Far Western University

Mahendranagar, Kanchanpur

Faculty of Science and Technology

B. Sc. Environmental Science

Far Western University

Faculty of Science and Technology

Course Structure of B. Sc. Environmental Science

Course Code	Course Code	Credit
Semester I		
ENV 111	Fundamentals of Environmental Science TH	3
ENV 111	Fundamentals of Environmental Science PR	1
Semester II		
ENV 121	Environmental Aspects of Meteorology and Hydrology TH	3
ENV 121	Environmental Aspects of Meteorology and Hydrology PR	1
Semester III		
ENV 231	Environmental Earth Science and Applications TH	3
ENV 231	Environmental Earth Science and Applications PR	1
Semester IV		
ENV 241	Environmental Pollution and control technologies TH	3
ENV 241	Environmental Pollution and control technologies PR	1
Semester V		
ENV 351	Urban Environment TH	3
ENV 351	Urban Environment PR	1
Semester VI		
ENV 361	Environmental Engineering TH	3
ENV 361	Environmental Engineering PR	1
Semester VII		
ENV 471	Remote Sensing and Geographical Information System	3
ENV 472	Environmental Modeling	4
ENV 473.1	Field Work Based Case Studies	1
ENV 473.2	Internship	1
Semester VIII		
ENV 481	Environmental Assessment and Management System	4
ENV 482	Environmental Economics	4
ENV 483	Environmental Assessment and Management System (Practical)	2

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Course Title: **Fundamentals of Environmental Science TH**	Full Marks: **100**
Course Code: **ENV 111**	Pass Marks: **45**
Nature of Course: **Theory**	Credit: **3**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **First**, Semester: **First**	Teaching Hours: **45**

1. Course Description

The course intends to provide basic theoretical and practical knowledge on Fundamental aspects of Environmental Science. The course has been divided into five units. The first unit deals with Concept, development and scope of Environmental Science. The second unit focuses on Ecology, its associated components and Microbial Ecology. The third unit deliberates basic knowledge on Population and Community Ecology and its application. The fourth unit put emphasis on Concept and types of ecosystem and Pattern of energy flow in Ecosystem. While the fifth unit focuses on interrelation between Environment and Human Society and use of sociological and anthropological knowledge and practices on environmental conservation.

2. Course Objectives

The general objectives of the course are as follows:

- To acquaint the students with fundamental aspects of environmental science.
- To familiarize with environment and environmental science
- To give knowledge on ecology and ecosystem
- To develop analytical skills on Population and community analysis.
- To make familiar about the human interaction with environment

3. Specific Objectives and Contents

Specific Objectives	Contents
• Provide knowledge on concept, historical development, Scope and importance of Environmental Science. • Familiarize with environmental science and its interrelation with other disciplines.	**Unit 1: Environment and Environmental Science (5 hrs)** Definition, concept and perspectives; historical development; objective, scope and importance; relationship between environmental science with other disciplines; environmental science in Nepalese and global context
• Discuss about concept, branches and Scope of Ecology; relation between environmental science and ecology.	**Unit 2: Ecology (10 hrs)** Ecology: Definition, preview, branches and scope of ecology; relationship between ecology and

• Describe about life supporting systems; ecological factors; limiting factors. • Explain about food chain, food web, trophic structure and ecological pyramids • Highlight on concept of niche and habitat • Discuss Distribution of microorganisms in the environment; characteristics of bacteria, cynobacteria, actinomycetes, fungi, algae and protozoan and factors affecting growth of microorganisms. • Provide Knowledge on microbial interaction and concept of bioremediation and biosensors.	environmental science; concept of ecosystem; life supporting systems; ecological factors; limiting factors; laws of limiting factors; ecological basics: terminologies, concept of food chain, food web, trophic structure, ecological pyramids; concept of niche and habitat Microbial Ecology: Distribution of microorganisms in the environment: bacteria, cynobacteria, actinomycetes, fungi, algae and protozoan; factors affecting growth of microorganisms; air, water, soil and food microbes; microbial interaction; concept of bioremediation and biosensors; microbes and human health, Use of microbes as biofertilizer and biopesticides.
• Describe Characteristic of population; theory of population growth and population dynamics. • Discuss the concept, characteristics and structure of communities. • Develop analytical skills on Population and community analysis. • Explain the meaning of Species interaction; explain their types with examples and their importance.	**Unit 3: Population and Community Ecology** **(10 hrs)** Population: Basic concept of population ecology; population characteristics; theory of population growth; population dynamics; population regulation. Community: concept, brief history, characteristics and structure; species interaction: positive and negative; linkage population, community and environment
• Explain the concept, meaning and different types of ecosystem. • Describe characteristic features and components of ecosystems. • Highlight the structure and functional aspects of pond and forest ecosystems • Describe the meaning and mechanism of biogeochemical cycle. • Discuss about the Energy flow process on ecosystem and its role in ecological balance. • Explain meaning and concept of	**Unit 4: Ecosystem** **(15 hrs)** Ecosystem: concept and types; terrestrial and aquatic ecosystems; structure and functional aspects of pond and forest ecosystems; biogeochemical cycle: gaseous, sedimentary and hydrological; energy flow; succession; productivity: primary and secondary

succession and trend of succession. • Describe different types of productivity and its measurement techniques.	
• Describe about development of human civilization and their socio-cultural perspective regarding environmental resources. • Explain about nexus population growth and environmental degradation. • Discuss the use of sociological and anthropological knowledge and practices on environmental conservation. • Explain the meaning of environmental sustainability: approach and principles • Highlight the environmental world views and ethics.	**Unit 5: Environment and Human Society** **(5hrs)** Environmental resources and socio-cultural perspective; human civilization and resources; nexus population growth and environmental degradation; use of sociological and anthropological knowledge and practices on environmental conservation; environmental sustainability: approach and principles; environmental world views and ethics

Text Books :

1. Miller, Jr. G. T. (2003). *Living in the Environment*: Wadsworth Publication.
2. Odum, E. P. (1996). *Fundaments of Ecology*: Saunders Company, USA
3. Sharma .P.D. Ecological and Environmental. Rostogi Publication, India

References:

1. Cunningham, W.P & Cunningham, M.A. (2004). *Principles of Environmental Science: Inquiry and Applications,* Second Edition. Boston: Mc Grow Hill.
2. Kormondy, E. J. (1996). *Concepts of Ecology*: Prentice-Hall of India, New Delhi.
3. Odum, E. P. and Barrett, G. W. (2005). *Fundamentals of Ecology*, 5th Edition, Saunders Company, USA.
4. Richard T. (2008). *Environmental Science, Toward a Sustainable Future,* PHI (P) Limited, India
5. Santra, S.C. (2004). *Environmental Science,* New Central Book Agency (P) Ltd. India.
6. Sharma .P.D. Ecological and Environmental. Rostogi Publication, India
7. Francis A. (1982). *Modern Sociological Theory: An Introduction,* Oxford University Press, New Delhi
8. PelczarM.J. 2010. *Microbiology, An Application based approach***,** second reprint,2010 ,Tata McGraw-Hill Co, New Delhi.

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Practical No.

Course Title: **Fundamentals of Environmental Science PR**	Full Marks: **20**
Course Code: **ENV 111**	Pass Marks: **09**
Nature of Course: **Practical**	Credit: **1**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **First**, Semester: **First**	Teaching Hours: **45**

1. Enumeration of floral and faunal diversity of terrestrial ecosystem
2. Measurement of population and community parameters: density, frequency, abundance, community composition, similarity index, species-area-curve, minimum number of sampling units, species diversity of vegetation and animals by quadrat method.
3. Measurement of primary productivity (using different methods)
4. Biological analysis of soil from grassland/cropland/forest ecosystems
5. Instrumentation and working principle: compound microscope, hot air oven, autoclave, incubator, biological safety cabinet, water bath and related instruments
6. Analysis of bacterial population (staining, enumeration)
7. Visit to nearby forest /grassland ecosystem to enumerate floral and faunal diversity
8. Visit to nearby health post/Municipality/DDC to assess the environmental administration and management system.
9. Visit to human settlement area for socio economic and cultural study and prepare a project report.

Some major points related to aforementioned practical:

1.Students have to carry out *one day field visit* to nearby national park/wildlife reserve for conducting practical number **1, 2, 7 and 9**. Since the field work is for complete academic purpose. For this purpose University will have to support students for necessary transportation cost. Total two separate field visits will be held. First field visit will address practical number 1, 2, 7 and second field visit will address practical number 9.

2. Students have to prepare a field report for practical no. **8 and 9** and submit during practical examination.

3. Students have to submit a field note book of all field visits during practical examination.

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Course Title: **Environmental Aspects of Meteorology and Hydrology TH**	Full Marks: **100**
Course Code: **ENV 121**	Pass Marks: **45**
Nature of Course: **Theory**	Credit: **3**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **First**, Semester: **Second**	Teaching Hours: **45**

1. Course Description

The aim of the course is to provide knowledge on Hydro- Meteorology, Climatology, and Limnology. The course has been divided into four units. The first unit familiarizes the students about limnology and its application. Second unit deals with concept and principles of Environmental Hydrology and its application. Third and Fourth unit give emphzise on aspect of Meteorology and climatology and their implication in environmental science.

