Mid-West University
Graduate School of Science and Technology (GSST)



B.Sc. in Environmental Science
Detailed Syllabus

December 2024
Birendranagar, Surkhet, Nepal

Bachelor of Science (B.Sc.) in Environmental Science

1. Introduction

In a world confronted by pressing environmental concerns, the need for skilled professionals with a holistic understanding of the natural world has never been more urgent. At Graduate School of Science and Technology (GSST), Mid-West University (MU), we recognize the significance of addressing these challenges head-on, and our four-year B.Sc. in Environmental Science program serves as a foundation for students to develop the expertise and innovative thinking necessary to create a more harmonious coexistence between humanity and nature.

Higher education of Nepal is facing the challenges of linking the curriculum with the labor market. The University Grant Commission (UGC), Nepal has launched the priority project Nurturing Higher Education Project (NEHEP) to improve the situation through entrepreneurship development. The GSST-MU agrees with the UGC-Nepal and has developed the Labor Market Driven Program (LMDP) based curriculum for B.Sc. Environmental Science. The Labor market-driven B.Sc. in Environmental Science Program aims to equip students with the knowledge, skills, and experience necessary to succeed in the evolving field of environmental science and sustainability. The emphasis will be on preparing graduates to address current environmental challenges and meet the demands of the job market. Hence, B. Sc. Environmental Science program has expected for ensuring a comprehensive and effective curriculum relevant to the LMDP.

Our curriculum is thoughtfully crafted to provide an interdisciplinary approach, combining elements of biology, chemistry, ecology, geology, mathematics, and social sciences. This fusion of knowledge enables students to grasp the intricate web of interactions that shape our environment and equips them with the tools to propose sustainable solutions. Through dynamic classroom discussions, hands-on fieldwork, laboratory experiments, and collaborative research projects, students gain practical insights that bridge theory with real-world applications.

Nepal, with its remarkable biodiversity and complex environmental challenges, serves as an ideal backdrop for this program. The country's diverse landscapes, from the towering Himalaya to the lush Terai plains, offer a living laboratory for students to engage in firsthand exploration and investigation. Our faculty, comprised of accomplished academics and experienced practitioners, guide students on this journey of discovery, fostering a deep connection to the environment and nurturing a sense of responsibility for its protection. The B.Sc. in Environmental Science program at GSST-MU not only imparts knowledge, but also fosters critical thinking, ethical reasoning, and the development of practical skills that can be applied to environmental challenges on local, national, and global scales.

Our Labor market-driven B.Sc. in Environmental Science program provides the foundation upon which the students can build a rewarding and impactful journey, leading the students to a career in environmental research, policy development, conservation, or sustainable development.

2. Program Objectives and Learning Outcomes

The main objective of the Labor market-driven B.Sc. in Environmental Science program is to develop competency on knowledge and skills on the various concepts and contemporary

environmental issues and enable them to find the sustainable solutions for the future of our planet. In specific, the course offers the following learning objectives:

a. to demonstrate competency of knowledge on the subjects related to environmental science;
b. to design an independent research project focused on some aspect of environmental science;
c. to demonstrate an ability to apply appropriate skills and techniques for data collection, and then analyze, integrate those data to draw conclusion related to environmental issues;
d. to demonstrate technical and problem-solving skills ranging from interpreting data, designing experiments, and analyzing scientific papers;
e. to demonstrate assessment of environmental impact and policy making skills;
f. to demonstrate ability to research and develop technology which helps to reduce the impact of humans on the environment.

3. Salient Features of the Program

This program shares the following salient features:

a. *Interdisciplinary Curriculum*: The B.Sc. Environmental Science course offers an interdisciplinary curriculum that draws from fields such as biology, chemistry, geology, sociology, economics and many more. This approach provides students with a well-rounded understanding of environmental issues.
b. *Fieldwork and Practical Experience*: The course emphasizes hands-on learning through fieldwork, laboratory experiments, and practical projects. More than 60% teachings and learning are based on the practical approach. Students have opportunities to apply theoretical knowledge in real-world situations, enhancing their problem-solving skills.
c. *Research Emphasis*: The program encourages students to engage in research activities, fostering critical thinking and analytical abilities. Students may work on projects related to environmental monitoring, conservation, pollution control, and more.
d. *Sustainability Focus*: A central theme of the course is sustainability. Students learn about sustainable development practices, resource management, and strategies for minimizing environmental impact while meeting societal needs.
e. *Global, Regional and Local Perspective*: The curriculum addresses the global, regional and local environmental challenges. Students gain insights into how regional issues fit into the broader context of global environmental concerns.
f. *Career Preparation*: The B.Sc. Environmental Science course is designed to prepare students for various career paths related to environmental conservation, policy-making, research, education, and more. Soft skills such as communication and teamwork are also developed.

4. Basic Eligibility for Admission

The candidates having successfully passed secondary level (12 Grade) or +2 or equivalent from *Science Steam* with an aggregate of 50 percent or 2.00 GPA out of 4.00 are eligible for applying for admission.

5. Criteria of Evaluation in Admission Test

The eligible candidates seeking admission in B.Sc. Environmental Science are notified through the public announcement in newspapers and the official website of Mid-West University, which is mu.edu.np. After collecting the forms from all the interested candidates at a certain deadline, the Entrance Committee will arrange entrance examination. All the applicants must appear in the entrance exam held be the Committee, which tests their proficiency in General Knowledge (10%), English (10%), biology (20%), chemistry (20%), mathematics (20%) and physics (20%). A merit list will be published after the entrance examination. Students will be admitted on the available seats based on the merit list.

6. Credit Transfer

B.Sc. in Environmental Science program of GSST is open for in-bound as well as out-bound credits transfer under the mutual understanding of the higher education institutions offering similar programs. Under such an arrangement, a student pursuing a B.Sc. in Environmental Science at GSST can explore opportunities to earn certain credits by attending the regular classes and assessment systems of higher education institutions in any part of the world and can come back with earned credits to be considered integral academic credentials of the ongoing program. A similar provision is made for international students seeking such opportunities on B.Sc. in Environmental Science at the GSST. Also, a two-way full transfer of credits is permitted; however, before any decision for such credit transfer provision of the GSST-MU, an approval should be taken from the Academic Council of the MU.

7. Learning Resources and Laboratory Requirements

The institutions offering this academic program is required to maintain the laboratory facilities sufficient for operating the course requirements, including field work gears. The foreseen laboratory for this course should be with the facility to monitor and test water, air, soil and various waste, ecology laboratory, microbiology, geology, computer etc. The physical and e-library should have a provision of maintaining adequate learning resources with a ratio of 4:1, i.e., one item of learning resource per four students at most.

8. Instructional Methods

The following are the instructural methods generally practiced in science; however, the subject teacher may adopt suitable methods to ensure better learning outcomes of students.

a) Lecture and Tutorial
b) Presentation
c) Assignment
d) Project Work
e) Guest Lecture
f) Group Discussion
g) Experimental Method
h) Field Survey
i) Case Study

9. Course Cycle

The total credit of this program is 128. It includes common foundation course, skill development, basic science course, core environmental course and cross-cutting courses. The total credit hour is distributed among different course as below:

Year I							
Semester I				**Semester II**			
Course Code	**Course Name**	**Cr. Hrs.**		**Course Code**	**Course Name**	**Cr. Hrs.**	
		Th.	**Pr.**			**Th.**	**Pr.**
ENV410	Computer Applications	1	2	ENV420	Basic Statistics	1	2
ENV411	Ecological Concepts and Principles	2	1	ENV421	Atmospheric and Hydrological Processes	2	1
ENV412	Mathematics of Environmental System	1	2	ENV422	Environmental Geology and Geomorphology	1	2
ENV413	Biology of Environmental System	1.5	1.5	ENV423	Contemporary Environmental Issues	2	1
ENV414	General Chemistry	1.5	1.5	ENV424	Evolutionary Biology	2	1
				ENV425	Theromodynamics and Kinetics	2	1
Total		**7**	**8**	**Total**		**10**	**8**
Total Semester Weightage		**15**		**Total Semester Weightage**		**18**	

Year II							
Semester III				**Semester IV**			
Course Code	**Course Name**	**Cr. Hrs.**		**Course Code**	**Course Name**	**Cr. Hrs.**	
		Th.	**Pr.**			**Th.**	**Pr.**
ENV430	Research Methodology	2	1	ENV440	Scientific Communication	1	2
ENV431	Environmental Economics	2	1	ENV441	Energy and Environment	2	1
ENV432	Environmental Pollution	2	1	ENV442	Biodiversity Conservation	1	2
ENV433	Microbial Ecology and Ecotoxicology	1	2	ENV443	Physiology and Biochemistry	2	1
ENV434	Freshwater Ecology	2	1	ENV444	Soil Science	2	1
ENV435	Biogeography and Phylogenetics	2	1	ENV445	Environmental Project	0	2
Total		**11**	**7**	**Total**		**8**	**9**
Total Semester Weightage		**18**		**Total Semester Weightage**		**17**	

Year III

Semester V				Semester VI			
Course Code	Course Name	Cr. Hrs.		Course Code	Course Name	Cr. Hrs.	
		Th.	Pr.			Th.	Pr.
ENV450	Computer Programming	1	2	ENV461	Environmental System Modelling	1.5	1.5
ENV451	Climate Change	2	1	ENV462	Environmental Policy and Governance	2	1
ENV452	Remote Sensing and GIS	1	2	ENV463	Environmental Biotechnology	2	1
ENV453	Watershed Management	2	1	ENV464	Drinking and Waste Water Technologies	2	1
ENV454	Pollution Monitoring and Controls	1	2	ENV465	Green Infrastructure and Economy	2	1
ENV455	Mountain Environment	2	1	ENV466	Environmental Assessments	1.5	1.5
Total		9	0	**Total**		**11**	**7**
Total Semester Weightage		**18**		**Total Semester Weightage**		**18**	

Year IV							
Semester VII				Semester VIII			
Course Code	Course Name	Cr. Hrs.		Course Code	Course Name	Cr. Hrs.	
		Th.	Pr.			Th.	Pr.
ENV471	Environmental Hazards and Disasters	1	2	ENV481	Final Year Project	0	3
ENV472	Restoration Ecology	2	1	ENV489	Internship	0	6
ENV473	Natural Resources Accounting	2	1	**Total**		**0**	**9**
ENV474	Climate modelling	2	1				
ENV475	Environmental Entrepreneurship	1	2				
Total		**8**	**7**				
Total Semester Weightage		**15**		**Total Semester Weightage**		**9**	

Total Program Duration:	**4 years**
Number of Semesters:	**8**
Total Program Credit Hours:	**128**

NOTE: *Common Foundation Course (CFC) course includes ENV410, ENV420, ENV430, ENV440, and ENV450, previously marked by CFC codes.*

Semester I

Computer Applications

Course Code: ENV410 ***Credit Hours:*** 3.0 [Theory: 1.0; Practical: 2.0]
Course Title: Computer Applications ***Teaching Hours***: 16Th+64Pr
Semester: **I**

Course Description: This course on **Computer Applications (ENV410)** is a Common Foundation Course (CFC) that covers the basic concepts of computers including introduction, hardware, software, networks, and social media. This course aims to introduce students to the basics of computers and its use in real-world situations. Students are expected to learn to use the MS Office for word processing, spreadsheet, graphic presentation, and the Internet. Laboratory work is mandatory in this course.

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

- understand the basic concepts and learn the computer applications
- realize the applications of the Internet in different sectors, and
- get acquainted with the contemporary technologies and security challenges facing computer technologies

Course Contents:

Unit	Unit heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Lecture Hour**	
I	***Introduction to Computer***	Introductions, Parts, Characteristics, Capabilities and Limitations, Classification, Generation, History of Computer in Nepal	2	Identification of Hardware and other peripheral devices, Proper connection of Devices, Knowledge about electrical power, Basic Computer Organization	6	Alexis Leon, Mathews Leon, *Fundamentals of Information Technology*, Leon TechWorld Albarran, Alan B. & Goff, David H. (2003): Understanding the Web, 1st Indian Reprint, Delhi: Surjeet Publication Pradeep K. Sinha, Priti Sinha, *Fundamental of the computer. (4th ed.). ND: BPB* Publication Peter Norton's, Introduction *to Computers*, Tata McGraw-Hill
II	***Hardware Components of Computer System***	CPU and its component, Memory and its types, I/O devices, Storage Devices	2			
III	***Computer Software***	Introduction to Computer Software, Classification of Software, Operating System, and Its Functions, Proprietary and Open-Source Software	2	**Word Processing Software:** Creating, typing (English/Nepali/Unicode) Editing, Formatting, Settings, Saving the file in respective folder with password, Printing documents	10	
				Spreadsheet Software	8	

				Creating, Format Cells, Using Formulae, Saving the file in respective folder with password, Printing Spreadsheet		
				Presentation Software Creating, Layout management, Designing, Slide transition, animation, Slide show	4	
IV	***Computer Networks and Social Media***	Network and its communication media, Types of Networks, Protocol, social media: Facebook, Twitter, LinkedIn	2	Identification of Network Cable, IP address, simple troubleshooting on Network related issues	4	
V	***Data Base Management System***	Data vs Information; Introduction to the database and database management system; Flat File System and DBMS; Advantages of Database Systems; Relational Database Model; Database Administrator	2	Creating database, Tables and Relationships, Query, Form, Report	8	Alexis Leon, Mathews Leon, *Fundamentals of Information Technology***,** Leon TechWorld William Stallings, Cryptography and Network Security: Principles and Practice, 5/E, ISBN-10: 0136097049, Prentice Hall, India Limited Rolf De, Richard A. Knippers, Yuxian Sun, *Principles of geographic information systems: An introductory textbook,* international institute for Geo-information Science and Earth Observation, the Netherlands Backus, Michiel, *e-Governance in Developing Countries,* IICD Research Brief, No. 1, March 2001
VI	***Introduction of Internet and Web***	Introduction to Internet and its applications; Client-Server Model of Internet; IP Address, Domain Naming System; Internet Protocols: TCP/IP, HTTP, POP, FTP, SMTP; WWW; Browsers; URL; Search Engine	2	E-mail and Settings; Online form and cloud storage (Google Forms, Google Drive and Sharing files and folders, Google Docs, Google Sheets, Google Slides, Dropbox) Any Desk Tool	8	
VII	***Contemporary Technologies***	Multimedia; E-Commerce; E-Learning; E-Governance; E-Banking; Mobile Computing; Cloud Computing; GIS; AI	2	**E-Learning Tools**: Video conferencing tool (Zoom, Google Meet, MS Teams, etc.) application installation and practicing **E-Commerce:** Transaction on the online payment system (Daraz Online, eBay, muncha.com, etc.) **E-Banking:** Mobile banking/Internet Banking techniques **E-Governance:** Online Government Services through web apps and URL, Nagarik app **GIS:** Basics of ArcGIS; QGIS; Map reading, Location finding, etc.	16	
VIII	***Computer Security***	Using computers, mobiles, and the internet for safer management of files, transactions, and livelihood happenings.	2			
		Total hours of theoretical events	***16***	***Total hours of practical events***	***64***	

Ecological Concepts and Principles

Course Code: ENV411 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Ecological Concepts and Principles ***Teaching Hours***: 32Th+32Pr
***Semester*: I**

Course Description: The **Ecological Concepts and Principles (ENV411)** is a comprehensive course designed to provide students with understanding the fundamental principles that govern ecosystems and their interactions. The course explores key ecological concepts, theories, and methodologies essential for comprehending the complex relationships between organisms and their environments.
The course will be delivered through mixed teaching methods including lectures, laboratory works, field observations and group discussions.

Course Objectives: At the end of the course, students will be able to:

- acquired a basic concept of ecosystems, its structural and functional aspects
- explore the interconnectedness among the ecosystem components and the dynamic nature of the ecological processes

Course contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Concepts of Ecology***	Definition; History; Hierarchical level of organization; ecosystem and its types (aquatic and terrestrial); Concept of landscape, habitat, and community; ecozones, ecotypes, ecads, and ecoclines; ecological niches, biomes, ecotones and edge effect.	6	Visit an ecosystem and determine the interaction/ organization between abiotic and biotic factors	8	Edward J. Kormondy (2017). Concepts of Ecology. Updated 4th Edition. Pearson. Eugene P. Odum (1971). *Fundamentals of Ecology*. Third Edition. W.B. Sounders.
II	***Population Ecology***	Concept of population; Characteristics of population: density, dispersion, natality, mortality, age structure; survivorship curves; life tables; Population growth: density-dependent and independent; population growth curves: exponential, logistic; limits of population growth (r-selection and k-selection)	8	Calculate the density (plants/animals) of species found in grassland/forest ecosystems Calculate the dispersion pattern of the species present	8	Charles J. Krebs (2014). Ecology. The Experimental Analysis of Distribution and Abundance. Sixth Edition. Pearson Education Limited

III	***Community Ecology***	Community structure and organizations; species interaction (positive: mutualism, symbiosis, protocooperation, commensalism; negative: predation, competition, parasitism, amensalism, herbivory and neutralism); species diversity; ecological successions and climax community, key stone species, Flagship species	8	Measure the species diversity, similarity and association between the animal/plant species selected	8	Eugene P. Odum (1971)
IV	***Ecosystem Structure and Function***	Components of ecosystems (biotic and abiotic); food chain, food web, ecological pyramid Ecological Productivity: Net primary productivity (NPP), secondary productivity, tertiary productivity Biogeochemical and nutrient cycle: Carbon cycle, nitrogen cycle, phosphorous cycle, sulphur cycle Energy flow in ecosystems	10	Develop models of food chain and food web of the selected ecosystems (e.g. pond ecosystem, forest ecosystem etc.)	8	Eugene P. Odum (1971)
Total hours of theoretical events			***32***	***Total hours of practical events***	***32***	

Mathematics of Environmental System

Course Code: ENV412 ***Credit Hours:*** 3.0 [Theory: 1.0; Practical: 2.0]
Course Title: Mathematics of Environmental System ***Teaching Hours***: 16Th+ 64Pr
***Semester*: I**

Course Description: The course on **Mathematics of the Environmental System (ENV412)** is designed to impart basic knowledge on mathematics to support students in the application of mathematical methods to model and analyze environmental phenomena. Topics include differential equations for describing population dynamics, spatial patterns, and the flow of pollutants in ecosystems. Students will develop computational skills and data analysis to address complex environmental challenges and understand the quantitative aspects of environmental processes.

Course Objectives: At the end of the course, students will be able to:

- develop proficiency in constructing and analyzing mathematical concepts that describe environmental phenomena
- acquire skills in using mathematical tools to quantitatively analyze the behavior and dynamics of environmental systems
- explore applications of mathematical techniques in interdisciplinary contexts

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Algebra***	Basic counting principle, Permutation for different and not all different objects in horizontal and circular form. (Formulae are not required to prove), Combination of things.; **Function**: Introduction, Types of function, way of representation of function, Domain and range (linear, quadratic and cubic) of a function, inverse function, composite function **Matrix and Determinant**: Matrix transpose, inverse of a matrix, solution of a system of linear equation using matrix and Cramer's rule up to three variables	6	• Alphanumeric Problems (Addition, Multiplication, Sequence, pattern and logical real-life problems) • Properties of Inequality (Addition, Multiplication, division, reverse inequality) • Percent, Fraction, Ratio, and Proportion (Real life problems solving), Round off	6 4 6	Cheney and Kincaid, *Linear Algebra Theory and Application,* Jones and Bartlett Indian Private Limited Malhotra O.P and Gupta S.K., *Mathematics Book II*, S. Chand and Company Ltd., Ramnagar, New Delhi Dewan R.K., and Verma S., *Together with Mathematics,* Rachana Sagar Private Ltd., New Delhi

						Bajracharya B.C., *Basic Mathematics* - M K Publishers, 2nd Edition (A text book for BBA / BIM)
II	***Vector***	Introduction, collinear and non-collinear vectors, linear combination of vectors, coplanar and non-coplanar vector, linearly dependent and linearly independent vectors.	4	• **Rate, Distance and Time problems** (Real life problems) **Trigonometry** (Trigonometry related real life problems)	8	Quarteroni, A., Sacco, R., & Saleri, F. (2006). *Numerical mathematics* (Vol. 37). Springer Science & Business Media
III	***Calculus***	**Limit and continuity:** Limit of algebraic function, indeterminate form, basic theorem of limit (without proof), continuity and discontinuity of a function. ; **Derivative**: Derivative of function (algebraic, trigonometric, exponential and logarithmic function), rules of differentiation (power rule, sum rule, product rule, quotient rule and chain rule); **Application of derivative**: Maximum and Minimum of a function of one variable.; **Integration and its application:** Indefinite Integrals and fundamental formula, definite integrals as an area under the given curve	6	• **Vector** Application of Vector in Navigation: Direction and Distance GPS and Mapping Oceanography: Current and wave patterns • **Differentiation** (Application of Differentiation in Real life problems: Velocity and acceleration, Force and work, Growth rates, Rate of change of pollution • **Integration** (Application of integration in real-life problems: Velocity and acceleration, Population growth, Rate of change of pollution level, Weather prediction)	10 15 15	King, J. P. (2006). *The art of mathematics*. Courier Corporation. Batschelet, (2012). *Introduction to Mathematics for Life Scientists*. Springer Science & Business Media. Sullivan, M. (2010). *Finite Mathematics: an Applied Approach*. John Wiley & Sons. Binmore, K., Davies, J. (2002). *Calculus: Concepts and Methods*. Cambridge University Press. Rahmani-Andebili, M. (2023). *Calculus I: Practice Problems, Methods, and Solutions*. Springer Nature.
Total hours of theoretical events			***16***	***Total hours of practical events***	***64***	

Biology of Environmental System

Course Code: ENV413 ***Credit Hours:*** 3.0 [Theory: 1.5; Practical: 1.5]
Course Title: Biology of Environmental System ***Teaching Hours***: 24Th+48Pr
***Semester*: I**

Course description: The Course on **Biology of Environmental System (ENV413)** covers a wide range of fundamental topics in biology, providing students about the foundation biological phenomena of environment systems. The course incorporates interactive activities, field activities, laboratory experiments, and discussions throughout the course to enhance student engagement and understanding in the field of environmental biology.

