Far Western University
Mahendranagar, Kanchanpur
Faculty of Science and Technology

B. Sc. Eighth Semester Biology Group

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Instrumental Method of Analysis F.M.: 100
Course No.: CHM486 P.M.: 45%
Nature of Course: Theory (Interdisciplinary) Credit: 2
Level: B. Sc. Number of hours per week: 2
Year: Fourth, Semester: Eighth Teaching Hours: 30

1. Course Description:

The course intends to enable the students acquainted with the basic knowledge of instrumental methods of analysis. Students will be familiar with the fundamentals of electro-analytical and spectroscopic methods.

2. Course Objectives:

The general objectives of the course are as follows:

- To familiarize the students with different electro-analytical techniques like polarography, electrogravimetry, coulometry and amperometry techniques.
- To acquaint the students with basic principle, instrumentation and applications of ion-selective electrodes.
- To familiarize the students with the basic principles, instrumentations and applications of atomic and molecular spectroscopic techniques.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Brief description of different types of electro-analytical techniques. • Discuss the basic principles, experimental set-up & applications of normal dc polarography. • Explain different techniques of linear sweep oscillographic polarography, pulse polarography, ac polarography and stripping voltammetry. • Describe the basic principle, experimental set-up & applications of electrogravimetric technique. • Explain the basic principle, experimental set-up & applications of constant potential & constant current coulometric titrations. • Explain the basic principles, experimental set-up and applications of different types of amperometric titrations including biamperometric titrations. • Describe the basic principle, types & applications of ion-selective electrodes.	**UNIT I: Electro-analytical Methods (10 hrs)** Introduction, classification of electro-analytical techniques, principle, experimental set-up and applications of polarography, basic principles, instrumentation and applications of electrogravimetry & coulometry, principle, experimental set-up and applications of amperometry techniques, principle, instrumentation and applications of ion selective electrodes.
• Brief introduction of electromagnetic radiation, electromagnetic spectrum, energy levels in both atoms and molecules. • Give a brief account on the interaction of electromagnetic radiation with atoms & molecules. • Describe the classification of different types of spectroscopic techniques. • Explain components and their functions of common spectrometers.	**UNIT II: Spectroscopic Methods (5 hrs)** Electromagnetic radiation and spectrum, energy level in atom and molecule, interaction of electromagnetic radiation with atom and molecule, classification of spectroscopic techniques, spectrometers and their components.
• Explain the flame, electro-thermal, glow discharge, cold-vapour, hydride atomizations. • Explain the basic principles, components of AAS spectrometer and their functions. • Describe the applications of AAS and different spectral & chemical interferences encountered in atomic absorption measurements. • Explain the basic principles involved in flame emission and plasma emission spectrometry.	**UNIT III: Atomic Spectroscopy (8 hrs)** Introduction, atomization & atomization methods, basic principle of atomic absorption spectrometry (AAS), atomic absorption spectrometer & functions of its components, working of AAS, AAS measurements and applications, emission spectroscopic techniques: basic principles of flame emission spectrometry and plasma emission spectrometry,

• Describe the components & their functions of flame emission and plasma emission spectrometers. • Discuss the applications of the flame & plasma emission spectroscopic methods.	flame emission and plasma emission spectrometers and functions of their components, applications of flame & plasma emission spectroscopy.
• Give a brief description of electronic spectra of molecules, Franck-Condon principle and electronic transitions in organic as well as in inorganic compounds. • Explain the factors affecting absorption bands. • Describe the components of UV-visible spectrometer and their functions. • Discuss the analytical applications of UV-visible spectroscopy. • Give a brief description of infrared region, molecular vibrations, vibrational frequency & IR absorption bands. • Describe the components of IR/FTIR spectrometers and their functions. • Discuss the applications of IR/FTIR spectroscopy.	**UNIT IV: Molecular Spectroscopic Methods (7 hrs)** UV-visible spectroscopy: electronic spectra of molecules, Franck-Condon principle, electronic transitions in organic and inorganic compounds, factor affecting absorption bands, UV-visible spectrometer, applications of UV-visible spectroscopy, infrared spectroscopy: infrared region, molecular vibration, vibrational frequencies and IR absorption bands, IR spectrometer, Fourier transform spectrometer, FTIR spectrum and their applications.

Note: The figures in the parentheses indicate the approximate periods for the respective units.

(4). Evaluation System

Undergraduate Programs

External Evaluation	Marks	Internal Evaluation	Weightage	Marks	Viva-voce	Weightage	Mark
End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

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

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

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

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

5. Prescribed Text for CHM486

1. B. Sivasankar. **Instrumental Methods of Analysis**, 1st Edition, Oxford University Press (Indian edition), New Delhi, India, 2012.
2. D. A. Skoog, D. M. West, F. J. Holler & S. R. Crouch. **Fundamentals of Analytical Chemistry**, 8th Edition, Books/Cole, Cengage Learning, CA, USA, 2004.

6. References for CHM486

1. H. Kaur. **Instrumental Methods of Chemical Analysis**, 10th Edition, Pragati Prakashan, Meerut, India, 2014.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Nanoscience F.M.: 100
Course No.: CHM484 P.M.: 45%
Nature of Course: Theory (Interdisciplinary) Credit: 2
Level: B. Sc. Number of hours per week: 2
Year: Fourth, Semester: Eighth Teaching Hours: 60

1. Course Description:

The course intends to enable the students acquainted with the basic knowledge of nanomaterials and their technological applications. Students will be familiar with the fundamentals of nano-science, nanomaterials & fabrication, characterization and applications of nanomaterials.

2. Course Objectives:

The general objectives of the course are as follows:

- To familiarize the students with terminologies used in nano-science and classification of nanomaterials.
- To acquaint the students with basic techniques of nanomaterials synthesis using bottom up and top down approaches.
- To familiarize the students with the uses of imaging microscopic techniques for nanomaterials characterization.
- To acquaint the students with high potential nanomaterials of quantum dots and carbon nanomaterials and their uses.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Define the terms of nano-scale & nano-science. • Describe the history, scope & interdisciplinary nature of nano-science. • Give a brief explanation of the early uses of nanomaterials and nanomaterials in nature. • Describe the classification of nano-materials based on dimension & their properties. • Explain the future challenges & opportunities of nanomaterials.	**UNIT I: Introduction of Nano-science (5 hrs)** Nano-scale, history, scope and interdisciplinary nature of nano-science, early applications of nanomaterials, nanomaterials in nature, classification of nano-structured materials (0D, 1D, 2D & 3D) and their unique properties, future challenges and opportunities of nanomaterials.
• Describe the concept of bottom up and top down approaches for nanomaterials synthesis. • Discuss the different physical vapour ((inert gas condensation, laser ablation, sputter-deposition, electron beam evaporation) & chemical deposition (thermally activated chemical vapour deposition, plasma enhanced chemical vapour deposition) methods, sol-gel process, spray conversion, wet chemical, physical and chemical self-assembly methods for synthesis of nanomaterials using bottom up approach. • Describe different synthesis techniques of mechanical alloying, STM based lithography, dip pen nanolithography, electron beam nanolithography, shockwave consolidation, hot & cold isotatic processes, and spark plasma sintering methods using top down approach.	**UNIT II: Synthesis of Nanomaterials (10 hrs)** Concepts of bottom up and top down approaches, synthesis of nanomaterials using bottom up approaches: physical vapor deposition, chemical vapour deposition processes, sol-gel process, spray conversion process, wet chemical synthesis and self-assembly methods, synthesis of nanomaterials using top down approaches: mechanical alloying, nanolithography (scanning tunneling microscopy based lithography, dip pen nanolithography, electron beam nanolithography), consolidation of nano-powders (shockwave consolidation, hot & cold isotatic processes), spark plasma sintering.