2. Course Objectives

The objectives of the course are as follows:

- To enhance students understanding on broader aspects of environmental Science linking it with limnology, hydrology, climatology and meteorology to develop analytical skills.
- To make students familiar with scope and application of Limnology.
- To familiarize the students with the importance and application of hydrology.
- To aquatint the students with principles and process of Climatology and Meteorology.
- To familiarize the students about climate and climatic systems.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Provide knowledge on concept, Scope and importance of Limnology. • Discuss about Physico-Chemical and Biological Characteristics of water. • Describe on conservation aspects and ecosystem services of wetlands.	**Unit 1: Limnology(10 hrs)** Introduction: Scope and Application; Fresh water Environment: Defination, Types,and limiting factors; Characteristics of lotic and lentic environment; Morphometry of Fresh water body; Physico - Chemical properties; Physico Chemical and Biological water quality index; Fresh water biodiversity; Wetlands: Concept, Types, Roles, Threats, Challenges and Conservation with focus to Nepal; Fresh Water habitat degradation; Ecosystem Services of aquatic ecosystem :case studies; Concept of water footprints, Ecological and economic importance of freshwater environment.

• Provide Knowledge about hydrological cycle, Global water budget and Nepal's water budget. • Discuss about precipitation, types and forms and its measurement techniques. • Explain about basin characteristics, drainage patterns, runoff and its components. • Provide knowledge on stream flow measurement. • Discuss about sedimentation process, its estimation and sedimentation problems in Nepal. • Describe about floods, its causes, measurement and forecasting techniques. • Highlight about concept of hydrogeology.	**Unit-2:Environmental-Hydrology (20 hrs)** Environmental Science and Hydrology: Definition and scope; hydrological cycle; global water budget; Nepal's water budget; Precipitation : Forms, measurement of precipitation: recording and non-recording rain gauges; analysis and interpretation of rainfall data; estimation of missing precipitation records; mass rainfall curve and hyetograph; intensity duration of rainfall; basin characteristics; drainage patterns; runoff:surface, subsurface and direct runoff, factors affecting runoff, Streamflow: components of runoff, factor affecting runoff, stream flow measurement and stage-discharge relationship; discharge measurement; hydrographs; evaporation, evapo-transpiration and infiltration: measurement and estimate, factor affecting evaporation, evapo-transpiration and infiltration, Sedimentation: Introduction and sources of sediment, factors affecting sediment yield, control measures, sedimentation problems in Nepal, Floods: causes, factor affecting and types; flood flow determination; Flood measurements: frequency analysis, reconstruction of hydrological data, control techniques and forecasting; hydrogeology: porosity, permeability, specific yield, specific retention, water table, aquifer, ground water flow measurement: Darcy's law.
• Discuss about Earth-Sun relationship, factors affecting the receipt of insolation by earth. • Estimation and of radiation and heat budget. • Explain about temperature, pressure, wind, general atmospheric circulation and their components. • Discuss about different types and forms of precipitations. • Provide Knowledge on meteorological principle to transport and diffusion of pollutants. • Explain; wind roses; lapse rate and temperature inversion; scavenging process	**Unit 3: Principles of Meteorological Fundamentals. (8 hrs)** Earth-Sun relationship; factors affecting the receipt of insolation by earth; radiation and heat budget; Insolation and factors affecting distribution of insolation; temperature: records, distribution, air temperature and its measurement; pressure: atmospheric pressure, pressure –height relationship, pressure distribution; air pressure and wind; wind: direction and speed; factors affecting wind; local wind systems; general atmospheric circulation and jet stream; thermal circulation; humidity: definition(absolute and relative), precipitation: general processes, Forms and types; atmospheric stability; stable, unstable and neutral atmosphere; turbulence and diffusion; meteorological principle to transport and diffusion of pollutants; wind roses; lapse rate and temperature inversion; scavenging process.

• Provide knowledge on concept, Scope and importance of climatology. • Discuss about weather and climate and its elements. • Describe climatic classification and climate types. • Explain about climate and seasons of Nepal and climatic factors affecting human settlement and livelihood. • Explain the meaning and concept of Dendro-Climatology and its application. • Explain about climate and climatic hazards.	**Unit 4: Climatology (10 hrs)** Climatology: Introduction, importance and types; composition and structure of the atmosphere; weather and climate; factors determining climate; microclimate; elements of weather and climate World climate and climatic systems; climatic classification; objectives and basis; koppen's, Thornwaiteclassification;climatetypes:tropical climate, temperate climate, highland climate, tundra climate; climate and seasons of Nepal; monsoon and its environmental significance; monsoon of Nepal; rainfall and temperature variation with east-west, north south, intraregional variation in Nepal; climatic factors affecting human settlement and livelihood in Nepal, concept of dendro-climatology. Climate and climatic hazards: drought; flood; climate and food security; thunderstorms, tornadoes, hurricanes and EL- Nino/ ENSO

Text Books :

1. Adoni, A.D. A text book of Limnology, Prathibha Publishers, Sagar.
2. Critchfield, H.J. *General Climatology*
3. Reddy, J.P. 2011, *A Text Book of Hydrology*, 3rd edition, Laxmi Publication, New Delhi.
4. Subramanya, K, 2002, *Engineering Hydrology*, Tata McGraw-Hill Publishing Company Limited, New Delhi, India.

References:

1. Critchfield, H.J. *General Climatology*
2. Grag, S.K. 2000, *Hydrology and Water Resources*, Khanna Publishers, Delhi.
3. Hewlett, J.D. 1982, *Prince of Forest Hydrology*, University of Georgia Press, Athens, Georgia.
5. Kohler, L. and Paulhus, 1992, *Applied Hydrology*, Tata McGraw-Hill Publishing Company Ltd., New Delhi, India.
6. Frey, D.G. and Fry, F.E.J. Fundamentals of Limnology. Toronto University Press, Canada.
7. Lockwood, J.G. *World Climatology*
8. Reddy, J.P. 2000, *A Text Book of Hydrology*, Laxmi Publication, New Delhi.
9. Suresh, R.1997, *Watershed Hydrology*, Standards Publishers and Distributors, Delhi.
10. Burkhard von Rabenau, 1993, *Project Financial Analysis for Physical Planners*, GTZ/DHUD/MHP, Kathmandu/Nepal and Columbus, Ohio/ USA
11. WECS 2002. *Water Resources Strategy Nepal,* Water and Energy Commission Secretariat, Kathmandu, Nepal.
12. Cunningham, W.P & Cunningham, M.A. (2004). *Principles of Environmental Science: Inquiry and Applications,* Second Edition. Boston: Mc Grow Hill.
13. Mather J. R, Water Resources, distribution, use and management, wiley, New York.

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Faculty of Science and Technology

Course Title: **Environmental Aspects of Meteorology and Hydrology PR**	Full Marks: **20**
Course Code: **ENV 121**	Pass Marks: **09**
Nature of Course: **Practical**	Credit: **1**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **First**, Semester: **Second**	Teaching Hours: **45**

Practical No.

1. Study of macrophytes and macro invertebrates communities from lentic and lotic environment (sampling methods, sampling sites, density distribution, composition and diversity)
2. Qualitative and quantitative estimation of phytoplankton and Zooplankton.
3. Determination of Temperature, pH, turbidity, conductivity, Dissolved Oxygen, Hardness, alkalinity, chloride, phosphate and Nitrogen.
4. Measurement of river discharge (float method, current meter method weir and bucket method)
5. Estimation of optimum number of rain gauge stations.
6. Estimation of missing precipitation data.
7. Analysis of flood frequency and estimate extreme flood events.
8. Study of infiltration of water through soil curve.
9. Estimation of potential evapo- transpiration.
10. Construction of Hydrograph, unit hydrograph, base flow and rating curve.
11. Field observation of agro-meteorological and hydro- meteorological stations
12. Analysis of weather parameters (temperature, precipitation, humidity)
13. Estimation of missing weather data (temperature, precipitation and humidity)
14. Study on classification of temperature and precipitation zones of Nepal.
15. Wind rose Construction.

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Some major points related to aforementioned practical:

1.Students have to carry out *one day field visit* to nearby lentic and lotic ecosystem for conducting practical number **1, 2, and 11**. Since the field work is for complete academic purpose. For this purpose University will have to support students for necessary transportation cost.

2. Students have to prepare a field report for practical no. **11** and submit during practical examination.

3. Students have to submit a field note book of all field visits during practical examination.

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Course Title: **Environmental Earth Science and Applications TH**	Full Marks: **100**
Course Code: **ENV 231**	Pass Marks: **45**
Nature of Course: **Theory**	Credit: **3**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **Second**, Semester: **Third**	Teaching Hours: **45**

1. Course Description

The aim of the course is to provide comprehensive knowledge on Earth resources, geological processes, make the students familiar with concepts of environmental geology, and developing the analytical skills of environmental survey. The course has been divided into four units.

