Stabilization Ponds
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. General reactions in Ponds, Role of bacteria and algae in waste treatment, Conversion of solar energy, Effect of illumination, temperature, nutrients on treatment efficiency.
Aerobic decomposition, Anaerobic decomposition, Protozoa and Fungi.

2. Design considerations: Quantity and nature of water, Sludge accumulation and grit, metrological data, Area requirements, Performance, Location, Shape and other constructional aspects, cost estimate.

SECTION-B

3.Constructional details: Pond bottom, Embankment, Top width, Slopes, Flood protection, Inlet arrangement, Inlet chamber, Grit removal channels, ponds interconnections, Outlet arrangement, Fencing, Warning sign, Access road and general lighting

SECTION-C

4. Operation and maintenance: Day to day inspection, Sampling and Analysis, maintenance of records, Overloading of ponds, Mosquitoes, Flies and water Fleas

5. Health aspects: bacterial removal, Removal of Salmonella, Virus removal, Removal of Helminthes, Amoeba and Snails vectors

SECTION-D

6. Effluent Utilization: Irrigation, Pisciculture, Harvesting of algae, Water reclamation.

References:

1. Archeivala SJ, Lakhshminarayana, JSSS, Alagarsamy, SR, Sastry, CA. (1970). Waste Stabilisation Ponds: Design, Construction & Operations in India. Central Public Health Engineering research Institute, Nagpur.
2. Sperling Marcos von ((2007). Waste Stabalisation Ponds. vol. 3, Biological Waste Treatment Series, IWA, London.

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL588 - Water and Wastewater Analysis
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Errors in quantitative analysis: Accuracy, Precision, Method Performance and Method validation.
2. Expression of results, Sampling, Grab, Composite, Integrated, Laboratory apparatus and reagents, Preservation of samples,
3. Precipitation, Filtration, Drying or Ignition, Desiccation. Preparation of standard solutions.

SECTION-B

4. Analytical balance, Gravimetric analysis, Volumetric analysis, Preparation of Normal solution, Primary and Secondary standards, Indicators used in water analysis,
5. Acid and base titrations, precipitation method, Oxidation-reduction methods,
6. Basics concepts of colorimeter, spectrophotometer, Calibration curve,.

SECTION-C

7. Conductivity, Turbidity (Nephelometric), Colour (Visual comparison, Spectrophotometric), Taste (Flavour threshold test), Oil & grease (Partition-Gravimetric),
8. Hardness (EDTA titration method), Alkalinity (Titration method), Sulphates (Gravimetric and Turbidimetric), Chlorides (Argentometeric),
9. Nitrite (Colorimetric), Nitrates (UV Screening and Cadmium reduction),
10. Iron (Phenanthroline), Flouride (SPANDS).

SECTION-D

11. BOD (5 day BOD and Respirometric method), COD (Closed reflux, Titrimetric),
12. Sample preparation for heavy metals, Extraction and enrichment in sample preparation, Principle of Extraction: Liquid-Liquid extraction, Liquid –solid extraction, Solid-Phase extraction.
13. Tests on Sludge: Oxygen consumption rate, Settled volume sludge, Sludge volume index, Zone settling rate, specific gravity, Capillary suction time, Time-to-Filter.

References:

1. Standard Methods for Examination of Water and Wastewater, APHA, 20th Ed.

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL589 - Water Treatment Processes
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. General layout plan for water treatment. Control of algae, Causative factors for growth of algae, remedial measures. Control of taste and odour in water, Preventive and corrective measures.

SECTION-B

2. Cause of colour, Colour due to presence of Iron and manganese and its removal techniques (precipitation, contact beds, Zeolite, catalytic method), Algae, Colloidal organic matter, Industrial waste, Oxidation of colour, Treatment by activated carbon.

SECTION-C

3. Water softening: Lime treatment, Lime-Soda process, and ion-exchange. Deflouridation of water, Demineralization of water, Distillation (Solar stills, Single and multiple effect distillation).

SECTION-D

4. Desalination of water using Reverse osmosis and electro dialysis. Case studies of desalination system.

Reference:

1. Manual of Water Supply and Treatment. (1999). Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, New Delhi.
2. Metcalf & Eddy Inc. Revised by Tchobanoglous, G., Burton, F. L. and Stensel, H. D. (2002). Wastewater Engineering Treatment and Reuse 4/e. Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Peavy, H. S., Rowe, D. R. and Tchobanoglous, G. (1985). Environmental Engineering. McGraw-Hill Book Company, Singapore.