• Explain the fundamental principles behind the formation of images of nanomaterials surface by optical, scanning electron, scanning tunneling, atomic force and transmission electron microscopic techniques. • Discuss the applications of the different microscopic images to characterize the nanomaterials. • Explain the fundamental principle of nano-indentation method and its uses for characterization of nanomaterials.	**UNIT III: Characterization of Nanomaterials (8 hrs)** Fundamental principles of imaging microscopic techniques (optical microscopy, scanning electron microscopy, scanning tunneling microscopy, atomic force microscopy and transmission electron microscopy), uses of OP, SEM, STM, AFM and TEM images to characterize nanomaterials, fundamental principle of nano-indentation technique and its uses to characterize nano-materials.
• Explain the concept of quantum dots (QDs). • Discuss different methods of QDs fabrication and its uses. • Describe different types of carbon nano-tubes, fabrication methods of the different carbon nano-tubes and their uses.	**UNIT IV: Nanomaterials with High Application Potential (7 hrs)** Quantum dots: concept of quantum dots (QDs), methods of quantum dots fabrication (lithographically made QDs, field affects QDs and self assembled QDs), uses of quantum dots, nano-tubes: carbon nano-materials (carbon black, graphite and graphene, single-walled and multi-walled nano-tubes, fullerene), fabrication of carbon nano-tubes and their uses.

Note: The figures in the parentheses indicate the approximate periods for the respective units.

(4). Evaluation System

Undergraduate Programs

External Evaluation	Marks	Internal Evaluation	Weightage	Marks	Viva-voce	Weightage	Mark
End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

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

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

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

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

5. Prescribed Text for CHM484

1. B. S. Murthy, P. Shankar, Balvev Raj, B. B. Rath & James Murday. **Textbook of Nanoscience and Nanotechnology**, Series in Metallurgy and Materials Science, Baldev Raj (Ed.), Universities Press Private Hyderabad, India, 2012.
2. C. P. Poole, Jr. & F. J. Owens. **Introduction to Nanotechnology**, Wiley India Limited, 2012.
3. B. B. Neupane, B. Pandey, B. Giri & M. K. Joshi, **A Text Book of Nanoscience and Nanotechnology**, Heritage Publishers & Distributors Pvt. Ltd., Kathmandu, 2016.

6. References for CHM484

1. J. Bhattarai, **Frontiers of Surface Science**, 1st Edition, Kathmandu, 2012.
2. K. K. Chattopadadhya & A. N. Banerjee. **Introduction to Nanoscience and Nanotechnology**, PHI Learning Private Limited, New Delhi, 2012.
3. C. N. R. Rao, **Nanoworld: An Introduction to Nanoscience and Nanotechnology**, JNCASR, Bangalore, 2010.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Polymer Science F.M.: 100
Course No.: CHM485 P.M.: 45%
Nature of Course: Theory (Interdisciplinary) Credit: 2
Level: B. Sc. Number of hours per week: 2
Year: Fourth, Semester: Eighth Teaching Hours: 30

1. Course Description:

The course intends to enable the students acquainted with the basic knowledge of polymer science. Students will be familiar with the fundamentals of polymers, chemistry and techniques of polymerization, analysis and testing of polymers, polymer degradation and polymer processing.

2. Course Objectives:

The general objectives of the course are as follows:

- To familiarize the students with different types of polymerization reactions and polymerization techniques.
- To acquaint the students with different types of polymer characterization techniques as molecular weight determination, spectroscopic, microscopic and thermal analysis.
- To acquaint the students with different types of polymer processing techniques for plastics, elastomerics and fibres.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Explain the basic concept of polymer science. • Discuss the classification of polymers based on origin, structure, mode of synthesis and interparticle forces. • Explain the meaning of natural, synthetic, linear, branched and cross linked polymers. • Describe the addition, condensation and coordination polymers. • Describe elastomers, fibres, thermoplastic and thermosetting polymers.	**UNIT I: Introduction (2 hrs)** Fundamentals of polymer science, classification of polymers on the basis of structure, origin, mode of synthesis and interparticle forces.
• Describe the mechanism and kinetics of free radical, cationic and anionic addition polymerizations. • Describe the mechanism and kinetics of condensation polymerization. • Explain the difference between addition and condensation polymerization. • Describe coordination polymerization with suitable examples. • Describe the process of bulk polymerization, solution polymerization, suspension polymerization and emulsion polymerization.	**UNIT II: Polymerization and Polymerization Techniques (8 hrs)** Basic methods of polymerization and their mechanism: addition, condensation, bulk, suspension, emulsion and solution processes, distinguishing features of addition and condensation polymerization mechanisms, coordination polymerization, kinetics of addition and condensation polymerizations.
• Explain the concept of average molecular weights of polymer. • Explain the terms polydispersity and molecular weight distribution of polymers. • Describe the principle and experimental method for the determination of number average molecular weight of polymers by end group analysis. • Describe the principle and experimental method for determination of average molecular weight of polymers by viscosity measurement.	**UNIT III: Polymer Characterization (10 hrs)** Average molecular weight concepts: number average concept, weight average concept, polydispersity and molecular weight distribution.

• Describe the principle and experimental method for the determination of molecular weight distribution of polymers by gel permeation chromatography. • Discuss briefly the chemical analysis of polymers by mass spectrometry and gas chromatography. • Explain the use of infrared spectroscopy and nuclear magnetic resonance spectroscopy in the analysis of polymers. • Describe the principle and experimental method for the analysis of polymers by x-ray diffraction study, microscopic techniques and thermal analysis.	Measurement of molecular weight: end-group analysis, viscometry, gel permeation chromatography. Analysis and testing of polymer-chemical analysis of polymers, spectroscopic methods, x-ray diffraction study, microscopy, thermal analysis.
• Explain the meaning of polymer processing. • Define the terms plastics, elastomers and fibres. • Explain the purpose of compounding in polymer making processes. • Describe the purpose and process of calendaring, die casting, rotational casting, film casting, injection molding, blow molding, extrusion molding, thermoforming, foaming, reinforcing and fibre spinning in polymer processing.	**UNIT IV: Polymer Processing (8 hrs)** Introduction, plastics, elastomers and fibres. Compounding. Processing techniques: calendaring, die casting, rotational casting, film casting, injection molding, blow molding, extrusion molding, foaming, and reinforcing.
• Describe the application of some inorganic, organic, natural and synthetic polymers.	**UNIT V: Application of Polymers (2 hrs)**

Note: The figures in the parentheses indicate the approximate periods for the respective units.

