

TRIBHUVAN UNIVERSITY
Institute of Science and Technology
Central Department of Environmental Science

Course of Study for
MASTER'S DEGREE IN ENVIRONMENTAL SCIENCE

Prepared by
Environmental Science Subject Committee
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Introduction

Central Department of Environmental Science (TU-CDES) under the aegis of Institute of Science and Technology, Tribhuvan University (IOST-TU) currently offers academic degree programmes in Master of Science (MSc) and Doctor of Philosophy (PhD) in Environmental Science. The Department established in 2001 envisages to produce technically sound and competent professionals of environmental science who can address local as well as global environmental challenges. The Department regularly revises its course of study to upgrade the curriculum in tandem with the current environmental scenarios and produce competent professionals. The Master's degree curriculum has been recently revised keeping in view the newly introduced four-year Bachelor's degree course of study.

The course of environmental science is interdisciplinary in nature. This curriculum of MSc in Environmental Science aims at giving the graduate students a broad scientific understanding of environmental aspects making them competent and aware decision makers through analytical interdisciplinary approach. The broad objectives of the course are:

- To enhance scientific understanding of nature,
- To empower with critical thinking and innovative practice,
- To build foundation for undertaking research studies, and
- To understand policy formulation and its implications.

The comprehensive two-year course distributed in four semesters builds the theoretical concepts and practical knowledge of environmental science subject with ample scope of research exploration. Each subject course in the syllabus has been designed to achieve a specific set of learning objectives. All chapters outlined within the units of the subject course must be covered during the course of teaching. However, the course content may be supplemented with updated knowledge and state-of-art tools. The reference list includes books referred as textbooks and suggested books for further readings, nevertheless, latest journal articles and scientific reports on the subject matter are highly suggested. The syllabus has adopted a progressive student oriented teaching methodology of class lecture, laboratory works, assignments, student seminar presentations, project works and research activities. Dissertation in the fourth semester is a mandatory provision for the completion of Master's degree.

The Department has been offering PhD in Environmental Science as a full time degree with three years dedicated time. The candidates with Master's degree in any subject are eligible to apply but the degree will be awarded in Environmental Science. For admission, the candidates must submit a proposal to Departmental Research Committee (DRC). The DRC will accept candidates based on the quality of the submitted proposal.

Course Structure

The MSc Environmental Science course of study is divided into four semesters in two academic years. The course comprises compulsory and specialized theory courses, compulsory practical courses and research activities. The two-year course carries 64 credits (39 credits theory, 15 credits practical and field, and 10 credits research) with 1,600 marks and 1,755 lecture hours.

The first semester covers six compulsory courses (four theory and three practical) with 18 credits. The theory courses of the first semester are Ecology and Environmental Philosophy, Environmental Earth Science, Atmospheric Science and Environmental Chemistry, and Environmental Quality Management. The practical courses are Terrestrial and Aquatic Ecology, Hydrology, Meteorology and Geology, and Environmental Pollution.

The second semester offers four compulsory courses (three theory and one practical), one specialized theory course, case study and intensive field work with 17 credits. The compulsory courses of the second semester are Climate Change and Resilience, Environmental Economics and Management, Remote Sensing and Geo-information Science (theory and practical), Case Study and Field Work. There are four specialized courses offered in the second semester, among which the students must select any one. The specialized courses offered are Mountains and Plains, Freshwater Environment, Biodiversity Conservation and Management, and Urban Environment.

The third semester offers three compulsory courses (two theory and one practical), two specialized theory courses and community work/internship along with field visit based on specialized course with 17 credits. The compulsory courses of the third semester are Energy and Environmental Interdisciplinary, Research Methodology and Biostatistics, Statistical Applications (practical), Community Work or Internship and Field Work. The specialized courses are divided into two groups, the students must select one from each group. Group A includes Water Resource Management, Environmental Hazards and Disaster Risk Reduction, and Wildlife Ecology and Conservation. Group B includes Environmental Policies and Sustainability, Pollution Control Technology, and Restoration Ecology.

The fourth semester offers two compulsory courses (one theory and one practical) and dissertation with 12 credits. The compulsory course is Environment Modelling and Applications (theory and practical). The students must complete the dissertation and submit it within six months after the completion of the academic session of the third semester. In special cases, the research committee may extend the duration with the consent of the Head of the Department on request from the student and the recommendation of the concerned supervisor with valid reasons.

The distribution of courses, credit, lecture hours and marks over the four semesters of the two academic years of the Master's degree programme is outlined below:

SN	Papers	Number of Papers					Credit				
		Sem I	Sem II	Sem III	Sem IV	Total	Sem I	Sem II	Sem III	Sem IV	Total
1.	Theory (Compulsory)	4	3	2	1	10	12	9	6	3	30
2.	Theory (Elective)	0	1	2	0	3	0	3	6	0	9
3.	Practical	3	1	1	1	6	6	2	2	1	11
4.	Field Work	0	1	1	0	2	0	2	2	0	4
5.	Case Study	0	2	0	0	2	0	1	0	0	1
6.	Community Work/ Internship	0	0	1	0	1	0	0	1	0	1
7.	Thesis	0	0	0	1	1	0	0	0	8	8
	Grand Total	7	8	7	3	25	18	17	17	12	64

SN	Papers	Lecture Hours/ Contact Hours					Full Marks				
		Sem I	Sem II	Sem III	Sem IV	Total	Sem I	Sem II	Sem III	Sem IV	Total
1.	Theory (Compulsory)	180	135	90	45	450	300	225	150	75	750
2.	Theory (Elective)	0	45	90	0	135	0	75	150	0	225
3.	Practical	270	90	90	45	495	150	50	50	25	275
4.	Field Work	0	90	90	0	180	0	50	50	0	100
5.	Case Study	0	45	0	0	45	0	25	0	0	25
6.	Community Work/ Internship	0	0	90	0	90	0	0	25	0	25
7.	Thesis	0	0	0	360	360	0	0	0	200	200
	Grand Total	450	405	450	450	1755	450	425	425	300	1600

Eligibility and Criteria for Admission

For admission in MSc Environmental Science, the candidates with Bachelor degree (BSc) in Environmental Science, Forestry, Environmental Management (PU/KU) with minimum of second division or equivalent grade recognized by Tribhuvan University are eligible to apply. The students other than BSc in Environmental Science in accordance with the decision of Faculty Board of Institute of Science and Technology (IOST-TU) are also qualified to apply. Applicants seeking admission in MSc Environmental Science must appear and pass the entrance examination conducted by Central Department of Environmental Science under IOST-TU. Admission is taken strictly on merit basis.