2. Course Objectives

The objectives of the course are as follows:

- To enrich students understanding on basic concept of earth resources and geological processes.
- To enhance students understanding on broader aspects of environmental Science linking Geology and geological consideration.
- To make students familiar with scope and application of Environmental Survey.
- To familiarize the students with soil and its role.
- To enhance the knowledge of students on depositional landforms of wind and water.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Provide basic concept and of Atmosphere, lithosphere and hydrosphere and their association. • Enhance students' knowledge on Earth materials and their implications. • Describe on Earth's Exogenic and endogenic processes.	**Unit 1:Earth Resources (8 hrs)** Atmosphere; lithosphere; hydrosphere; interior of Earth; Earth Materials (Rocks and minerals): rock cycle, rock types, minerals and types, mineral resources of Nepal; Earth Processes: Endogenic and Exogenic; Tectonism; Volcanism.

• Provide Knowledge on weathering, erosion and its types. • Discuss about physio-Chemical and biological properties of soil. • Explain about soil profile, its formation and soil types of Nepal. • Provide knowledge on Geological work of wind and Water. • Describe about Mass movements, their causes and types. • Discuss about erosional land forms and depositional land forms of fluvial environment.	**Unit-2:Geological Surface processes and Environment (15hrs)** Geological surface processes : Weathering and erosion: types, Characteristics, factors; Erosion cycle; Soil: Concept and relation with environment; Process and factors affecting soil genesis; Chemical and mineralogical composition of soil; Properties of soil: Physical, chemical and biological; Humus: Nature, properties and formation Soil profile and types; Soil types of Nepal; Soil erosion and control. Geological work of wind and Water; Mass movements: types; Fluvial environment: Types of Drainage pattern; Channel pattern, Erosional landforms; Fluvial deposits; Flood plain and river terraces.
• Discuss about broader aspects of environmental Science linking Geology and geological consideration. • Explain about the Land use, land use planning and policy of Nepal. • Explain about Geological criteria and decision making for waste disposal and infrastructural development. • Discuss about Physiographic, geomorphic and tectonic division of Nepal Himalaya. • Provide Knowledge on major hazards associated with physiographic zones of Nepal and mitigation measures.	**Unit 3: Environmental Geology(15 hrs)** Environmental Geology: concept and its application; Anthropogenic activities and Geology: Land degradation and soil erosion; Land Use: Land use planning; Land use policy of Nepal; Land use patterns in Nepal; Geological criteria of land use planning and decision making for waste disposal and infrastructural developments: roads, tunnels, bridges and foundation, Dams and reservoirs; Geotechnical consideration and environmental impacts; Land capability mapping; Instability of hill slopes and land slides; Case studies; Geological aspects of environmental health; Physiographic, geomorphic and tectonic division of Nepal Himalaya and major hazards associated with thesezones, mitigation measures.

• Provide knowledge on concept, scope and importance of environmental survey. • Discuss about different types of maps and their interpretation. • Describe Topographic surveying and their methods. • Enhance students' knowledge on contour map preparation and locating contours. • Explain about Concept and application of Remote Sensing (RS) and Geographic Information System (GIS) • Explain the use of GPS in relation to environmental monitoring.	**Unit4 - Geo -Environmental Skills(15 hrs)** Environmental survey: Definition and concept, objective, importance and scope; Introduction and types of map; Topographic surveying: Concepts, inventory and mapping, methods of topographic surveying, methods of representing relief; Contours: concepts and characteristics, methods of locating and interpolation; Concept and application of Remote Sensing (RS), Geographic Information System (GIS), Global Positioning System (GPS) in relation to environmental monitoring; Methods of resources surveying: land, water, forest, mines.

References:

1.Adoni , A. D. A text book of Limnology, Prathiba Publishers, Sagar India.
2.Agrawal K.M. Sikdar P.K. Deb, S.c. .A text book of Environment, Macmillan India Limited.
3.Avery, T.E. and Berlin, G.L. 1992, Fundamentals of Remote Sensing and Air Photo Interpretation, Macmillan.
4.Bloom, A.L. 1992, Geomorphology, Prentice Hall Pvt. Ltd, New Delhi.
5.Brady, N. C. and well R.R, (2007). The Nature and properties of Soils, Pearson Prentice Hall, New Delhi.
6.Critchfield, H.J. *General Climatology* Prentince Hall Pvt. Ltd, New Delhi.
7.Cunningham, W.P and Cunningham, M.A. (2004). Principles of environmental Science: Inquiry and Applications 2nd edition .MC Grawhill, Boston.
8.Joseph , G. , 2005, Fundamentals of Remote Sensing, University Press (India) Pvt. Ltd, Hyderabad.
9.Keller ,E.A. (1985) Environmental Geology, Charles E. Merrill publishing company, Bell and Howell company, columbus, Ohio.
10.Mahapatra, G. B., (2008).Text Book of Physical Geology, CBS Publishers and Distributers, India.
11.Punmia, B.c, Jain A.k. (2005), Surveying Vol. I , Surveying Vol. II, 16 th publication.Laxmi PublicationsP. Ltd, New Delhi.
12.Reineck, H.E and Barrett, G. W. (1990).Depositional Sedimentary Environments with reference to Rerrigeneous Clastics. Pringer Verlag, Berlin Heidelberg.
13.Singh, s. Geomorphology
14.Valdiya, K.S. (1987) Environmental Geology, Ist edition, Tata MC Grawhill Limited, New Delhi.

Far Western University
Faculty of Science and Technology

Course Title: **Environmental Earth Science and Applications PR**	Full Marks: **20**
Course Code: **ENV 231**	Pass Marks: **09**
Nature of Course: **Practical**	Credit: **1**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **Second**, Semester: **Third**	Teaching Hours: **45**

Practical No.

16. Study of basic components of topographic map and interpretation for geo-environmental study.
17. Study of geological maps and describing its geological features.
18. Identification and study of Rocks (Igneous, sedimentary and metamorphic) and common minerals in hand on specimen.
19. Rock mass classification
20. Study of soil profile: recording profile, sampling of soil and laboratory study of soil samples, grain size analysis.
21. Handling and application of geological compass.
22. Preparation of contour maps and Drainage patterns.
23. Study on survey tools, techniques.
24. Study on map reading techniques and GPS tracking method.

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Some major points related to aforementioned practical:

1. Students have to carry out *field visit* for supporting practical number **3,4,5, 6,8 and 9**. Since the field work is for complete academic purpose. For this purpose University will have to support students for necessary transportation cost.

2. Students have to prepare a field report of field visit and submit during practical examination.

3. Students have to submit a field note book of each field visits, during practical examination.

Instructional Techniques in Environmental Science

All topics are discussed with emphasis on real-world application. List of instructional techniques is as follows:

- Lecture and Discussion
- Group work and Individual work
- Self study
- Assignments
- Presentation by Students
- Term Paper writing/Project work/Field work/Work shop/Seminar/internship
- Quizzes
- Field Visits and Demonstration

(More emphasis should be given in field visit)

Evaluation

This course is for one semester (15 weeks) which carries 100 percentage marks. The examination evaluation procedure consists of both internal examination and external examination. The weightage of these examinations are as follows:

Internal Evaluation: 40%

External Evaluation: 60%

a) Internal Evaluation:

This is a continuous evaluation process which carries 40 % weightage. Assuming it as 100%, the bases of Internal Evaluation will be as follows:

1. Assignments 20%
2. Quizzes 10%
3. Semester(Mid Term) Exam: 60%
4. Attendance 10%

Attendance in Class: Students should regularly attend and participate in discussions in the class. 90% class attendance is mandatory for the students to enable them to appear in the End-Term examination. Below 80% in attendances that signify as NOT QUALIFIED (NQ) in subject to attend the end term examination.

Assignment: Each student must submit the assignment individually. The stipulated time for submission of the assignment will be seriously taken as one of the major criteria of the evaluation.

Mid-Term Examinations: It is a written examination and the questions will be set covering the topics as taught in the sessions. Mid-term examination will be based on the model prescribed for End-term examination.

b) End-Term/External Examinations: It is also a written examination and the questions will be set covering all the topics in the session of the course. The question model, full marks, time and others will be as per the following grid. Full Marks: 100, Pass Marks: ....., Time: 3 Hrs

Strict Notice for students: Each student must secure ....% marks with 80% attendance in internal evaluation in order to qualify the End-Term Examinations. Failing to get such score will be given NOT QUALIFIED (NQ) and the student will not be eligible to appear in the End-Term examinations.

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title **Environmental Pollution and Control Technologies TH** Credit: **3**

Course Code **ENV 241** Number of hours per **3** week

Nature of theCourse **Theory (Core Course)** Total hours **45**

Year **Two** Semester **Fourth** Level **B.Sc.**

Course Objectives:

Upon completion of this course, Students will be able to

- Understand basic science about various type of environmental pollution,
- Understand the process behind these phenomenon
- Incept the knowledge and theory of pollution control technologies.
- Understand the discipline of ecotoxicology and fate of toxicants in environment.