(4). Evaluation System

Undergraduate Programs

External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**	**Viva-voce**	**Weightage**	**Mark**
End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner

will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

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Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

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

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

5. Prescribed Text for CHM485

1. F. W. Billmeyer Jr., **Textbook of Polymer Science,** 3rd Edition, Wiley–Interscience Publication, 1984.
2. V. R. Gowariker, N. V. Viswanathan & J. Sreedhar, **Polymer Science**, New Age International (P) Ltd., 2001.
3. G. S. Misra, **Introductory Polymer Chemistry**, New Age International (P) Ltd., 2001.

6. References for CHM485

1. A. L. Gupta, **Polymer Chemistry,** 3rdEdition, PragatiPrakashan, Meerut, India, 2013.
2. M. P. Stevens, **Polymer Chemistry An Introduction**, 3rd Edition, Oxford University Press, 2012.
3. M. S. Bhatnagar, **A Textbook of Polymer Chemistry**, S. Chand and Company Ltd., 2012.

FAR WESTERN UNIVERSITY

ZOOLOGY CURRICULUM (B.Sc.)

2074

EIGHTH SEMESTER

Semester	Course Nature	Course Code	Course Title	Credit	Instruction hrs
VIII	Theory	ZOO481	Entomology & Parasitology	4	60
	Theory	ZOO482	Ecology & Fisheries Biology	4	60
	Practical	ZOO483	Related to ZOO481 & ZOO482	2	90
Any one (Interdisciplinary subject)	Theory (Interdisciplinary subject)	ZOO484	Ethnobiology	3	45
	Theory (Interdisciplinary subject)	ZOO485	Bioinformatics	3	45
	Theory (Interdisciplinary subject)	ZOO486	Bio-instrumentation	3	45

Far Western University

Faculty of Science and Technology

B. Sc. Syllabus of Zoology

Course Title: Entomology & Parasitology **Credit 4**
Nature of the Course: Theory **Number of inst. hours per week: 4**
Course No: ZOO481 **Total instruction hours: 60**
Year: Fourth
Semester VIII

Course Objectives:

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

- Explain and demonstrate general anatomy of insects and host-parasite relationship.
- Understand value of virus, bacteria, protozoan and helminth parasites and insects.
- Epidemiology of diseases caused by parasites/environment and concept of pharmacology.
- Acquire knowledge of some common insect pests and parasites of agriculture and understand their control measures.
- Create understanding of economic and commercial insects, vectors and vector-borne diseases.

Course Description:

A: Entomology

Specific Objectives	Units & Course Contents
• Enumerate the importance of insects. • Give an account on naming and classification of insects.	**Unit 1: Diversity and Importance of Insects (3 hrs)** Insect naming and classification, salient characters of insect orders; examples from major families of economic importance. Importance of insects.
• Describe the head and head appendages. • Give an account on thorax and thoracic appendages. • Discuss abdomen and abdominal appendages of insects.	**Unit 2: Insect Morphology (4 hrs)** General body plan. Head and head appendages: antennae and mouthparts. Thorax and thoracic appendages: legs and wings. Abdomen and abdominal appendages: external genitalia and other appendages.
• Describe different systems of insects.	**Unit 3: Insect Anatomy and Physiology (7 hrs)** Digestive, Excretory, Circulatory, Nervous & Sense organs, Respiratory and Reproductive system.

• Explain feeding and reproductive behavior of insects.	**Unit 4: Insect Behaviour (2 hrs)** Feeding and reproductive behaviour.
• Discuss the causes of success of insects. • Explain principles and methods of insect pests control. • Give an account on IPM. • Classify pesticides and give an account on pesticides used in Nepal. • Give an account *Quadraspidiotus pernicisus, Aphis gossypii, Leptocorisa acuta, Sitophylus zeamais.*	**Unit 5: Pest Management (8 hrs)** Causes of success of insects. Principles and methods of insect pests control i.e. cultural, biological, physical, mechanical, reproductive, legislative, chemical and bio-technological control. Introduction to Integrated Pest Management (IPM). Pesticides/Insecticides, their classification, formulations and application equipments. Pesticide use in Nepal. Safe use of pesticides. Identification, life histories, mode of damage and control of important insect pests of selected crop *(Quadraspidiotus pernicisus, Aphis gossypii, Leptocorisa acuta, Sitophylus zeamais)*.
• Give an account on beneficial insects. • Give an account on Apiculture, Sericulture and Lac culture. • Discuss Yarsa Gumba.	**Unit 6 : Entomological industries (6 hrs)** **Beneficial insects:** Insects of medicinal, food and aesthetic value; insect pollinators and environmental indicators; scavengers, entomophagous (predators and parasitoids) and weed-feeding insects; beneficial insect industries. **Apiculture:** Society organization of honey bee. Honey bee species. Morphology and life cycle of honey bee. Bee keeping. Prospects of beekeeping in Nepal. **Sericulture:** Introduction. Life cycle of silk moth. Strains of silkworm. Rearing of silkworms. Cocoons. Mulberry cultivation. Composition & uses of silk. Prospects of sericulture in Nepal. **Lac culture**: Introduction. Life cycle of the lac insect. Strains of lac. Host plants for lac insects. Lac cultivation. Composition and uses of lac. **Yarsa Gumba** (Parasitic fungus & Ghost moth caterpillar): Introduction, economic importance & conservation.

B: Parasitology

Specific Objectives	Units & Course Contents
• Define parasitism. Give an account on different types of hosts and parasites. • Explain effect of parasites on host and effect of host on parasites. • Enumerate the properties of parasites.	**Unit 1: General Parasitology (3 hrs)** Parasitism and other inter-specific interactions (symbiosis, commensalism and mutualism). Host parasite relationship. Types of host and parasites. Properties of parasites.
• Enumerate the molecular characteristics of bacteria and virus. • Give an account on modes of transmission, pathogenicity and control measures of different bacterial and viral diseases.	**Unit 2: Bacteriology and Virology (4 hrs)** **Bacteria-** Characterization and classification of bacteria (on the basis of staining methods). Modes of transmission, pathogenicity and control measures of bacterial diseases (Tetanus, Syphilis and Leprosy). **Virus-** Molecular characteristics. Modes of transmission, pathogenicity and control measures of viral diseases (Hepatitis, Dengue, Avian influenza and Swine flu).
• Discuss epidemiology of different mentioned diseases. • Give an account on nematodes in citrus plants. • Explain the role of agricultural practices in phytonematode control.	**Unit 3: Protozoology and Helminthology (5 hrs)** **Epidemiology of:** **Protozoan diseases** (Amoebiasis Giardiasis, Malaria, Leishmaniasis, Trichomoniasis) and **Helminthic diseases** (Fasciolopsis, Echinococcosis, Ancylostomiasis, Enterobiasis and Filariasis). **Phytonematodes**: Introduction, Control of phytonematode. Parasitic nematodes in citrus plants.
• Explain zoonoses. Mention the epidemiology of brucellosis and Japanese encephalitis. • Give a brief account on emerging zoonotic diseases.	**Unit 4: Zoonotic Diseases (2 hrs)** **Introduction.** **Epidemiology of common zoonotic diseases** viral (Japanese encephalitis), bacterial (Brucellosis), protozoan (Thellariasis) and helminthic (Trichinelliosis). **Emerging zoonotic diseases**.
• Define vector. Explain insects as vectors. • Give the mode of transmission and pathogenecity of dengue and typhus fever. • Mention the status of Leishmaniasis and Chikungunya in Nepal.	**Unit 5: Vector and Vector Borne Diseases (6 hrs)** Introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs. Insects as Vectors. Study of diseases transmitted by sandflies (Visceral and Cutaneous Leishmaniasis); mosquitoes (Dengue,