Medium of Instruction

English

Duration

Four semesters completed in two academic years.

Instruction Hours and Credit Calculation

Working Days : 90 days per semester

Total credits : 64

Teaching hours : 1,755

Full marks : 1,600

Theory

One credit is equivalent to 15 lecture hours and 25 marks. One theory paper of one credit will have one hour of lecture per week.

Practical

One credit is equal to 45 lecture hours (laboratory hours or research work) and 25 marks. One practical paper of one credit will have three hours practical per week.

Evaluation

Students must obtain pass marks in all theory and practical subjects separately in order to award the degree. There will be an internal examination in each semester carrying a weightage of 40% of the total marks. Appearing in and passing the internal examinations is mandatory to take the final examinations. The pass marks of all theory, practical, research work, field and community work is 50%. TU-IOST will conduct the final examinations that carry a weightage of 60% of the total marks, while the internal examinations will be conducted by Central Department of Environmental Science or respective Campuses. The grading of students' performance will be as follows:

Grade	GPA	Percentage
A	4.0	90 and above
A ⁻	3.7	80 – 89.99
B ⁺	3.3	70 – 79.99
B	3.0	60 – 69.99
B ⁻	2.7	50 – 59.99
F	0.0	Below 50

Course Distribution**Semester I Compulsory Courses**

Course Code	Subject	Credit hrs
ENV 511	Ecology and Environmental Philosophy	3
ENV 512	Environmental Earth Science	3
ENV 513	Atmospheric Science and Environmental Chemistry	3
ENV 514	Environmental Quality Management	3
ENV 551	Terrestrial and Aquatic Ecology (Practical)	2
ENV 552	Hydrology, Meteorology and Geology (Practical)	2
ENV 553	Environmental Pollution (Practical)	2
Total		18

Semester II Compulsory Courses

Course Code	Subject	Credit hrs
ENV 521	Climate Change and Resilience	3
ENV 522	Environmental Economics and Management	3
ENV 523	Remote Sensing and Geo-information Science	3
ENV 561	Remote Sensing and Geo-information Science (Practical)	2
ENV 591	Field Work (Research)	2
ENV 592	Case Study (Research)	1
Total		14

Semester II Specialized Courses (Any One)

Course Code	Subject	Credit hrs
ENV 524	Mountains and Plains	3
ENV 525	Freshwater Environment	3
ENV 526	Biodiversity Conservation and Management	3
ENV 527	Urban Environment	3
Total		3

Semester III Compulsory Courses

Course Code	Subject	Credit hrs
ENV 631	Energy and Environmental Interdisciplinary	3
ENV 632	Research Methodology and Biostatistics	3
ENV 651	Statistical Applications (Practical)	2
ENV 691	Field Work (Research)	2
ENV 692	Community Work (Research)	1
ENV 693	Internship (Research)	1
Total		11

Semester III Specialized Course Group A (Any One)

Course Code	Subject	Credit hrs
ENV 633	Water Resource Management	3
ENV 634	Environmental Hazards and Disaster Risk Reduction	3
ENV 635	Wildlife Ecology and Conservation	3
Total		3

Semester III Specialized Courses Group B (Any One)

Course Code	Subject	Credit hrs
ENV 636	Environmental Policies and Sustainability	3
ENV 637	Pollution Control Technology	3
ENV 638	Restoration Ecology	3
Total		3

Semester IV Compulsory Courses

Course Code	Subject	Credit hrs
ENV 641	Environment Modelling and Applications	3
ENV 661	Environmental Modelling (Practical)	1
ENV 699	Dissertation	8
Total		12

Semester I**Course Title: Ecology and Environmental Philosophy****Credit Hours: 3****Course No: ENV 511****Lecture Hours: 45****Nature of Course: Theory (Compulsory)****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Principles of Ecology and Philosophical Perspectives	8
2.	Population and Community Ecology	7
3.	Ecosystem Dynamics and Applications	10
4.	Bio-geography and Biomes	7
5.	Evolutionary Ecology	6
6.	Environment and Social Responsibility	7
Total		45

Course Title: Environmental Earth Science**Credit Hours: 3****Course No: ENV 512****Lecture Hours: 45****Nature of Course: Theory (Compulsory)****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Fundamentals of Geomorphology	8
2.	Hydrological Processes	7
3.	Geological Materials and Structures	8
4.	Geological Processes and Mechanisms	10
5.	Earth Hazards	12
Total		45

Course Title: Atmospheric Science and Environmental Chemistry**Credit Hours: 3****Course No: ENV 513****Lecture Hours: 45****Nature of Course: Theory (Compulsory)****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Atmosphere	10
2.	Meteorological Phenomena and Instruments	5
3.	Plume Behaviour and Air Quality	5
4.	Environmental Chemistry	8
5.	Geochemistry	7
6.	Environmental Toxicology	10
Total		45