Course Objectives: At the end of the course, the students will enable to:

- develop foundational knowledge of biological concepts,
- identify the advanced processes, structures, and mechanisms of the biological system in the earth.
- underpin biological life and inner core of diversification on earth system

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Introduction to Biological Systems***	Classification of living organisms, international nomenclature system (ICZN, ICBN); Dichotomous keys and taxonomic terminologies; Herbarium preparation and preservation technique of plant and animal species	3	Enlist the common plant and animals found in your locality and write their binomial nomenclature in standard scientific format Prepare a dichotomous key to identify plant and animal (one of each)	8	• Pandey, S.N. and Singh, H.N. (2006) *A Text book of Botany*, Vol 1, Vikash Publishing House, New Delhi • Parker, T.J. and Haswell, W.A., Textbook of Zoology, Vol. I, The MacMillan Press Ltd., London, UK

II	***Cell and Cellular Functions***	Prokaryotic and Eukaryotic cells; Cell structure: Cell membrane, Cell organelles and inclusions, Cytoskeleton; Cell Function: Diffusion and osmosis with significance; exocytosis & endocytosis Cell division types and significance	5	Study of cytological slides showing cell organelles Demonstrate diffusion process Demonstrate the process of osmosis by egg membrane/ potato osmoscope method study of cell division through onion root tip cells	12	• Rostogi, S.C, *Cell and Molecular Biology*, New age Int. (P) Ltd. Pub., New Delhi • DeRobertis, D.P. abd E.M.F. DeRobertis, Jr., *Cell and Molecular Biology*, B.I. WarerlyPvt. Ltd, New Delhi • Sinha, U. and Sinha S., 1997, *Cytogenetics, Plant breeding and Evolution*, Vikas Publishing House Pvt. Ltd. New Delhi, India
III	***Photosynthesis and Mode of Nutrition in Animals***	Ultrastructure of chloroplast, photosynthetic pigments, Mechanism of photosynthesis (light reaction, dark reaction) factors affecting photosynthesis. Concept of C3 and C4 plants. Animal Nutrition; Introduction Metabolism: lipid, carbohydrate, protein	6	Demonstrate that CO2 is necessary for photosynthesis by Moll's half leaf experiment. Measurement of oxygen produced during photosynthesis	12	• Shrivastava, H. S., 1998, *Plant Physiology,* Rastogi Publications. • V.K. Jain, Fundamentals of plant physiology • Noggle, G. R. and Frits, G. J., 1992, *Introductory Plant Physiology*, CBS Publications & Distributors, New Delhi, India.
IV	***Respiration***	Plant respiration: Mechanism of respiration (glycolysis, Kreb's cycle, ETS); Animal respiration: mode of respiration in animal; cutaneous, gill, buccopharyngeal	6	Production of CO2 during aerobic and anaerobic respiration	6	
V	***Growth and Development***	Plant: growth hormones, seed germination, seed dormancy; Animal: direct and indirect development in animals; Juvenile hormones; polymorphism in animals	4	Identify the development forms and polymorphism in the surrounding animals Calculate seed germination index using common seed of wild plants	10	
	Total hours of theoretical events		***24***	***Total hours of practical events***	***48***	

General Chemistry

Course Code: ENV414 ***Credit Hours:*** 3.0 [Theory: 1.5; Practical: 1.5]
Course Title: General Chemistry ***Teaching Hours***: 24Th+48Pr
***Semester*: I**

Course Description: The **General Chemistry (ENV414)** is designed to impart fundamental knowledge of chemistry among the students and generate curiosity in chemical environments. The course is theoretical and practical as it exposes the fundamental ideas and their applications in environmental science. It is designed to enable the students to be able to use chemical principles, handling of instruments, analysis of chemical data, and general chemical knowledge.

Course Objectives: At the end of the course, students will be able to:

- understand theoretical and analytical aspects of chemistry
- acquaint the students with different chemical properties
- provide knowledge of calibration, estimation, preparation, and analysis
- introduce the basic concepts of experimental techniques in chemistry

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Chemical Arithmetic***	Mole concept; Avogadro's number; Chemical Calculation	1	• Calibration of Instrument • Burette, Pipette, and Thermometer	2	G. Svehla & B. Sivasankar Vogel's (2012) Qualitative Inorganic Analysis, Pearson edition.
II	***Quantitative Analysis***	Volumetric Analysis: Expressing concentration; Acidimetry and Alkalimetry; Permanganometry; Dichromatometry; Argentometry; Iodometry (Related numerical)	6	• Preparation of standard solution • Estimation of HCl and NaOH • Estimation of Ferrous salt • Estimation of Calcium and Magnesium (Hardness) • Estimation of Chloride • Estimation of Ammonia and Chromium	12	I. Vogel, A Text Book of Quantitative Inorganic Analysis, Including Elementary Instrumental Analysis, ELBS & Longman, 1969, (Preferably available recent edition). N. M. Khadka, S. D. Gautam& P. N. Yadav, *A Core Experimental Chemistry for B.Sc.,* Heritage Publication, Kathmandu, 2013.

						A. K. De, *Environmental Chemistry*, New age International Ltd. Publishers, New Delhi.
III	***Equilibrium***	Law of mass action: Ostwald's law, Buffer solution, Common ion effect and solubility product principle, Colligative properties, Vant't Hoff factor (Related numerical)	5	Preparation of Buffer solution Analysis of Cu(II), Fe(III), Al(III), Zn(II), Co (II)and Ni(II) salt (at least three salts)	10	M. L. Sharma & P. N. Chaudhary, A Textbook of B. Sc. Chemistry (Vol. I & II), 2nd Edition, Ekta Books Nepal, 2007.
IV	***States of Matter (Solid, liquid, and gas)***	Kinetic molecular theory of gas: Kinetic gas equation, Maxwell distribution of molecular velocity, Van der Waals equation and its significance, Determination of Surface tension and Viscosity of liquid, Seven-crystal system (Related numerical)	6	Free energy calculation in a reaction (Window Power cell Method) Determination of Surface tension by Stalagnometer Determination of Viscosity by Ostwald's Viscometer Analysis of Simple cubic unit cell of NaCl (Axial length and Axial angle)	12	S. H. Maron& C. Prutton, *Principles of Physical Chemistry*, 4th Edition, Oxford & IBH Pub. Co., 1992. A. Bahal, B. S. Bahal& G. D. Tuli, *Essential of Physical Chemistry,* Revised Multicolor Edition, S. Chand & Co. Ltd., New Delhi, 2009.
V	***Electrochemistry***	Nernst equation: Standard Hydrogen electrode, Calomel electrode, and Quinhydron electrode, Electrochemical series and its applications, Lithium-ion battery and fuel cell.	4	Measurement of conductance of water (Conductometry) Quantitative analysis of mineral water (Spectrophotometry) Analysis for purity of air Estimation of lead in Petrol. (Spectrophotometry) Estimation of methane in dunk Estimation of CO_2 from Rock	8	K. L. Kapoor, *Text Book of Physical Chemistry*, Macmillan India Ltd., Vol. I to Vol.V, 3rd Edition, 2001. J. O'M Bockris and A. Reddy, *Modern Electrochemistry,* Vol. I, 2nd Edition, Plemum Pub. Corp., New York, 1998.
VI	***Synthetic Chemistry***	Polymers; Drugs; Dyes; Pesticides; Cement; Clay; Extraction of ore and minerals; Chemistry of Carbon	2	Heat of combustion of plastics (Enthalpy calculation) Determination of percentage of ore Chemical analysis of cement (Spectrophotometry) Adsorption of toxic metal on modified carbon (Adsorption Isotherm)	4	N. M. Khadka, S. D. Gautam& P. N. Yadav, *A Core Experimental Chemistry for B.Sc.,* Heritage Publication, Kathmandu, 2013 A. K. De, *Environmental Chemistry*, New Age International Ltd. Publishers, New Delhi
Total hours of theoretical events			***24***	***Total hours of practical events***	***48***	

Semester II

Basic Statistics

Course Code: ENV420 ***Credit Hours:*** 2.0 [Theory: 1.0; Practical: 2.0]
Course Title: Basic Statistics ***Teaching Hours***: 16Th + 64Pr
Semester: **II**

Course Description: This course on **Basic Statistics (ENV420)** is a Common Foundation Course (CFC) that provides the basic knowledge and skill in statistics and application of statistics in data analysis as well as fundamental knowledge of bioinformatics, its importance, and applications for analyzing biological data using computers.

Objectives of the Course: After the completion of this course students will be able to -

- understand the computing solution of biological problems, and biological processes
- show students the relevance of statistics
- familiarize the students with software used for the data analysis.
- provide guidance to students for using software

Course Contents:

Unit	Unit heading Contents	Micro Content				References
		Theoretical Concept	**Lecture Hour**	**Practical Application**	**Lecture Hour**	
I	***Introduction to Statistics and Data collection***	Origin and history, meaning, definition, uses, Functions, and limitations of Statistics, important terminologies (population, sample, parameter, statistic, census) Data classification (data types based on sources and nature), measurement and scaling (Nominal, ordinal, interval and ratio)	3	Introduction to Microsoft Excel Collection of data related to profile of classmates and classify them Collection of different types of data	**10**	Statistics for who hate statistics Using excel 2016(by-Neil-J.-Salkind), *Sage publication* Understandable Statistics by Charles Henry Brase Corrinne Pellillo Brase, *Houghton Company, Boston, New York* Outline of Business Statistics by Leonard
II	***Presentation of Data***	Frequency distribution, bar diagram, histogram, pie-chart, Frequency curve	2	Data entry and formation of frequency table and charts using MS Excel	**14**	

III	***Summary Measures***	Central Tendency (mean, median, mode, quartiles) Measure of Variation (Range, quartile deviation, standard deviation, coefficient of variation Five-point summary, Box and whisker diagram	4	Using MS EXCEL to calculate summary measures and measures of variation, normality check	**20**	Kazmier, *McGraw-Hill companies*
IV	***Relationship between variables***	Definition and differences between correlations and regression	4	Using MS EXCEL to calculate correlation and regression from the data collected previously and interpretation of the results	**20**	
Total hours of thematic teaching-learning			**16**	Total hours of practical activities	**64**	

Atmospheric and Hydrological Processes

Course Code: ENV421 ***Credit Hours:*** 3.00 [Theory: 2.0; Practical: 1.0]
Course Title: Atmospheric and Hydrological Processes ***Teaching Hours***: 32Th+32Pr
Semester: **II**

Course Description: This course **Atmospheric and Hydrological Processes (ENV421)** offers an introduction to the fundamental processes of the Earth's atmosphere and hydrosphere. It explores the interactions between these spheres and their implications for the environment and human activities, with a particular focus on topics relevant to landlocked regions.

Course Objectives: At the end of the course, students will be able to:

- understand the basic processes of the Earth's atmosphere and hydrosphere
- learn about meteorological and hydrological fundamentals
- develop practical skills in data collection, analysis, and interpretation

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Introduction to Earth Systems***	Overview of Earth system science; Components of the Earth system: lithosphere, atmosphere, hydrosphere, biosphere; The water cycle: Phases, interaction and global water budget	3	• Field Data Collection Techniques • Introduction to Field Equipment and Methods • Overview of essential field equipment (e.g., flow meters, GPS units, soil moisture sensors) • Safety procedures and best practices for fieldwork	2	Neil C. Wells. The Atmosphere and Ocean: A Physical Introduction
II	***Atmospheric Processes***	Meteorological parameters; Weather and climate; Air mass formation and types; frontal systems; pressure systems; Classification of climate: objectives of the classification, basis of the classification, Koppen's classification, Thornthwaite classification; climates of Nepal, climatic pattern, spatial and temporal patterns of climatic parameters in Nepal; Atmospheric	8	• Weather Observation and Data Logging • Use of Weather Instruments Introduction to weather instruments: thermometers, barometers, anemometers, hygrometers, rain gauges	14	"Physical Geography" by Robert Gabler, James Petersen, and L. Trapasso

		circulation and weather systems; Heat transfer in the atmosphere; Cloud formation; Precipitation; Forms and types of precipitation; Analysis and interpretation of rainfall data		● Setting up and calibrating weather instruments ● Analyzing weather patterns and trends ● Using weather data to predict local weather conditions ● Analysis of climatological data		
III	***Surface water Processes and Runoff***	River systems and fluvial processes; Floods and floodplain management; Lakes and wetlands; Principles of runoff generation; Runoff; Factors affecting runoff; Introduction to stream simulation model; Hydrological prediction: probability of hydrologic event, distribution functions; Frequency analysis, analysis of hydrologic time series, reconstruction of hydrologic data; Flood forecast technique, extreme flood event estimation method; Techniques for measuring streamflow; Discharge measurement by area-velocity method, float method, dilution method, electromagnetic induction method, ultrasonic method; Hydrograph analysis; Features of Hydrograph; Hydrograph uses and application	15	● Measuring stream flow and water levels in a local river or stream ● Flood frequency analysis; return period ● Rating curve and hydrograph (DAD curve, IDF curve)	16	Rami J. P. and Reddy (2008). A Textbook of Hydrology, University Science Press.
IV	***Groundwater Processes***	Zonation and Occurrence of Groundwater: Aquifer Parameters: Porosity, permeability, specific yield, and specific retention; Hydraulic conductivity and transmissivity; Darcy's Law: Principles and applications; Calculation of groundwater flow rates; Groundwater Level and Environmental Influences: Factors affecting groundwater levels (e.g., precipitation, extraction); Seasonal and long-term changes in groundwater levels; Groundwater-surface water interactions	6			
Total hours of theoretical events			***32***	***Total hours of practical events***	***32***	

Environmental Geology and Geomorphology

Course Code: ENV422 ***Credit Hours:*** 3.0 [Theory: 1.0; Practical: 2.0]
Course Title: Environmental Geology and Geomorphology ***Teaching Hours***: 16Th+64Pr
Semester: **II**

Course Description: This course **Environmental Geology and Geomorphology (ENV422)** offers a comprehensive introduction to environmental geology and geomorphology focussing on the geological processes that shape the earth's surface and their environmental implications. The students will learn the dynamic earth system and apply this knowledge to real-world environmental challenges.

Course Objectives: At the end of the course, students will be able to:

- understand the fundamental concepts of environmental geology and geomorphology
- identify and assess environmental issues and hazards related to geological processes
- strategies for sustainable management and mitigation of geological hazards
- apply theoretical knowledge to practical case studies and field observations.

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Introduction to environmental geology and geomorphology***	Definition, scope and importance of environmental geology and geomorphology; Introduction to geological process: Internal structure of earth, plate tectonics; Rocks: rock cycle, Rock types, rock formation	4	• Identification of different types rocks and minerals in the hand specimen and interpretation of different geomorphic features in the field	20	Keller, E. Introduction to Environmental Geology, 800p.

II	***Natural Hazards and geomorphic process***	Introduction to earthquake, landslide, volcanic activities; Process and landform produced by glacier, wind, river and sea water; Altitude of geological planes (geological compass and its types); Geological structure (primary and secondary structure)	4	● Analysis of different geomorphic processes ● Analysis if sediment samples and understand the sedimentary process ● Study and interpretation of geological structure.	16	Holmes (1978). Principles of Physical Geology", ELBS English Language Society
III	***Human impacts on geological process***	Mining and its environmental impacts**;** Urbanization and land-use changes**;** Environmental pollution and waste management	4	● Use of geographic information system and remote sensing for mapping and analysis geological and geomorphic features	12	S. C. Ray, I. N. Sinha, "Mine and mineral economics", PHI Learning Pvt. Ltd., Delhi, 2016. Mazumder, Ra. And Shaw, R. (eds) Surface Environments and Human Interactions. Springer, Singapore
IV	***Geology of the Nepal Himalaya***	Geological sub-division of the Nepal Himalaya; Geomorphic/physiographic sub-divisions of the Nepal Himalaya	4	● Examination of a detailed geological and topographical map of Nepal for the identification of major fault system and its implications for geological hazards	16	Deoja, B., Dhital, M., Wagner, A., & K.B, T. (1991). Mountain Risk Engineering Handbooks I and II. ICIMOD. Dhital, M.R. (2015), Geology of the Nepal Himalaya, Springer International Published, Switzerland
Total hours of theoretical events			***16***	***Total hours of practical events***	***64***	

Contemporary Environmental Issues

Course Code: ENV423 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Contemporary Environmental Issues ***Teaching Hours***: 32Th+32Pr
Semester: **II**

Course Description: The course on **Contemporary Environmental Issues (ENV423)** is designed based on evolving challenges observed in the natural environment or ecosystems. The course offers information to aware of students regarding the emerging regional and global environmental issues.

Course Objectives: At the end of the course, students will be able to:

- know about the current environmental issues
- understand the emerging challenges in anthropogenic activities
- identify the role to minimise the impact of contemporary environmental issues

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Introduction to Environmental Factors***	Definition and types of environmental factors: Abiotic and Biotic, natural ecosystem; Evolution of human interference in the natural ecosystem; Shelford's Law of Tolerance, Liebig's Law of Minimum, and Concept of Limiting Factors	10	Writing a response paper on Evolution of human beings and its interference to the natural ecosystem (Group Presentation)	4	Abel D C, McConnell R L (2012) Environmental Issues: Looking Towards a Sustainable Future (4th Edition) 4th Edition. Pearson Learning Solutions Harris F (2005) Global Environmental Issues. Wiley & Sons, Inc., USA Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. 2012. An Introduction to Sustainable Daly, Herman E. 1996. Beyond Growth: The Economics of Sustainable Development. Boston: Beacon Press
II	***Environmental Issues and Challenges (Global to local)***	Human development and its pressure on the natural environment, Environmental pollution (land, air, water, and noise), Solid waste management; Global warming, GHG emission, and climate change; Deforestation and biodiversity loss	10	Response paper on the "Polluter Pay Principle" and its opportunity and challenge in Nepal Group presentation on local environmental challenges and mitigation measures from government and non-government agencies	8	

III	***Environmental Disasters***	Environmental crises; Climate-induced disasters (flood, landslide, GLOF, and epidemics) and its implication on the natural ecosystem; Threats and challenges of Nuclear and radioactive disaster	7	Writing a response paper on Environmental governance, actors, and instruments in Nepal	4	
IV	***Global Environmental Movement***	Concept of human and development, Stockholm conference, the establishment of UNEP, and role of the non-government organization in environment protection; Concept of environmental sustainability and sustainable development; Environmental standards: WHO guidelines, US EPA, National standard	5	Visit a local NGO/INGO and learn their activities about environmental stewardship		
Total hours of theoretical events			***32***	***Total hours of practical events***	***32***	

Evolutionary Biology

Course Code: ENV424 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Evolutionary Biology ***Teaching Hours***: 32Th+32Pr
Semester: **II**

Course Description: This course **Evolutionary Biology (ENV424)** focuses on the processes of evolution and patterns generated. The topics include the theories of evolution, genetic basis of evolutionary changes in organisms.

Course Objectives*:* At the end of the course, students will be able to:

- understand the comprehensive overview on evolution
- explore salient features of various theories of evolution
- acquire knowledge on micro and macro-evolutionary changes

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Origin and diversification of life on Earth***	Origin-of first living organism; prokaryotes and eukaryotes Major diversity changes; Evolution of biosphere during different era	**1**	Sketch the flow chart reflecting origin of life on earth	**2**	Hafner, M.S. (1994). Evolution laboratory: *Laboratory exercises and discussions in evolutionary biology.* Baton Rouge, LA: Louisiana State University. Minkoff, E. C. (1983). *Evolutionary biology*. Reading, MA: Addison-Wesley Publishing Company.
II	***Theories of Evolution***	Concept of Organic Evolution; Lamarckism; Darwinism; Neo-Darwinism	**3**	Study on contribution and bibliography of any evolutionary biologist	**2**	Verma, P.S. and Agrawal, V.K., Year *Cell Biology, Evolution and Ecology*, Latest Edition. S.Chand and Company, New Delhi.
III	***Fossils/Evidences***	Fossil record (types and dating of fossils);	**6**	Study of fossils from models/pictures/specimens Study of fossils of Nepal	**6**	Kapadia, Harish Geologic Year *Formation of the Himalaya*, Himalayan Journal 66(2010), Mumbai.