	Chikungunya); Flea (Plague, Typhus fever); Human louse (head, body and pubic louse) (Relapsing fever, Trench fever, Phthiriasis); Control of vector and vector borne diseases.
• Define epidemiology. Mention its uses. • Explain the basic tools of measurement in epidemiology. • Give an account on measurement of any one: mortality, morbidity, incidence and prevalence. • Show the relationship between prevalence and incidence.	**Unit 6: Epidemiology (3 hrs)** Uses. Tools of measurement (rates, ratios and proportions). Measurements of mortality, morbidity, incidence and prevalence.
• Explain active and passive immunity. • Describe types of vaccines. • Give an account on the cold chain. • Mention the Current National Immunization schedule.	**Unit 7: Immunology (3 hrs)** Immunity. Immunizing agents: vaccines and immunoglobulins. The Cold Chain. Current National Immunization schedule.
• Give an account on nomenclature of drugs. • Explain the routes of drug administration. • Describe pharmacokinetics and pharmacodynamics. • Mention the commonly used anthelmintic and antiprotozoan medicines.	**Unit 8: Pharmacology (4 hrs)** Nomenclature of drugs. Routes of drug administration. Pharmacokinetics and pharmacodynamics. Anthelmintic and antiprotozoan medicines.

Text and Reference Books

Entomology (latest editions)

Aruga, H. Principles of Sericulture. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.

Chapman, R.F. The Insects: Structure and Function. 4th ed.Cambridge University Press.

Fenemore, P.G. and Prakash, A. Applied Entomology. New Age International Publishers.

Gillot, C. Entomology. Plenum Press, New York.

Gullan PJ & PS Cramston, The insects: An outline of Entomology, Wiley Publishers

Hill, D.S. 1993. Agricultural Insect Pests of the Tropics and their Control. Special edition for sale in Asia only. Cambridge University Press, Cambridge.

Metcalf, R.L. and Luckmann, W.H. Introduction to Insect Pest Management.. John Wiley & Sons, New York

Metcalf, R.L. and Flint, W.P. Useful and Destructive Insects, their Habitats and Control. McGraw- Hill, New York.

Pedigo, L.P. Entomology and Pest Management. Prentice Hall of India Private Limited, New Delhi.

Richards, O.W. and Davies, R.G. IMMS' General Textbook of Entomology. vol. 1. BI Publications Pvt. Ltd., New Delhi.

Snodgrass, R.E. Principles of Insect Morphology. CBS Publishers & Distributors.

Verma, L.R. (eds) Honeybees in mountain agriculture, Oxford & IBH publishing Co. Pvt. Ltd. New Delhi, India

Parasitology (latest editions)

Arora, D.R. and Arora B. Medical Parasitology.CBS Publishers and Distributors, New Delhi.

Arora, D.R. Text book of Microbiology .CBS Publishers and Distributor, New Delhi.

Belding, D.L. Text book of Parasitology. Mereditch, New York.

Chatterji, K.D. Parasitology (Protozoology and Helminthology). Medical Publishers, Calcutta, India.

Chandler, A.C. and Read, C.P. Introduction to Parasitology. John,Wiley and Sons, inc.

Mathur, J.S. Preventive and Social Medicine, A comprehensive Text book with special focus on Nepal. CBS Publication and Distributor, New Delhi.

Park, K. Text book of Preventive and Social Medicine. Banarsidas Bhanot Publishers Jabalpur, India.

Parija, S.C. Review of Parasitic Zoonoses. A.I.T.B.S. Publishers and Distributors, Delhi.

Tripathi, K.D. Essentials of Medical Pharmacology. Jaypee Brothers, Medical Publishers P. Ltd., New Delhi.

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Far-Western University

Faculty ofScience and Technology

B. Sc. Syllabus of Zoology

Course Title: Ecology and Fisheries Biology **Credit 4**

Nature of the Course: Theory **Number of inst. hours per week: 4**

Course No: ZOO482 **Total instruction hours: 60**

Year: Fourth

Semester VIII

Course Objectives:

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

- Understand the basic concepts and principles of ecology.
- Understand the basic concepts of fish biology and fish farming

Course Description:

A: Ecology

Specific Objectives	Units & Course Contents
• Describe the abiotic factors of the environment. • Describe the laws of limiting factors.	**Unit 1: Abiotic Components of Ecosystem (4 hrs)** Abiotic environmental factors. Laws of limiting factors- Liebig's law of minimum , Shelford's law of tolerance. Combined concept of limiting factors.
• Describe the biotic components of an ecosystem with their interrelationship with abiotic components. • Explain how the energy flows in an ecosystem with flow models. • Discuss the trophic structure of ecosystems, including reference to food chains and trophic levels • Explain the major biogeochemical cycles. • Explain the primary and secondary productivity of an ecosystem. • Describe the ecological indicators. • What is ecological efficiency? • Describe the terrestrial and aquatic ecosystem with examples.	**Unit 2: Ecosystem (8 hrs)** Definition. Biotic components and their interrelationship with abiotic components, Dynamics of ecosystem- Energy flow in ecosystem and flow models. Food chain in ecosystem and food web. Ecological pyramids. Biogeochemical cycles. Concept of productivity. Ecological indicators. Ecological efficiencies. Types and examples of ecosystem- terrestrial (grassland) and aquatic (pond).

• Discuss the characteristics of population.	**Unit 3: Population Attributes (3 hrs)** Population density, natality, mortality, fecundity, life tables, survivorship curves, dispersal, dispersion and distribution patterns.
• Explain the growth pattern of population. • Discuss the regulation of population.	**Unit 4: Population Dynamics/Population Growth and Regulation (3 hrs)** Exponential and logistic, Verhulst-Pearl growth equation, 'r' and 'k' strategies, density dependent and density independent factors.
• Discuss the interactions of population.	**Unit 5: Population Interactions (3 hrs)** Types of population interaction. Niche concept. Gause principle of competition exclusion, interspecific and intraspecific competitions, Lotka Volterra model.
• Describe the characteristics of community. • Explain the diversity index, species richness and abundance. • Describe the stratification of community. • Describe the ecotone /edge effects of the community. • Describe the ecological succession. • Explain climax community	**Unit 6: Community Ecology (6 hrs)** Characteristics of community, diversity index, species richness, abundance, community stratification, ecotone/edge effect, Ecological succession, types of ecological succession with examples, climax community.
• Describe the renewable and non-renewable resources. • Discuss the conservation of natural resources. • Discuss the human impact on natural resources.	**Unit 7: Resource Ecology (3 hrs)** Renewable and Non-renewable resources and their conservation. Human impact on natural resources.