Course Title: Environmental Quality Management**Credit Hours: 3****Course No: ENV 514****Lecture Hours: 45****Nature of Course: Theory (Compulsory)****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Management of Air Pollution	10
2.	Management of Water Pollution	10
3.	Management of Land	10
4.	Management of Waste	7
5.	Occupational Health and Safety Management	8
Total		45

Course Title: Terrestrial and Aquatic Ecology**Credit Hours: 2****Course No: ENV 551****Lecture Hours: 90****Nature of Course: Practical (Compulsory)****Full Marks: 50**

Course Title: Hydrology, Meteorology and Geology	Credit Hours: 2
Course No: ENV 552	Lecture Hours: 90
Nature of Course: Practical (Compulsory)	Full Marks: 50
Course Title: Environmental Pollution	Credit Hours: 2
Course No: ENV 553	Lecture Hours: 90
Nature of Course: Practical (Compulsory)	Full Marks: 50

Semester II**Course Title: Climate Change and Resilience****Course No: ENV 521****Nature of Course: Theory (Compulsory)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Climate Change and Variability	5
2.	Paleoclimatology	10
3.	Climate Modelling and Analysis	15
4.	Global and Regional Assessment	10
5.	Policy and Legal Instruments	5
Total		45

Course Title: Environmental Economics and Management**Course No: ENV 522****Nature of Course: Theory (Compulsory)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75**

SN	Unit	Lecture hrs
Group A : Environmental Economics		
1.	Introduction to Environmental Economics	7
2.	Economics of Natural Resources and Pollution	6
3.	Ecosystem Services and Natural Capital	10
Group B : Environmental Management Tools		
1.	Environmental Assessment	5
2.	Impact Prediction and Analysis Techniques	7
3.	Environmental Management Systems	10
Total		45

Course Title: Remote Sensing and Geo-information Science**Course No: ENV 523****Nature of Course: Theory (Compulsory)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Remote Sensing Principle and Sensors	15
2.	Image Processing	7
3.	Geographic Information System	10
4.	Cartographic Principles and Techniques	3
5.	Application of GI Science in Environmental Analysis	10
Total		45

Course Title: Mountains and Plains**Course No: ENV 524****Nature of Course: Theory (Specialized)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Mountains and HKH	7
2.	Mountains and People	8
3.	Mountain Linkages	15
4.	Alpine Landscape and Glaciers	7
5.	Integrated Mountain Development	8
Total		45

Course Title: Freshwater Environment
Course No: ENV 525
Nature of Course: Theory (Specialized)

Credit Hours: 3
Lecture Hours: 45
Full Marks: 75

SN	Unit	Lecture hrs
1.	Dynamics of Freshwater Ecosystem	8
2.	Wetland and Conservation	7
3.	Water and Agriculture	8
4.	Hydropower Development	10
5.	Water Supply and Sanitation	7
6.	Urban and Water Management	5
Total		45

Course Title: Biodiversity Conservation and Management
Course No: ENV 526
Nature of Course: Theory (Specialized)

Credit Hours: 3
Lecture Hours: 45
Full Marks: 75

SN	Unit	Lecture hrs
1.	Biodiversity Pattern and Process	7
2.	Biodiversity Assessment and Monitoring	10
3.	Threats to Biodiversity	10
4.	Approaches to Biodiversity Conservation	10
5.	Conservation Planning and Financing	8
Total		45

Course Title: Urban Environment
Course No: ENV 527
Nature of Course: Theory (Specialized)

Credit Hours: 3
Lecture Hours: 45
Full Marks: 75

SN	Unit	Lecture hrs
1.	Urbanization and Environmental Issues	15
2.	Urban Environmental Quality	10
3.	Urban Sustainability and Dynamics	10
4.	National and Global Initiatives	10
Total		45

Course Title: Remote Sensing and Geo-information science
Course No: ENV 561
Nature of Course: Practical (Compulsory)

Credit Hours: 2
Lecture Hours: 90
Full Marks: 75

Course Title: Field Work
Course No: ENV 591
Nature of Course: Research (Compulsory)

Credit Hours: 2
Lecture Hours: 90
Full Marks: 50

Course Title: Case Study
Course No: ENV 592
Nature of Course: Research (Compulsory)

Credit Hours: 1
Lecture Hours: 45
Full Marks: 25

Semester III**Course Title: Energy and Environmental Interdisciplinary****Course No: ENV 631****Nature of Course: Theory (Compulsory)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75**

SN	Unit	Lecture hrs
Group A : Energy		
1.	Introduction to Energy	5
2.	Renewable Energy	15
3.	Non-renewable Energy	5
Group B : Environmental Interdisciplinary		
1.	Bioremediation	6
2.	Agriculture and Food Security	7
3.	Human Health and Risk Assessment	7
Total		45

Course Title: Research Methodology and Biostatistics**Course No: ENV 632****Nature of Course: Theory (Compulsory)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Research Design	10
2.	Data Management	10
3.	Hypothesis Testing Concepts	15
4.	Multivariate Tools	10
Total		45

Course Title: Water Resource Management**Course No: ENV 633****Nature of Course: Theory (Specialized)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Water Resource Management	10
2.	Surface Water Dynamics	5
3.	Groundwater Hydrology	10
4.	Climate Extreme and Building Resiliency	10
5.	Water Governance	10
Total		45

Course Title: Environmental Hazards and Disaster Risk Reduction**Course No: ENV 634****Nature of Course: Theory (Specialized)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Natural Hazard Risk Management Framework	5
2.	Hazard Assessment	10
3.	Vulnerability and Risk Assessment	15
4.	Risk Evaluation and Risk Reduction	10
5.	Disaster Risk Reduction Policies and Practices	5
Total		45

Course Title: Wildlife Ecology and Conservation

Course No: ENV 635

Nature of Course: Theory (Specialized)