Specific Objectives	Contents
• To make students able to understand the basic concept of Air pollution. • To provide scientific knowledge about process behind Air Pollution • To explain students about effect of Air pollution	**Unit I: Basic Concept of Air pollution (5 hours)** Basic concepts: Definition, Natural vs. Contaminated Air; Types of Air pollution: origin, chemical composition and State of Matter; Source of Air pollution; Mode of formation of criteria air pollutants (Ozone, COx, NOx, SOx, Particulate matters): Toxic Air Pollutants; Aerosols: Mode of formation, Types, Vertical variation of Aerosols; Effects of Air Pollution: Effects on human health: Effects on Vegetation: Effects on properties/materials: Effects on visibility: Effects on climate/Weather; Laws Governing Air Pollution: Gas Laws, Gaussian Plume dispersion Model, Plume Rise; Atmospheric Brown Cloud, Green House Effect, Ozone Depletion, Trans-boundary Air pollution; Indoor Air Pollution: Introduction and Effects
• To provide knowledge about various type of air pollution control technologies • To explain the working principle of air pollution control measures	**Unit II: Air pollution Control Technologies (7 hours)** Introduction to Air Pollution Control; Approach to Air Pollution Control: Improve Dispersal (Atmospheric Cleansing Process), Preventive and Control Technologies, Equipment selection, Best Available Technology (BAT), Process Change and Use of Devices (Control Devices of Particulate Matter: Gravitational Settling Chambers, Centrifugal Collectors, Wet Collectors, Electrostatic Precipitators; Control of gaseous pollutants: Absorption, Adsorption and Combustion; Vehicular Emission Control); Air Pollution Control Strategies: Fundamental Approaches, Guiding Principles (Short term and Long Term); Indoor Air Pollution Control: ICS, Building Design; Legal and Regulatory Tools for Air Pollution Control: National Vehicular Emission Control

• To make students able to understand the basic concept of Water pollution. • To provide scientific knowledge about process behind Water Pollution • To explain students about effect of Water pollution	**Unit III: Basic concept of Water Pollution (5 hours)** Properties of Water; Criteria of Safe Drinking water: Drinking Water quality parameters; Water pollution: Cause and Sources (Point and Non-Point sources); Water Pollutants: Types, sources, Mode of Formation; Surface water Pollution: Water pollution parameters: Bio-chemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Nitrification in Surface Water, Deoxygenation Oxygen Sag Curve, Eutrophication, Thermal Stratification, Acidification; Ground Water Pollution: Darcy's law, Flow Velocity, Cone of Depression, Groundwater Plumes and its Effect; Waste water: Types and Source; Characteristics of Municipal and Industrial Wastewater; Environmental Impacts of Water pollutants;
• To provide knowledge about various type of water pollution control measures • To familiarize students about various type of water treatment system • To study the legal instruments related to water pollution	**Unit IV: Water Pollution Control Technologies (5 hours)** Water Treatment System: Municipal Water treatment and Waste Water Treatment; Drinking Water treatment System: Process; Household drinking water treatment methods; Waste water Treatment Methods: Types and General Approaches; Primary Treatment: Working Mechanism; Biological Treatment: Process and general Principal: Advance treatment: Introduction and Principal, Constructive Wetlands; Groundwater Pollution Control methods; Legal and Regulatory Tools for Water Pollution Control; Water Quality Criteria and Guidelines; Water Legislative Tools in Nepal
• To make students able to understand the basic concept of Noise pollution. • To provide scientific knowledge about process behind Noise Pollution • To explain students about effect of Noise pollution • To provide knowledge about various type of Noise pollution control measures	**Unit V: Noise Pollution (8 hours)** Sound: Properties (Frequency, Wavelength, Pressure); Noise – How it differs from Sound; Human Sensitivity to Sound; Types of Sound/Pattern of Noise; Source of Noise; Sound Physics: Measurement of Sound Level, Sound Level vs Distance, Inverse Square Law; Environmental Impact of Noise; Noise Pollution Control: Source Control, Path Control and Receiver Control Technologies; Legal and Regulatory Tools for Noise Pollution Control; Noise Control Strategies and Guidelines;
• To make students able to understand the basic concept of Soil pollution. • To provide scientific knowledge about process behind Soil Pollution • To explain students about source and effect of Soil pollution • To accustom students about waste and Waste management system	**Unit VI: Soil Pollution (8 hours)** Properties of Soil; Role of Soil in Environment; Soil Pollution: Changes in Soil Characteristics, Sources; Environmental Impact of Soil Pollution: Soil Quality Index and Salinity Hazard; Concept of Soil Health; Residual Toxicity; Soil Pollution Control Technologies: Sustainable Soil Management Techniques, Farmer to Farmer Diffusion Model, Soil Conservation and Watershed Management Modules; Legal and Regulatory Tools for Soil Pollution Control; Waste: Definitions and Concept; Types of waste; source of waste; Municipal Solid waste; hazardous Waste; E-waste; Environmental impact of waste; Waste management Issue;

• To make students capable of understand the discipline of eco-toxicology and fate of toxicants in environment. • To accustom students about effect of toxicants in environment	**Unit VII: Environmental Toxicology (7 hours)** Introduction to Toxicology and eco-toxicology; Types of Eco-toxicants: Toxic Elements and elemental form, Toxic Inorganic compounds, Toxic organic compounds, Radio-nuclides: Sources, Radioactive decay; Distribution and fate of Toxic substances: Types of Toxicity-Acute and chronic Toxicity, Persistence, Chemical interaction, Relative Toxicity, Xenobiotic and Endogenous substances, Toxicological chemistry: Phase I and Phase II Reactions, Phases of Toxicants movements; Dose response relationships; Toxic Effects: Independents, Additive, Synergetic, Antagonism, Teratogenesis, Mutagenesis, Carcinogenesis, Estrogenesis; Factors that influence Toxicity, Routes of Exposure; Environmental effects of toxicants: Terrestrial and Aquatic Environments, Effects on Human health; Eco-toxicological Tests; Ecological Risk Assessments: Hazard Identification, Exposure Assessment, Dose response assessment, Risk Characterization; Environmental Toxicity management: Technical Approach, Environmental Regulation

Text Books:

1. De, A. K., 2008. Environmental Chemistry. New Age International Publishers, New Delhi.
2. Manahan S. E., 2000. Environmental Chemistry (7th edition). CRC Press, LLC Boca Raton. ISBN 1-56670-492-8 U.S.
3. Masters, G.M., 2008. Introduction to Environmental Engineering and Science 4th Edition. Prentice Hall, New Delhi

Reference Books:

1. APHA, 1998. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington, DC.
2. Asthana and Asthana 2010. Environment: Problems and solutions, S. Chand and Company ltd.
3. Banerji, S. k., 2003. Environmental Chemistry, Prentice Hall of India Private Limited
4. Goel, P.K., 2001. Water pollution: Causes, Effects and Control, New age International publishers
5. Mark, Z.J., 2002. Atmospheric Pollution: History, Science and Regulation. Cambridge University Press, Cambridge.
6. Miller, Jr. G.T., 2010. Environmental Science. Thirteen Edition. Brooks/Coles Ceenage learning, USA
7. Sharma, P.D., 1998. Environmental Biology and Toxicology. Rastogi Publications, New Delhi.
8. Sapkota, B., 2004 Fundamental of Noise pollution, Department of Physics, Pulchowk campus

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

Course Title **Environmental Pollution and Control Technologies PR** Credit **1**

Course Code **ENV 241** Number of hours per week **3**

Nature of theCourse: **Practical (Core Course)** Total hours **45**

Year **Two** Semester **Fourth** Level **B.Sc.**

Thematic Areas	**Practical**	**Hours**
Sampling Techniques	**Practical No. 1**: Sampling and Preservation techniques for: a. Drinking water quality assessment. b. River water quality assessment c. Lentic water bodies for water quality assessment. d. Ambient air quality e. Soil quality f. Solid waste assessment	2 hours
Air Pollution	**ıctical No. 2:** Examination of air pollution in urban area/rural area using Natural Indicators **ıctical No. 3:** Study of particulate matter (**TSP, $PM_{2.5}$ and PM_{10}**) presence in ambient air. **ıctical No. 4:** Study of presence of **SO_x, NO_x, CO_x** in ambient air.	9 hours
Water Pollution	**actical No. 5:** Examination of water quality: To determine the **Iron** concentration in drinking water of given sample water. **OR** **actical No. 6:** Examination of drinking water quality: To determine the **Arsenic** concentration in drinking water of given sample water. **actical No. 7:** Examination of drinking water quality: To determine the **Coliform bacteria** presence in drinking water of given water sample. **actical No. 8:** Examination of water pollution in surface water bodies (River/Rivulets/Lake/Ponds): To determine the **Biological Oxygen Demand (BOD)** of given Samplewater. **actical No. 9:** Examination of water pollution in surface water bodies (River/Rivulets/Lake/Ponds): To determinethe **Chemical Oxygen Demand (COD)** in River Water and Lake Water.	15 hours
Soil Quality Analysis	**actical No. 10:** Soil Analysis: To determine the **Organic Carbon** content of soil of given sample. **Practical No. 11:** Soil Analysis: To determine the **Total**	10 hours

	available Nitrogen content of given sample of soil. **Practical No. 12:** Soil Analysis: To determine the **Phosphorous** content of given sample of soil. **Practical No. 13:** Soil Analysis: To determine the **Potassium** content of given sample of soil. **Practical No. 14:** Soil Analysis: To determine the **C: N ratio** of given sample of soil.	
Noise Assessment	**Practical No. 15:** To measure and compare **Noise level (equivalent and percentile)** in public, residential and business area.	3 hours
Study of Solid Waste	**ıctical No. 16:** Waste Analysis: Study the **Composition** of Municipal Solid waste and classify them into various category of waste. **ıctical No. 17:** Waste Analysis: To determine the **Mass, Volume and Density** of municipal waste. **ıctical No. 18:** Waste Analysis: To determine the **Moisture content** in municipal solid waste.	6 hours