		Geological time scale; Genetic evidence; Fossils evidences from Himalaya				
IV	***Forces of evolution***	Mutation; Gene flow; Genetic drift; Natural selection	**2**	Protein electrophoresis to show relationship among organisms	**4**	Mark Ridley. *Evolution*, 3rd Edition. Blackwell Pubishing. (2004).
V	***Speciation***	Speciation: allopatric, sympatric, parapatric, peripatric; Adaptive radiation; Microevolution, Macroevolution, Co-Evolution	**8**		**6**	Rastogi, Beer Bala, Year *Organic Evolution*, 14th Edition, Medtech Publication. .
VII	***Extinction and Human Evolution***	Major extinctions, Role of extinction in Evolution, Human ancestors and modern man	**5**	Project introduction, plan and work distribution Project work/field visit Project presentation and Submission	**10**	Mishra, S. K. and Mohanty, M. K. Year *Evolutionary Biology*, Kalyani Publication
VIII	***Significance of Evolution***	Applications of evolutionary concepts to human health and well-being.	**2**			Mohan P. Arora. *Evolutionary Year Biology*, Himalaya Publishing House, Bombay.
Total hours of theoretical events			***32***	***Total hours of practical events***	***32***	

Thermodynamics and Kinetics

Course Code: ENV425 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Thermodynamics and Kinetics ***Teaching Hours***: 32Th+32Pr
Semester: **II**

Course Description: The course on **Thermodynamics and Kinetics (ENV425)** is designed to provide fundamental concepts of thermodynamics and kinetics, with a focus on their application in environmental science. The course explores energy transformations, chemical equilibria, reaction rates, and the dynamics of environmental systems. Emphasis is placed on understanding processes such as heat transfer, energy efficiency, and chemical reactions occurring in natural and anthropogenic environmental systems, including air, water, soil, and biological ecosystems.

Course Objectives: At the end of the course, students will be able to:

- Understand the principles of thermodynamics and kinetics as they apply to environmental systems
- Apply thermodynamic principles to processes like pollution, resource management, and climate change
- Evaluate the effects of temperature, pressure, and concentration on environmental processes
- Use basic thermodynamic and kinetic models to solve environmental science problems

Course Content:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Introduction***	Overview of thermodynamics and kinetics in envionmental science; Key terminologies: energy, enthalpy, entropy, Gibbs free energy, reation rates; First and second laws of thermodynamics, applications of thermodynamics in environmental contexts	2	• Basic numerical practical problems solving for 1) first law of thermodynamics (conservation of energy), 2) second law of thermodynamics, 3) Gibbs free energy, 4) rate of reaction, 5) Half-life of a reaction, 6)	32	Atkins, P. W., Ratcliffe, R. G., de Paula, J., & Wormald, M. (2023). *Physical chemistry for the life sciences*. Oxford University Press (relevant chapters on thermodynamics and kinetics)

II	***Thermodynamics systems and Processes***	Forms of energy (thermal, mechanical, chemical, etc.); Conservation of energy: first law of thermodynamics; Heat trasfer methods: Conduction, convection, and radiation; Energy in environmental systems (energy cycles in ecosystems, energy use); Open, closed and isolated systems; State variables: temperature, pressure, volume, and composition; Thermodynamic processes: isothermal, adiabatic, isobaric, and isochoric; Work and heat in envionmental processes (weather systems, hydological cycles)	10	Arrhenius equation, with the examples in enviromental sciences.		Manahan, S. E. (2022). *Environmental chemistry*. CRC press. De, A. K. *Environmental Chemistry*, New age International Ltd. Publishers, New Delhi
III	***Entropy and Spontaneous Processes***	Second law of thermodynamics: entropy and disorder; Entropy in environmental systems; Spontaneity of processes (e.g., diffusion, heat transfer, and pollution dispersion); Calculating entropy changes in environmental reactions	8			
IV	***Environmental Reactions and Kinetics***	Rate of reaction and factors affecting it: temperature, concentration, catalysts; Rate laws and reaction mechanisms; Applications to environmental chemical reactions (e.g., pollutant degradation, atmospheric reactions); *Temperature Dependence and Arrhenius Equation:* Temperature and reaction rate; Arrhenius equation and activation energy; Effects of temperature on environmental processes (e.g., seasonal variations, microbial activity in soil); *Chemical Kinetics in the Atmosphere:* Atmospheric	12			

		reactions and kinetics; Reaction rates of pollutants and greenhouse gases in the atmosphere; Photochemical smog and ozone layer depletion; Modeling environmental reactions in the atmosphere				
Total hours of theoretical events			***32***	***Total hours of practical events***	***32***	

Semester III

Research Methodology

Course Code: ENV430 | ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Research Methodology | ***Teaching Hours***: 32Th+32Pr
Semester: **III**

Course Description: The **Research Methodology (ENV430)** is a Common Foundation Course (CFC) designed to develop the foundation of the research process in students. The course will make students familiar with research concepts, methodologies and the overall process of scientific research. The course is theoretical and practical in nature as it exposes both theoretical concepts of research as well as training students in designing tools and techniques of data collection, analysis, report preparation and scientific publications.

Course Objectives: At the end of the course, students will be able to:

- acquire the knowledge of basic research methods
- learn to collect data through sampling methods
- understand various types of research
- know about writing research proposal, report and prepare manuscript

Course Contents:

Unit	Unit heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Fundamentals of Research***	Definition and concepts of scientific research; Philosophy of scientific enquiry; Critical reading and thinking; Purpose of research; Process of research; Approaches of scientific research: inductive and deductive reasoning	4	- Exercise critical thinking - Select a piece of scientific note and practice for critical reading - Identify the examples of inductive and deductive reasoning	6	Kothari, C.R. 1998. Research Methodology, Methods and Techniques, Vishwa Prakashan, New Delhi Singh M.L.., 1998, Understanding Research Methodology, Publ.JM Singh, Kathmandu
II	***Formulation of Research Questions***	Sources of research problems; Literature review- process; Steps of formulating research questions; Criteria of good research questions; Research hypothesis: definition and importance	6	- Select few related literatures and practice to review to find gaps in knowledge - Learn to derive statement of hypothesis	4	

				- Identify a research area and learn to explore research problems and questions - Literature review techniques		
III	***Research Design and Data Collection Methods***	Definition and characteristics of research design; Dimensions of research design; Data: Types and Sources; Data Collection Methods (Observation, Experimental, Survey, Sampling, Questionnaire, Interviews etc.)	6	- Visit a library and enlist the sources of literatures on the chosen research areas - Develop a questionnaire and upload in KoboToolbox - Identify a research area develop dimensions of research design	6	
IV	***Data Analysis***	Data processing (coding, decoding, sorting); Data presentation and visualization; Basic biostatistics; Reliability and validity of data; Interpretation and generalization of the findings	6	- Learn various statistics for data analysis: Correlation coefficient, Standard deviation and standard error, p-value, parametric and non-parametric test with examples - Differentiate reliability and validity of the given data for practice	6	
V	***Scientific Communication***	Basic concept of *Scientific Communication*; Basic Instruction for seminar; Scientific Journals: Impact factor, h-index, Indexed journals, DOI numbers; Basic Instruction for writing manuscript, poster and oral presentation; Scientific Database (e.g., Web of Science); Research ethics	6	- Give a seminar on the developed proposal - Enlist the peer-reviewed Journals - Make a poster of your primary data. - Learn about fabrication, falsification and Plagiarism	6	
VI	***Proposal and Report Writing***	General Guideline of Proposal Writing and purpose of proposals	4	- Develop a proposal with basic components	4	
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Environmental Economics

Course Code: ENV431 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Environmental Economics ***Teaching Hours***: 32Th+32Pr
Semester: **III**

Course Description: This course on **Environmental Economics (ENV431)** is designed based on principles of developing the fundamental concept of Environmental and Natural Resources Economics. The course is theoretical and practical in nature as it exposes different concepts of Environment and Natural Resources Economics. The course covers introductory concepts to describe environmental resource economics, market failure, externalities in natural resources, valuation techniques to ecosystem services, economic valuation of environmental resources and green economy.

Course Objectives: At the end of the course, students will be able to:

- understand the role of natural resources to promote green economy
- estimate the value of ecosystem services and internalize PES to manage externalities
- learn the market failure for efficiently allocate natural resources and relevant policies to correct it
- analyse the use of natural resources from economic perspective and their optimum utilisation
- familiarize students with the different non-market valuation techniques

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Introduction to natural resources***	Natural Resources: Concept, types, classification & scarcity; Factors influencing resource availability, distribution, and uses; Fundamental of Renewable Resource; Exploitation: Marginal rule and Price change rule; The Rate of Exploitation and Maximum Sustainable Yield (MSY); Principle of Exhaustible Resource use and Optimal Resource use	6	• Visit your locality and identify the natural resources and their significance. • Case study about any type of natural resources of your locality and identify its socio-economic drivers • Field work on MSY the resources	8	Bergstrom J.C., Randall A. (2016). Resource Economics. An Economic Approach to Natural Resource and Environmental Policy, Fourth Edition. Edward Elgar Publishing Limited. Cheltenham, UK. Northampton, MA, USA

						.
II	***Environment resource economics***	Concept of environment and resource economics; Environment- economy interaction; Concept of different types of goods, public, private, club and commons.	5		4	Tietenberg T. (2000). Environmental and Natural Resource Economics. Fifth Edition. Published by Addison Wisley Longman Inc. David W. Pearce and R Kerry Turner (1991). Economics of Natural Resources and the Environment. The John Hopkins University Press, Baltimore, Maryland
III	***Approaches and Methods of NRM***	Ethics in resource management, conflicts, low carbon lifestyles, case studies behavioral dimensions of participatory management, Participatory approaches, Participatory Rural Appraisals (PRA) methods, their purpose and applications	6		8	Bergstrom J.C., Randall A. (2016). Resource Economics. An Economic Approach to Natural Resource and Environmental Policy, Fourth Edition. Edward Elgar Publishing Limited. Cheltenham, UK. Northampton, MA, USA
IV	***Valuation of Ecosystem Services***	Concept of Ecosystem Services & total economic value; Economic Valuation of non-market goods & services; Measures of indirect utility: WTP & WTA; Indirect Valuation: The Travel Cost & Hedonic Pricing Method; Direct Valuation: Contingent Valuation Method.	8	● Workout in paying ecosystem services ● Practice of non-market valuation environmental goods & services. ● Practice of direct and indirect valuation methods of ecosystem services.	8	Gunatilake H. M. (2003). Environmental Valuation: Theory and Applications. Postgraduate Institute of Agriculture, University of Peradeniya. Haque, A., Murty, M., & Shyamsundar, P. (2011). Environmental Valuation in South Asia. Cambridge University Press. doi:10.1017/CBO9780511843938
V	***Environment & Sustainable Development***	Concept of Development and Conservation; Concept of weak and strong sustainability; Safe minimum standard approach; Irreversibility and Sustainability;Circular economy	7	● Practice in System of Environmental Economics Accounting. ● Worked out with the examples of circular economy.	6	Karki M. (2020). Green Economy for Sustainable Development in Nepal: Role of Forestry Sector. United Nations (2021). System of Environmental-Economic Accounting— Ecosystem Accounting (SEEA EA). White cover publication, pre-edited text subject to official editing.

						Available at: https://seea.un.org/ecosystem-accountings
VI	***Sustainable natural resources management and development***	Industrialization and its impacts, growth vs. inclusive growth, societal impacts, types of farming systems, globalization, urbanization, and privatization, sustainability of modern developments: dams and displacement, mining, high impact agriculture		Identify the sustainability approaches of development infrastructure of your locality		
Total hours of theoretical events			***32***	***Total hours of practical events***	***32***	

Environmental Pollution

Course Code: ENV432 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Environmental Pollution ***Teaching Hours***: 32Th+32Pr
Semester: **III**

Course Description: The **Environmental Pollution (ENV432)** Course is designed to provide critical understanding on the scientific principles governing pollution in air, water, and land. The course encompasses one-third of theory and two-third of practical components, including hands-on tutorials, laboratory work, and analyzing real-world problems. It is designed to enable the students to be able to understand the foundational science of environmental pollution and its applications in the real-world problems.

Course Objectives: At the end of the course, students will be able to:

- foundational scientific principles governing environmental pollution problems
- release and fate of contaminants in the environment
- concept of interaction of environmental compartments.

Course Contents:

Unit	Unit heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Air Pollution***	Types and sources of air pollutants; Emerging air pollutants; Units of measurement; Air quality index Combustion stoichiometry and pollutant generation: CO, NO_x, SO_x, HC, PM; Motor vehicle emissions; Air-to-fuel ratio; Photochemical and industrial smog; Effects of meteorological parameters on air quality; Dispersion: Advection and diffusion; Atmospheric stability and air quality; Plume behaviour; Mixing depth and atmospheric ventilation; Causes and characteristics of air pollution episodes; Indoor air pollution: characteristics and sources; Ventilation and	12	• Air pollution monitoring tools, techniques, types, and objectives, measurement uncertainty • Ambient air quality monitoring and analysis (gaseous and particulate pollutants) • Analysis and interpretation of open-source ambient air quality monitoring data (at least one year data) • Monitoring indoor air quality and ventilation rates (calculation of ACH)	12	Jacobson, M.Z., 2002. Atmospheric Pollution: History, Science, and Regulation. Cambridge University Press, Cambridge. Masters, G.M., Ela, W.P., 2008. Introduction to Environmental Engineering and Science, Third Edition. Pearson Education, Inc., London. Miller, G.T., 2017. Living in the Environment, Nineteenth

		indoor air quality; Air-change hour and residence time: air quality standard.		● Field observation of air quality monitoring stations and vehicle emission testing centre ● Air-to-fuel ratio (Related practical) ● Air pollution sampling tools and techniques (PMx, CO, NOx, etc.)		Edition. Cengage Learning, Boston. Nazaroff, W.W., Alvarez-Cohen, L., 2001. Environmental Engineering Science. John Wiley & Sons, Inc., New York. Seinfeld, J.H., Pandis, S.N., 2016. Atmospheric Chemistry and Physics: From Air Pollution to Climate Change, Third Edition. John Wiley & Sons, Inc., New Jersey. Cunningham, W. P., & Cunningham, M. A.. Principles of environmental science. *Inquiry & Applications (McGraw-Hill, NY 2008)*. 15th edition Vallero, D., 2014. Fundamentals of Air Pollution, Fifth Edition. Elsevier Inc., Amsterdam.
II	***Water Pollution***	Sources and types of pollutants; Physicochemical and biological water quality parameters; Major contaminants of surface water and groundwater; Emerging contaminants in water; Characteristics of wastewater; Units of measurement; Water quality standard, index (NDWQs 2022, WHO guideline); Wastewater effluent standard; Impact of water pollutants: Eutrophication; Acidification of lakes and bicarbonate buffering; Biomagnification of contaminants; Water-borne disease, water safety plan.	12	● Sampling and monitoring of water quality. ● Sampling and analysis of physicochemical and microbial characteristics of water ● Biomonitoring of surface water quality ● Sampling and analysis of physicochemical and microbial characteristics of wastewater ● Sampling and monitoring of water quality parameters.	12	APHA, 1998. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington. Masters, G.M., Ela, W.P., 2008. Introduction to Environmental Engineering and Science, Third Edition. Pearson Education, Inc., London. Miller, G.T., 2017. Living in the Environment, Nineteenth Edition. Cengage Learning, Boston. Nazaroff, W.W., Alvarez-Cohen, L., 2001. Environmental

						Engineering Science. John Wiley & Sons, Inc., New York. Peavy, H.S., Rowe, D.R., Tchobanoglous, G., 2015. Environmental Engineering. McGraw Hill Education Pvt. Ltd, New Delhi.
III	***Soil Pollution and Solid Waste***	Characterization of soil; Chemical contamination of soil; Pesticides, fertilizer and soil microorganisms; Soil erosion and land degradation; Solid waste types: Municipal, industrial and hazardous solid waste; Waste composition and characteristics	6	● Sampling and analysis of soil: texture; density; moisture; nutrients ● Sampling and analysis of solid waste: generation rates, composition, density, moisture	5	Brady, N.C., Well, R.R., 2002. The Nature and Properties of Soils, Thirteenth Edition. Pearson Education, Inc., Singapore. Masters, G.M., Ela, W.P., 2008. Introduction to Environmental Engineering and Science, Third Edition. Pearson Education, Inc., London. Miller, G.T., 2017. Living in the Environment, Nineteenth Edition. Cengage Learning, Boston.
IV	***Noise and light Pollution***	Noise definition; Sources; Sound pressure level; Percentile level; Noise dose; Effect of noise on human health	2	● Noise measurement in different indoor and outdoor microenvironments	3	Singal, S.P., 2005. Noise Pollution and Control Strategy. Narosa Publishing House, New Delhi.
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Microbial Ecology and Ecotoxicology

Course Code: ENV433 ***Credit Hours:*** 3.0 [Theory: 1.0; Practical: 2.0]
Course Title: Microbial Ecology and Ecotoxicology ***Teaching Hours***: 16Th+64Pr
Semester: **III**

Course Description: The course on **Microbial Ecology and Ecotoxicology (ENV433)** course has been designed to provide understanding of the interrelationship between microorganisms and their biotic and abiotic environments and wide knowledge on environmental toxicants. The comprehensive understanding of essential roles of microorganisms in ecosystems will help students design approaches to control and sustain environmental quality. Further, it helps to understand the toxicants disposition and metabolism, fate of toxicants in the environment, impacts of various pollutants and heavy metals.

Course Objectives: At the end of the course, students will be able to:

- explain the interaction of microorganisms with biotic and abiotic environments
- use knowledge and skill for designing approaches for controlling and utilizing microorganisms for sustainable environment quality
- apply the safety and precautionary measures related to environmental toxicants

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	**Microbes and microbial ecology**	Microorganisms in soil, water and air and their roles, microbial association in different environments, rhizospheric and phyllospheric microorganisms, their functions and factors influencing their growth and activities	2	Isolation and enumeration of microorganisms present in soil, water and air	10	Alexander M (1961). Introduction to Soil Microbiology, Academic Press. Atlas RM and Bartha R (1998). Microbial Ecology: Fundamentals and Applications. The Benjamin Cummins Publication Co. Inc. Madigan, M. T., Martinko, J. M., & Parker, J. (1997). Brock biology of microorganisms (Vol. 11).
		Microbial interactions in ecosystem, their types		Buried slide technique for isolation of microbial flora of soil	3	

						Upper Saddle River, NJ: Prentice Hall.
II	**Microbiology of extreme environments**	Growth and survival of microorganisms in extreme environment: temperature, pH, humidity, salinity, and applications of extremophiles	2	Sampling, culture and identification of microorganism from various environments	5	
III	**Biogeochemical cycles and role of microorganisms**	Microbial Processes Contributing to Biogeochemical Cycles; nitrogen cycle and carbon cycle Degradation of organic material; cellulose and hemicellulose	2	Demonstration of cellulolysis, use of cellulose; Demonstration of Winogradsky's column, uses of column in differentiation of microbial ecology; Determination of total nitrogen value of soil	10	
IV	**Environmental toxicology**	Definition and branches of toxicology, scope and importance of toxicology; Principles of Toxicology; Major classes of toxicants and contaminants; Uptake, biotransformation, detoxification, elimination and accumulation; Categories of toxic effects - synergistic, antagonistic and additive effects, Acute and chronic toxic effects; Dose-effect and dose response relationships	3	Determination of biological oxygen demand, chemical oxygen demand Field visit and observation of municipal waste water treatment and solid waste management	12	Shaw, I.C. and Chedwick, J. (2004), Principles of Environmental Toxicology, Boca Raton, FL, Taylor and Francis. Walker, C.H., Sibly, R.M., Hopkin, S.P., Peakall, D.B. (2012), Principles of Ecotoxicology. Fourth Edition. USA, CRC Press. Zakrzewski, S.F (2002), Environmental Toxicology. 3 Edition. New York, Oxford University Press. Landis, W., Sofield, R., Yu, M.H. (2017), Introduction to Environmental Toxicology:
V	**Toxicity of environmental pollutants**	Effects on population, community and ecosystem; Toxicity of Persistent Organic Pollutants – pesticides, insecticides. Toxicity of heavy metals – Chromium, cadmium, mercury, arsenic, lead, iron; Biohazards, radioactive; substances, fluorides and carbon monoxide. Mode of action of toxicants, mechanism of toxicants	3	Analysis of water quality, ambient air quality; Toxic effect of chemicals on the seed germination; Toxic effect of chemicals on growth of the plants	12	

VI	**Analytical methods for toxicity testing**	Principles of toxicity testing; Measurements of LC50and LD50 values; Monitoring approaches - indicator populations and indicator species Bioassays – in vitro and in vivo; Biosensors – enzyme based and DNA based, immunosensors; whole-cell based biosensors and bio-markers; Bioindicators – metabolites; Risk assessment of contaminants in Environment	4	Calculating the LC50/LD50 value of the given sample; Analysis of the toxicants from environmental samples; Toxic effects of xenobiotics on morphological changes of fishes; Toxic effect on chlorophyll and carotenoid content of the plants exposed detoxicants/pollutants	12	Molecular Substructures to Ecological Landscapes, Fifth Edition. Canada, CRC Press.
		Total hours of theory	***16***	***Total hours of practicals***	***64***	

Freshwater Ecology

Course Code: ENV434 | ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Freshwater Ecology | ***Teaching Hours***: 32Th+32Pr
Semester: **III**

Course Description: The **Freshwater Ecology (ENV434)** course is designed to develop scientific knowledge about the freshwater ecosystem in students. The course will make students familiar with functional aspects of freshwater resources, its diversity and dynamism. The course is theoretical and practical in nature as it exposes both theoretical concepts of research as well train students in designing tools and techniques of data collection, analysis, report preparation and scientific publications.