Credit Hours: 3

Lecture Hours: 45

Full Marks: 75

SN	Unit	Lecture hrs
1.	Introduction to Wildlife Conservation	5
2.	Wildlife Ecology	11
3.	Wildlife Data Collection and Analysis (Wildlife Techniques)	13
4.	Theories of Conservation	7
5.	Approaches of Conservation	9
Total		45

Course Title: Environmental Policies and Sustainability

Course No: ENV 636

Nature of Course: Theory (Specialized)

Credit Hours: 3

Lecture Hours: 45

Full Marks: 75

SN	Unit	Lecture hrs
1.	Policy, Plan and Strategies	5
2.	International and National Environmental Laws	10
3.	Development Perspectives	10
4.	Sustainability Science	10
5.	Policy Decisions and Development Goals	10
Total		45

Course Title: Pollution Control Technology

Course No: ENV 637

Nature of Course: Theory (Specialized)

Credit Hours: 3

Lecture Hours: 45

Full Marks: 75

SN	Unit	Lecture hrs
1.	Air Pollution Control Technology	10
2.	Noise Pollution Control Technology	5
3.	Water Pollution Control and Water Resources Comprehensive Utilization Technology	10
4.	Solid Waste Treatment and Disposal	10
5.	Ecological Restoration Technologies	10
Total		45

Course Title: Restoration Ecology

Course No: ENV 638

Nature of Course: Theory (Specialized)

Credit Hours: 3

Lecture Hours: 45

Full Marks: 75

SN	Unit	Lecture hrs
1.	Community Assembly	10
2.	Restoration Practices	15
3.	Management of Restoration Projects and Legal Provisions	10
4.	Degraded Sites Reclamation and Restoration	10
Total		45

Course Title: Statistical Applications

Course No: ENV 651

Nature of Course: Practical (Compulsory)

Credit Hours: 2

Lecture Hours: 90

Full Marks: 75

Course Title: Field Work	Credit Hours: 2
Course No: ENV 691	Lecture Hours: 90
Nature of Course: Research (Compulsory)	Full Marks: 50
Course Title: Community Work	Credit Hours: 1
Course No: ENV 692	Lecture Hours: 90
Nature of Course: Research (Compulsory)	Full Marks: 25
Course Title: Internship	Credit hours: 1
Course No: ENV 693	Lecture hours: 90
Nature of Course: Research (Compulsory)	Full Marks: 25

Semester IV**Course Title: Environment Modelling and Applications****Course No: ENV 641****Nature of Course: Theory (Compulsory)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75**

SN	Unit	Lecture hrs
1.	Fundamentals of Modelling	5
2.	Model Development and Evaluation	5
3.	Basics of Mathematical Modelling	10
4.	Statistical and Time-series Modelling	5
5.	Application of Modelling in Environmental Systems	15
6.	Spatial Modelling	5
Total		45

Course Title: Environmental Modelling**Course No: ENV 661****Nature of Course: Practical (Compulsory)****Credit Hours: 1****Lecture Hours: 45****Full Marks: 25****Course Title: Dissertation****Course No: ENV 699****Nature of Course: Research (Compulsory)****Credit Hours: 8****Lecture Hours: 360****Full Marks: 200**

Semester I**Course Title: Ecology and Environmental Philosophy****Course No: ENV 511****Nature of Course: Theory (Compulsory)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75****Learning Objectives**

Students who complete this course will be able to:

- Explain the underlying principles of ecology in perspective of scientific philosophy
- Describe the distribution pattern of population and characteristics of community
- Develop understanding of ecosystem principles at different scales including biomes and identify how ecosystem structure relates to function, and the dynamics of ecosystems
- Understand how organisms have evolved and adapted to their environments
- Recognize social structure and responsibility towards environmental protection

Unit 1: Principles of Ecology and Philosophical Perspectives**8 hrs**

- 1.1 Ecology as a science: Integration, Understanding, Scales in ecology
- 1.2 Energy flow and nutrient cycling in ecosystems
- 1.3 Nature of scientific understanding, Modes of understanding (Science, Faith and Art), Deep ecology
- 1.4 Classical philosophy of science and its integration in ecological understanding, Modern philosophy of science (Demarcation, Falsification, Covering-law model, Reductionism)
- 1.5 Contemporary/emerging science philosophy (Constructivism, Realism and Postmodernism), Approaches to scientific reasoning (Induction and Deduction)

Unit 2: Population and Community Ecology**7 hrs**

- 2.1 Population ecology: Demography, Population growth, Regulation of population size (Extrinsic and intrinsic mechanisms)
- 2.2 Eco-physiological adaptations to terrestrial and aquatic environment
- 2.3 Community ecology: Species interactions, Competition, Predator-prey oscillations (Lotka-Volterra model), Herbivory and mutualism, Disease, Foodweb interactions, Trophic dynamics and cascades, Patch dynamics
- 2.4 Factors that limit distributions and abundance (biotic and abiotic) of species

Unit 3: Ecosystem Dynamics and Applications**10 hrs**

- 3.1 Ecosystem metabolism (Primary and secondary production), Ecological niche (Breadth and Overlap)
- 3.2 Succession: Clements's climax concept, Gleason's individualistic concept, Pattern and process in ecosystem, Stability analysis of ecosystems
- 3.3 Concepts of species diversity (Species richness, Heterogeneity, Evenness), Species richness measures (Rarefaction method, Jackknife estimate, Bootstrap procedure, Species area curve estimates)
- 3.4 Heterogeneity measures (Simpson's index, Shannon-wiener function, Brillouin's index, Species abundance models), Evenness measures (Simpson's measure, Camargo's index of evenness, Smith and Wilson's index of evenness)
- 3.5 Gradient analysis, ordination and beta diversity measurements, Measurement of similarity (Binary similarity coefficients, Distance coefficients, Correlation coefficients and other similarity measures)