Some major points related to aforementioned practical:

1. Practical number 1 is fully demonstration class where sampling techniques will be demonstrated by instructor.
2. Students have to carry out ***field visit*** to nearby urban/rural area for supporting practical number **2, 3, 4, 15, 16, 17 and 18**. The field work is for complete academic purpose. For this purpose University will have to support students for necessary transportation cost.
3. Students have to prepare a field report of the field visit and submit during practical examination.
4. One day field visit will be conducted in nearby urban/rural area with following objectives:
   a. To identify point and non-point sources of water pollution.
   b. To identify sources of air pollution.
   c. To study the various pollution control technologies/measures adopted by local authorities.
   d. To collect the samples for waste characterization.
5. Students have to submit a field note book of each field visits, during practical examination.

Far Western University

Faculty of Science and Technology

Course Title: **Urban Environment TH**	Full Marks: **100**
Course Code: **ENV 351**	Pass Marks: **45**
Nature of Course: **Theory (Core Course)**	Credit: **3**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **Third** , Semester: **Fifth**	Teaching Hours: **45**

Objectives

Upon the completion of the course, the students should be able to

- Understand an overview of urban environment, urbanization, urban growth and pattern
- Understand the socio-cultural and environmental issues of urbanization and acquire knowledge on urban environmental planning
- Know the concept of sustainable cities, strategies for sustainable urbanization, and urban management initiatives
- Analyze the urban area from scientific perspective and conduct research on present issues of urban environment

Objectives	**Units, Contents and Lecture Hours**
• Understand fundamental concepts related to urban environment and urbanization • Take insights on influencing factors and patterns of urban growth and urbanization in Nepal	**Unit I: Introduction to Urban Environment and Urbanization(6 Hrs)** Introduction to Urban environment; Concept and characteristics of urban areas; Trends, process and pattern of urbanization; Trend of urbanization in developed and developing countries; Influencing factors and patterns of urban growth and urbanization in Nepal.
• Understand various environmental issues in urban areas • Acquaint with economic and ecological components of urbanization	**Unit II: Urban Environnemental Issues (15Hrs)** Concept of urban ecology; Economic and ecological components of urbanization; Socio-cultural and environmental impacts; Urban poverty, slum and squatters; Environmental sustainability and urban health; Socio-economic challenges in urban areas, urban food security; Urban infrastructures; Urban environmental issues: Sanitation, drainage, water supply and solid waste management, traffic congestion, air and noise pollution, urban land use change and patterns.
• To acquaint with concept of urban planning	**Unit III: Urban Planning (12 Hrs)** Principles of urban planning; planning process, methods and technique; Comprehensive planning; Green infrastructure; Concept of zoning and land pooling; Guided Land Development (GLD), Land Pooling and Nepalese experience; Role of

	environmental components in urban planning; Urban Planning in Nepal-Case Study
• Understand concept of sustainable urban development (SUD) • Identify fundamentals of climate resilient urban development	**Unit IV: Sustainable Urban Development** **(6 Hrs)** Concept on sustainable cities; Sustainable urbanization; Concept of inclusive urban development; Strategies for Sustainable Urban Development (SUD); Eco-cities, energy and water efficient cities; Smart cities; Climate resilient urban development
• Understand various national and international initiatives on sustainable urban development • Critically examine Sustainable Development Goal 11 on sustainable cities and communities	**Unit V: National and International Initiatives on Sustainable Urban Development(6 Hrs)** Policy and practice of sustainable urban development; Urban governance in Nepalese context; Urban planning, policies and institutions; Laws and policies related to urban issues; Development control of zoning regulations; SDG 11: Sustainable Cities and Communities

References

1. Adhikari, A.D. (1998). Urban and environmental planning in Nepal. IUCN, Kathmandu.
2. Cities and Bio-diversity Outlook. (2013.) Action and policy: a global assessment of the links between urbanization, biodiversity, and ecosystem services. Secretariat of the Convention on Biological Diversity.
3. Mitlin, Diana and Satterthwaite D. (1994). "Cities and Sustainable Development", background paper, Global Forum '94, Manchester.
4. Mostafavi, M. and Doherty, G. (2010). Ecological urbanism. HarvardUniversityGraduateSchool of Design, Baden.
5. MoUD. (2015). National Urban Development Strategy (NUDS), 2015 (Final Draft). Ministry of Urban Development, Government of Nepal, Kathmandu.
6. National Planning Commission, 2015: Sustainable Development Goals, 2016-2030, National (Preliminary) Report. Government of Nepal, National Planning Commission, Kathmandu, Nepal
7. Price, Charles and Tsouros A., eds. (1996). Our Cities, Our Future: Policies and Action Plans for Health and Sustainable Development. Healthy Cities Project Office, Copenhagen.
8. Rodney R. (1994). White Urban Environmental Management: Environmental Change and Urban Design. John Wiley &Sons, Chichester.
9. Thapa, G.B. and Devkota, S.R. (1999). Managing solid wastes in metro Kathmandu. Asian Institute of Technology, Bangkok.
10. UN-HABITAT. (2011). Global report on human settlements - cities and climate change: policy directions. United Nations Human Settlements Programme.
11. Viessman, W. and Hammer, M.J. (1998). Water supply and pollution control. Adison-Wesley Publication, Boston.

Far Western University

Faculty of Science and Technology

Course Title: **Urban Environment PR**	Full Marks: **20**
Course Code: **ENV 351**	Pass Marks: **09**
Nature of Course: **Practical**	Credit: **1**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **Third** , Semester: **Fifth**	Teaching Hours: **45**

Objectives: Upon the completion of the course, students will get field based practical knowledge on several aspects of urban environment management. The students will also get insights on preparing field reports.

Practical

1. Field-based study to identify environmental issues and urban environmental planning (S*tudents will visit nearby urban areas/centers to identify all the major issues of the locality, rank them in order of importance and work on to assess the influence of the issues on urban environment planning. Each student has to prepare an individual report at the end of the study following the prescribed format of the university. Examples include solid waste management.*)
2. Discuss, design, and conduct field survey and review of local/national planning program and designs related to urban environmental quality (*Students will work in a group/team of 4-5 and conduct this field-based study under the supervision of a faculty. Each group/team will submit a group report following the prescribed format of the university.*)
3. Innovative solutions for your own urban living environment (*This follows an approach of 'Community Work'. Students will visit communities of their choice, interact with the local inhabitants, identify key issues of the locality and provide innovative solutions. Each student will work independently under the supervision of faculty/expert and prepare report following the prescribed format of the university.*)
4. Environmental Good Practices – a case study of any one municipality (or rural municipality if municipality is not feasible) of Nepal. (*Students will visit one municipality and assess good practices being undertaken by the municipality to improve the environmental quality. For example, many municipalities in Nepal have implemented 'Environmental Friendly Local Governance Program, EFLGP' under the auspices of Ministry of Federal Affairs and Local Development, MoFALD. If possible students will visit such municipalities and will carry out SWOT i.e. Strengths, Weaknesses, Opportunities and Threats analysis of the program.*)

Far Western University

Faculty of Science and Technology

Course Title: **Environmental Engineering TH**	Full Marks: **100**
Course Code: **ENV 361**	Pass Marks: **45**
Nature of Course: **Theory (Core Course)**	Credit: **3**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **Third** , Semester: **Six**	Teaching Hours: **45**

Objectives

Upon the completion of the course, the students should be able to

- Understand the fundamentals of environmental engineering
- Acquaint with air and water pollution, pollutants and their classification, sources and effects
- Understand air, noise, water and solid waste pollution control technology
- Understand the fundamentals of water pollution, characteristics of wastewater and treatment of wastewater
- Understand the basics of landfill sites (design and operation)