Course Objectives: At the end of the course, students will be able to:

- make understanding on the importance of freshwater ecosystems and their conservation
- provide knowledge on sustainable use of water in Irrigation, hydropower, water supply sanitation and urban water management
- produce competent and analytical professionals having a broad knowledge on freshwater environment

Course Content:

Unit	Unit heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Freshwater Ecosystem***	Freshwater Ecosystem: lentic system (wetlands, ponds, lakes), hot water springs and lotic system (river, streams) types of freshwater ecosystem, significance of freshwater resources, Cryospheric (frozen) water system of Nepal, Overview of important glaciers of Nepal	5	• Economic importance of water resources in Nepal • Identification of lentic and lotic system and their significance.	4	Dodds, W. K. (2002). *Freshwater ecology: concepts and environmental applications*. Academic Press. Closs, G., Downes, B., & Boulton, A. (2009). *Freshwater ecology: a scientific introduction*. John Wiley & Sons. Martin, J. L. (2014). *Hydro-Environmental Analysis*. Taylor & Francis Group.

II	***Dynamics of Freshwater Ecosystem***	Thermal and chemical Zonation and stratification; Methods of bathymetry and morphometry (depth-area-volume relationship); Eutrophication and sedimentation; Assessment of aquatic ecosystems; Water quality and physico-chemical properties	8	• Bathymetric analysis of lakes and rivers • Case study of eutrophication in local pond/lake	10	
IV	***Freshwater Biota***	Freshwater biodiversity: Zooplanktons and Phytoplankton; Macro-invertebrates; Invertebrates; Vertebrates; Aquatic plants; Indicator species; Ecological adaptation in aquatic plants and animals	6	• Visit a local aquatic habitat and survey various animals and plants • Identify the morphological, anatomical and physiological adaptation in aquatic plants and animals	4	
V	***Significance of Freshwater resources***	Water and Agriculture: Hydropower development; Water supply and sanitation; Irrigation system and diversion canal; Biodiversity value; Sustainable use of freshwater resources	4	• Learn the effects significance or of water on soils; crop water requirement • Learn hydropower potential of Nepal, • Learn about minimum environmental flow.	4	
V	***Invasion in Freshwater system***	Introduction of invasive species; Causes and consequences of invasion; Prevention and management of invasions in waters	4	• Collection and identification of invasive plants from aquatic habitats • Learn the severity of invasion in the system	6	
VI	***Water Policy of Nepal***	Policies and Legal Instruments Related to Water; National Water Policies/Leases/Acts/Laws: Constitution of Nepal, 2015; Water Resources Strategy 2002; National Water Plan 2005; Water Resources Act 1992; Water Resources Bill 2020; Irrigation Policy 2013; National Climate Change Policy 2019; Agricultural Development Strategy 2015; Hydropower Environmental Impact Assessment Manual 2018; Guidelines and manuals in the Irrigation and Water Resources	5	• Learn various national and international conventions and protocols on freshwater resources in Nepal	4	
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Biogeography and Phylogenetics

Course Code: ENV435 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Biogeography and Phylogenetics ***Teaching Hours***: 32Th+32Pr
Semester: **III**

Course Description: The course **Biogeography and Phylogenetics (ENV435)** integrates the study of biogeography with the evolutionary links among species as phylogenetic evidences regulating the distribution of species across geographic areas and across geological time. The biogeographical and phylogenetic methods also discourse ecological and historical factors that shape species distributions. The use of molecular data is also used to reconstruct evolutionary histories.

Course Objectives: At the end of the course, students will be able to:

- understand the historical development of biogeography and phylogenetics
- use molecular data to reconstruct evolutionary histories of organisms and collect the evidences from the field to recognize the applications of phylogenetics

Course Contents:

Unit	Unit heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical	Practical Hours	
I	***Introduction to Biogeography***	Definition, comma, scope and histories of biogeography, Importance and applications of biogeography; Branches of biogeography: Phytogeography & Zoogeography	4	Conduct a survey and prepare checklist to document the presence and distribution of species in different habitats.	3	Cox, C. B., R. Ladle, and P. D. Moore. 2016. Biogeography: An Ecological and Evolutionary Approach. John Wiley & Sons. Riddle, B.R. 2017. Biogeography: History. International Encyclopedia of Geography: People, the Earth, Environment and Technology, 1-5. Doi:10.1002/9781118786352.wbieg1063.

II	***Types of Biogeography***	Ecological biogeography: Ecology, Individual, Population, community structures, Environmental factors, biodiversity Conservation Biogeography: Island biogeography, Synthetic biology, Climate change, Invasive species	9	Compare biodiversity across different regions or habitats to identify patterns and hotspots. Work on projects aimed at restoring degraded habitats to support native species.	7	Cox, C. B., R. Ladle, and P. D. Moore. 2016. Biogeography: An Ecological and Evolutionary Approach. John Wiley & Sons. Flannery, T. 2015. The Eternal Frontier: An Ecological History of North America and Its Peoples. Grove/Atlantic, Inc. Gavin, D. G. 2012. Biogeography. Pages 77-89 in J. P. Stoltman, editor. 21st Century Geography: A Reference Handbook. SAGE Publications, Thousand Oaks, CA.
III	***Biogeographic realms and its types***	Climatic conditions, sub-realms, distribution of plant and animals	3	Review on how climate change affects the distribution of species and ecosystems. Identify and map the distribution of invasive alien plant species in Nepal Identify and map the distribution of invasive alien animal species in Nepal	6	Lomolino, M. V., B. R. Riddle, J. H. Brown, and R. J. Whittaker. 2010. Biogeography. Fourth Edition. Sinauer Associates, Sunderland, MA. Jackson, S. T. 2004. Quaternary biogeography: Linking biotic responses to environmental variability across timescales. Pages 47-65 in M. V. Lomolino and L. R. Heaney, editors. Frontiers of Biogeography: New Directions in the Geography of Nature. Sinauer, Sunderland, MA. Six assessment report to CBD, 2021, Ministry of Forest of Nepal
IV	***Introduction and basic concept of Phylogenetic***	Overview of phylogenetic, Importance in biology; History and development of phylogenetic methods; Homology and analogy; Phenetics and evolutionary taxonomy	8	Conduct genetic sampling and analysis to understand the evolutionary history of species.	3	Williams, T. A., & Heaps, S. E. 2014. An introduction to phylogenetics and the tree of life. In *Methods in Microbiology* (Vol. 41, pp. 13-44). Academic Press. Charleston, M. 2017. Phylogeny. Reference Module in life Sciences. doi:10.1016/b978-0-12-809633-8.06904-1 Science Direct. 2017. Phylogeny. https://www.sciencedirect.com/topics/immunology-and-microbiology/phylogeny

V	***Phylogenetic Analysis and population genetics***	Molecular data: DNA, RNA, proteins, Morphological data, Collecting and preparing data, multiple sequence alignment; Population genetics principles, Phylogeography	4 2	Extraction of DNA from different organisms (plants and animals). PCR Amplification: Amplify specific genes or regions of interest.	6	Ziemert, N., & Jensen, P. R. 2012. Phylogenetic Approaches to Natural Product Structure Prediction. Natural Product Biosynthesis by Microorganisms and Plants, Part C, 161–182. doi:10.1016/b978-0-12-404634-4.00008-5 Avise, J. C., &Wollenberg, K. (1997). Phylogenetics and the origin of species. *Proceedings of the National Academy of Sciences*, *94*(15), 7748-7755. Yang, Z., &Rannala, B. (2012). Molecular phylogenetics: principles and practice. *Nature reviews genetics*, *13*(5), 303-314.
VI	***Applications of Phylogenetics***	Systematics and taxonomy, Evolution of traits and behaviours, Applications in conservation biology	2	Review the historical processes that could be responsible for the current geographic distributions of species. Develop a dendrogram (with the support from secondary genetic/ species trait data) to explain the interconnectedness between the species	7	EMBL-EBI. What is phylogenetics? https://www.ebi.ac.uk/training/online/course/introduction-phylogenetics/what-phylogenetics Wiley, E. O., & Lieberman, B. S. (2011). *Phylogenetics: theory and practice of phylogenetic systematics*. John Wiley & Sons. Yoshida, R., Zhang, L., & Zhang, X. (2019). Tropical principal component analysis and its application to phylogenetics. *Bulletin of mathematical biology*, *81*, 568-597.
Total hours of theoretical events			**32**	**Total hours of practical events**	**32**	

Semester IV

Scientific Communication

Course Code: ENV440 ***Credit Hours:*** 3.0 [Theory: 1; Practical: 2]
Course Title: Scientific Communication ***Teaching Hours***: 16Th+64Pr
Semester: **IV**

Course Description: This course on **Scientific Communication (ENV440)** is a Common Foundation Course (CFC) that is designed to develop skills for effective scientific communication through written as well as oral methods. Technical writing is utmost important for science and technology graduates. They should go through wider range of audiences including peers, the general public, and professionals.

Course Objectives: At the end of the course, students will be able to:

- read and write clear and concise scientific reports, research papers, and abstracts
- design and deliver effective oral presentations
- utilize digital tools and platforms for scientific communication
- critically evaluate and provide constructive feedback on scientific communication

Course Contents

Unit	Unit heading Contents	Micro Level Contents				References
		Theoretical Elements of Leaching	**Lecture Hours**	**Practical Elements of Learning**	**Lecture Hours**	
I	***Introduction to Scientific Communication***	Overview of scientific communication; Forms of scientific communications; Significance of scientific communications; Importance and impact on scientific progress and public understanding; Considerations for effective scientific communications	2	Analysing cases of successful and unsuccessful science communication Identification of different science communication types (students will collect the cases of different communication types and present in the class selecting the science topic of students' interest	5	"The Craft of Scientific Writing" by Michael Alley "How to Write and Publish a Scientific Paper" by Robert A. Day and Barbara Gastel

II	***Scientific Writing Fundamentals***	Elements of a technical reports: Proposals, reports, and papers; Structure of scientific papers (IMRaD format: Introduction, Methods, Results, and Discussion); An hourglass concept for research writing; Crafting research reports & papers: clear and concise abstracts, introduction/background, statement of problems, objectives, methods, results, discussion; Developing a research question and hypothesis, organizing data and results, interpreting and discussing findings	4	Selection of a peer-reviewed journal article(s) and review of its structure, compositions, and contents	4	Zikmund, Carr, & Griffin. (2011). Business research method. (8th ed.). Iltis, A. S. (Ed). (2006). *Research ethics*. New York: Routledge Taylor and Francis Group. e-book ISBN 0-203-79927-5. "Basic English Usage" by Michael Swan,Oxford University Press Online resources and tutorials on scientific communication tools
III	***Creating Impactful Presentations***	*Posters*: Principles of effective poster design; Poster sizes; Data visualization techniques (graphs, charts, tables); Using tools like PowerPoint, Canva or Adobe Spark *PowerPoint Presentation Skills*: Structuring a scientific presentation; Designing effective slides (using PowerPoint, Google Slides, PowerPoint design, font size, use of animation, text amount); Engaging the audience and handling questions	4	Creating and presenting a scientific poster and a presentation based on the selected journal article Students present their final projects (research papers, presentations, posters) Students will attend the paper seminar and discuss them in class	20	
IV	***Digital and Social Media in Science***	Utilizing social media for scientific communication (Twitter, ResearchGate, LinkedIn); Blogging and writing for non-specialist audiences; Ethical considerations and managing online presence	2	Each student will explore the digital and social media used in the science communication and develop a brief report Discussion of the findings in student group(s)	5	

V	***Communicating Science to Non-Specialists***	Adapting content for general public understanding; Storytelling techniques; Examples of successful science communication	2	Selection of science topic, and do research on it exploring different research article and prepare at least one news article by each student	10	
VI	***Publication Process: Peer Review and Feedback***	Understanding the peer review process; Author's guidelines; Providing and receiving constructive feedback; Revising and improving communication materials; writing response letter *Ethics and Professionalism*: Ethical considerations in reporting and presenting data; Avoiding plagiarism and ensuring transparency; Professional conduct in scientific discussions	2	Prepare a review article on a science question(s)	20	
Total hours of thematic teaching-learning			***16***	***Total hours of practical events***	***64***	

Energy and Environment

Course Code: ENV441 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Energy and Environment ***Teaching Hours***: 32Th+32Pr
Semester: **IV**

Course Description: The **Energy and Environment (ENV441)** course is designed to provide fundamental understanding on the scientific principles governing energy production, consumption, and environmental impacts. The course encompasses one-third of theory and two-third of practical components, including laboratory work, analyzing real-world problems, and field observations. It is designed to enable the students to be able to understand the foundational science of energy use and its impacts on the environment.

Course Objectives: At the end of the course, students will be able to demonstrate knowledge and understanding of the following:

- fundamental concepts on the global and national energy landscapes
- foundational scientific principles governing energy production, consumption, and environmental impacts
- understanding on renewable and alternative energy resources and technologies

Course Content*:*

Unit	Macro Level Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Concepts of Energy***	• Classification of energy resources; Global and national energy landscape; Energy consumption and human civilization; Energy crisis • Measurement units of energy; Laws of thermodynamics; Heat engines and Carnot efficiency; Entropy and irreversibility of thermodynamic processes • Energy conversion; Energy storage: mechanical, chemical,	6	Analysis of energy consumption data (e.g., global/national energy outlook; regional differences within the country) Measurement of calorific value of fuels	8	Boyle, G. (Ed.), 2011. Renewable Energy: Power for a Sustainable Future. Oxford University Press. da Rosa, A.V., 2013. Fundamentals of Renewable Energy Processes. Third Edition. Elsevier. https://doi.org/10.1016/C2011-0-06913-2 Ginley, D.S. Ginley, Cahen, D., (Eds.) 2012. Fundamentals of Materials for Energy and Environmental Sustainability. Cambridge University Press. https://doi.org/10.1017/CBO9780511718786

		electromagnetic and electrostatic, thermal, biological energy				Khan, B.H., 2009. Non-conventional Energy Resources. Tata McGraw Hill Education Private Limited, New Delhi.
II	***Non-renewable Energy Resources***	• Overview of fossil fuel formation • Nuclear energy; Principles of nuclear fission and fusion and applications; Nuclear fuel reserve and status	6	Estimation of GHG and air pollutant emissions from fossil fuel combustion	4	
III	***Renewable and Alternative Energy Resources***	• Nature and availability of solar radiation; Solar thermal systems; Solar photovoltaics; • Bioenergy; Biogas and methanogenesis; Biomass gasification; Biodiesel and bioethanol • Hydroelectricity; Types and technologies of hydropower systems; Environmental considerations • Renewables potential and use in Nepal	10	Field observation of hydroelectricity power plant and preparation of a report Analysis of solar energy potential of a residential/ commercial unit/ facility Calculate the heat of combustion of hydrocarbons	10	
IV	***Environmental Aspects of Energy Consumption***	• Energy conservation; Demand management; Energy efficiency; Technological and regulatory tools for energy conservation • Environmental impacts of energy consumption: air, water, land, ecosystem and biodiversity, climate, agriculture; Management of environmental impacts of energy use • Nuclear reactor accidents and safety	10	Calculation of energy demand of a facility or a residential/ commercial unit/ building Evaluation of energy efficiency of residential/ commercial building	10	
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Biodiversity Conservation

Course Code: ENV442 ***Credit Hours:*** 3.0 [Theory: 1.0; Practical: 2.0]
Course Title: Biodiversity Conservation ***Teaching Hours***: 16Th+64Pr
Semester: **IV**

Course Description: The **Biodiversity Conservation (ENV442)** is designed to provide an in-depth understanding of biodiversity, its levels, values and importance. It explores the diversity of life at genetic, species, and ecosystem levels and highlights the significance of biodiversity. It also addresses the causes of biodiversity loss, the relationship between biodiversity and ecosystem services, and the methods used to measure biodiversity. Students will gain knowledge of national and international policies related to biodiversity conservation, including Nepal's National Biodiversity Strategy and Action Plan (NBSAP) and the Convention on Biological Diversity (CBD).

Course Objectives: At the end of the course, students will be able to:

- understand the concept, values and causes of biodiversity loss and consequences
- a Grasp the relationship between biodiversity and ecosystem services
- learn about biodiversity conservation approaches and policies

Course Contents:

Unit	Macro Level Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	**Introduction**	Concept of Biodiversity: Definition, clarification of terms (taxonomic, spatial levels, endemism) Types of Biodiversity- alpha, beta, gamma diversity Levels of Biodiversity: genetic, species and ecosystem;	3	Review and present the alph, beta, and gamma diversity types in Nepal and present in a brief report	8	Chaudhary RP, 1998. Biodiversity in Nepal: Status and Conservation. Craftman Press Bangkok *and conservation*, 3-20.
		Distribution of Biodiversity: Gradients in biodiversity, global and national example	2	Review and present the biodiversity distribution in Nepal Himalaya	8	
II	**Ecosystem Services**	Ecosystem Services: types and valuation of ecosystem services	2	Visit a nearby forest ecosystem. List out different ecosystem services and valuate the provisioning services	16	Biodiversity: An Introduction" by K. J. Gaston and J. I. Spicer "The Living Planet Report" by WWF

III	**Threats to Biodiversity**	Habitat degradation and loss, invasion, climate change, exploitation and trade, pollution, synergistic effect	2			
III	**Biodiversity of Nepal**	*Biogeographical Zones of Nepal:* Tarai, Siwaliks, Mountains and the Himalayas Key species: endemic, endangered, and flagship species *Key Biodiversity Areas (IBA/KBA)- ramsar sites, in Nepal, agrobiodiversity of Nepal, urban biodiversity*	5	Conduct a literature review and enlist the key flora including NTFPs and fauna of the Karnali Province Nepal	8	
IV	**Biodiversity Conservation**	Conservation Approaches*:* In-situ and ex-situ conservation, Community-based conservation Major National and International Policies: *Nepal's National Biodiversity Strategy and Action Plan (NBSAP), CBD, CITES, RAMSAR,* Kunming-Montreal Global Biodiversity Framework (GBF)	4	Visit a local conservation sites/ seed banks/Zoo-Zoological Parks/ Botanical Garden/Gene banks etc. (prepare a brief report explaining about conservation interventions ongoing at the sites. Or Visit to In-Situ Conservation Area or Community Based Conservation Area to develop a report about ongoing management practices	16	25 Years of Achievements on Biodiversity Conservation in Nepal': Published by Ministry of Forests and Environment Singha Durbar, Kathmandu Nepal,2018 Nepal's 6th National Report to the Convention on Biological Diversity
		Concept of rangeland management and its role in livelihood in Nepal		Identity a pastureland and its various uses in Nepal	8	
Total hours of theoretical events			***16***	***Total hours of practical events***	***64***	

Physiology and Biochemistry

Course Code: ENV443 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Physiology and Biochemistry ***Teaching Hours***: 32Th+32Pr
Semester: **IV**

Course Description: The course on **Physiology and Biochemistry (ENV443)** is intended to teach the fundamentals of plant physiology and biochemical processes. The course covers both theoretical and practical aspects of plant physiology and biochemical processes. It is intended to help students understand the idea, categorisation, and practical use in everyday life, academic, and professionalism.

Course Objectives: At the end of the course, students will be able to:

- understand the physical and chemical properties of macromolecules
- provide students with an in-depth understanding of water interactions and physiological processes
- understand physiological process in animals
- apply thermodynamic principles to understand biological processes

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Water Relations***	Concepts; water potential, chemical potential; absorption of water and its mechanism; diffusion and osmosis; mechanism of stomatal transpiration, factors affecting transpiration and its significance	5	Perform an Osmosis experiment using an egg membrane. Determine the rate of transpiration by using Ganong's Potometer. Effect of light and wind on transpiration by plant twigs	6	Shrivastava, H. S., 1998. *Plant Physiology,* Rastogi Publications. V.K. Jain, Fundamentals of plant physiology, S. Chand & Company Ltd.

II	***Mineral Nutrition***	Role of minerals (macro and micro elements); Mechanism of mineral salt absorption in plants; fertilizers; hydroponics.	5	Demonstrate and observe an experiment on soilless growth.	5	Noggle, G. R. and Frits, G. J., 1992. *Introductory Plant Physiology*,CBS Publications & Distributors, New Delhi, India. Roy, R. N.,1989. *A TextBook of Biophysics*, New Cen. Book Agency, New York. Volkenstein, M. V., 1999, *General Biophysics*, Vol I &II. Academic press, New Ranjitkar H.D. A Practical manual for Botany, Kathmandu Nepal Verma S.K. and Mohit Verma, A text book of Plant physiology, Biochemistry and Biotechnology, 6th ed., S.Chand Publication Chattarji C.C., A text book of human physiology, Cbs publishing house.
III	***Photosynthesis***	Mechanism of photosynthesis (light and dark reaction), factors affecting photosynthesis, concept of C3 and C4 Plants.	5	Separation of chloroplast pigments by paper chromatography. Demonstrate that CO2 is necessary for photosynthesis by Moll's half leaf experiment. Measurement of oxygen produced during photosynthesis	6	
IV	***Respiration***	concepts, Mechanism of respiration (Glycolysis, Krebs cycle, ETS) factors affecting respirations;	5	Production of carbon dioxide during aerobic and anaerobic respiration.	4	
V	***Growth and Development***	Concepts of plant hormones, discovery and physiological role of auxins, gibberellins and cytokinins; animal hormones; seed germination and seed dormancy.	4	Effect of Plant Growth Regulators on rooting of cuttings and on abscission. Estimation of fat by Soxhlets extraction method.	2 4	
VI	***Plant Biochemistry***	Concepts of biomolecules: classification, characteristics and significance (carbohydrates, lipids, and proteins, enzymes, nucleic acid)	5	Separation and identification of amino acids. Estimation of protein		
VII	***Animal physiology***	digestion and absorption of carbohydrates, fats and proteins; transport of gases	3	Observation of heart in different animals	5	
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Soil Science

Course Code: ENV444 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Soil Science ***Teaching Hours***: 32Th+32Pr
Semester: **IV**

Course Description: The **Soil Science (ENV444)** Course is designed based on the principles of developing an interest and maintaining a sense of wonder and curiosity about properties of soil and their role in environment. This syllabus offers a comprehensive introduction to soil science, emphasizing practical applications and sustainable soil management practices. The combination of theory, case studies, and hands-on learning will help students build a solid foundation in soil science.