3.6 Cluster analysis: Single linkage clustering, Complete linkage clustering, Average linkage clustering.

Unit 4: Bio-geography and Biomes

7 hrs

4.1 Major biomes: Concept and Distribution

4.2 Terrestrial biomes and their characteristics: Tundra, Northern coniferous forest, Moist temperate coniferous forest, Temperate deciduous forests, Broad leaved evergreen subtropical forest, Tropical rain forest, Tropical deciduous forests, Grassland and Arid land

4.3 Biogeographic regions of Nepal

4.4 Forests of Nepal: Management regime, Geographic location, Sustainable management and certification

4.5 Geological time and Continental drift

4.6 Island biogeography theory

Unit 5: Evolutionary Ecology

6 hrs

5.1 Evolutionary ecology: Concept and Historical perspective

5.2 Major ecological transitions, Natural selection and genetic basis of evolutionary change

5.3 Speciation, Evolutionary consequences of species interactions

5.4 Extinction, Macro-ecology and Macro-evolution

5.5 Demography of source-sink populations and Evolution of ecological niches

5.6 Evolutionary significance of phenotypic plasticity in organisms

Unit 6: Environment and Social Responsibility

7 hrs

6.1 Social structure and responsibilities

6.2 Socialization process, Norms and values as means of social cohesion

6.3 Gender equality meaning and gaps

6.4 Global gender equality agenda, Gender leadership and environmental protection

6.5 GESI perspectives in environmental issues

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Semester I**Course Title: Environmental Earth Science****Course No: ENV 512****Nature of Course: Theory (Compulsory)****Credit Hours: 3****Lecture Hours: 45****Full Marks: 75****Learning Objectives**

After completing this course, students will be able to:

- Know the geomorphological and geological characteristics of the earth and differentiate various types of geological materials
- Explain the geomorphological and geological processes and their role in shaping earth's surface
- Understand the hydrological processes in the environment
- Apply geomorphological and geological knowledge for various environmental studies
- Diagnose various environmental hazards and find their mitigation measures

Unit 1: Fundamentals of Geomorphology**8 hrs**

- 1.1 Introduction to Geomorphology: Nature of geomorphology and concepts of landform evolution, Interdisciplinary nature and sub-divisions of geomorphology
- 1.2 Continental landscape dynamics: Continental drift, Plate tectonics, Global topography, Surface processes, Tectonic uplifts, Erosion, Surface deposition
- 1.3 General background of geomorphic processes and their types: Rock weathering, Mass wasting/erosion (gravity-driven), Work of running water (fluvial), Groundwater activity, Wind action, Glacial activity/Moving ice, Wave action /Tide action
- 1.4 Equilibrium System: Concept, Driving forces, Gravity, Tectonics

Unit 2: Hydrological Processes**7 hrs**

- 2.1 Hydrological processes in different climatic zones
- 2.2 Processes of precipitation, Evaporation, Snowmelt, Runoff, Soil-water dynamics and groundwater recharge, Mass rainfall curve and hyetograph, Intensity duration of rainfall, River discharge, Runoff generation
- 2.3 Soil moisture and groundwater, Stream flow and stage-discharge relationship
- 2.4 Floods: Classification, Causes, Triggering factors, Flood flow determination
- 2.5 Hydrology of urban areas and agricultural system

Unit 3: Geological Materials and Structures**8 hrs**

- 3.1 Silicate and non-silicate minerals
- 3.2 Rocks: Igneous, metamorphic and sedimentary, Composition, occurrence and formation, Field identification of igneous, sedimentary and metamorphic rock units, sample collection, making rock descriptions
- 3.3 Measuring geological features (e.g., strike and dip of bedding, lineation and foliation in metamorphic rocks), Plotting geologic features on a topographic map, Geologic field note taking, and Preparing geologic reports
- 3.4 Plate tectonics and structure in rock bodies

Unit 4: Geological Processes and Mechanisms**10 hrs**

- 4.1 Geological surface processes: Weathering (Types, Characteristics, Factors and Products), Soil horizons and profiles, Erosion (Types, Cycle and Control), Landslides and their types
- 4.2 Fluvial environment: Drainage basin evolution, Erosional landforms, Channel patterns, Fluvial deposits, Flood plain and its mapping, River basin, River mapping, River terraces
- 4.3 Glaciers: Growth, Decay, Types, Movements, Erosion and Sediment transport, Deposition
- 4.4 Periglacial processes and landforms, Lake and desert environments (Lake environment and deposits), Dry climates and landforms of dry regions, Eolian process and landforms

Unit 5: Earth Hazards**12 hrs**

- 5.1 Concept of hazard, exposure, vulnerability and risk
- 5.2 Landslide: Classification, causes, control and mitigation measures, Slope stability analysis, Landslide hazard mapping techniques, Landslide in Nepal
- 5.3 Glacial Lake Outburst Flood (GLOF): Creation and types of glacial lake, Factors contributing to GLOF and mitigation techniques, Potentially dangerous glacial lakes in Nepal, History of GLOFs in the Himalayas, Glacier hazard in Nepal Himalaya
- 5.4 Earthquake: Nature, intensity and magnitude, Intensity scale (Modified Mercalli), Epicenters, Earthquake zones, Effects of earthquakes, History of earthquakes in Nepal, Seismic hazard assessment and mapping techniques, Preparedness
- 5.5 Flood: Open channel hydraulics, Factors contributing flood, Flood frequency analysis, Flood hazard mapping, Flood control measures
- 5.6 Wild fire: Causes and effects, Trend in global and Nepalese perspectives, Prevention techniques

References

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Semester I

Course Title: Atmospheric Science and Environmental Chemistry

Course No: ENV 513

Nature of Course: Theory (Compulsory)