B: Fisheries Biology

Specific Objectives	Units & Course Contents
• Describe the general principles of systematics. • Explain the different methods used in fish identification. • Give the general morphology, classification and characteristic features of major groups of fishes.	**Unit 1: Fish Systematics (3 hrs)** Principles. Different methods used in fish identification. General morphology and outline classification of major groups of fishes and their characteristics.

• Describe the digestive, circulatory, respiratory, nervous and reproductive systems of fishes. • Describe the sensory organs of fishes. • Give the hill stream modifications of cold water fishes.	**Unit 2: Fish Biology (6 hrs)** Basic anatomy of fish - digestive, circulatory, respiratory, nervous and reproductive systems. Sensory organs and adaptive modifications-Lateral line system, swim bladder and weberian ossicles, electric organ, sound producing organ, light producing organ. Adaptive modifications of hill stream fishes.
• Describe the different fresh water ecosystems. • Discuss the different system of river zonation. • Describe the origin and classification of lakes.	**Unit 3: Fresh Water Ecology (3 hrs)** Freshwater ecosystem (lakes, wetlands, streams and rivers). River system and zonation. Lakes-origin, and classification.
• Describe the different physical and chemical parameters of water. • Explain the planktons, nekton and benthos.	**Unit 4: Limnological Parameters (6 hrs)** Physicochemical parameters - turbidity, temperature, pH, dissolved oxygen, dissolved CO_2, alkalinity, hardness, ammonia, phosphorus, BOD, COD etc. Biological parameters- phytoplankton, zooplanktons, nekton and zoo benthos.
• Discuss the status of inland water resources and inland fishery resources of Nepal. • Describe the major threats and conservation of capture fishery. • Explain the different systems of fish culture with their status. • Describe the fish culture techniques including the pond construction, cultivable species selection with stocking management.	**Unit 5: Fisheries (8 hrs)** **Concept of Capture and Culture Fisheries: Capture fishery-** Status of inland water resources and inland capture fishery in Nepal. Threats and conservation management of capture fishery. **Culture fishery -** Different systems of fish culture, status of fish culture and aquaculture. **Fish culture and management**- Pond engineering, criteria for selection of fish species for culture, characteristics of cultivable species, common cultivable fishes of Nepal, pre stocking and post stocking management.
• Describe the role of gonadotropin in fish breeding. • Discuss the induced breeding in indigenous major carps. • Discuss the management and rearing techniques of hatchling, fry, fingerling and broodstock.	**Unit 6: Fish Breeding and Management (4 hrs)** Role of gonadotropin in fish breeding. Induced breeding of indigenous major carps. Management and rearing of hatchling, fry, fingerling and broodstock.

Text and Reference Books

Bone, Q. and Moore, R. Biology of Fishes, Talyor and Francis Group, CRC Press, U.K.

Chapman, J.L., Reiss, M.J. Ecology: Principles and Applications (2nd edition) Cambridge University Press.

Colinvaux, P.A. Ecology. II Edition. Wiley, John and Sons, Inc.

Dash, M.C. Fundamentals of Ecology. Tata McGraw-Hill Publishing Company Limited.

Day, F. 1981. Fishes of India, Vol.I and Vol. II. William Sawson & Sons Ltd., London. Dreamland Publication, Kathmandu.

Evans, D.H. and Claiborne, J.D. The Physiology of Fishes, Taylor and Francis Group, CRC Press, UK.

Evans,D.H. 1998. The Physiology of Fishes, CRC Press, UK.

FAO. Species Identification Guide for fishery.

Groom, M.J., Meffe, G.K. and Carroll, C.R. eds. Principles of Conservation Biology. 3rd ed. Sinauer Assoc. Inc

Gupta, S.K and Gupta, P.C. 2014. General and Applied Ichthyology (Fish and Fisheries) Pub. S. Chand & Company Pvt. Ltd. New Delhi, India.

Jayaram, K.C.2002. Fundamentals of Fish Taxonomy, Narendra Publishing House, Delhi.

Jhingran, V.G. 1991. Fish and Fisheries of India. 3rd ed. Hindustan Publishing Corporation New Delhi, 727 p.

Khanna, S.S. 2006. An Introduction to Fishes. Silver Line Publications, New Delhi. Revised and Up-graded Edition.

Kormondy, E.J. Concepts of Ecology. Prentice Hall of India, New Delhi.

Krebs, C.J. Ecology. VI Edition. Benjamin Cummings.

Lagler, K.F., Bardach J.E., Miller R.R. and May Passino, D.R.2003. Ichthyology, John Wiley.

Odum, E.P. Fundamentals of Ecology. Indian Edition. Brooks/Cole.

Pillay, T.V.R., Aquaculture Principles and Practices, Blackwell Publishing, USA.

Primack, R.B., Poudel, P.K. & Bhattarai, B.P. 2013. Conservation Biology: A Primer for Nepal. Dreamland Publication, Kathmandu.

Ricklefs, R.E. Ecology. V Edition. Chiron Press.

Santhanam, N. Sukumaran and Natrajan, P. 1987. Fresh Water Aquaculture. Oxford and IBH Publishing Co. Pvt. Ltd.

Sharma, P.D. Ecology and Environment. Rastogi Publication.

Smith, R.L. Ecology and Field Biology. Harper Collins College Publisher.

Sodhi, N.S. and Ehrlich, P.R. Conservation Biology for All. Oxford University Press.

Srivastava, C.B.L. 1999. Fish Biology. Narendra Publishing House, Delhi.

Zijpp, V.D., Verreth, J.A.J., Tri, L.Q., Van Mensvoort, M.E.F., Bosma, R.H., and Beveridge, M.C.M. Fishponds in Farming Systems, Wageningen Academic Publishers, Netherlands.

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Far-Western University

Faculty ofScience and Technology

B. Sc. Syllabus of Zoology

Course Title: Ento., Para., Eco. & Fisheries Biology **Credit 2**
Nature of the Course: Practical **Number of inst. hours per week: 6**
Course No: ZOO483 **Total instruction hours: 90**
Year: Fourth
Semester VIII

- **Course Objectives:** To impart practical knowledge and better understanding of the topics on Entomology, Parasitology, Ecology & Fisheries Biology (ZOO481 & 482).

Course Contents :

Entomology

1. **Study of museum specimens and permanent slides** of pest species up to orders (using keys).
2. **Collection, preservation and identification**: of major crop pest species and insect vectors: Wet and dry preservation. (liquid preservatives, insect pinning, labeling and storing).
3. **Preparation of permanent slides**: whole mount of insects of economic importance and their parts as antennae, wings and mouth parts.
4. **Dissection:** Honey bees (sting), grasshoppers (nervous system).
5. **Insecticides & its application equipments**: Survey for synthetic chemical pesticides available in the market and their analysis. Observation of different kinds of sprayers and their parts with their functions during operation.