Course Objectives: At the end of the course, students will be able to:

- Understand the fundamental concept of soil science
- Analyse the relationship between soil properties, plant growth and relation with the environment
- Perform basic soil analysis, including sampling techniques, soil pH, texture, and nutrient content assessments

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Introduction***	Defination of soil and its importance; Basic functions of soil in ecosystems; Soil as a medium for plant growth; Global soil distribution Processes of soil formation (parent material, climate, organisms, time, topography); Weathering and mineral transformation; Soil horizons and profiles	8	• Study of physical properties of soil • Study of chemical properties of soil		Brady, N.C. and Weil, R.R. (2016). *The Nature and Properties of Soils* (15th Edition). Pearson. Hillel, D. (2008). *Environmental Soil Physics*. Academic Press.

		Soil Properties: Physical properties (texture, structure, porosity, and density); Chemical properties (pH, cation-exchange capacity, base saturation); Biological properties (soil organisms and their role in soil health); Soil water retention, movement, and availability				
II	***Soil Classification Systems***	Overview of major soil classification systems (USDA Soil Taxonomy, FAO World Reference Base); Soil orders and their characteristics; Soil Mapping and Survey: Principles of soil mapping, Soil surveys and their applications in agriculture and land use planning	4			
III	***Soil Fertility and Plant Nutrition***	Macronutrients and micronutrients essential for plant growth; Nutrient availability and soil amendments; Soil nutrient management practices; Types of fertilizers and their application; Organic and inorganic fertilizers; Fertilizer use efficiency and environmental considerations	4			
IV	***Soil Erosion and Conservation***	Causes and types of soil erosion; Erosion impacts on soil productivity and environmental health; Erosion control techniques: terracing, contour farming, and windbreaks; Best management practices for soil conservation	4			
V	***Geochemistry***	Geosphere: Physical form of Geosphere; Nature of solids in Geosphere; Geochemistry and weathering of rock; Clays chemistry; Sediments Soil: Chemical composition, structure, formation, ion exchange reaction in soil, micronutrients in soil, degradation of soil; Groundwater;	12	• Determination of water of hydration present in the given rock salt • Estimation of Iron present in the given sample of soil • Estimating the amount of copper present in the given minerals gravimetrically	12	Brian, M., & Carleton, B. M. (1982). Principles of Geochemistry. Geochemistry: Pathways and Processes" by Harry Y. McSween, Steven M. Richardson, and Maria E. Uhle (Latest edition) Manahan, S.E. (2022). Environment al Chemistry: Eleventh Edition (11th

		The Geosphere as a source of natural capital; Environmental phenomenon of Geosphere; Volcanoes; Earthquake; Surface Earth movement; Effect of Human Activities in the Geosphere ; Air pollution and Geosphere; Water pollution, Geosphere & its effect; Waste repository		● Calcination of Dolomite and study of its chemical properties ● Determine the percentage distribution of different elements and compounds in the given sample of mining water		ed.). CRC Press. https://doi.org/10.1201/9781003096238.
Total hours of theoretical events			***32***	***Total hours of practical events***	***32***	

Environmental Project

Course Code: ENV445 ***Credit Hours:*** 2.0
Course Title: Environmental Project ***Teaching Hours***: 64Pr
Semester: IV

Course Description: The course **Environmental Project (ENV445)** is designed to develop the skills of conducting project work and prepare academic reports. Students will develop proposal with the guidance of supervisor and qualified through the department's research committee. Students will conduct field research, collect and analyse data and prepare report. The report should be submitted to the department and present in final defence.

Course Objectives: At the end of the course, students will be able to:

- identify and resolve a specific issue and solutions
- should improve research and analytical skill to develop project
- encourage teamwork and collaboration along with communication and reporting talents
- learn effectively to document procedures and outcomes of project results and remark on the learning process
- bring fresh ideas or techniques to the field with ongoing learning and professional development

Key Components of a Project Proposal

Title	The title of your project.
Proposer	Names of the investigators and institution.
Problem	A description of the problem should be addressed.
Hypothesis	A statement of the hypothesis you are testing, or the research question you are endeavouring to answer.
Background	A summary of the key relevant literature, references, or needs analysis that justifies the project.
Aims	A statement of the expected outcomes of your project, and how they will help to address the problem.
Objectives	An outline of the specific strategies or steps by which you intend to achieve your research aims.
Methodology	A more detailed outline (sometimes called 'project protocol') of the actual research, data collection and analysis methods you will use.
Ethics	An appreciation of any ethical issues raised and how they will be addressed.
Time frame	A timetable or plan of the key activities or stages of your project.

General Guidelines for Project Work

The format of the Environmental Project Work included the following headings/items:

Draft Format for the Environmental Project Work Reporting

Cover Page
Letter of Recommendation
Letter of Approval
Acknowledgements
Highlights (of the internship performed)
Contents (also include list of tables and figures)

Introduction: (Specific)
Organization Activities: (Also state how the organizational activities are linked to your work and syllabus of B.Sc. in Environmental Science)
Problem Statement: Why specific office was chosen for internship?
Objectives
Approach
Activities Performed: With timeframe
Output/Outcome (of the internship): Accomplishment, discussion; in the last paragraph, state how did you feel to get involved in the particular organization (lesson learned)
Conclusion

References
Appendices
Appendix: Letter from the executive stating involvement (duration and major activities performed) of the student in the organization for internship of the student
Appendix 2: Schedule (approved by supervisor) for the internship work

Appendix 3: Photographs and others relevant documents

References:

Antoniou, S. A., Tsokani, S., Mavridis, D., López-Cano, M., Antoniou, G. A., Stefanidis, D., ... & Brouwers, M. C. (2019). Guideline assessment project: filling the GAP in surgical guidelines: quality improvement initiative by an international working group. *Annals of surgery*, *269*(4), 642-651.

Berry, R. (2013). *The Research Project: How to Write It, Edition 5*. Routledge.

Drob, C., & Zichil, V. (2013). Overview regarding the main guidelines, standards and methodologies used in project management. *Journal of Engineering Studies and Research*, *19*(3), 26.

Horvat, E. (2013). *The beginner's guide to doing qualitative research: How to get into the field, collect data, and write up your project*. Teachers College Press.

Olson, J. S., Wang, D., Olson, G. M., & Zhang, J. (2017). How people write together now: Beginning the investigation with advanced undergraduates in a project course. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *24*(1), 1-40.

Semester V

Computer Programming

Course Code: ENV450 ***Credit Hours:*** 3.0 [Theory: 1.0; Practical: 2.0]
Course Title: Computer Programming ***Teaching Hours:*** 16Th+64Pr
Semester: **V**

Course Description**:** The **Computer Programming (ENV450)** course is designed to introduce students to the fundamental concepts of programming using Python. The course covers both theoretical aspects of programming and provides practical experience in writing, testing, and debugging Python code. It aims to equip students with the skills to develop software applications relevant to environmental sciences.

Course Objectives**:** At the end of the course, students will be able to:

- Apply fundamental programming concepts in Python to solve environmental science problems
- Analyze and visualize environmental data using Python libraries such as Pandas, NumPy, and Matplotlib
- Develop practical solutions and models for environmental systems, addressing real-world challenges in sustainability and conservation

Course Contents**:**

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Introduction to Python and Programming Basics***	Overview of Python: History, features, Applications, Python Programming for Biology and Environmental Science	2	• Installing Python, Integrated Development Environments (IDEs) for Python: Setting up and Configuration in popular IDEs like PyCharm, VS Code • Writing and Running Simple Python Programs: Basic Syntax, Variables, data types, and operators, Input/Output Operation	1 6	John Zelle. Python Programming: An Introduction to Computer Science. Third Edition, Franklin, Beedle & Associates Inc. **Python Tutorial:** https://www.w3schools.com/python/ **Python Case Studies and Success Stories:** https://brochure.getpython.info/media/releases/psf-python-brochure-vol.-i-final-download.pdf
II	***Control Statements***	Introduction to Conditional Statements in Python: if, elif, else, match case	1 1	• Writing and executing Python programs using if, elif, and else statements • Implementing for and while loops in Python programs	4 4	Sweigart, A. (2019). Automate the Boring Stuff with Python: Practical Programming for Total Beginners. No Starch Press. Lambert, K. (2018). Fundamentals of Python: First Programs. Cengage Learning.

		Python Looping Constructs: for loop, while loop, break, continue, pass statements				https://www.w3schools.com/python/
III	***Functions and Modules***	Introduction to functions and modules	2	• Defining and using functions. • Importing and utilizing Python modules (math, os, datetime, random). • Installing and Using Third-Party Modules	3 3	Lambert, K. (2018). Fundamentals of Python: First Programs. Cengage Learning. Downey, A. (2015). Think Python: How to Think Like a Computer Scientist. O'Reilly Media. https://www.w3schools.com/python/
IV	***Strings, Lists, Tuples, Sets, Dictionaries and Files***	Definition, characteristics, operations on strings, tuples, sets and dictionaries	2	• Perform different tasks on strings, lists, tuples, sets and dictionaries • Reading and writing files	4 3	Sweigart, A. (2019). Automate the Boring Stuff with Python: Practical Programming for Total Beginners. No Starch Press. https://www.w3schools.com/python/ Python for everyone 2/e. Cay Horstmann & Rance Necaise. Wiley 2016
V	***Exception Handling***	Python Exceptions, Python Exception Handling, Python Custom Exceptions	1	• Real-life examples of exception handling in Python applications	2	https://docs.python.org/3/tutorial/errors.html#
VI	***Introduction to NumPy***	Overview of NumPy and its importance for numerical computations	2	• Creating arrays and perform basic mathematical operations, • Aggregation and Statistical Operations	8	McKinney, W. (2017). Python for Data Analysis. O'Reilly Media. VanderPlas, J. (2016). Python Data Science Handbook. O'Reilly Media. https://www.w3schools.com/python/numpy
VII	***Data Manipulation with Pandas***	Introduction to Pandas, Importance of Pandas in data manipulation and analysis.	2	• Pandas Data Structures: Series and DataFrame, • Data Manipulation in Pandas, • Handling Missing Data, Basic Aggregation and Grouping	8	McKinney, W. (2017). Python for Data Analysis. O'Reilly Media. VanderPlas, J. (2016). Python Data Science Handbook. O'Reilly Media. https://www.w3schools.com/python/pandas

VIII	***Visualization with Matplotlib***	Introduction to Matplotlib, Case Studies and Real-World Applications	2	● Installing and importing Matplotlib, creating line plots, adding titles, labels, and legends, ● Displaying and saving plots, Common Plot Types: Line plots, Scatter plots, Bar charts, Histograms, Pie charts, box plots, Subplots and Layouts, customizing plots, ● Saving and Exporting Plots	9	McKinney, W. (2017). Python for Data Analysis. O'Reilly Media. VanderPlas, J. (2016). Python Data Science Handbook. O'Reilly Media. https://www.w3schools.com/python/matplotlib_intro.asp
IX	***Project Work: "Environmental Data Analysis and Visualization Using Python"***	Introduction to Project Work, Project Overview	1	● Collect environmental data, (e.g., air quality, climate data, or pollution levels). ● Clean and preprocess the data. ● Perform analysis to extract insights. ● Create visualizations to present the results. ● Document the work in a clear and structured report	9	McKinney, W. (2017). Python for Data Analysis. O'Reilly Media. VanderPlas, J. (2016). Python Data Science Handbook. O'Reilly Media. https://www.kaggle.com/datasets
	Total hours of theoretical even		**16**	***Total hours of practical l even***	**64**	

Climate Change

Course Code: ENV451 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Climate Change ***Teaching Hours***: 32Th+32Pr
Semester: **V**

Course Description: This course **Climate Change (ENV451)** explores the structure and composition of the atmosphere, the science of climate change, and global climate change's impacts and mitigation strategies. Practical sessions will provide hands-on experience with climate data analysis and atmospheric observations.

Course Objectives: At the end of the course, students will be able to:

- analyze the mechanisms and impacts of global climate change
- develop skills to interpret climate data and model climate change scenarios
- strategies for mitigating and adapting to climate change

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Structure and Composition of the Atmosphere***	Atmospheric chemical composition and trace gases; Vertical and horizontal structure of the atmosphere; Atmospheric pressure and temperature distribution	4			"Atmosphere, Climate, and Change" by Thomas Graedel and Paul Crutzen "Climate Change: The Science of Global Warming and Our Energy Future" by Edmond A. Mathez Lal, D. S. (2013). Climatology, Revised Edition. ShardaPustakBhawan, Allahabad.

II	***Climate Change Science***	Earth's energy balance and average temperature of Earth surface; Greenhouse effect and greenhouse gases; Global warming potential, radioactive forcing; Climate feedback loops; Role of clouds and aerosols in climate regulation; Ocean-atmosphere interactions (El Niño and La Niña); Theories of climate change; Historical climate data; Ice cores, tree rings, and sediment records; Modern climate measurements; Paleoclimatology and proxies for past climate; Observed changes in temperature, precipitation, and extreme weather events; Natural drivers- solar variability, volcanic activity; Anthropogenic drivers: Greenhouse gas emissions and deforestation; Role of land use changes; Industrialization and urbanization impacts; Carbon cycle and human influences	14	• Analysis of climate variability and change using secondary datasets • Dendrochronological tools and techniques in climatic studies • Field trip to a local weather station or climate research facility and report preparation • Identify GHG sources of local enterprises such as hotel, restaurant • Survey the carbon lifestyles of various personalities of your community	20	MOE-GON. (2010). National Adaptation Programme of Action (NAPA) to Climate Change. Ministry of Environment, Government of Nepal, Kathmandu IPCC Reports on Climate Change MOE-GON. (2010). Climate Change Vulnerability Mapping for Nepal. Ministry of Environment, Government of Nepal, Kathmandu MOE-GON. (2010). Review of Community Based Vulnerability Assessment Methods and Tools. Ministry of Environment, Government of Nepal, Kathmandu
III	***Global Climate change impacts, mitigation, and adaptation***	Climate change impacts in different sectors; Regional impacts and vulnerable areas; Climate change mitigation: Greenhouse gas emission; scenario and projections; Mitigation gap; Mitigation Strategies and Global effort to reduce emission; mitigation challenges; Adaptation: Planned and autonomous; Community and Ecosystem-based adaptation; Concept of vulnerability (exposure, sensitivity and adaptive capacity); International and national policies and agreements	14	• Review and presentation of National Adaptation Plan (NPC) and Nationally Determined Contribution (NDC) • Documentation of climate change impacts and adaptation strategies in different sectors (field observation and reporting)	12	
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Remote Sensing and GIS

Course Code: ENV452 ***Credit Hours:*** 3.0 [Theory: 1.0; Practical: 2.0]
Course Title: Remote Sensing and GIS ***Teaching Hours***: 16Th+64Pr
Semester: **V**

Course Description: The **Remote Sensing and GIS (ENV452)** course is a course designed to provide students with a foundational understanding of remote sensing and Geographic Information System (GIS), with a particular emphasis on their applications in the context of Nepal. The course aims to equip students with the theoretical knowledge and practical skills to analyse and interpret spatial data, particularly in the fields of environmental science.

Course Objectives: At the end of the course, students will be able to:

- the fundamental concepts and principles of remote sensing
- the knowledge of the theories of geographical information system and skill in handling spatial / geographic data
- the introduction of the recent advances in the state-of-art applications of these tools and technologies for data acquisition, processing and visualization of the environmental processes and phenomena

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Remote Sensing (RS) Principle and Sensors***	Definition, Principles, and Historical Development; Sensor and Platforms concept; Concept of Satellite and orbits in remote sensing: HEO, MEO, LEO; Types of remote sensing: Optical, Thermal, Microwave, Multispectral and Hyperspectral Remote Sensing; Environmental Applications of Remote Sensing	2	● Exploring different satellite data (resolutions, sources, procedure to download, cost etc) ● Downloading the satellite image (Landsat and Sentinel)	2 6	Campbell, J.B. (2002). *Introduction to Remote Sensing.* Fifth Edition. Taylor and Francis, London. Jensen, J.R. (2007). *Remote sensing of the environment: an earth resource perspective*. 2nd ed. Upper Saddle River, NJ, Prentice Hall, pp.592.

		Resolution in Remote Sensing; Electromagnetic spectrum, its interactions with geographic features and spectral signature	2			
II	***Digital Image Processing and Interpretation***	Characteristics of a digital image; Concept of Image processing; Corrections and enhancement	2	● Exploring the properties of a digital image ● Image processing and enhancement techniques: Geometric and radiometric corrections, spatial filtering, Pan-sharpening ● Band ratio and spectral indices ● Image classification: Supervised and Unsupervised	2 8 6 8	Jensen, J. R. (2005): *Introductory Digital Image Processing*, Prentice Hall, New Jersey
		Image classification and algorithms, and accuracy assessment; Digital Image Interpretation	2			
III	***Geodesy and Geographical Information System***	Concept and component of Geographic information system; Data types, spatial entities and models	1	● Exploring spatial and vector data ● Defining coordinate system, customising the coordinate system, transformation ● Spatial data analysis: proximity, geoprocessing and overlay analysis using vector and raster data ● Generation of terrain parameters and extraction of required criteria ● GPS device handling, data collection and management	2 2 8 6 6	Campbell, J. E., & Shin, M. (2011). *Essentials of geographic information systems*. https://www. saylor. org/books/. Chang, K.T. (2018). *Introduction to Geographic Information Systems*. Ninth Edition. McGraw-Hill Education, New York Longley
		Projection, coordinate system and transformations	1			
		Basics of spatial data analysis: proximity, geoprocessing and overlay	2			
		Terrain characteristics	1			
		Global Navigation Satellite System (GNSS): Concept, components, working mechanism.	1			
IV	***Cartography***	Concept of Cartography; Cartographic process and principles Key map types	1	● Demonstration of different types of maps and their application	2	Peterson, G. N. (2020). *GIS cartography: a guide to*

		Visual variables; Minimum elements of a map layout	1	● Designing a good map layout applying visual variables	6	*effective map design*. CRC Press. Dent, Torguson, JS., Hodler, T. (1999). *Cartography: thematic map design*. —6th ed. McGraw-Hill.
Total hours of theoretical events			***16***	***Total hours of practical events***	***64***	

Watershed Management

Course Code: ENV453 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Watershed Management ***Teaching Hours***: 32Th+32Pr
Semester: V

Course Description: This course **Watershed Management (ENV453)** provides a comprehensive understanding of watershed management principles, practices, and techniques. It aims to equip students with the necessary knowledge and skills to manage and conserve watershed resources. The course covers physical, biological, social, and policy dimensions of various aspects of watershed management, with a focus on Nepal's unique geographical context. The course covers the theoretical (2 credit hours) and practical (1 credit hour) aspects of watershed management. Practical applications and case studies from different socio-ecological settings will be integrated to provide real-world insights into watershed management. By the end of the course, students will be well-prepared to address watershed management challenges and implement effective conservation strategies in diverse environments.

Course Objectives: At the end of the course, students will be able to understand the following basic general objectives:

- To understand the fundamental concepts and principles of watershed management.
- To analyze the physical, biological, and socio-economic components of watersheds.
- To assess drivers, status, impacts, and management responses to watershed
- To develop skills in planning, implementing, and evaluating watershed management practices.
- To explore the policies, laws, and institutions related to watershed management in Nepal.