Credit Hours: 3

Lecture Hours: 45

Full Marks: 75

Learning Objectives

After the completion of this course, the students will be able to:

- Describe the dynamic structure of earth's atmosphere and explain its underlying physical laws
- Explain the principles behind, and use of, meteorological instrumentation
- Understand scientific methods employed in environmental chemistry and establish an appreciation of the role of chemistry in environmental science
- Explain various geochemical components and understand to use them in solving environmental problems
- Understand principles of environmental toxicology and assess toxic effects at various levels of environment

Unit 1: Atmosphere

10 hrs

- 1.1 Introduction to atmosphere
- 1.2 Dynamic structure of atmosphere: General circulation, Air masses, Fronts, Frontal trapping, Topographical influences
- 1.3 Principles of vertical motion and Atmospheric stability
- 1.4 Atmospheric heat balance: Heat budget, Radiation and insolation, Heat balance, Heat distribution, Differential heating, Transport of heat, Distribution of heat(regional and global)

Unit 2: Meteorological Phenomena and Instruments

5 hrs

- 2.1 Introduction to meteorology
- 2.2 Wind speed and direction, Measurements
- 2.3 Temperature and temperature differences, Temperature sensors, Sodar and LIDAR, Radiation, Mixing height
- 2.4 System performance, Quality assurance and Quality control

Unit 3: Plume Behaviour and Air Quality

5 hrs

- 3.1 Plume behavior and Plume rise
- 3.2 Dispersion estimates, Air quality dispersion models, Gaussian distribution, Long range transport
- 3.3 Use of meteorology in air quality regulation
- 3.4 Transboundary air pollution

Unit 4: Environmental Chemistry

8 hrs

- 4.1 Atmospheric chemistry: Introduction of environmental air chemistry, Stratospheric ozone chemistry (Natural ozone formation and destruction, Principal ozone depletion reactions, PSCs mechanism - Type 1 and 2), Traffic rush hours reactions and distribution, Fossil fuels emission (Chemistry of emission from coal, diesel, petrol, ATF), Nielsen mechanism (Formation and absorption of SO₂ in cement kiln), CO₂ emissions (CO₂ emission in clinker and lime production), and Global climate change
- 4.2 Aquatic chemistry: Introduction of aquatic chemistry, Chemistry of natural water (Hydrogen bond and Specific water reactions), Complexation in wastewater (Basic factors, Hydrolysis, Transboundary movement of heavy metals and Humic compound reactions), Significances of

solubility of gases in water, Microorganisms as catalyst of aquatic chemical reaction, Microbially mediated elemental transitions cycles (Sulphur, carbon, nitrogen, phosphorous cycles and halogens and organohalides)

- 4.3 Soil chemistry: Introduction of soil chemistry, Types of soil reactions, Wastes and pollutants in soil (Plastic chemicals and additives relevant to ecological and human health (Bisphenol A, Phthalates, Brominated Flame Retardants), Relevant biodegradation of plastic (Microorganism associated with degradation), Weight loss and reduction in tensile strength, Collection and transport of other contaminants by plastic waste

Unit 5: Geochemistry

7 hrs

- 5.1 Introduction to geochemistry
5.2 Rock-water interactions and water quality, Cation-anion balance
5.3 Effect of weathering in river water, Carbonate water reactions, Silicate water reactions
5.4 Redox reactions: Concepts of pE, Eh-pH diagrams, Redox conditions in surface and groundwater, Biochemical vs. geochemical influence
5.5 Sediment characteristics, Suspended load and rate of mechanical erosion, Dissolved load and rate of chemical erosion

Unit 6: Environmental Toxicology

10 hrs

- 6.1 Introduction and basic principles of environmental toxicology
6.2 Sources and types of ecological pollutants, Transport and fate of toxicants in environment
6.3 Ecotoxicity testing methods
6.4 Toxic effects: Molecular, Physiological, Population, Community, Regional and Global
6.5 Ecological risk assessment

References

- APTI. (2005). Basic air pollution meteorology: self instrumental manual. Air Pollution Training Institute, United States Environmental Protection Agency. www.epa.gov/apti
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Semester I

Course Title: Environmental Quality Management

Course No: ENV 514

Nature of Course: Theory (Compulsory)

Credit Hours: 3

Lecture Hours: 45

Full Marks: 75

Learning Objectives

At the end of this course, the students will:

- Have knowledge of scientific process of standard setting in environmental quality management
- Describe management modalities of various forms of pollution and their control measures needed to meet the set standards
- Familiar with various issues involved in achieving the desired environmental quality
- Know how to take and prescribe occupational health and safety management

Unit 1: Management of Air Pollution

10 hrs

- 1.1 Introduction to air quality criteria: Exposure to air pollution, Evaluating exposure-response relationships, Formulation of air quality criteria or guidelines, Criteria for endpoints other than for carcinogenicity, Criteria for carcinogenic end points, Ecological effects
- 1.2 Air quality standards, Advantages and disadvantages of air quality standards, Adoption of standards, Aspects of air pollution control strategy
- 1.3 Air quality standards in Nepal : History, Standards, Air quality measurements, Air quality control in Nepal

Unit 2: Management of Water Pollution

10 hrs

- 2.1 Surface water: Water quality monitoring, Natural purification processes, Oxygen balance, Sediments, Water quality in water reservoirs, Discharge of wastewater, Emission strategies, Legislation
- 2.2 Groundwater: Pollution migration transport processes, Specific pollutant substances, Protection of groundwater, Water quality monitoring
- 2.3 Rainfall water: Pollution of rainfall water, Transport processes
- 2.4 Water quality accidents (disasters)
- 2.5 Common procedures, practice, removal and prevention (both ground and surface water)
- 2.6 Setting of standard, Guidelines for various water uses