Specific Objectives	Contents
• Understand the fundamentals of environmental engineering	**Unit I: Introduction to Environmental Engineering (5 Hrs)** Definitions: environment, engineering and environmental engineering; Scope and areas of application of environmental engineering; Units of measurement: base SI units, derived SI units, units outside SI system; Measurement of environmental pollution: air/water pollutant concentration measurement units, conversion of measurement units
• Acquaint with air pollution, air pollutants and their classification, sources and effects • Understand air pollution control technology • Know basics of noise pollution and control options	**Unit II: Air and Noise Pollution Control (10 Hrs)** Sources and types of air pollutants: definition of air pollution, classification of air pollutants, sources of air pollutants; Effects of air pollutants; Environmental standards for air quality: Air Quality Standards (AQS), emission standards; Transport and diffusion of air pollutants: source characteristics, downwind distance, wind speed and direction, atmospheric stability; Introduction of air pollution control technology: control of gaseous pollutants, control of particulate pollutants, control of mobile source/automobile emissions; Positive Crankcase Ventilation (PCV) system; Adsoprtion

	Canisters; Catalytic converters Noise Pollution Control: Sound vis-a-vis Noise; Typical sources of noise; Quantification of sound in terms of SPL and PWL; Typical noise levels at different places and effects of noise; Noise control options
• Get fundamentals of water quality analysis • Understand raw water treatment technology and monitoring of water quality	**Unit III: Water Supply and Treatments (10 Hrs)** Sources of Water Supply; Impurities in water: states of solution impurities; Water quality analysis: types of sampling (grab, composite), types of quantitative analysis (gravimetric analysis, volumetric analysis, colorimetry, physical methods/nephelometry); Engineered systems for water purification; Raw water treatment technology: surface water treatment technology, groundwater treatment technology; Monitoring of water quality: water quality parameters and standards (in-stream standards, potable water standards)
• Understand the fundamentals of water pollution and characteristics of wastewater • Understand the basics of wastewater treatment technology	**Unit IV: Water Pollution Control and Wastewater Treatment (10 Hrs)** Sources of Wastewater: Point sources and Non-point Sources, Water pollutants and their sources; Environmental pollution caused by untreated wastewater; Characteristics of wastewater: characteristics of domestic/municipal WW, characteristics of industrial WW; Characteristics of WW sewerage system: Types of wastewater sewerage system; Wastewater Treatment Technology: Primary treatment, Secondary (Biological) treatment, Advanced treatment; Effluent Standards: Definition, Types; Design and criteria of constructed wetlands
• Acquaint with resource recovery from solid waste (material, energy) • Understand the basics of landfill sites (design and operation)	**Unit V: Solid Waste Management (10 Hrs)** Concept of Integrated SW Management (ISWM): hierarchy of waste management; Collection, transfer, disposal of SW: types of collection system, inter-route transfer, final disposal and sanitary landfill, site selection, site preparation; Introduction to resource recovery: material recovery, recovery of biological conversion products, recovery of thermal conversion products, recovery of energy from conversion products; Landfill sites: design and operation aspect of landfill sites; Overview of SW Management in Nepal

Far Western University

Faculty of Science and Technology

Course Title: **Environmental Engineering PR**	Full Marks: **20**
Course Code: **ENV 361**	Pass Marks: **09**
Nature of Course: **Practical (Core Course)**	Credit: **1**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **Third** , Semester: **Six**	Teaching Hours: **45**

Practical Session for EE

1. Water quality analysis of wastewater (pH, EC, TSS, COD, BOD, Ammonia, TKN, Total Phosphorus, Coliform bacteria, Relevant heavy metals)
    a. Municipal wastewater
    b. Industrial wastewater
2. Analysis of solid waste: household, commercial and municipal
    a. Physical – mass, volume, density, moisture content, physical classification, calorific value
3. Analysis of leachate from landfill sites (Temperature, pH, EC, Ammonia, BOD, COD, Relevant heavy metals)
4. Determination of TSP and PM_{10} Concentration in Ambient Air
5. Measurement and comparison of noise level (equivalent, percentile) in residential, public and work places
6. Field Visits
    a. Field visit to water and wastewater treatment plants for water treatment and wastewater treatment technologies (*Students are required to submit field visit report individually*)
    b. Field visit to landfill sites for solid waste management technologies (*Students are required to submit field visit report individually*)
    c. Field visit to industries for air pollution control technologies (*Students are required to submit field visit report individually*)

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND Technology

Course Title: **Remote Sensing and Geographical Information System**

Course Code: ENV 471 Credit: 3

Full Marks: 100 Pass Mark: 45

Course Objectives

This course is designed to provide the students an understanding of the methods and theories of Remote Sensing and GIS, and enable them to spatial-temporal analysis that will support students to apply the knowledge and skills in various fields of environmental science.

Specific Objectives	**Units, Contents and Lecture Hours**
• To Understand the basic concept of remote sensing • T o familiarize students with electromagnetic radiation and various types of remote sensing	**Unit I: Fundamentals of Remote sensing (4 hours)** Historical Overview; Concept of remote sensing; Electromagnetic radiation: Characteristics, Interaction between matter and electromagnetic radiation, Wavelength regions of electromagnetic radiation; Types of Remote Sensing with respect to wavelength regions
• To study the different types of Sensors and characteristics of various types sensors.	**Unit II: Sensors (2 hours)** Types of Sensor: Characteristics of optical sensors; Resolving Power; Dispersing Element; Spectroscopic Filter; Spectrometer; Characteristics of optical detectors; Cameras for remote sensing; Film for remote sensing; Scanner: optical mechanical scanner. Push-broom scanner; Imaging spectrometer; Atmospheric sensors; Sonar; Laser and RADAR
• To study the various platform of remote sensing. • T o understand the significance of orbital characteristics.	**Unit 3: Platforms and orbital Characteristics (2 hours)** Types of platform; Atmospheric condition and Altitude; Attitude: Attitude of Platform, Attitude sensors; Orbital elements of satellite; Orbit of satellite; Satellite Positioning system; Remote Sensing satellites: Landsat, Sentinel, IRS, SPOT, NOAA, MODIS; Geostationary meteorological satellites
• To understand the various types of data used in remote sensing analysis. • To study the different characteristics of data used in remote sensing works.	**Unit 4: Data used in Remote sensing (2 hours)** Digital Image data; Characteristics of Image data: Geometric and Radiometric Characteristics; Format of remote sensing image data; Auxiliary data; Calibration and Validation of data; Ground Data; Ground positioning data; Map data; Digital terrain data; Media for data storage, recording and distribution; Satellite data transmission and

	reception; Retrieval of remote sensing data
• T o interpret the images for environmental works • T o study the technique of processing. • T o apply classification techniques for further analysis	**Unit 5: Image processing (15 hours)** Image Interpretation: Information extraction in remote sensing, Visual Interpretation of Image, Stereoscopy, Interpretation elements, Interpretation keys, Generation of thematic maps; Image Processing System: Image processing in remote sensing, Image processing systems, Image input systems, Image display systems, Hard copy system; Correction in Remote sensing: Radiometric correction, Atmospheric correction, Geometric distortions of image, Geometric correction, Coordinate transformation, Co-linearity equation, Resampling and interpolation; Conversion of Image: Image enhancement and feature extraction, Grayscale conversion, Histogram conversion, Color display of image data, Color representation - Color mixing system and color appearance system, Operation between images, Image correlation; Image Classification: Classification techniques
• Define Geographic Information Systems (GIS) • Identify, compare and contrast vector and raster ; and the appropriate use of each of these data structures in GIS • Understand the importance of scale, projection, and coordinate systems in GIS	**Unit 6: Introduction of Geographic Information Science and Spatial Data Types (5 Hours)** Concepts of GIS: History, Definitions and Basic Principles; Geographic Phenomena and Spatial Representation In GIS: Models, Maps, Data Sources and Storage; Spatial and Temporal Dimensions Of Data; Coordinate system and transformation: Geodesy, Coordinate Systems, Geographic Projections, and Scale; Geographic versus Projected Coordinates; Geo- referencing a digital map or raster data, Geographic Transformation
• List and evaluate the capabilities of various GIS programs. • Explain uncertainty as it relates to scale, resolution and projection; discuss uncertainty propagation within a GIS • Understand the basics of data capture, storage, analysis, and output in a GIS	**Unit 7: Data: processing, quality, management and metadata (8 hours)** Hardware and Software Data Sources: Global Positioning System (GPS), Google Earth, Online and Other Data Sources; Creating and editing data: Spatial data input, Spatial referencing and data preparation, Point data transformations, Advanced data operations and continuous field raster; Basic concepts and definitions for data quality: Types of errors on a map, Error Propagation in spatial data processing; Database management systems (DBMS): Using DBMS, alternatives for data management, DBMS in GIS; Metadata and Data Sharing: Metadata concepts and functionality, spatial data transfers and its standards, data sharing related problems
• Apply spatial analysis functions on a GIS to a Geospatial problem.	**Unit 8: Spatial Analysis (6 hours)** Spatial query: querying data, selecting features, joining and relating data; Concepts of geographic

	data production; Classification of analytic GIS capabilities; Geographical data production methods: Retrieval Classification and Measurement, Overlay functions, Neighborhood functions, Network analysis; Statistical analysis
• Apply cartographic principles of scale, resolution, projection and data management to a problem of a geographic nature.	**Unit 9: Data visualization and Cartography (6 hours)** Principles of cartography; GIS and maps: Visualization process and strategies; The cartographic toolbox; Map making process: Displaying and presenting data
• Discuss the value and applications of GIS and remote sensing in various aspect of Environment.	**Unit 10: Application of RS and GIS (10 hours)** Introduction to application of drone and UAV; Indices development and its use in environmental studies; Land-use/Land-cover Mapping and Survey; Hazard and Risk Assessment; Conservation and resource management; Land-use and Urban planning; Watershed management

Instructional Methodology

Lecture will consist of an opening discussion, lecture, project exercise, and description of the lab assignment relative to the weekly topic. Students will be permitted to begin lab work if time permits. Lab will begin with a guest speaker when appropriate; otherwise the instructor will be available to assist students with the weekly lab assignment. This Lab assignment is integral part of class lecture.