Course Contents:

Unit	Macro Level Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Introduction and Concepts of Watershed Management***	1.1. Definitions and classification of watersheds (e.g., river basin, watershed/subwatershed, Springshed, catchment, sub-catchment) 1.2. Delineation of watersheds and sub-watershed (Shape, Size, aspect, elevation, Drainage Network)	6	**Exposure visit to a watershed** Visit a nearby watershed and understand its biophysical, social, economic and, community, management aspects	8	Watershed Delineation using ArcGIS from DEM - Simple and Straightforward (youtube.com) Nepal land cover data 1990, 2000, 2010 (ICIMOD | RDS)

		1.3. Watershed characteristics: Physical, biological, and socio-economic 1.4. Watershed as a Planning and Management Unit		Understand issues and challenges of watershed management through interaction with the local community and user groups (such as forest and water management user groups) Observe Drivers, pressures, states, impact, and response (DPSIR) components of the watershed		
II	***Watershed hydrology***	2.1 Hydrological cycle 2.2 Water balance components (Rainfall, Snowfall, evapotranspiration) 2.3 Surface runoff, sub-surface runoff and groundwater hydrology 2.4 Watershed hydrology monitoring (precipitation, snowfall, discharge) 2.5 Streamflow generation mechanism (basin size, slope, topography, land use, management practices) 2.6 Hydrological modeling tools (SWAT model, JAMS-J2000 model, WA+)	8	**Delineate Watershed** Delineate the sub-watershed using a gauging point in the downstream areas (below 100 km^2) using GIS and RS techniques. Prepare a land use map of the watershed using the delineated watershed Prepare a historic land use map of the last four decades Prepare a table of land use and land cover changes for different types	8	DPSIR framework: Driver-Pressure-State-Impact-Response Framework (DPSIR) | Land & Water | Food and Agriculture Organization of the United Nations | Land & Water | Food and Agriculture Organization of the United Nations (fao.org)
III	***Soil, vegetation and water conservation***	3.1 Soil erosion: Causes, types, and effects 3.2 Problem of soil erosion, landslides, and sedimentation 3.3 Soil conservation techniques: Contour plowing, terracing, gully control, small storage structure, the role of vegetation, etc. 3.4 Vegetation management (reforestation, bioengineering) 3.5 Water conservation techniques: spring shed management, rainwater harvesting,	6	Forest management practices for watershed protection (community forestry etc.) Site specific case studies of soil and water conservation in Nepal	4	

		recharge ponds, check dams, small storage, ponds, etc.				
IV	***Integrated Watershed Management/ One Water Approach***	4.1 Concept of integrated watershed management and one water approach 4.2 Integrated watershed management component (physical, biophysical, social, economic 4.3 Watershed management practices (Integrated water resources management and integrated river basin management) 4.4 Participatory approaches and community involvement 4.5 Watershed management planning: Steps and procedures 4.6 Tools and techniques for integrated watershed management (delineating watershed, characterizing major components, issues, challenges, solutions)	6	Case study report Prepare a project report of the watershed (10-15 pages) Delineate sub-watershed Identify ecosystem services Highlight major issues and challenges Recommend solutions for integrated watershed management	12	
V	***Policies and laws and institutions of watershed management***	5.1 Watershed management laws, acts and strategies in Nepal 5.2 National policies and programs on watershed management in Nepal 5.3 Role of government and non-governmental organizations 5.4 Institutional arrangements and capacity building	6	Identify policy gap on watershed management and recommendation	2	
Total hours of theoretical events			***32***	***Total hours of practical events***	***32***	

Pollution Monitoring and Controls

Course Code: ENV454 ***Credit Hours:*** 3.0 [Theory: 1.0; Practical: 2.0]
Course Title: Pollution Monitoring and Controls ***Teaching Hours***: 16Th+64Pr
Semester: **V**

Course Description: The **Pollution Monitoring and Controls (ENV454)** Course is designed to provide the scientific, engineering, and regulatory concepts on the environmental pollution and control. The course encompasses one-third of theory and two-third of practical components, including hands-on tutorials, laboratory work, and analysing real-world problems. It is designed to enable the students to be able to understand generic approaches to the control and management of environmental pollution.

Course Objectives: At the end of the course, students will be able to:

- Pollution control principles and approaches
- Generic engineering systems for air and water pollution control

Course Contents

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Air Pollution Control***	Air pollution control: regulatory, engineering, and economic principles; Emission standard and air quality standard philosophy; Control at source, path and receptor sites; Industrial emission control: Cleaner technologies and fuels; Cleaner manufacturing processes; Stack emission control technologies for particulate matter and gaseous pollutants; Emission standards and regulatory tools in Nepal; Mobile-source emission control: Cleaner and reformulated fuels; Aftertreatment technologies for compression ignition and spark ignition engines; Diagnostics and powertrain technologies; Control of tire and brake wear particle emissions; Traffic management; Regulatory approaches; Improvement in road infrastructure; Aircraft emission control	6	• Measurement and analysis of stack emission of particulate and gaseous pollutants • Measurement and analysis of smoke opacity, CO, NOx and HC emissions from in-use diesel and petrol vehicles • Analysing the efficiency of indoor air purifiers • Field observation of various after-treatment devices	25	Masters, G.M., Ela, W.P., 2008. Introduction to Environmental Engineering and Science, Third Edition. Pearson Education, Inc., London. Miller, G.T., 2017. Living in the Environment, Nineteenth Edition. Cengage Learning, Boston. Nazaroff, W.W., Alvarez-Cohen, L., 2001. Environmental Engineering Science. John Wiley & Sons, Inc., New York. Seinfeld, J.H., Pandis, S.N., 2016. Atmospheric

		measures; Indoor air pollution control: Ventilation; Air purifier; Control strategies for residential fuel combustion emissions and environmental tobacco smoke				Chemistry and Physics: From Air Pollution to Climate Change, Third Edition. John Wiley & Sons, Inc., New Jersey. Vallero, D., 2014. Fundamentals of Air Pollution, Fifth Edition. Elsevier Inc., Amsterdam.
II	***Water Pollution Control***	Drinking water treatment systems: Pretreatment; Sedimentation; Coagulation and flocculation; Filtration; Softening; Disinfection; Membrane filtration and reverse osmosis; Regulatory tools for water pollution control standard and guideline; Wastewater treatment: Primary treatment; Secondary treatment: microbial kinetics; suspended, attached and hybrid growth treatment methods; Sludge treatment; Nutrient removal; Industrial wastewater treatment; Wastewater treatment guidelines and standards Integrated watershed management and water quality control; Strategies for groundwater conservation and pollution control	6	• Analysis of drinking water quality based on physicochemical and biological parameters • Analysis of wastewater based on physicochemical and biological parameters • Field observation of drinking water treatment plants • Field observation of wastewater treatment plants	20	APHA, 1998. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington. Masters, G.M., Ela, W.P., 2008. Introduction to Environmental Engineering and Science, Third Edition. Pearson Education, Inc., London. Miller, G.T., 2017. Living in the Environment, Nineteenth Edition. Cengage Learning, Boston. Nazaroff, W.W., Alvarez-Cohen, L., 2001. Environmental Engineering Science. John Wiley & Sons, Inc., New York. Peavy, H.S., Rowe, D.R., Tchobanoglous, G., 2015. Environmental Engineering. McGraw Hill Education Pvt. Ltd, New Delhi.
III	***Solid Waste Management and Resource Recovery***	Solid waste treatment: integrated solid waste management; Source reduction strategies; Lifecycle assessment; Recycling; Composting and vermicomposting; Solid waste collection and transfer operations; Segregation; Material and	3	• Analysis of solid waste composition and energy content • Study of composting/vermicomposting techniques	15	Masters, G.M., Ela, W.P., 2008. Introduction to Environmental Engineering and Science, Third Edition.

		energy recovery; Incineration; Pyrolysis; Gasification, Aerobic and anaerobic treatment of solid waste; Landfilling; Circular economy		• Physicochemical analysis of leachate • Field observation of waste collection, treatment and disposal systems		Pearson Education, Inc., London. Miller, G.T., 2017. Living in the Environment, Nineteenth Edition. Cengage Learning, Boston.
IV	***Noise Pollution Control***	Technologies for noise control at source, path and receptor; Regulatory control: Standards and guidelines	1	• Noise hazard mapping	4	Singal, S.P., 2005. Noise Pollution and Control Strategy. Narosa Publishing House, New Delhi
		Total hours of theoretical events	***16***	***Total hours of practical events***	***64***	

Mountain Environment

Course Code: ENV455 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Mountain Environment ***Teaching Hours***: 32Th+32Pr
Semester: **V**

Course Description: The **Mountain and Environment** (ENV455) course is designed based on principles of developing the fundamental concept of mountain environment, livelihood of people, mountain resources, mountain agriculture, and in Mountain. The course is theoretical and practical as it explains the mountain livelihood and its challenges in a real context. It is designed to enable the students to know the concept and their formation, sustainable uses, and in various social, academic, and professional settings.

Course Objectives: At the end of the course, students will be able to understand the following basic general objectives:

- Find the basic nature, formation, and physical dimensions of the Hindu-Kush-Himalaya
- Understand the agricultural farming system in mountainous regions
- Participate in various social, academic, and professional communications on the environmental issues regarding the Himalaya

Course Contents:

Unit	Macro Level Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Mountains and the Himalaya***	Major mountain ranges of the world; Himalaya and its physical dimensions; Hindu-Kush-Himalaya (HKH, characteristics, resources, and challenges), importance of mountain regions to humankind	2	• Prepare a map of HKH region and identify major ecoregions	1	Ives J.D. (2006). *Himalayan Perceptions: Environmental Challenges and Well-being of the Mountain People,* Second edition. Himalayan Association for the Advancement of Science Korner, C. (2003). *Alpine Plant life: Functional Plant Ecology of High Mountain Ecosystems,* Second edition. Southwood, T. R. E. & Henderson, P. A. (2000). Ecological Methods (3rd ed.). Blackwell Science.
II	***Characteristics of Mountain Environment***	Mountain specificities; climate, geology, water, and forests of the Himalayas; ecological systems and biodiversity; mountains and human adaptability	2	• Study of topographic map to characterize the area. • Analysis of climate pattern (temperature and precipitation) using data from nearby meteorological station.	2	

III	***Mountain resources***	**Water resources:** Status, distribution, water use pattern in rural Nepal **Mineral resources:** status, distribution, conservation, environmental consequence of mineral extraction **Forest resources:** mountain forests and their characteristics, NTFPs; approaches of forest management in Nepal; community forestry in rural development in mountains; REDD (concept, REDD+ initiative in Nepal) **Tourism:** Introduction, impacts of tourism; ecotourism in Nepal; Range land as mountain resource.	6	● Estimation of field capacity to analysis of soil water availability. ● Study of different types of rocks. ● Enlist the NTFPs found in your nearby locality ● Prepare a report on the community forestry program and practice in your locality ● Identify the contribution of ecotourism to the mountain people	7	Zobel, D. B., Jha, P. K. Behan, M. J. and Yadav, U. K. R. (1987). A Practical Manual of Ecology. Singh J.S. & Singh S.P. (1992). Forests of Himalayas. Gyanodaya Prakashan, Nainital, India. APHA (1998). Standard Methods for the Examination of Water and Wastewater. Washington, USA: American Public Health Association. Pant M.P. & Gautam J.C. (1990). Mountain Farming System in Nepal. In: Riley K.W., Mateo N., Poudel, K. C. (2003). *Watershed Management in the Himalayas: A Resource Analysis Approach.* Delhi: Adroit Publishers. Sharma, C.K. (n.d.). *Water and Energy Resources of the Himalayan Block.* Calcutta, India: Navana Printing Works Private Limited. Singh J.S. & Singh S.P. (1992). Forests of Himalayas. Gyanodaya Prakashan, Nainital, India. Yamada, T. (1998). *Glacier Lake and Its Outburst Flood in the Nepal Himalaya.* Zurick et. al. (2005). *Atlas of the Himalayas*, ICIMOD. Beniston M. (2000). Environmental Change in Mountains and Uplands. Arnold, London.
IV	***Mountain Agriculture***	Mountain agriculture and its characteristics; challenges of mountain agriculture; agro-biodiversity and food security; Mountain farming system in Nepal	3	● Field visit to study farming practices in the mountains.	7	
V	***Environmental Changes in Mountains and Their Impacts***	Drivers of environmental change in mountains (relief, hydro climate, human activities), environmental degradation (concept, key issues, causes and consequences); land-use changes: concept and consequences; tree line and tree line ecotone	6	● Documenting livelihood options of rural people in the mountain communities.	5	
VI	***Mountain Hazards***	Background, impact, and control measures of mountain hazards (earthquakes, glacial lake outburst floods (GLOF), landslides, avalanches, forest fire, extreme event (snowfall, rainfall, lightening hazards) Rangeland management Practices Livelihood and human settlement; climate change and vulnerable groups (Indigenous communities and	5	● Study of landslide areas and their restoration efforts.	10	

VI **VIII**	***Livelihood of Mountain*** ***Mountain and Sustainable Development***	gender); coping strategies of the mountain communities; globalization and livelihood in the mountains. Concept, components, and indicators of sustainable development; challenges in mountain development sustainable Development Goals in context of mountain,	 5	● Prepare a report on livelihood of Mountain ● Study the indicators of sustainable development and prepare a report. ● *Field visit: Students should visit different sites and submit the report to the department for which marks are allocated.*		Blyth, S. et al. (2002). *Mountain Watch: Environmental Change and Sustainable Development in Mountains.* United Nations Environment Programme (UNEP) ICIMOD (1993). *Mountain Environment and Development. Proceedings of the Tenth Anniversary Symposium of ICIMOD.* Kathmandu, Nepal. ICIMOD (1999). *Handbook of Mountain Risk Engineering*, 1 and 2. Pant M.P. & Gautam J.C. (1990). Mountain Farming System in Nepal. In: Riley K.W., Mateo N., Hawtin G.C. & Yadav R. (eds.). Mountain Agriculture and Crop Genetic Resources. Oxford & IBH Publishing Co. Pvt. Ltd. Pp. 51-68. use the format of EIA/IEE report from MOITFE /MUFE
Total hours of theoretical events			***32***	***Total hours of practical events***	***32***	

Semester VI

Environmental System Modelling

Course Code: ENV461
Course Title: Environmental System Modelling
Semester: **VI**
Credit Hours: 3.0 [Theory: 1.5; Practical: 1.5]
Teaching Hours: 24Th+48Pr

Course Description: This course **Environmental System Modelling (ENV461)** provides students with a basic understanding of environmental system modelling, including theoretical concepts, data handling techniques, and practical applications in various environmental domains. The practical component allows students to gain hands-on experience with modelling software and tools, while the project/ case study enables them to apply their knowledge to a real-world environmental problem.

Course Objectives: At the end of the course, students will be able to:

- understand the fundamental concepts and approaches in environmental system modelling, including system dynamics, model structures, and modelling techniques
- acquire skills in data acquisition, preprocessing, and handling environmental data from various sources
- develop understanding in applying and implementing various environmental models
- evaluate and validate environmental models through model performance metrics, calibration techniques, sensitivity analysis

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Introduction to Environmental System Modelling***	Definition and importance of environmental system modelling; Types of environmental systems (e.g., hydrological, ecological, atmospheric); Modelling approaches (deterministic, stochastic, empirical, mechanistic)	2	-		Barnsley, M. J. (2007). *Environmental modeling: A practical introduction*. CRC Press. Gray, W. G., & Gray, G. A. (2017). *Introduction to environmental*
II	***Fundamental Concepts in Modelling***	System dynamics and feedback loops; Model structure and components; Model formulation and parameterization; Model uncertainty and sensitivity analysis	2	-		

III	***Model Data Acquisition and Pre-processing***	Environmental data sources (in-situ measurements, remote sensing, GIS); Data quality control and pre-processing; Handling missing data and outliers	2	-		*modeling*. Cambridge University Press. Schnoor, J. L. (1996). *Environmental modeling: fate and transport of pollutants in water, air, and soil*. Wainwright, J., & Mulligan, M. (Eds.). (2013). *Environmental modelling: finding simplicity in complexity*. John Wiley & Sons.
IV	***Model Calibration and Validation***	Model validation: need and types; Parameter estimation techniques; Sensitivity and uncertainty analysis;	2	-		
V	***Modelling Applications***	Hydrological Modelling Rainfall-runoff models; Groundwater flow models; Water quality models	3	1. Hydrological Modelling Exercises (Any one) Implementing simple rainfall-runoff models; Groundwater flow simulations; Water quality modelling case studies	10	
		Ecological Modelling: Population growth models; Ecosystem models; Habitat suitability models	3	2. Ecological Modelling Exercise (Any one) Population growth models; Species distribution models	8	
		Air Quality Modelling: Atmospheric dispersion and Receptor models, Indoor air modelling	3	3. Air Quality Modelling Exercises (Any one) Gaussian plume dispersion models; Photochemical modelling case studies	10	
		Soil transport model: RUSLE model; Soil Carbon Model	3	4. Soil transport modelling Exercise (Any one) RUSLE model; Soil Carbon Model	8	
		Climate modelling: Purpose, type, structure, GCM, RCM	3	Review the applications of climate models in Nepal	4	
VI	***Project/ Case study***	Orientation and briefing on the Application of environmental system modelling to a real-world problem; Data collection, model development, and analysis; Presentation of project findings	1	5. Students should undertake a project related to the application of environmental system modelling to a real-world problem. This includes problem identification, data collection, model development, analysis and presentation of project findings.	8	
		Total hours of theoretical events	***24***	***Total hours of practical events***	***48***	

Environmental Policy and Governance

Course Code: ENV462 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Environmental Policy and Governance ***Teaching Hours***: 32Th+32Pr
***Semester*: VI**

Course Description: The **Environmental Policy and Governance (ENV462)** course is designed based on the basic legislative and policy requirements for environmental protection. The course offers information on national and international policy initiatives in conserving and protecting the environment. Different legislative approaches and the role of planning and policy in regulating development and its effective implementation will be explored through interaction and writing comprehensive response papers.

Course Objectives:

- To make a clear understanding of fundamental concepts of environmental legislation and policy and its requirements
- To explain the role of law, policy, and institutions in conserving and managing nature and the environment
- To support students in analyzing and evaluating the effectiveness of Nepal's current environmental legislation and policies
- To demonstrate research and communication skills relevant to environmental governance

Course Contents:

Unit	Macro Level Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Introduction to Environmental Legislation and Policy***	1.1 Need of Environment law policy 1.2 General principle in environment law, constitutional rights, environmental pollution, polluter pays principle, sustainable development,	7	Writing of response paper after an interaction with an Environmental lawyer to understand how environmental legislation, policy, and law are being formed and implementation challenges	8	Hussein Movahedian and NimaNorouzi. "Principles of Environmental Policy and Legislation." *In Pragmatic Legal and Policy Implications of Environmental Lawmaking*. Hershey, PA: IGI Global, 2023. https://doi.org/10.4018/978-1-6684-4158-9.ch002

II	***International Environmental Legislation and Policy***	2.1 Origin of global environmental policies law and institutions (UN Conference on the Human and Environment, World Conference on Environment and Development, Earth Summit, World Summit on Convention on Biodiversity, Sustainable Development, Rio+20, Paris Agreement and Sustainable Development Goal, Sendai framework for DRR) 2.2 An introduction to international law; sources of international law; law of treaties; signature, ratification, US EPA 2.3 Environment policy and law formulation process in Nepal	10	Group presentation on Global dimensions of environmental policies and laws.	8	Rogers, Peter P., Kazi F. Jalal, and John A. Boyd. 2012. An Introduction to Sustainable Development. Earthscan. Sachs, Jeffrey (2015) The Age of Sustainable Development. New York: Columbia University Press.
III	***Environment policy and Governance in Nepal***	3.1 Introduction to environmental policies and laws in Nepal 3.2 Hierarchy of polices and laws 3.3 Policy and legal framework on air, water, forest, solid waste, soil/ minerals, biodiversity, climate change and disaster. 3.4 Institution framework for environment governance (federal, provincial, local) 3.5 Good governance and Environmental justice 3.6 BS/IEE/EIA process 3.7 Constitution of Nepal 3.8 Nepal Environmental Policies and Action Plan (NEPAP Proposal preparation TOR, Scoping of environmental study project	8	3.1. Response paper on the "Do No Harm" Principle with notions of the environment and changing scope of environmental laws in Nepal. 3.2. Writing a response paper on Environmental governance; actors and instrument in Nepal	16	Uprety, B. K. (2003). *Environmental impact assessment: Process and practice*. Uttara Uprety. Campbell, B., 2008. Environment Assessment of Nepal: Emerging Issues and Challenges. https://lib.icimod.org/record/20749/files/c_attachment_20_66.pdf https://www.mofe.gov.np/resources/policy-and-strategies-9446 https://www.mofe.gov.np/resources/acts-and-regulations-7963

IV	***Natural Resource and Governance/ Policy***	Legal and political environments in resource management. Global and local governance, challenges of good governance. Ostrom design principles and basic frameworks, organizational structure, and stakeholders in NRM and livelihood. Natural Resource Governance in a rapidly changing world. Overview of legal policy instruments in Natural Resource Management: National Environment Policy of 2004, National Conservation Policy, National Action Plan on Climate Change of 2008, Wildlife Protection Act of 1972, Forest Protection Act of 1980, Environment Protection Act of 1986, and Rule 2004, Green Tribunal Act, 2009.	7			
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Environmental Biotechnology

Course Code: ENV463 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Environmental Biotechnology ***Teaching Hours***: 32Th+32Pr
***Semester*: VI**

Course Description: This course **Environmental Biotechnology (ENV463)** aims to introduce fundamental concepts and applications of modern biotechnological tools and procedures for all aspects of the environment. This course emphasizes recent development of biotechnology for harnessing its potential in environmental applications.