Unit 3: Management of Land

10 hrs

- 3.1 Land degradation and Desertification: Causes, Effect/impact, Extent, Preventive and remedial efforts
- 3.2 Land capability and Land utilization: Land capability classification (various systems), Land capability maps of Nepal, Land capability and land utilization relationship
- 3.3 Land utilization/use policies and Land act: Salient features of Land Use Policy (Nepal), Land Use Policy and Land Act relationship (Nepal), Other major policies influencing land management (Nepal)

Unit 4: Management of Waste

7 hrs

- 4.1 Waste as an environmental issue: Urban challenge, Principles of integrated, holistic and sustainable waste management
- 4.2 Baseline data preparation (UNEP IETC guidelines), Data collection and analysis, Presenting and projecting baseline

- 4.3 Municipal solid waste management
- 4.4 Setting boundaries and criteria for information, Information collection and analysis
- 4.5 Identification of gaps in current waste management system: Waste management policy and strategy, Legal framework, Status of compliance, Prevalent deficiencies in solid waste management systems, Steps toward an improved solid wastes management system

Unit 5: Occupational Health and Safety Management

8 hrs

- 5.1 Nature and types of occupational hazards, Occupational and environmental health, Occupational health and safety management (Principle and Requirement), Occupational hygiene, Economics of occupational health and safety (OHS), OHS legislation, OHS implementation and certification
- 5.2 Health and safety management systems: Policy, Responsibility, Implementation, Monitoring, Audit and review
- 5.3 Occupational hygiene: Tools, techniques and measurement
- 5.4 Hazard identification and risk assessment (Qualitative and Quantitative), Hazard control principle and techniques
- 5.5 Accident investigation and Root cause analysis
- 5.6 Toxicology: Routes of entry of harmful substances and their effect, Ergonomics, Personal safety gears (Principle and Classification)
- 5.7 Certification process of OHSMS, OHS tools and their application: Environmental Management System (EMS), Green Productivity (GP), Cleaner Production (CP), Energy Efficiency (EE), Product Quality, Globalization, Industrial Relation (IR)

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Semester I**Course Title: Terrestrial and Aquatic Ecology****Course No: ENV 551****Nature of Course: Practical (Compulsory)****Credit Hours: 2****Lecture Hours: 90****Full Marks: 50****Module 1: Methods in Ecological Study****[3 Practicals = 9 hrs]**

1. Various techniques for studying plant population and communities quadrats, transects (line, belt) in ecological study
2. Various sampling techniques (random, stratified, cluster) and their uses in ecological studies
3. Collect field data (vegetation) using different techniques and sampling strategies
4. Various techniques of studying animal populations (pans, pitfalls, light traps, sweeps and distances)
5. Publish data as scientific report (Effective practical/lab report writing in ecology)

Module 2: Community Analysis**[7 Practicals = 21 hrs]**

6. Sampling vegetation and graphical exercises (cumulative distribution curves, species composition: abundance and Euclidean distances, species area curves, scatter plots, log transformations)
7. Estimate species richness, evenness and diversity of community (plant and animal) using different indices
8. Study on intraspecific aggregation of species using indices
9. Study species interaction/association using statistical methods
10. Study on community similarity/dissimilarity using statistical methods
11. Cluster analysis on distribution of vegetation communities

Module 3: Gradient Analysis**[2 Practicals + 1 Day Field = 15 hrs]**

12. Ordination analysis of vegetation
13. Gradient analysis of vegetation along different environmental gradients (altitude, disturbance)

Module 4: Carbon Stock Estimation of Ecosystems (Grasslands and Forests)**[5 Practicals = 15 hrs]**

14. Estimation of above and below ground carbon stock
15. Estimation of soil organic carbon
16. Estimation of total carbon stock of ecosystem
17. Fitting regression models (including checking assumptions like normal distribution of residuals, homoscedasticity and independent errors) for response variables and predictors in vegetation study

Module 5: Assessment of Lake Ecology**[5 Practicals = 15 hrs]**

18. Ecological assessment of standing water bodies by applying Biotic Index
19. Determination of candidate metrics of aquatic organisms: macroinvertebrates and macrophytes to understand the response to stress
20. Determination of primary production (light and dark bottle oxygen technique) in fish pond and natural lake
21. Determination of composition and biomass of zooplankton and phytoplankton (depth wise sampling and analysis)

Module 6: Assessment of River Ecology

[5 Practicals = 15 hrs]

22. Application of biotic index for assessing ecological health of undisturbed and disturbed river sections
23. Determination of candidate metrics between undisturbed and disturbed river sections
24. Application of screening protocol for river quality mapping
25. Understanding the impacts of environmental variables in determining macroinvertebrates composition

References

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Course Title: Hydrology, Meteorology and Geology
Course No: ENV 552
Nature of Course: Practical (Compulsory)

Credit Hours: 2
Lecture Hours: 90
Full Marks: 50

Module 1: Fundamental of Geology, Study of Minerals and Rocks [5 Practicals = 15 hrs]

1. Study of silicate minerals in hand specimen and interpretation of their uses and roles for rocks and soil stability
2. Study of non silicate minerals in hand specimen and interpretation of their economic importance and roles for rocks and soil stability
3. Study of sedimentary rocks in hand specimen and interpretation of depositional environment
4. Study of igneous rocks in hand specimen and interpretation of formational and environmental history
5. Study of metamorphic rocks in hand specimen and interpretation of uses for environmental protection and development

Module 2: Geological Structures, Land Features and Mapping [6 Practicals = 18 hrs]

6. Study of geological structures in 3D model and analysing the impacts of those structures in natural environment
7. Study of different features of geological map and its importance for the development activities
8. Study of environmental geological map, methods of preparation and its importance
9. Classification of soil after laboratory analysis (sieve analysis) of soil sample