M.Sc. (Environmental Sciences) (Semester-IV)
(Credit Based Evaluation & Grading System)

ESL590 - Environmental Laws and Impact Assessment
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Meaning, definition and historical development of Environment Law, environment and constitution of India, environmental legislative machinery, fundamental rights, directive principles of State policy and fundamental duties.
2. The Factories Act, 1948 (Chapter III and IV – A).
3. Indian Boiler's Act, 1923 with latest amendments
4. Urban Land (Ceiling and Regulation) Act, 1976.
5. Motor Vehicles Act, 1939 with latest amendments

SECTION-B

6. Water (Prevention and Control of Pollution) Act, 1974 and Rules with latest amendments
7. Water (Prevention and Control of Pollution) Cess Act, 1977.
8. Air (Prevention and Control of Pollution) Act, 1981 and Rules with latest amendments.

SECTION-C

9. Environment Protection Act, 1986 & Environment Protection and Rules with latest amendments.
10. Forest Conservation Act, 1980; Indian Forest Act (Revised 1982) with latest amendments.
11. Wildlife (Protection) Act, 1972 with latest amendments.

SECTION-D

12. **Introduction to Environmental Impact Analysis:** Environmental impact statement and Environmental management plan, EIA guidelines and notifications.
13. **Details of EIA process:** Goal identification, Survey of current and future resource needs, Identification and prediction of environmental effects and benefits, Alternatives, Evaluation of environmental effects, cost benefit analysis, risk benefit analysis, Record of decisions taken, Creation of Environmental impact statement.
14. **Impact assessment methodologies:** Generalized approach to impact analysis, Procedure for reviewing Environmental impact analysis and statement, guidelines for Environmental audit.
15. **Introduction to environmental planning:** Baseline information and predictions (Land, water, atmosphere, energy etc.), Restoration and rehabilitation technologies.

References

1. Canter, L. W. (1996). Environmental Impact Assessment. McGraw Hill, New York.
2. Jain, R.K., Urban L.V. and Stacey, G.S. (1981). Environmental Impact Analysis: A New Dimension in Decision Making. Van Nostrand Reinhold Company, New York.
3. Kreske, D.L. (1996). Environmental Impact Statement: A practical guide for agencies, citizens and consultants. John Wiley and Sons Inc., New York.
4. Kulkarni, V.S., Kaul, S.N. and Trivedi, R.K. (2002). A Handbook of Environmental Impact Assessment. Scientific Publishers, India.
5. Singh, P.P. and Sharma, S. (2004). Environment and Pollution Education. Deep and Deep Publication Pvt. Ltd, New Delhi.
6. Smith, K. (1996). Environmental Hazards. Routledge, London.

ESL502 - Software System Analysis in Ecology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A
Numerical Methods

1. Pitfalls in computing in computers, approximations and errors in computation, accuracy of numbers. Types of errors: inherent errors, rounding errors, truncation errors, absolute, relative and percentage errors.
2. **Roots of Equation:** Bisection method, Newton method.
3. **Solution of System of Linear Equations:** Gauss elimination, Gauss-Seidel method.
4. **Interpolation:** Lagrange's method, inverse interpolation using Lagrange's method.
5. **Integration:** Trapezoidal method, Simpson's one-third method, Simpson's three-eight method.
6. **Solution of Differential Equations:** Runge-Kutta forth order method.

SECTION-B
System Analysis & Design

7. **System Concept:** Introduction, definition of system, characteristics of a system, elements of system, types of system
8. **System Development Life Cycle:** Problem analysis, project selection, feasibility study, analysis, design, implementation, testing, post-implementation and maintenance, considerations for candidate systems.
9. **System Analysis:** System planning, bases for planning, initial investigation, problem definition and project initiation, background analysis, fact-finding, fact analysis, determination of feasibility., information gathering, information about the firm, work flow and user staff, information gathering tools.

SECTION-C

10. **Tools of Structured Analysis:** Introduction, data flow diagram (DFD), data dictionary, decision tree and structured English, decision tables, pros and cons ofeach tool.
11. **Feasibility Study:** Introduction, identification of specific system objectives, description of outputs, steps in feasibility analysis, feasibility report.
12. **System Design:** Introduction, process of design, logical and physical design, design methodologies

SECTION-D

13. **System Testing and Quality Assurance:** Introduction, need of system testing, nature of test data, test plan, activity network for system testing, quality assurance goals in the systems life cycle, levels of quality assurance.
14. **Implementation and Software Maintenance:** Introduction, conversion, activity network for conversion, post-implementation review and review plans, software maintenance, primary activity of a maintenance procedure.

References:

1. Awad. E.M. (2000). System Analysis & Design. Galgotia Publications, New Delhi.
2. Grewal, B.S. (2001). Numerical Methods in Engineering and Science. Khanna Publishers, Delhi.
3. Salaria R.S. (1996). A Computer Oriented Numerical Method. BPB Publications, Delhi.
4. Darnell, R. (2004). HTML 4 Unleashed Edition. Techmedia, New Delhi
5. Sybex (2005). XML Complete. BPB Publications, New Delhi