Parasitology

1. **Study of museum specimens/permanent slides:** of bacteria, protozoans and helminthes.
2. **Collection, preservation/slide preparation and identification of parasites.**
3. **Stool examination:** Examination of faecal samples for identification of intestinal parasites and eggs.
4. **Microphotography** of parasites. Identification of photos of different stages of parasites.
5. **Diagnostic tools:** Principle and use of *in vitro* diagnostic tools: Immunochromatographic Test (ICT) / Rapid Diagnostic Test (RDT) for different human diseases (malaria, filariasis, dengue etc).

Ecology

1. **Tools and techniques**: Principle and applications of Sechi disc, Altimeter, Soil thermometer, Min-Max thermometer, Maps, GPS. Quadrat: Determination of minimum

number and size. Determination of density/frequency/abundance of the vegetation by quadrat method.

2. **Soil**: Determination of water holding capacity and percolation rate of soil.
3. **Water:** Determination of physico-chemical properties of water (O_2, CO_2, chlorides, alkalinity, etc).
4. **Ecosystem:** Determination of primary productivity of aquatic and terrestrial ecosystem.
5. **Biodiversity**: Assessment; Estimation of population density of animals from aquatic and terrestrial habitat.

Fisheries Biology

1. **Identification of fishes:** Taxonomic study to identify the important locally available freshwater fishes of Nepal.
2. **Study of accessory respiratory organs:** in locally available fishes (Clarias, Channa, Anabas, Heteropneustes fossilis etc.)
3. **Water & Planktons:** Study of different water quality parameters and planktons.
4. **Pathogen of fishes:** Identification of pathogens and diseases of fishes.
5. **Gastro-somatic index:** Determination of GSI Gastro-somatic index).

Practical note book preparation as regular study.

Field training – Submission of report (in group/individual with photographic documentations). Survey of anyone place from the following locality (freshwater fish farm , poultry farm, animal husbandry, apiary, sericulture center, place of wild life interest, species diversity studies in local area, hospitals, market, agriculture farms, stored grains, field crops and vegetables etc) regarding any related topic and writing a report of about 5-10 pages.

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Far-Western University

Faculty ofScience and Technology
B Sc Syllabus of Zoology

Course Title: Ethnobiology **Credit 3**
Nature of the Course: Theory; Interdisciplinary **Number of inst. hours per week: 3**
Course No: ZOO484 **Total Instruction Hours: 45**
Year Fourth
Semester VIII

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

- Understand the overall concept of ethnobiology.
- Know some basic field and laboratory methods used in ethnobiology research.
- Explain the extensive applications of ethnobiology for human well-fare.

Course Description:

Specific Objectives	Units & Course Contents
• Familiarize with overview of ethnobiology, its evolutionary history, bio-cultural civilization, scope cum perspective and indigenous and modern knowledge system.	**Unit 1: Evolutionary history, Civilization, Scope and Perspective of Ethnobiology, Indigenous and Modern Knowledge System (8 hrs)** Definition of ethnobiology and its evolutionaryhistory. Past conferences, biological and cultural civilization. Scope and prospective of ethnobiology. Coining of terms related to Ethnozoology, Ethnobotany and Ethnobiology. Basic interactions between humans and their natural surroundings (human-animal relationship, human-plant relationship, and human-ecosystem relationship). Indigenous and modern knowledge system.
• Describe basic sub-disciplines of ethnobiology, multi-disciplinary relationship with other subjects and relationship between humans and natural surroundings.	**Unit 2: Basic Sub-disciplines of Ethnobiology (4 hrs)** Basic sub-disciplines of Ethnobiology: Ethnozoology, Ethnobotany, Ethnoecology. Multi-disciplinary relationship of ethnobiology with various subjects.

• Understand the various uses of medico-zoology, medico-botany and ethnopharmacology for treating various diseases along with its commercial applications.	**Unit 3: Medico-ethnobiology and Ethnopharmacology (6 hrs)** Medico-ethnozoology: Various uses of animal parts and products for treating different diseases. Medico-ethnobotany: Various useas of plants parts and products for treating different diseases. Ethnopharmacology: Various uses of traditional medicine for treating diseases of local communities including its commercial applications.
• Describe various field methods to collect ethnobiological data, and their identification and analysis in the laboratory.	**Unit 4: Field and Laboratory Methods of Ethnobiology (5 hrs)** Ethnobiological Guidelines for Field Visits, Research, Collections, Databases and Publications. Laboratory methods of animal and plant identification and tabulation.
• Give an account on status of ethnobiology in the world and Nepal.	**Unit 5: Status and Field of Ethnobiology (4 hrs)** Status of Ethnobiology in the World: Status of Ethnobiology with special reference to Nepal**.**
• Explain basic principles of ethnobiology very shortly.	**Unit 6: Principles of Ethnobiology (6 hrs)** **1.**Principle of Prior Rights and Responsibilities **2.** Principle of Self-Determination 3. Principle of Inalienability 4. Principle of Traditional Guardianship 5. Principle of Active Participation 6. Principle of Full Disclosure 7. Principle of Educated Prior Informed Consent 8. Principle of Confidentiality 9. Principle of Respect 10. Principle of Active Protection 11. Principle of Precaution 12. Principle of Reciprocity, Mutual Benefit and Equitable Sharing 13. Principle of Supporting Indigenous Research 14. Principle of The Dynamic Interactive Cycle 15. Principle of Remedial Action 16. Principle of Acknowledgement and Due Credit 17. Principle of Diligence.

• Understand the various applications of ethnobiology for human welfare.	**Unit 7: Various Applications of Ethnobiology (6 hrs)** (1)Sustainable Agriculture or Rural Development or Community Development, (2) Ethnobiology for Diversity Conservation, (3) Marginalized Land Use System, (4) Tropical Forest Management, (5) Ethnobiology for Eco-tourism , (6) Ethnobiology for Bioassy of Resources-Conservation and Biochemical Analysis, (7) Food and nutrition (8) Health-care and ethno-medicine (new bio-innovation), (9) Exchange and Trainings, (10) Religious studies, (11) Policy issues and Community rights.
• Understand the concept of intellectual property rights, personal property rights vs. collective property rights of ethnic groups.	**Unit 8: Role of Women and Ethnic Groups in Biodiversity Conservation (3 hrs)** Role of women in biodiversity conservation. Role of ethnic groups in biodiversity conservation initiatives. Native/indigenous peoples as the guardians of bio-resource conservation and protection.
	Unit 9: Intellectual Property Rights and the Position of Ethnobiology (3 hrs) Intellectual Property Law. Patents, Trademarks and Copyright. Personal Property Rights vs. Collective propertyRights of ethnic groups.

Text and Reference Books:

Anderson, E.N., Pearsall, D., Hunn, E., Turner, N. (2011): Ethnobiology. Published by Wiley-Blackwell, New Jersey, USA. ISBN: 978-0-470-54785-4

Jain, S.K. (1996): Ethnobiology in Human Welfare. Proceedings of IV International Congress of Ethnobiology held at Lucknow, India, during 17-21 November, 1994. Deep Publications, A-3/27A, D.D.A. Flats, Paschim Vihar, New Delhi-110063, India.

Martin, G.J. (1996): Ethnobotany: A Methods Manual. A 'People and Plants' Conservation Manual. Chapman & Hall, London, Weinheim, New York, Tokyo, Melbourne, Madras.