Assignments for Remote Sensing

- Basics of Remote Sensing Software, downloading satellite image data from various platform, scales, navigation, online help
- Visual Interpretation of Satellite Imagery
- Geometric, Radiometric and Atmospheric correction of raw satellite imagery
- Pan sharpening and Enhancement of Satellite imagery
- Calculation of Various Indices and their interpretation
- Land use and Land Cover Classification through automated, semi automated and Manual ways
- Histogram Analysis and Image classification
- Interacting with map: layout view and making maps

Assignments for GIS

- Arc GIS basics, loading data, scales, navigation, online help
- Attribute query, joining and relating, projection
- Create feature classes, vector data editing, geo-coding
- Location query, overlay and adjacency analyses
- Map algebra, surface analysis, raster-vector conversion, geo-referencing
- Spatial dependency, clustering, fragmentation, interpolation
- Interacting with map: layout view and making maps

Text Books

1. Geographic Information Systems and Science (4thEdition), Authors: Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind; Publisher:

Wiley (March 2015, ©2016), ISBN-13: 978-1118676950; ISBN-10: 1118676955
2. Fundamentals of Remote Sensing. Joseph, G., 2005. University Press (India) Pvt. Ltd., Hyderabad

Reference Books and Materials

1. Getting to Know ArcGIS (4thEdition), Authors: Michael Law, Amy Collins; Publisher: ESRI Press ISBN-13: 978- 1589483828; ISBN-10: 1589483820,2015
2. Principles of Geographic Information Systems: An introductory textbook, Editor: Rolf A. de The International Institute for Aerospace Survey and Earth Sciences (ITC), 2001.

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND Technology

Course Title **Environmental Modeling** Course Code **ENV 472**
Nature of the Course **Theory (Core Course)** Year **Four**
Level **B.Sc.** Credit **4** Number of hours per week **3**
Total hours **60** Semester **Seventh**

Course Objectives

Upon completion of this course, the students will able to

- Acquire fundamental concept of the environmental modeling;
- Understand the process behind the modeling;
- Acquire knowledge on the various applications of the modeling and be able to select appropriate model for their applications.

Specific Objectives	**Units, Contents and Lecture Hours**
• Understand the basic concept of environmental modeling and various types of models.	**Unit I: Basics of Environmental Modeling (5 hours)** Basic concepts of Model; Complexity in Environmental Systems; Application and Scope of Environmental Modeling; Fundamental Principals used in Modeling; Types of Model: Conceptual Model, Deterministic (Mathematical) Model, Statistical Model, Static and Dynamic Models
• Incept the knowledge about modeling building process and basic principles that drive the model development.	**Unit II: Model Development (25 hours)** Elements of Model Development; Model Selection: Principle of Parsimony and Criteria of Model Selection; Modeling Steps and Ingredients; Conceptual Modeling: Steps in development of Conceptual Model; Balance Equation of a State Variables; Dimensional Homogeneity; Consistency of Units Statistical Modeling: Variables – Dependent and Independent Variables; Linear and Non-Linear Regression Analysis
• Analyze the process of model evaluation. • To study the various methods of model evaluation and validation.	**Unit III: Model evaluation (10 hours)** Basics of Model Evaluation; Graphical Analysis; Quantitative Analysis: Analysis of Coincidence, Analysis of Association; Sensitivity Analysis: Methods used in Sensitivity Analysis, Importance of Sensitivity Analysis; Uncertainty Analysis: Importance of Uncertainty Analysis, Methods used in Uncertainty Analysis, Representation of Variation in Input and Output, Expression of Uncertainty, Error Analysis, Residual Analysis
• Understand the basics of GIS based model and formulation process.	**Unit IV: GIS based Models (5 hours)** Basic of GIS Modeling; Types of GIS Models: Structural and Relational Models, Cartographic and Spatial Model; Characteristics of GIS Models: Scale, Extent, Purpose, Approach, Technique, Association and Aggregation; Classification Guide for GIS Models; Selected Examples and Cases
• Study the basics principles of	**Unit V: Modeling Platform (5 hours)**

various modeling platform used in environmental studies.	Modeling Principles of Various Software Model: Maximum Entropy Model, HEC-RAS Model for Hydrology, SWAT Model;
• Study the uses of model and modeling process in various aspects of environmental studies.	**Unit VI: Application of Modeling in Environmental System (10 hours)** Modeling of transportation of Contaminants in atmosphere, Water and Soil; Modeling of subsurface and surface hydrology; Niche Modeling; Modeling of Species and Habitat distribution; Disaster Hazard and Risk Modeling; Modeling of Global and regional Climate and Weather

References

1. Smith, J. & Smith, P.: Introduction to Environmental Modeling. Oxford University Press, Oxford, 2007.
2. Wainwright, J. &Mullingan, M.: Environmental Modelling: Finding Simplicity in Complexity. Wiley-Blackwell, 2013.
3. M.M. Aral, Environmental Modeling and Health Risk Analysis (ACTS/RISK), DOI 10.1007/978-90-481-8608-2_2, Springer Science Business Media B.V. 2010
4. Soetaert, K. and Herman, P.: A Practical Guide to Ecological Modelling Using R as a Simulation Platform. ISBN: 978-1-4020-8623-6 e-ISBN: 978-1-4020- 8624-3 Springer Science Business Media B.V. 2010.
5. Maguire, Batty, &Goodchild: GIS, Spatial Analysis, and Modeling. ESRI Press, 2005.
6. Clarke, K. et al.: Geographic Information Systems and Environmental Modeling. Prentice Hall, 2001.
7. DeMers, M.: GIS Modeling in Raster. Wiley, 2002
8. Goodchild et al.: GIS and Environmental Modeling: Progress and Research Issues. GIS world, Inc., 1996.

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

Course Title	**Field work based Case**	Credit	**1**
Course Code	**ENV 473.1**	Number of hours per	**3** week
Nature of theCourse	**Practical (Core Course)**	Total hours	**45**
Year	**Four**	Semester	**Seventh**
Level	**B.Sc.**		

Description

Field work will be organized for seventh semester in a pre-selected study site. Each student is required to submit Field work Report based on their specialized subject theme. This course is designed to introduce the student to strengthen the field base knowledge about their specialized paper and widen the exposure of student in field based works. Along with the basic principles and techniques of GIS, Remote Sensing and Modeling student will prepare a case study that integrate application of GIS and remote sensing and modeling of Environment system.

This practical section is divided into two sections

1. Field Work
2. Case Studies

Field Work (10 days)

A ten days extensive field study has been designed as a part of practical course in this semester. It has been developed to understand the environmental issues related to their elective subjects. This field will be organized by the department of environmental science in predefined location. During Ten days of field works students will conduct following activities:

1. Preparation of Field observation Notes and Maintenance of Note Dairy
2. Evening Seminar
3. Journal assignment
4. Data Collection for case studies

After completion of the field work student has to submit his/her report for the evaluation. On the basis of data collected from field student had to complete three of these practical from their practical pools.

Note: Field work will be basically focused on data collection for case studies.

Thematic Area A: Ecology

1. Mapping of Forest and Natural resources
2. Habitat Suitability Modelling

3. Estimation of Primary productivity of an Ecosystem through application of RemoteSensing and GIS

Thematic Area B: Water and Hydrology

1. Mapping of Water bodies and water resources.
2. Flood hazard Modelling
3. Estimation of impact of climate change in water resources

Thematic Area C: Disaster and Land Use

1. Terrain Analysis and Watershed Characterization
2. Land use Change and Mapping
3. Landslide Risk Modelling

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

Course Title	**Internship**	Credit	**1**
Course Code	**ENV 473.2**	Number of hours per week	**3**
Nature of the Course	**Practical (Core Course)**	Total days	**45**
Year	**Four**	Semester	**Seventh**
Level	**B.Sc.**		

An Internship program has been organized in this semester where student will get engaged in various organizations. Students have following task other than assisting and involving in organizational activities:

1. To identify the environmental issue related to their subject of interest.
2. Develop an environmental management plan to tackle those environmental issues

Note: For the Internship Program Department of Environmental Science have to sign MoU with various organization and Industries.

There will be two supervisor for a student for the Internship. One will be Academic Supervisor and one will be organizational supervisor. Objective for Internship will be developed from the discussion of Internship supervisor team and Student will conduct their Internship with already defined Objective.