Course Objectives: At the end of the course, students will be able to:

- Know the biotechnological tools in environmental applications and remediation
- Gain knowledge and skills on environmental biotechnology for future prospects

Course Contents:

Unit	Macro Level Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Introduction to environmental biotechnology***	1.1 Definitions of biotechnology, Applications of biotechnology	1	-	-	
II	***Bioremediation***	2.1 Bioremediation, biotranformation, biodegradation, composting, biostimulation, bioaugmentation, bioreactor, bioleaching, bioventing.	4	2.2 Perform small scale composting, case study	2	1. Sangeetha J, Thangadurai D, David M, Abdullah M. A. (2016). Environmental Biotechnology: Biodegradation, Bioremediation and Bioconversion of Xenobiotics for Sustainable Development, Boca Raton, Florida, USA, CRC Press.
		2.3 Biodegradation of xenobiotics; Bioremediation of heavy metals and radio-active wastes, Waste water treatment using aquatic plants	3	2.4 Screening and isolation of active natural microbial strains capable of degrading persistent pollutants	3	
		2.5 Microbe mediated bioconversion; Role of genetically engineered microbes in pollution control	2	2.7 Carry out an experiment with nitrification in a continuous lab-scale bioreactor for ammonia removal	3	

III	***Biotechnological applications***	3.1 Bioenergy, biofuels, biomineralization, biofertilizers and biopesticides	4	3.2 Isolation and culture of *Rhizobium*, *Azotobacter* from soil 3.3 Application experiment of *Rhizobium* for legume plant growth	4	2. Evano, G.H. and Furlong, J.C. (2004), Environmental Biotechnology - Theory and Application. USA, John Wiley and Sons.
IV	***Genetic engineering***	4.1 Introduction to genetic engineering/recombinant DNA technology, Environmental applications of genetic engineering, Restriction endonucleases, Plasmid and phage vectors, Cloning of single stranded DNA, Uses of genetically engineered microorganisms in environment, GMO	6	4.2 Extraction of plasmids 4.3 Visits to biotechnology research institutes.	6	3. Rittmann, B.E. and McCarty, P.L. (2001), Environmental Biotechnology – Theory and Application. USA, McGraw Hill.
V	***Molecular tools in biotechnology***	5.1 PCR, gene probes, real time PCR, blotting techniques, next generation sequencing	4	5.2 Demonstration of PCR	4	4. Kuhad R.C., Singh A. (2013), Biotechnology for Environmental Management and Resource Recovery. New York, Springer-Verlag.
VI	***Management of resources***	6.1 Bio-transformation of heavy metals, role of environmental biotechnology in management of resources, microorganisms in mineral and energy recovery, nanotechnology for control of pollution.	4	6.2 Case study	6	
VII	***Fermentation in environmental biotechnology***	7.1 Importance of fermentation in environmental biotechnology Types of bioreactors, design of bioreactor, Types of fermentation: Batch, Continuous and Fed-batch system; Methods of strain improvement in fermentation.	4	7.2 Case study	4	
		Total hours of theory	***32***	***Total hours of practicals***	***32***	

Drinking and Waste Water Technologies

Course Code: ENV464 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Drinking and Waste Water Technologies ***Teaching Hours***: 32Th+32Pr
Semester: **VI**

Course Description: The **Drinking and Waste Water Technologies (ENV464)** course provides a comprehensive understanding of water, water quality, and water purification for drinking and other purposes. Combining theoretical knowledge with practical applications, this course covers the fundamentals of water sources, water quality, and water treatment. Students will gain insights into the nature of water, its sources, contamination issues, the impact of water quality on human health, and various methods of water purification.

Course Objectives: At the end of the course, students will be able to:

- understand the sources of drinking water and strategies for preserving these sources
- identify potential water contaminants and their impacts on human and animal health
- learn the methods and technologies used to purify water for drinking purposes

Course Contents:

Unit	Unit heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Sources of Water***	Safe water community: Classification of sources of water; Surface sources – Rivers, Streams; Lakes, Ponds, Impounded reservoir; Ground sources - Confined and unconfined aquifers, Springs, Wells, infiltration galleries and wells; Identification of spring-shed; Method of Source protection; Nature based solution for source protections e.g., recharge pond, bio-engineering, rainwater harvesting etc; Climate resilient technology	6	• Field visit for water supply and water treatment plant (Gravity Water Supply Schemes, Lifting water supply system and its components, • Prepare report with schematic diagram • Rain water harvesting	16	BC. Punmia, Ashok Kuamr Jain and Arun Kumar Jain, "Water Supply Engineering", Laxmi Publications (P) Ltd., New Delhi, 1998 P.N. Modi, "Water Supply engineering", Standard Book House, Delhi, 1998

II	***Drinking water technology***	Type of water supply System Gravity Water Supply Schemes and its components; Lifting water supply system and its components Multiple Use Water system and its components; Operation and maintenance of water supply system	6	• Delineation of spring shed, and protection measures according to types of sources .		G.S. Birdie and J.S. Birdie, "Water Supply and Sanitary Engineering", DhanpatRai Publishing Company (P) Ltd, New Delhi, 2002 K.N. Duggal, "Elements of Environmental Engineering"' S. Chand and company Ltd.., New Delhi, 1997 "Water Supply and Pollution Control" by Warren Viessman Jr. and Mark J. Hammer "Introduction to Environmental Engineering and Science" by Gilbert M. Masters and Wendell P. Ela "Principles of Water Treatment" by Kerry J. Howe, David W. Hand, John C. Crittenden, R. Rhodes Trussell, George Tchobanoglous AK De: Environmental Chemistry WHO and Nepal standard of drinking water
III	***Quality of Water***	Impurities in water, their classification and effects; Suspended impurities Colloidal impurities; Dissolved impurities; Hardness and alkalinity; Types of hardness; Types of alkalinities; Relation between hardness and alkalinity; Numerical on hardness and alkalinity; Living organisms in water Algae, Bacteria, Viruses, Worms; Water related diseases, Water borne diseases, Water washed diseases, Water based diseases; Water vector diseases, Transmission routes, Preventive measures; Examination of water Physical examination of water (tests for temperature, color and turbidity) Chemical examination of water (tests for pH, suspended, dissolved and total solids); Biological examination of water (multiple tube and membrane fermentation method), most probable number; Water quality standard for drinking purpose	6	• Multiple use of water system	16	
III	***Water Treatment***	Objectives of water treatment; Treatment processes and impurity removal; Screening; Purpose; Coarse, medium and fine screens; Plain Sedimentation; Purpose; Theory of settlement; Derivation of Stoke's law Temperature effect on settlement Ideal sedimentation tank; Types of sedimentation tank; Design of	14	• Sampling technique • Collection of water sample for lab test • Determination of temperature, color, turbidity and pH • Determination of suspended, dissolved and total solids		

		sedimentation tank; Numerical on theory and design of sedimentation tank; Sedimentation with coagulation Purpose; Coagulants (types and their chemical reactions); Mixing devices (purpose and types); Flocculation tanks, Clarifier, Jar test, Filtration, Purpose; Theory of filtration; Types of filters; Slow sand filter, Rapid sand filter, Pressure filter; Numerical on dimensions and units of filters; Disinfection, Purpose; Methods of disinfection (introduction only); Chlorination (theory, chlorine demand, chlorine dose, residual chlorine, contact time; Types of chlorine (hypochlorites, chloramines, liquid/gas chlorine);Forms of chlorination (plain chlorination, pre chlorination, post chlorination, double chlorination, multiple chlorination, breakpoint chlorination, super chlorination, dechlorination); Factors affecting efficiency of chlorination; Softening; Purpose; Removal of temporary hardness; Boiling method; Lime treatment method; Removal of permanent hardness; Lime soda method; Zeolite method; Ionization method Miscellaneous treatments; Aeration; Purpose; Methods of aeration; Removal of iron and manganese; Removal of color, odor and taste; PH adjustment through chemical dosing; System integration and Automation		● Determination arsenic and Iron in water ● Determination of optimum dose of coagulant by jar test apparatus ● E-coli test Note: all tests have to be done for protected and non-protected sources		
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Green Infrastructure and Economy

Course Code: ENV465 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Green Infrastructure and Economy ***Teaching Hours***: 32Th+32Pr
Semester: **VI**

Course Description: This course on **Green Infrastructure and Economy (ENV465)** ensures a balanced approach between theoretical understanding and practical application of concepts related to sustainable urban environment system. It encourages students to engage with real-world examples and gain hands-on experience in planning, evaluating, and implementing sustainable infrastructure solutions. The course will be delivered through a mix of lectures, field observations, and group works to ensure a well-rounded learning experience.

Course Objectives: The course aims to provide students with a holistic understanding of green infrastructures and economy, equipping them with both theoretical knowledge and practical skills necessary to address sustainability challenges in urban and rural settings. At the end of the course, students will be able to:

- understand the concept and principles of green infrastructures
- gain skills to analyze the economic and policy frameworks impacting green infrastructures
- develop practical skills in planning and implementing green infrastructures

Course content:

Unit	Macro Level Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Introduction to Green Infrastructures***	Definition, scope, and importance; Principles of sustainable infrastructure design; Role of green infrastructure in economic growth	6	• Field Visits and Case Studies • Field visit to local green infrastructure projects (e.g., parks, green buildings)	16	Kumareswaran, Keerththana and Jayasinghe, GuttillaYugantha (2023). Green Infrastructure and Urban Climate Resilience: An Introduction. Springer.

II	***Ecological Foundations***	Understanding ecosystem services and their significance; Role of green infrastructure in Biodiversity conservation; Green and resilient infrastructure as a means of Climate change adaptation and mitigation	6	• Case studies on successful green infrastructure implementations • Analysis of the environmental, social, and economic impacts of selected projects		Kumareswaran, Keerththana and Jayasinghe, GuttillaYugantha (2023). Green Infrastructure and Urban Climate Resilience: An Introduction. Springer. Austin, Gary (2014). Green Infrastructure for Landscape Planning. Routledge Taylor & Francis Group, London & New York
III	***Policy and Governance***	Future trends and challenges in green economy; Environmental policies and regulations influencing green infrastructures; Green infrastructure initiatives, strategies and policies in Nepal; International frameworks and agreements (e.g., Paris Agreement, Sustainable Development Goals); Role of government, and non-state actors in promoting green infrastructures	6	• Simulation Exercises and Practical Applications • GIS mapping exercises related to green infrastructure planning • Simulation exercises on sustainable energy solutions (e.g., solar panel placement, wind energy feasibility)	16	Kumareswaran, Keerththana and Jayasinghe, GuttillaYugantha (2023). Green Infrastructure and Urban Climate Resilience: An Introduction. Springer.
IV	***Economic Aspects***	Concept of ecological economics, Opportunities in green industries; Economic valuation methods for green infrastructures; Cost-benefit analysis of green projects; Green finance and investment opportunities	7			Kumareswaran, Keerththana and Jayasinghe, GuttillaYugantha (2023). Green Infrastructure and Urban Climate Resilience: An Introduction. Springer.
V	***Technological Innovations***	Renewable energy technologies; Waste management systems; Smart cities and IoT applications in green infrastructures; Global green infrastructure projects; Green initiatives in Nepal; Sustainable infrastructures development in the Karnali Province	7			Austin, Gary (2014). Green Infrastructure for Landscape Planning. Routledge Taylor & Francis Group, London & New York Brears, Robert C. (2023). Blue and Green Cities: The Role of Blue-Green Infrastructure in Managing Urban Water Resources. Second Edition. Palgrave Macmillan.
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Environmental Assessment

Course Code: ENV466 | ***Credit Hours:*** 3.0 [Theory: 1.5; Practical: 1.5]
Course Title: Environmental Assessment | ***Teaching Hours***: 24Th+48Pr
Semester: **VI**

Course Description: The course on **Environmental Assessment (ENV466)** introduces students to the methods of environmental impact assessment, the systematic identification, prediction and evaluation of the potential effects on the physical, biological, cultural, and socioeconomic components of the environment of proposed developmental projects and actions. This course aims to provide tools which can assess the potential impacts of any developmental projects which ultimately help and support to conserve the environment.

Course Objectives: At the end of the course, students will be able to:

- Explore the knowledge and science of impact assessment of the developmental projects
- Assess different environmental impacts and determine the ways to resolve those impacts
- Familiarize the students with specific models and methodologies used for impact prediction on the physical-chemical, biological, cultural, and socioeconomic components of the environment
- Acquaint with different regulatory mechanisms related to impact assessment, and provide knowledge on fundamentals of environmental management systems and provisions

Course Contents:

Unit	Unit Heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Fundamentals of Environmental Assessment***	Emergence of Environmental Assessment (EA); History of EA in Nepal; Definition and Types of EAs; Project Types, Impacts and their Types; Project cycle	4	• Make a project cycle in a chart, and discuss the different stages of a project implementation in class	10	Canter, Larry W., 'Environmental Impact Assessment', McGraw Hill. IUCN / Nepal, "ElA Training Manual for Professionals and Managers', IUCN/Nepal.
II	***Impact Assessment Procedures***	Project screening; Scoping and preparation of ToR; Establishment of environmental baseline; Impact identification, prediction and evaluation; Monitoring and Auditing; Environmental	4	• Review of approved Scoping and ToR of different project • Develop a Scoping and ToR document for a proposed project (brief report	10	IUCN / Nepal, "ElA Training Manual for Professionals and Managers', IUCN/Nepal. Uprety, B. K. (2003). *Environmental impact*

		protection measures; Management of EIA process Report format for EIA and IEE		identifying the potential impacts from a proposed project)		*assessment: Process and practice.* Uttara Uprety.
III	***Impact assessment and prediction techniques***	Method 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; Mitigation measures; Public participation and consultations; Environmental Management Plan	8	● Develop an impact identification checklist and assess the impacts for the proposed project. Predict the impacts and evaluate the impacts. After evaluation prepare a mitigation plan ● Field survey for impact assessment and report presentation	10	Glasson J. et al., (1998). Introduction to Environmental Impact Assessment, Taylor and Francis Group Yerramilli A., Manickam V. (2023). Environmental Impact Assessment, BS Publications / BSP Books IUCN / Nepal, "ElA Training Manual for Professionals and Managers', IUCN/Nepal.
IV	***Legal frameworks***	EPA 2019; EPR 2020 and other legal provisions of Nepal; Sectoral environmental legislations: National strategies, plans and polices, guidelines, manuals and standards; International convention and treaties applicable to EAs; Provincial level legal frameworks related to environmental assessments	4	● Document the legal national and international legal provisions related to the proposed project	8	Legal frameworks of Nepal (Nepal Law Commission)
V	***Environmental Management Systems***	Environmental management systems and their application: historical development, 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; Introduction of Quality Management System (QMS)	4	● Present the report prepared in the class. Faculties will be the expert of the report review team	10	ISO. (2004). International Standard ISO 14001, Reference No. 14001:2004 (E), International Organization for Standardization, Geneva. NPC and IUCN (1993). National Environmental Impact Assessment Guidelines, Kathmandu
Total hours of theoretical events			***24***	***Total hours of practical events***	***48***	

Semester VII

Environmental Hazards and Disasters

Course Code: ENV471 ***Credit Hours:*** 3.0 [Theory: 1.0; Practical: 2.0]
Course Title: Environmental Hazards and Disasters ***Teaching Hours***: 16Th+64Pr
Semester: **VII**

Course Description: This course **Environmental Hazards and Disasters (ENV471)** provides an in-depth understanding of environmental hazards and disaster management. The course covers the types, causes, and impacts of various environmental hazards including natural and anthropogenic disasters. Students will learn about the role of government as well as non-governmental organizations in disaster management and the importance of community resilience and sustainable development.

Course Objectives: At the end of the course students will be able to understand the following basic general objectives:

- Analyse the impacts of environmental hazards on human health, infrastructure and the environment in Nepal
- Identify and describe various environmental hazards and their underlying causes.
- Develop strategies for enhancing community resilience and sustainable development in the context of disaster management
- Apply theoretical knowledge to real-world case studies and scenarios.

Course Contents:

Unit	Macro Level Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Introduction to environmental hazards***	Definition and classification of environmental hazards; Natural Vs. anthropogenic hazards; Overview of major environmental hazards (earthquakes, floods, landslides, glacial lake outburst flood, forest fire, lightning etc.)	4	• Review and identify different hazards in Nepal with examples • Field visit to understand the recent disaster/hazard area • Case studies of recent disaster and its management practices in Nepal	4 10 12	Smith, K and Smith K, Environmental hazards: Assessing Risk and Reducing disaster, 2013, UNDRR.2009 UNISDR terminology on disaster risk reduction, United Disaster Risk reduction.

II	***Introduction to Risk Assessment***	Concept of risk, hazard, exposure and vulnerability; Vulnerability analysis techniques; Risk assessment methods	4	• Analysis of past disaster database from different source: Desinventar, EM-DAT, DRR portal Nepal (http://drrportal.gov.np).bipatportal. • Vulnerability risk management/multi hazard risk management	12	Bass, S., Ramasamy, S., Pyyck, J.D.D., and Battisa, F., (2008). Disaster risk management systems analysis, A guide book, Food and Agriculture Organization of the United Nations, 90p.
III	***Disaster management in Nepal***	Introduction to disaster management (Preparedness, rescue and recovery and mitigation); Early warning system in Nepal: Components, structure and operation; Role of different organizations for effective disaster risk management; Disaster risk reduction and management strategies in Nepal	4	• Study of early warning system for landslide, flood and earthquake in Nepal	12	Bhandari, D., Neupane, S., Hayes, P., Regmi, B., and Marker, P., (2020). Disaster risk reduction and management in Nepal: Delineation of roles and responsibilities. Oxford Policy Management GoN, (2017). Disaster Risk Reduction and Management act, Ministry of Home Affairs, Government of Nepal. 27p. GoN, (2018). National Policy for Disaster Risk Reduction, Ministry of Home Affairs, The Government of Nepal, 40p.
IV	***Community resilience and sustainable development***	Building resilient communities in Nepal; Sustainable development goals, Sustainable development principles in the context of Nepal; Integrating disaster management into development planning in Nepal	4	• Analysis of disaster risk reduction and management process for sustainable risk reduction in the Nepal Himalaya	12	GoN, (2017). Disaster Risk Reduction and Management act, Ministry of Home Affairs, Government of Nepal. 27p. GoN, (2018). National Policy for Disaster Risk Reduction, Ministry of Home Affairs, The Government of Nepal, 40p.
		Total hours of theoretical events	***16***	***Total hours of practical events***	***64***	

Restoration Ecology

Course Code: ENV472 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Restoration Ecology ***Teaching Hours***: 32Th+32Pr
Semester: **VII**

Course Description: The course on **Restoration Ecology (ENV472)** is an interdisciplinary field that builds foundations of ecology and makes use of other disciplines of the natural and social sciences in both theory and practice. The course is designed based on the principles of applied ecological fields to ensure conservation of nature and biological diversity.

Course Objectives: At the end of the course, students will be able to;

- identify the attributes of the ecosystems for their scientific understanding and management
- explore the knowledge and science of ecological applications to recover degraded, damaged and destroyed ecosystems.
- acquaint the practices that guide restoration, and management of the ecosystems through fieldwork and desk activities

Course Contents:

Unit	Macro Level Contents	Micro Level Contents				References
		Theoretical Elements of Learning	**Lecture Hours**	**Practical Elements of Learning**	**Practical Hours**	
I	***Conceptual Framework on Ecological Restoration***	Ecological Restoration: History and importance; Disturbances to natural ecosystems; Ecological attributes of restored ecosystems; Reference sites; Ecosystem engineers; Active and passive restorations	6	Visit to a degraded site (degrading cause: anthropogenic or natural) and develop a plan and activities for the restoration of the site. For example, students can develop a plan for restoration of flood hit areas (field-based short report)	8	Howell, E.A., Harrington, J.A., and Glass, S.B. 2011. Introduction to Restoration Ecology, Island Press. SER International. 2004. Primer on Ecological Restoration, Society of Ecological Restoration.
II	***Ecosystem processes***	Ecosystems: structural and functional components; Energy flow, nutrient cycling; Limiting factors in ecosystems; Population growth and regulation; Plants' and animals' adaptation to environment;	8	Select a site (forest/grassland/wetland) where restoration practices are ongoing. Report the existing restoration practices and determine the purpose and effectiveness of such	8	Odum, E. P. and Barrett, G. W. (2005). Fundamentals of Ecology, 5th Edition. Saunders Company, USA. Clewell, A. and Aronson, J. 2013. Ecological Restoration: Principles,

		Ecosystem development; Human impacts on ecosystem health		activities. For example, students can study about indigenous practices of eco-restoration or nature's healing potential (field-based short report)		Values, and Structure of an Emerging Profession, Society for Restoration Ecology International, Island Press: Washington D.C., 2nd ed. ISBN 13: 978-1-61091-168-9.
III	***Community Assembly***	Ecosystem stability: resilience, resistance; Ecological constraints; Assembly rules; Ecosystem thresholds; Alternative stable states; Equilibrium theory of island biogeography	8	Report on resilience and resistance strategies developed by plants communities in response to the stressors in the selected ecosystem (field-based short report)	8	Falk, D.A., Palmer, M.A., and Zedler, J.B., editors. 2006. Foundations of restoration ecology, Society for Ecological Restoration International. Island Press, Washington, D.C., USA.
IV	***Habitat restoration***	Methods to restore and monitor wildlife habitats (aquatic and terrestrial); Species reintroduction and interactions; Formulation and implementation of restoration plans; Habitat restoration design. Landscape: Pattern and process; Corridor and Connectivity; Metapopulation: Metapopulation networks, metapopulation dynamics	10	Visit a site affected by exotic plant species on species assemblage in forest/agricultural ecosystems. Note the quantitative (for example: richness, evenness, productivity) and qualitative (for example: frequency, composition) changes with reference to controlled site (field-based short report)	8	Morrison, M.L. 2009. Restoring wildlife: Ecological concepts and practical applications. Island Press, Washington, D.C., USA. Whisenant, S.G. 1999. Repairing Damaged Wildlands, Cambridge University Press, Cambridge. ISBN: 9780521665407. Bainbridge, D.A. 2007. A Guide for Desert and Dryland Restoration, SERI, Island Press: Washington D.C. ISBN: 9781559639699.
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Natural Resource Accounting

Course Code: ENV473 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Natural Resource Accounting ***Teaching Hours***: 32Th+32Pr
Semester: **VII**

Course Description: The **Natural Resource Accounting (ENV473)** course is designed based on principles of developing the fundamental concept of Environmental and Natural Resources Economics. The course is theoretical and practical in nature as it exposes different concepts of Green Economy & Natural Resources Accounting. The course covers introductory concepts to describe natural resources, green economy and national economy, financing and marketing ecosystem services and preparation of Natural Resources Asset Account, Paying for Ecosystem services etc. It is designed to enable the students to be able to use environmental resources accurately and appropriately in various social, academic, and professional settings.