Module 3: Geological Data Collection, Data Input and Interpretation of Result

[4 Practicals + 1 Day Field = 21 hrs]

10. Study of discontinuity analysis of rocks
11. Study of discontinuities plotting methods in stereographic net
12. Study of slope stability analysis by using stereographic projection method
13. Study of geomorphology and geological data collection in field

Module 4: Natural Hazard Mapping and Interpretation of Result [6 Practicals = 18 hrs]

14. Study of landslide hazard by preparing landslide hazard map
15. Preparation and interpretation of flood hazard map

Module 5: Hydrological Analyses [6 Practicals = 18 hrs]

16. Interpretation of raw meteorological data obtained from DHM
17. Estimation of average rainfall by isohyetal and Thiessen polygon methods
18. Estimation of water balance of a given station by Thornthwaite method
19. Data handling, formatting and management for surfer and cropwat softwares
20. Preparation of climatic and solar radiation maps of Nepal by using surfer software
21. Analysis of crop water requirement by using cropwat model

Course Title: Environmental Pollution
Course No: ENV 553
Nature of Course: Practical (Compulsory)

Credit Hours: 2
Lecture Hours: 90
Full Marks: 50

Module 1: Sampling and Preservation Techniques [4 Practicals = 12 hrs]

1. Sampling and preservation techniques for drinking water quality (Physicochemical, Microbial) and surface water quality (Nutrients, Pollution, Physicochemical)
2. Sampling techniques for ambient air quality: Particulates, Gases and Heavy metals
3. Sampling techniques for solid waste and leachate
4. Sampling techniques for agricultural soil quality

Note: The module intends to familiarize with different sampling techniques (Grab, Composite etc.).

Module 2: Environmental Analytic Techniques [4 Practicals = 12 hrs]

5. Quality Assurance (QA) and Quality Control (QC)
6. Volumetric analysis (Basic Principles, Types)
7. Spectrophotometric analysis (Principle, Examples)
8. Atomic absorption spectrometry (Theoretical approach, Instrumentation, Application)

Note: The module comprises of class lectures and demonstrations.

Module 3: Water Quality Monitoring [5 Practicals + 1 Day Field = 21 hrs]

9. Drinking water quality analysis (Temperature, pH, TDS, Alkalinity, Hardness, Chloride, Ammonia, Nitrate, Coliform bacteria, Fe, Mn, As)
Sample category (Any one – community supplied water/bottled water/treated water/water supplied in hospital)
10. Water quality analysis of surface water (Temperature, pH, EC, TDS, TSS, Free CO₂, Alkalinity, Hardness, DO, BOD, Phosphate, Nitrate, Relevant heavy metals)
Sample category (Any one – pond/lake/river)
11. Water quality analysis of groundwater (pH, EC, TDS, Free CO₂, Alkalinity, Hardness, Ammonia, Nitrate, Phosphate, Fe, Mn, As; Coliform bacteria)
Sample category (Any one – dug well/shallow groundwater well/deep groundwater well)
12. Water quality analysis of wastewater (pH, EC, TSS, COD, BOD, Ammonia, TKN, Total Phosphorus, Coliform bacteria, Relevant heavy metals) and efficiency of wastewater treatment plant
Sample category (Any one – municipal wastewater treatment plant/industrial wastewater treatment plant/natural wastewater treatment system)
13. Water quality analysis of irrigation water (pH, Alkalinity, Hardness, SAR: Ca, Mg, Na)
Sample category (Any one – canal/pond/lake/stone spout/river/spring water)
14. Field visit to water and wastewater treatment plants for water treatment and wastewater treatment technologies.

Students are required to submit field visit report.

Notes:

- The classroom practicals are carried out in group.
- The students are required to prepare assessment reports after completion of the module.
- Out of the five practicals, the students are required to prepare two assessment reports based on primary data.

Module 4: Air Quality Monitoring**[4 Practicals + 1 Day Field = 18 hrs]**

15. Monitoring and assessment (Primary data of at least two parameters - TSP, PM₁₀, PM_{2.5}, NO_x, SO_x, CO_x, O₃, HC, Pb)
 16. Assessment on secondary data
 17. Emission inventory using equivalent default emission factors
 18. Field visit to industries for air pollution control technologies
- Students are required to submit field visit report.

Module 5: Soil Quality Monitoring**[4 Practicals = 12 hrs]**

19. Analysis of soil quality in forest land (Texture, Organic Carbon)
20. Analysis of soil quality in agricultural land (pH, Texture, Organic matter, P₂O₅, K₂O, Total nitrogen)
21. Analysis of micronutrient in soil of agricultural land
22. Analysis of soil quality in contaminated sites (Texture, Relevant heavy metals)

Module 6: Monitoring of Solid waste and Leachate**[2 Practicals + 1 Day Field = 12 hrs]**

23. Analysis of solid waste: household, commercial and municipal (Physical - mass, volume, density, moisture content, physical classification, calorific value)
 24. Analysis of leachate from landfill sites (Temperature, pH, EC, Ammonia, BOD, COD, Relevant heavy metals)
 25. Field visit to landfill sites for solid waste management technologies
- Students are required to submit field visit report.

Module 7: Monitoring of Noise Pollution**[1 Practical = 3 hrs]**

26. Measurement and comparison of noise level (equivalent, percentile) in residential, public and work places

References

- APHA-AWWA-WEF. (2005). Standard methods for the examination of water and wastewater. 21st ed. American Public Health Association, American Water Works Association, Water Environment Federation, Washington.
- ISRIC. (2002). Procedures for soil Analysis. International Soil Reference and Information Centre, Wageningen.
- MoEST/GoN. (2009). National indoor air quality standards and implementation guideline. Ministry of Environment, Science and Technology, Government of Nepal, Kathmandu.
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