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Environmental Assessment and Management system**

Full Marks: **100**

Course Code: **ENV 481**

Pass Marks: **45**

Nature of Course: **Theory (Core Course)**

Credit: **4**

Level: **B. Sc.**

Number of hours per week: **4**

Year: **Fourth**, Semester: **Eight**

Teaching Hours: **60**

Course Objectives

Upon completion of the course, the students should be able to:

- Understand linkages between development and environment
- Assess environmental impacts on various steps of project cycle
- Take in sights on environmental management system
- Identify and analyze the environmental consequences due to developmental projects
- Understand legal aspects in environmental assessment in national and international context

Specific Objectives	Contents
• Understand linkages between development and environment • Understand importance of environmental assessment in reconciling development and environment	**Unit I: Introduction to Environmental Assessment(7Hrs)** Development and environmental consideration; Tools for the environment inclusion in Development; Initiation of Environmental Assessment; History of Environmental Assessment; Legal requirement of Environmental Assessment; Project development; Components of project cycle; Environmental inclusion on various steps of project cycle;
• Acquaint with environmental assessment process (in context of Nepal) • Differentiate between IEE And EIA • Know methods of collecting baseline information	**Unit II: Environmental Assessment Process (12 Hrs)** Environment Assessment (EA) and its types; The EA Process; Environmental screening; Scoping to determine the Terms of Reference(TOR);Terms of Reference; Initial Environmental Examination (IEE)/ Environmental Impact Assessment (EIA) (differences); Types of impact; Baseline information (physical, biological, social, economic and cultural environment); Methods of collecting baseline information; Issues identification; Mechanism to give the weight age for issues; Prioritization of issues; Project Alternatives Analysis; Potential Impact Identification
• Understand different methods of impact identification • Know methods of impact prediction	**Unit III: Impacts Assessment Techniques (10 Hrs)** Methods of impact identification: Checklist, interaction matrix, overlay mapping, networks, GIS, task specific computer model, expert system; Impact prediction: introduction, method of impact prediction, uncertainty of impact prediction, impact ranking and comparison of alternatives; Evaluation and determination of significance; Categorization of impacts

• Understand various impact mitigation measures including public participation	**Unit IV: Impact Mitigation Measures(5Hrs)** Mitigation measures; Public participation and consultations; Challenges and opportunities of public involvement; Environmental Management Plan(EMP)
• Get insights on environmental monitoring andauditing • Take insights on quality andreviewofEIA reports	**Unit V: Environmental Monitoring and Auditing (7Hrs)** Monitoring: introduction and types of monitoring, monitoring criteria and methodologies, monitoring indicators and monitoring processes; Environmental auditing: introduction, types of audit, time frame for conducting audit, environment auditing plan; Quality and review of EIA reports
• Understand environmental management system with different tools and their application • Introduce quality managementsystem • Know different stages of EMSimplementation and certification processof EMS	**Unit VI: Environmental Management System (12Hrs)** Environmental management tools and their application: Green Productivity (GP), Environmental Management System(EMS), Cleaner Production (CP) and Life Cycle Assessment (LCA);Introduction to International Organization for Standardization(ISO) and ISO 14000 series; Historical development of EMS; Introduction and requirements of EMS; Introduction of Quality Management System (QMS); Stages of EMS implementation; environmental review, identification of significant environmental aspects, documentation requirements of EMS, environmental policy, objectives, targets and programs, operation control, review; Certification process of EMS; EMS auditing and Mechanism for certification in Nepal
• Understand Environmental Assessment related legal aspectsinNepal	**Unit VII: Legal Aspects in Environmental Assessment(7Hrs)** Environmental Assessment related legal aspects in Nepal; National legislative framework: Environment ProtectionAct(EPA),Environment Protection Rule (EPR); Sectoral environmental legislations: national strategy, plans and polices, guidelines, manuals and standards; Legislative framework; International convention and treaties; Major international conventions adopted by Nepal.

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FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Environmental Assessment and Management System (Practical)**	Full Marks: **50**
Course Code: **ENV 483**	Pass Marks: **22.5**
Nature of Course: **Practical**	Credit: **2**
Level: **B. Sc.**	Number of hours per week: **6**
Year: **Fourth**, Semester: **Eight**	Teaching Hours: **90**

Course Objectives

Upon completion of the course, the students should be able to: Carry out environmental assessment (IEE/EIA)of development projects Identify and analyze the environmental consequences due to developmental projects

Prepare Environmental Management Plan(EMP) of development works Review IEE/EIA reports and comment on the quality of environmental assessment reports

Practical

1. Carry out environmental assessment (IEE/EIA) of any development projects (identify impacts, predict impacts, rank impacts and compare alternatives).

   a. Road construction b. Dumping/landfill site construction

   c. Hospital construction d. Hotel construction

   (*The practical involves Case Study approach. It essentially involves preparation of baseline information related to physical, biological, socio- economical and cultural environments. Further, it also identifies mitigation measuresfortheidentifiedimpactsandpreparesenvironmentalmonitoring and auditing plan*.)

2. Prepare Environmental Management Plan (EMP) of Development Works (as mentioned in Practical 1)

3. Reviewof IEE/EIA reports

   (*Students will go through available IEE/ EIA reports and critically / thoroughly examine the different sections of reports, prepare r view reports and comment upon the quality of the reports. This will familiarize students with the different components of the IEE/ EIA reports and help them prepare better quality reports in their future endeavours / assignments*.)

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Environmental Economics**	Full Marks: **100**
Course Code: **ENV 482**	Pass Marks: **45**
Nature of Course: **Theory (Core Course)**	Credit: **4**
Level: **B. Sc.**	Number of hours per week: **4**
Year: **Fourth**, Semester: **Eight**	Teaching Hours: **60**

Objectives

Upon completion of the course, the students should be able to:

- Understand the economic approaches, methods and tools to address environmentalissues
- Have understanding about the linkages between economy and environment
- Familiarize with methods and tools adopted for environmental valuation and be able to diagnose the environmental issues from an economic prospective

Specific Objectives	Contents
• Understand interdependence between economyandenvironment	**Unit I: Introduction (8Hrs)** Introduction to natural resource and environmental economics; Emergence of resource and environmental economics; Fundamental issues in economic approach to resource and environmental problems; Origin of sustainability problem; Economy- Environment interdependence; Drivers of environmental impact ; Poverty and inequality; Limits to growth; Pursuit of sustainable development
• Understand fundamentals of environmental economics • Get insights on various contemporary issuesin environmentaleconomics	**Unit II: Environmental Economics(12Hrs)** Concept, scope and origin of environmental economics; Inter-linkages between economy and environment; Market economy: Notion of market, Perfectly competitive market and resource allocation, Pareto criterion of efficiency; Market failure (Lack of property rights, Externalities, Asymmetric information); Type of goods(Private, club, common and public goods); Contemporary issues in environmental economics (Climate change, Sustainable development, Poverty, Carbon Credit, Clean Development Mechanism (CDM), Reducing Emission from Deforestations and Forest Degradations (REDD); Experience and examples from Nepal on Carbon Credit, CD MandREDD.

	Unit III: Economics of Natural Resources (8 Hrs)
• Know various types of naturalresources • Understand scarcity of naturalresources and its consequences	Types of resources: Renewable and nonrenewable; Theories of natural resource use: Elementary capital theory, Models for renewable resources with logistic growth and maximum sustainable yield, Models for nonrenewable resources; Natural resource scarcity; Resource substitutability and consequences of increasing resource scarcity; Social welfare function and optimal allocation of natural resources; Example of commercial forestry economics from Nepal.
	Unit IV: Economics of Pollution Control (10 Hrs)
• Acquaint with various instruments forachieving pollutioncontroltargets	Criteria for choice of pollution control instruments; Cost efficiency and cost-effective pollution a battement instruments; Instruments for achieving pollution a battement targets; Economic incentive (quasi-market)instruments; Comparison of relative advantages of command and control, emissions tax, emission abatement subsidyand marketable permitinstruments
	Unit V: Ecosystem Services and Natural Capital (16Hrs)
• Know various methods andtechniques for valuation of environmental goods and services • Understand the importance ofpayment for ecosystem services (PES) inNepalesecontext	Introduction to ecosystem services and goods; Types of ecosystem services; Valuation of environmental goods and services: Dimensions of value, Benefit Cost Analysis (BCA)(Meaning, Components and Steps) with examples and calculations, Markets. non market valuation; Theory of environmental valuation; Methods for valuing environmental costs and benefits: Contingent Valuation method(CVM), Willingness to Pay (WTP)and Willingness to Accept (WTA), Travel Cost Method(TCM),Hedonic Pricing Method)with examples and calculations; Payment for ecosystem services: Theoretical perspectives, Opportunities, Approaches and Deals; Examples of PES from Nepal
• Know theory and practice of accounting for environment	**Unit VI: Accounting for Environment(6Hrs)** Environmental indicators; Environmental accounting theory; Environmental accounting practice; Sustainability indicators; Alternative measures of economic welfare and Green accounting; Green economy and green governance

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