Course Objectives: At the end of the course, students will be able to:

- learn the concept of Natural Resources Accounting and its role for the National Economy
- familiar with Green Economy and Natural Resources Accounting
- work out the ecosystem services green financing and marketing
- familiarize students to prepare the Natural Resources Asset Account
- understand the opportunities and challenges of NRA

Course Contents:

Unit	Unit heading Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Introduction***	Concept of Environment & Natural Resource Accounting; The concept of Circular Economy & Accounting process; Need & importance of NRA; Guiding Value of NRA	8			Tietenberg T. (2000). Environmental and Natural Resource Economics. Fifth Edition. Published by Addison Wisley Longman Inc. David W. Pearce and R Kerry Turner (1991). Economics of Natural Resources and the Environment. The John Hopkins University Press, Baltimore, Maryland.

II	***Natural Resources & National Economy***	Concept and importance of Resource accounting in the National Economy; Role of Natural Resources in the National Economy; Natural Resources Contribution to GDP (Existing practices, direct & indirect); Relation of NRA & national Economy	6	• Practices of the direct and indirect contribution of NR to National Economy. • Work out role of NR in National Economy	10	Bergstrom J.C., Randall A. (2016). Resource Economics. An Economic Approach to Natural Resource and Environmental Policy, Fourth Edition. Edward Elgar Publishing Limited. Cheltenham, UK. Northampton, MA, USA
III	***Green Economy & Resources Accounting***	Concept and rationale for green economy; Sectors of green economy; Resource accounting and Sustainable Management; Relation of NRA, SDGs and Climate Change; Green Economy: Initiative of Environmental Accounting and the concept of SEEA; future trads and challenges in green economy	6			Wunder S. 2014. Revisiting the concept of payments for environmental services. Ecological Economics. Pg10:2014 Anderson D.A. (2010). Environmental Economics and Natural Resource Management. Third Edition. Taylor & Francis e-Library.
IV	***Ecosystem Services Financing, valuation & Market***	Financing Green and Greening Financing; Green Accounting; Forest Carbon Offset and Market; Biodiversity Offsets	6	Practice of Green financing, ecosystem payment biodiversity offsets	10	Gunatilake H. M. (2003). Environmental Valuation: Theory and Applications. Postgraduate Institute of Agriculture, University of Peradeniya. Haque, A., Murty, M., &Shyamsundar, P. (2011). Environmental Valuation in South Asia. Cambridge University Press. doi:10.1017/CBO9780511843938
V	***Preparation of Natural Resources Asset Account***	Land Resources: Concept, management, design and sources of data; Water Resources: Concept, management, design and sources of data; Forest & Wildlife Resources: Concept, management, design and sources of data; Mineral Resources: Concept, management, design and sources of data; Issues & Challenges of Natural Resource Accounting	6	Practice the preparation of Natural Resources Asset Account Workout the issues & Challenges of NRA in Nepalese context.	12	Karki M. (2020). Green Economy for Sustainable Development in Nepal: Role of Forestry Sector. United Nations (2021). System of Environmental-Economic Accounting—Ecosystem Accounting (SEEA EA). White cover publication, pre-edited text subject to official editing. Available at: https://seea.un.org/ecosystem-accounting.
		Total hours of theoretical events	***32***	***Total hours of practical events***	***32***	

Climate Modelling

Course Code: ENV474 ***Credit Hours:*** 3.0 [Theory: 2.0; Practical: 1.0]
Course Title: Climate Modelling ***Teaching Hours***: 32Th+32Pr
Semester: **VII**

Course Description: The course **Climate Modelling (ENV474)** introduces climate modelling, covering the fundamental concepts, components of the climate system, and various types of climate models. The practical component allows students to gain hands-on experience with climate modelling software, data handling, and analysis of climate model outputs.

Course Objectives: At the end of the course, students will be able to:

- understand the fundamental principles and components of the Earth's climate system and different types of climate models.
- develop knowledge and skills in climate model simulations, including model components, mechanisms, forcing factors, and the interpretation of model outputs
- acquire practical skills in handling and visualizing climate data, using climate modelling software, and conducting simulations and analyses
- understand the importance, challenges, and limitations of climate modelling in projecting future climate scenarios and addressing global climate change.

Course Contents:

Unit	Macro Level Contents	Micro Level Contents				References
		Theoretical Elements of Learning	Lecture Hours	Practical Elements of Learning	Practical Hours	
I	***Introduction to Climate Modelling***	1.1 Definition and importance of climate modelling 1.2 Overview of climate system components (atmosphere, ocean, land surface, cryosphere) 1.3 Types of climate models (general circulation models, regional climate models, earth system models)	4	Overview of climate modelling tools and programming languages Data Handling and Visualization: Accessing and processing climate data; Plotting and visualizing climate model outputs	2 8	Arias, P., Bellouin, N., Coppola, E., Jones, R., Krinner, G., Marotzke, J., ... &Zickfeld, K. (2021). *Climate Change 2021: the physical science basis.* Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on

II	***Fundamentals of Atmospheric Dynamics***	2.1. Atmospheric composition and structure 2.2. Radiation and energy balance 2.3. Atmospheric motion and circulation patterns 2.4. Atmospheric chemistry and aerosols 2.5. Green House Gases and Emission Inventory	6	Atmospheric Dynamics Simulations: Simulating atmospheric circulation patterns; Radiative transfer and energy balance calculations; Emission inventory calculations	6	Climate Change; technical summary. Critchfield, H.J. (1999). *General Climatology*. Prentice-Hall, New Delhi and Earthscan, London IPCC (2006). *IPCC guidelines for national greenhouse gas inventories*. Intergovernmental Panel on Climate Change, Geneva Lee, H., Calvin, K., Dasgupta, D., Krinmer, G., Mukherji, A., Thorne, P., ... &Zommers, Z. (2023). Synthesis report of the IPCC Sixth Assessment Report (AR6). Intergovernmental Panel on Climate Change. Stocker, T. (2011). *Introduction to climate modelling*. Springer Science & Business Media. Thakuri S., Pokhrel, G. (2023). *Mountain Meteorology: Weather Forecasting and Early Warning System in Nepal.* Nepal Mountain Academy, Kathmandu, Nepal Trenberth, K. E. (Ed.). (1992). *Climate system modeling*. Cambridge University Press. McGuffie, K., & Henderson-Sellers, A. (2014). *The climate modelling primer*. John Wiley & Sons.
III	***Oceanic Processes and Modelling***	3.1. Ocean circulation and heat transport 3.2. Ocean-atmosphere interactions 3.3. Sea ice dynamics 3.4. ocean models	6			
IV	***Land Surface and Cryosphere Modelling***	4.1 Land surface processes (vegetation, hydrology, soil processes) 4.2 Cryosphere processes (glaciers, ice sheets, permafrost) 4.3 Terrestrial ecosystem models	4			
V	***Climate Model Components and Coupling***	5.1 Atmospheric general circulation models (AGCMs) 5.2 Ocean general circulation models (OGCMs) 5.3 Land surface models and vegetation models 5.4 Coupled climate models and earth system models	6	Case study on IPCC models	4	
VI	***Climate Model Simulations and Projections***	6.1 Climate model scenarios and forcing factors 6.2 Climate model simulations and projections 6.3 Downscaling techniques and regional climate models 6.4 Uncertainties and limitations of climate models	6	Climate Model Scenario Analysis: Analyzing climate model projections under different scenarios; Interpreting and communicating climate model results	12	
		Total hours of Theoretical events	***32***	***Total hours of practical events***	***32***	

Environmental Entrepreneurship

Course Code: ENV475 ***Credit Hours:*** 3.0 [Theory: 1.0; Practical: 2.0]
Course Title: Environmental Entrepreneurship ***Teaching Hours***: 16Th+64Pr
Semester: **VII**

Course Description: The **Environmental Entrepreneurship (ENV475)** course introduces students with basic concepts and characteristics of the entrepreneurship process and practices. It makes them learn about environment-friendly entrepreneurship business in the competitive market. Students will learn about life cycle assessment of the products or goods and learn to follow low carbon lifestyle and pathways in the market system.

General Objective: At the end of the course, students will be able to:

- To develop an understanding of environmental entrepreneurship and small business and appreciate their role in an economy
- To demonstrate competence in basic business and marketing planning sustainably
- To improve their perspective on innovation and continuously integrate, and accumulate new knowledge to mold their innovative ability and personality

Course Guideline:
Mentors should introduce the concept of entrepreneurship and start-up projects. Students can develop certain prototypes for solving burning environmental problems. Students can learn about national and international provisions for Micro, Cottage, and small and large enterprises. UGC has a scheme to provide an entropy grant to invest in start-up grants. Mentors and students can learn skills in fundraising for startups. Students should learn the life cycle assessment of the products and be aware of emission footprints. Students should understand trademarks, copyrights, licensing, product safety and liability insurance, etc. Students can conduct projects about energy recycling, solid waste management, pollution, and other important action research projects.

Examples	
Ecosystem-based solution - case studies	Cases studies on NRM-based Livelihood Development for Enhanced Income Generation: Bamboo Based Enterprise Development Case Study of Bamboo Mission, Biofuels Plantation for Rural Development. watershed economics, sustainable fisheries in Karnali, forests certification, watershed economics; Alpine medicinal plant trade and Himalayan Mountain livelihood strategies Visit a community and identify NRM-based Livelihood Development.
Waste Management and Recycling (Waste - 3R)	Environmental entrepreneurship based on the 3R principles—**Reduce, Reuse, Recycle**—focuses on sustainable business practices that minimize waste, conserve resources, and promote eco-friendly innovation. Entrepreneurs create solutions that reduce resource consumption, design products for reuse, and develop

	efficient recycling systems. This approach drives environmental impact through waste reduction, resource efficiency, and circular economy models. Examples include businesses that recycle materials, produce energy-efficient products, or design with sustainability in mind. Emphasizing the 3Rs not only benefits the environment but also aligns with growing consumer demand for sustainable products and services, offering both economic and ecological value.
Other areas of Environmental entrepreneurship development can be renewable energy solutions, green infrastructure development - Green Construction and building materials, eco-friendly packaging of the products, sustainable agriculture practices, ecotorism, information technology, water Conservation etc.	

Semester VIII

Final Year Project

Course Code: ENV481 ***Credit Hours:*** 3.0
Course Title: Final Year Project ***Teaching Hours***: -
Semester: **VIII**

Course Description: The course Final Year Project (ENV481) is designed to develop the skills of conducting project work and prepare academic reports. Students will develop a proposal with the guidance of a supervisor and qualified through the department's research committee. Students will conduct field research, collect and analyse data and prepare reports. The report should be submitted to the department and present in final defence.

Course Objectives: At the end of the course, students will be able to:

- identify and resolve a specific issue and solutions
- should improve research and analytical skill to develop project
- encourage teamwork and collaboration along with commu
- nication and reporting talents
- learn effectively to document procedures and outcomes of project results and remark on the learning process
- bring fresh ideas or techniques to the field with ongoing learning and professional development

Key Components of a Final Year Project Proposal

Title	The title of your project.
Proposer	Names of the investigators and institution.
Problem	A description of the problem should be addressed.
Hypothesis	A statement of the hypothesis you are testing, or the research question you are endeavouring to answer.
Background	A summary of the key relevant literature, references, or needs analysis that justifies the project.
Aims	A statement of the expected outcomes of your project, and how they will help to address the problem.
Objectives	An outline of the specific strategies or steps by which you intend to achieve your research aims.
Methodology	A more detailed outline (sometimes called 'project protocol') of the actual research, data collection and analysis methods you will use.
Ethics	An appreciation of any ethical issues raised and how they will be addressed.
Time frame	A timetable or plan of the key activities or stages of your project.

General Guidelines for Project Work

The format of the Final Year Project Work included the following headings/items:

Draft Format for the Final Year Project Work Reporting

Cover Page
Letter of Recommendation
Letter of Approval
Acknowledgements
Highlights (of the internship performed)
Contents (also include a list of tables and figures)

Introduction: (Specific)
Organization Activities: (Also state how the organizational activities are linked to your work and syllabus of B.Sc. in Environmental Science)
Problem Statement: Why specific office was chosen for internship?
Objectives
Approach
Activities Performed: With timeframe
Output/Outcome (of the internship): Accomplishment, discussion; in the last paragraph, state how did you feel to get involved in the particular organization (lesson learned)
Conclusion

References
Appendices
Appendix: Letter from the executive stating involvement (duration and major activities performed) of the student in the organization for internship of the student
Appendix 2: Schedule (approved by supervisor) for the internship work

Appendix 3: Photographs and other relevant documents

References:

Antoniou, S. A., Tsokani, S., Mavridis, D., López-Cano, M., Antoniou, G. A., Stefanidis, D., & Brouwers, M. C. (2019). Guideline assessment project: filling the GAP in surgical guidelines: quality improvement initiative by an international working group. *Annals of surgery*, *269*(4), 642-651.

Berry, R. (2013). *The Research Project: How to Write It, Edition 5*. Routledge.

Drob, C., & Zichil, V. (2013). Overview regarding the main guidelines, standards and methodologies used in project management. *Journal of Engineering Studies and Research*, *19*(3), 26.

Horvat, E. (2013). *The beginner's guide to doing qualitative research: How to get into the field, collect data, and write up your project*. Teachers College Press.

Olson, J. S., Wang, D., Olson, G. M., & Zhang, J. (2017). How people write together now: Beginning the investigation with advanced undergraduates in a project course. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *24*(1), 1-40.

Internship

Course Code: ENV489 ***Credit Hours:*** 6.0 [Practical: 6.0]
Course Title: Internship ***Teaching Hours***: Three months
Semester: **VIII**

Course Description: The course **Internship (ENV489)** provides a guideline for B.Sc. Environmental Science students for maximizing their learning and development during their three-month internship, preparing them effectively for future careers in environmental science and related fields.

Course Objectives: At the end of the course, students will be able to:

- **Skill Development**: Enhance practical skills in environmental monitoring, data analysis, and project management
- **Application of Knowledge**: Apply theoretical knowledge gained in academic studies to real-world scenarios
- **Professional Development**: Gain insights into the field of environmental science, network with professionals, and explore career paths
- **Contribution to Organization**: Provide meaningful contributions to ongoing projects and initiatives of the host organization

Course Contents:

Orientation and Introduction

- Introduction to the internship program, objectives, and expectations
- To identify intern organizations/ institutions
- Familiarization with the organization's mission, vision, and key personnel
- Overview of safety protocols and procedures

Training and Skill Development

- Specialized training in environmental monitoring techniques (e.g., water quality testing, air quality monitoring, soil sampling).
- Introduction to relevant software and tools (GIS, statistical analysis software).
- Workshops on environmental regulations and compliance.

Field Work and Data Collection

- Hands-on experience in field data collection and sampling techniques.
- Supervised field trips to local ecosystems, parks, or industrial sites.
- Collection of samples (water, soil, air) and data recording.

Data Analysis and Reporting

- Learn data management and analysis techniques using collected data
- Interpretation of results and identification of trends or patterns
- Preparation of preliminary reports summarizing findings and initial conclusions

Internship Reporting Format

Draft Format for the Internship

Cover Page
Letter of Recommendation
Letter of Approval
Acknowledgements
Highlights (of the internship performed)
Contents (also include list of tables and figures)

Introduction: (Specific)
Organization Activities: (Also state how the organizational activities are linked to your work and syllabus of M.Sc. in Environmental Science)
Problem Statement: Why specific office chosen for internship?
Objectives
Approach
Activities Performed: With time frame
Output/Outcome (of the internship): Accomplishment, discussion; in the last paragraph, state how did you feel to get involved in the particular organization (lesson learned)
Conclusion

References
Annexes

Annex1: Letter from the executive stating involvement (duration and major activities performed) of the student in the organization for internship of the student
Annex 2: Schedule (approved by supervisor) for the internship work
Annex 3: Photographs and others relevant documents

Evaluation and Grading System

MU-GSST follows a standardized system of continuous assessment and semester-end structured testing for the evaluation and grading of the learning performance of each graduating student.

Internal Assessment

All students must pass internal assessment examination according to schedule given by the course teacher to qualify for final examination. Under valid reason, student may allow to makeup internal assessment, if he or she has made prior arrangement with course teacher; however, it should be done with the permission of the Department Head. It can be completed within 15 days of the last date of schedule of mid-term examination. There will be no makeup examination for final exam of respective courses. In this case students have to pass the course under backup exam system in the following semesters.

B.Sc. in Environment Science follows a standardized system of continuous assessment and semester-end structured testing for the evaluation and grading of the learning performance of each graduating student. The University-defined system has been presented in the following table:

SN	Activities	No. of Events	Total Weightage
1.	***Internal Assessment (Continuous Assessment)***		***40 Percent***
1.1.	Discussion questions (DQs) / Comprehensive learning assignment (CLA)	2	5 percent
1.2.	Thematic Presentation (TP)	1	2 percent
1.3.	Class Attendance		3 percent
1.4.	Mid-Term Examination	1	10 percent
1.5.	Lab Work / Project Work / Case Study		20 percent
2.	***End-Semester Examination***	***1***	***60 percent***

Internal Assessment Summary in Marks

SN	Credit Hrs.	DQs/CLA	TP	Class Attendance	Mid-Term Exam	Lab Work / Project Work / Case Study	Total Marks	Remarks
1	≤ 1.5	1.5	1.5	2	5	10	20	
2	> 1.5	3	3	4	10	20	40	

Mid-Term and End-Semester Examination System

Mid-Term examination will be controlled and coordinated by respective department head/coordinator. A mid-term exam should be conducted along the half way of the course teaching. Subject teachers are responsible to evaluate and mid-term marking. End semester examinations will be conducted under the control of Mid-West University, Exam Management Office (MU EMO). The examination scheme for mid-term and final examination is given below in the table:

SN	Credit Hrs.	Mid-Term		Final		Remarks
		FM	PM	FM	PM	
1	≤ 1.5	15	7.5	30	15	
2	> 1.5	30	15	60	30	

Question Models for Mid-Term and End-Semester Examination

The question paper for the mid-term and end-semester examination will consists of three sections of the questions, i.e., very short questions, short questions and long questions. The question model and marks distribution are given below

Question Model for Mid-Term Examination

SN	Credit Hrs.	Very Short Questions		Short Questions		Long Questions		Total Question	Time	Remarks
		Number of Questions	Marks	No. of Questions	Marks	No. of Questions	Marks			
1	≤ 1.5	5	5 × 1 = 5	2 out 3	2 × 3 = 6	1 out of 2	1 × 4 = 4	10	1 hour	
2	> 1.5	5	5 × 2 = 10	3 out of 4	3 × 4 = 12	1 out of 2	1 × 8 = 8	12	1.5 hours	

Question Model for End Semester Examination

SN	Credit Hrs.	Very Short Questions		Short Questions		Long Questions		Total Question	Time	Remarks
		Number of Questions	Marks	No. of Questions	Marks	No. of Questions	Marks			
1	≤ 1.5	10	10 × 1 = 10	4 out 5	4 × 3 = 12	2 out of 3	2 × 4 = 8	18	2 hours	
2	> 1.5	10 out of 12	10 × 2 = 20	4 out of 5	4 × 5 = 20	2 out of 3	2 × 10 = 20	20	3 hours	

Examination Scheme

Examination scheme of semester will be given below
Completion of semester activities – 2+1+1+1
Upto 2 month – Completion of registration form
Upto 3 months – Submission of mid-term result
Upto 4 months – Completion of exam form
Upto 5 months – Conduction of final examination

Attendance Requirements

Every student must have at 80% attendance in each subject to be eligible for final examination of each semester. All teachers should submit their attendance to the respective department head and coordinators after the end of classes of each subject.

Grading System

B.Sc. in Environment Science follows an absolute grading system for the academic learning achievement of the students using the following range of grades and grade points allocation:

SN	Percentage (%)	Letter Grades	Grade Points	Grade Category
1	85 and above	A	4.00	Outstanding
2	80-84	A-	3.67	Distinction
3	75-79	B	3.33	Excellent
4	70-74	B-	3.00	Very Good
5	65-69	C	2.50	Good
6	60-64	C-	2.00	Average
7	55-59	D	1.50	Satisfactory
8	50-54	D-	1.00	Fair
9	Less than 50	F	0.00	Fail