Singh, N.B. (1997): The Endangered Raute Tribe: Ethnobiology and Biodiversity. GLoRECA Kathmandu.

Suggested other documents:

*The Journal of Ethnobiology and Traditional Medicine: https://sites.google.com/site/photonfoundationorganization/home/the-journal-of-ethnobiology-and-traditional-medicine
*Journal of Ethnobiology and Ethnomedicine: https://link.springer.com/journal/13002
*ILO-convention 169: Indigenous and Tribal Peoples Convention, 1989
*United Nations Convention on Biological Diversity, June 5, 1992
*WTO and the TRIPS Agreement, 1995

[Practical field visit for interested:

(1) Making a report as a case study of various medicinal uses of animals and plants by specific ethnic group in the particular given area in Nepal.

(2) Preparing a report as a case of the different forms of indigenous knowledge system of particular ethnic groups in relation to biodiversity conservation in a given area.

(3) Making an in-depth documentation with ample description about the uses of traditional medicines by local communities for the treatment of various diseases.

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Far-Western University

Faculty ofScience and Technology

B Sc Syllabus of Zoology

Course Title: Bioinformatics **Credit 3**

Nature of the Course: Theory; Interdisciplinary **Number of inst. hours per week: 3**

Course No: ZOO485 **Total Instruction hours: 45**

Year: Fourth

Semester VIII

Course Objectives:

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

- Understand the overall usefulness of bioinformatics in research and human life.
- Know some the use of some tools and techniques for analyzing biodata.
- Explain very clearly the extensive applications of bioinformatics in various fields.

Course Description:

Specific Objectives	Units & Course Contents
• Familiarize with overview of history, scope and importance of bioinformatics in relation to biological data analysis.	**Unit 1: History, Scope and Importance of Bioinformatics (4 hrs)** Important contributions, Sequencing developing, Aims and tasks of bioinformatics, Applications of bioinformatics, Sequence homology analysis. Drug design, Predictive functions, Medical areas, Intellectual property rights, Challenges and opportunities.
• Describe various techniques of how to use computers, internet browsers, WWW, EMBnet, SRS and NCBI in order to analyze DNA and protein sequences and gene discovery as well.	**Unit 2: Computers, Internet, World Wide Web and NCBI (6 hrs)** Computers and programs, internet, World Wide Web, Browsers, EMBnet and SRS, NCBI. Background of DNA, RNA, Transcription, Translation and Proteins. DNA and Protein sequencing analysis: Genomics and proteomics, Genome mapping, DNA sequencing methods, Open reading frame, Determining sequence of a clone, Expressed sequence tag.

	2.4 Protein sequencing: Gene and protein expression analysis, DNA microarrays, Protein expression analysis, Gene discovery, Human genome project.
• Have knowledge of DNA and protein sequence databases along with their uses.	**Unit 3: Databases, Tools and their Uses (3 hrs)** Importance of databases, nucleic acid sequence databases, protein sequence databases. Structure databases, bibliographic databases and virtual library, specialized analysis packages, useof databases.
• Describe the goals and types of algorithm, sequence alignment methods and thereby domains within a protein structure can be identified by using the algorithm.	**Unit 4: Sequence Alignment (5 hrs)** Algorithm, goals and types of algorithm, study of similarities, scoring mutations, deletions, and substitutions. Sequence alignment methods: Pairwise alignment, Multiple sequence alignment. Algorithm for identifying domains within protein structure, algorithm for structural comparison. Carrying out a sequence search.
• Understand the basic concept of sequence alignment tools like BLAST, KLAST,FASTA, HMMER, Genoogle etc.	**Unit 5: Sequence Alignment Tools (5 hrs)** Concept of sequence alignment tools. BLAST: Reasons of BLAST popularity, using of BLAST, anatomy of BLAST report, BLAST table databases at NCBI FASTA: Different FASTA programs. Other available sequence alignment tools
• Understand the protein structure prediction and analysis, various protein databases and application of protein structure prediction.	**Unit 6: Protein Structure Prediction and Analysis (8 hrs)** Concept of protein structure prediction and analysis. Anatomy of amino acids. Structure of proteins: Primary structure, Secondary structure, Tertiary structure and Quaternary structure. Methods of protein structure prediction: Computational methods of protein structure prediction. Protein databases: Protein structure databases, Protein structure visualization databases, Protein structure alignment database. Application of Protein structure prediction.

• Understand the homology and be able to create phylogeny and evolutionary tree based on various tree-building methods.	**Unit 7: Homology, Phylogeny and Evolutionary Trees (6 hrs)** Homology and similarity, phylogeny and relationships. Approaches used in phylogenetic analysis, Phylogenetic trees, Tree-building methods Molecular approaches to phylogeny. Phylogenetic analysis databases.
• Realize the importance of drug discovery by the use of bioinformatics.	**Unit 8: Drug Discovery and Pharmainfomatics (4 hrs)** Discovering a drug. Target identification and validation. Identifying the lead compound. Optimization of lead compound. Pharmainformatics. Chemical libraries.
• Understand diverse applications of bioinformatics in various fields.	**Unit 9: Applications of Bioinformatics (4 hrs)** Concept and different fields of applications of bioinformatics: Molecular medicine, Personalized medicine, Drug design, Preventive medicine, Industrial research and development, Gene therapy, Microbial genome applications, Waste clean-up, Climate change studies, Alternative energy sources, Antibiotic resistance, Forensic analysis of microbes, Improvement of crops and nutritional qualities, Veterinary science, Comparative studies

Text Books

Pangeni, R.P. (2007): Concept of Bioinformatics. Published by Sukunda Pustak Bhawan, Bhotahity, Kathmandu, Nepal.

Ignacimuthu, S. (2006): Basic Bioinformatics. Narosa Publishing Hourse, New Delhi, Chennai, Mumbai, Kolkata, India.

References:

Lesk, A.M. (2014): Introduction to Bioinformatics. Oxford University Press, Great Clarendon Street, Oxford, Ox2 6DP, UK.

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Far-Western University

Faculty ofScience and Technology

B. Sc. Syllabus of Zoology

Course Title: Bioinstrumentation **Credit 3**

Nature of the Course: Theory; Interdisciplinary **Number of inst. hours per week: 3**

Course No: ZOO486 **Total instruction hours: 45**

Year: Fourth

Semester VIII

Course Objectives:

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

- Provide the basic knowledge of Biological Instrumentation
- Understand the general principles and working mechanism of instruments use in biological science.
- Develop skills in using biological instruments
- Impart practical knowledge related to molecular biology

Course Description:

Specific Objectives	Units & Course Contents
• Describe the basic principles and types of centrifugation.	**Unit 1 : Centrifugation (3hrs)** Introduction. Basic principles of sedimentation. Types, care and safety aspects of centrifuges. Preparative centrifugation. Analytical centrifugation
• Describe the basic principles and applications of Light microscope, phase contrast microscope, Fluorescence microscope, Electron microscope and Confocal microscopy.	**Unit 2 : Microscopy (5 hrs)** Principles and applications of Light microscope, Phase contrast microscope, Fluorescence microscope, Electron microscope and Confocal microscopy.
• Discuss the basic principles of interaction of electromagnetic radiation with matter. • Describe the principles, instrumentation and applications of UV/Vis spectrophotometers. • Describe the Fluorescence spectroscopy with its working principles and applications. • Describe the principles, instrumentation and applications of Luminometry. • Describe the principles, instrumentation	**Unit 3 : Spectrophotometry (8hrs)** Introduction, Ultraviolet and visible light spectroscopy, Fluorescence spectroscopy, Luminometry, Circular dichroism spectroscopy, Light scattering, Atomic, Infrared and Raman spectroscopy, Nuclear magnetic resonance.

and applications of Circular dichroism spectroscopy. • Explain the light scattering spectroscopy. • Describe the principles, instrumentation and applications of atomic spectroscopy. • Describe the principles, instrumentation and applications of Infrared and Raman spectroscopy. • Describe the principles, instrumentation and applications of Nuclear magnetic resonance.	
• Describe principles of chromatography. • Explain the Chromatographic performance parameters. • Describe principle, types, instrumentation and applications of HPLC. • Describe Ion-exchange chromatography with its principle, and applications. • Describe the principle and application of molecular (size) exclusion chromatography. • Describe the principle and application of Affinity chromatography. • Describe principle, instrumentation and applications of gas chromatography and MALDI, TOF mass spectrometry.	**Unit 4: Chromatography (6 hrs)** Principles of chromatography, Chromatographic performance parameters, High-performance liquid chromatography, Ion-exchange chromatography, Molecular (size) exclusion chromatography, Affinity chromatography, Gas chromatography, MALDI, TOF mass spectrometry.
• Describe the general principles of electrophoresis. • Describe the types of support media use in electrophoresis. • Describe the procedures for protein, DNA and RNA electrophoresis. • Explain the basic principles and modes of capillary electrophoresis.	**Unit 5: Electrophoresis (5 hrs)** General principles, Support media, Electrophoresis of proteins, Electrophoresis of nucleic acids, Capillary electrophoresis.
• Explain the nature of radioactivity. • Describe the detection, measurement and safety aspects of radioisotope.	**Unit 6: Radioisotope Techniques (3 hrs)** Nature of radioactivity, detection, measurements, safety aspects
• Describe the haemocytometer with its uses. • Describe coulter counter with its principle and applications. • Describe the principles, instrumentation, types and applications of flowcytometry.	**Unit 7: Cytometry (3 hrs)** Hemocytometer, Coulter counter, Flowcytometry, Fluorescence-activated flow cytometry (FACS), Hydrodynamic focusing and sheath flow, Cell sorting.

• Explain the chromosome banding techniques. • Describe the principles and techniques of cryopreservation of cells, tissues, organs and organisms. • Describe the histological techniques (fixation, microtomy, staining and mounting). • Describe the process of histo-chemistry. • Describe the principle and techniques of in situ hybridization.	**Unit 8: Cytohistological Techniques (6 hrs)** Chromosome banding techniques (G.C.Q. R. banding), Cryotechniques - Cryopreservation of cells, tissues, organs and organisms, Histological techniques - Principles of tissue fixation – Microtomy, Staining, Mounting, Histo-chemistry, In situ hybridization (radio labelled and non-radio labelled methods), FISH.
• Describe the principle, procedure and applications of Southern and Northern hybridization • Describe the principle, procedure and applications DNA Sequencing and Polymerase chain reaction (PCR). • Describe the basic principle, techniques and applications of autoradiography.	**Unit 9: Molecular Biology Techniques (4 hrs)** Southern and Northern hybridization, DNA Sequencing and Polymerase chain reaction (PCR), Autoradiography.
• Discuss the principle, applications and challenges of multiplexed binding assays. • Discribe the principle, procedure, types and applications of ELISA. • Describe the principle, procedure and applications of Microarrays.	**Unit 10: Binding Assays (2 hrs)** Multiplexed binding assays, Enzyme-linked immunosorbent assay (ELISA), Microarrays.

Text and Reference Books

Boyer. 1993. Modern Experimental Biochemistry. Benjamin.

Clark & Swizer. 2000. Experimental Biochemistry. Freeman.

Cooper. 1997. The Cell-A Molecular Approach. ASM.

Freifelder. 1982. Physical Biochemistry. Freeman.

John R.W. Masters. Animal Cell culture- A practical approach. IRL Press.

John G.Webster. Bioinstrumentation.

Locquin and Langeron. 1983. Handbook of Microscopy. Butterwaths.

Robert Braun. Introduction to instrumental analysis- -McGraw Hill.

Wilson and K.H. A biologist Guide to principles and Techniques of Practical Biochemistry, Goulding ElBS Edn.

Wilson and Wlaker. 2000. Practical Biochemistry. Cambridge.

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Far Western University

Faculty of Science and Technology

Course Title: **Project Work (Physical Science)**	Full Marks: **100**
Course Code: **PRW 481**	Pass Marks: **45**
Nature of Course: **Research / Presentation**	Credit: **3**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **Fourth**, Semester: **Eight**	Teaching Hours: **45**

Project Work

Course Title: **Project Work (Physical Science)**
Course No.: **PRW481**
Nature of the Course: **Research/Presentation**
Credit: **3**
Year: **Fourth**, Semester**: Eighth**
Level: **Undergraduate (B.Sc.)**

Course Description

The course intends to enable the students to be acquainted with the original research for the students of biological science under the supervision of supervisor.

Course Objectives

At the end of this course the students should be able:

- to understand the method of problem identification through literature review
- to acquire sufficient basic knowledge regarding the method of analysis
- to apply this knowledge to interpret the result
- to draw research conclusion and hence recommendation for future works

Guidelines

Thesis, dissertation and/or project work appear as an important component in almost all curricula these days like in Far Western University in order to achieve an academic University degree for its partial fulfillment. This component is understood as research activities in a broader sense. The difference between above terms depends upon the depth of expected knowledge and the duration of involvement in the proposed and registered work in the concerned department/institutions to be undertaken under the guidance of a supervisor.

Research in general is an essential ingredient of all fields of study as well as all professionals in order to become better equipped in the chosen field on interest. Research work increases the some of practical knowledge so far achieved in the area. It may be a replica of some other previous studies to test their findings and relevance, to make decisions about new developments, to redefine previous results or findings.

Research may be based on the search of materials in Journals, books, other publications, field surveys at different sites and samples or carefully defined new set of experiments, etc. But objectives have to be kept always in mind that some newness in results appear irrespective of the method followed to address research questions.

Project work in academic program initially at the level of B.Sc. like in far western University has very high value because it is the first stage involvement of students as research or researcher is concerned. Students learn almost all steps of research training and knowledge about chosen field or topic. It can also generate critical thinking for further research leading to higher academic degree.

All the terms mentioned above are guided research. Supervisors are supposed to be ethically committed to subject the ways and directions works to be performed so that a critical thinking of students about research develops. These are the reasons the methodology of research are almost the same in all above terms, quality or level of which may vary.

Methodology of project work begins with the problem identification and ends with its formal presentation in the presence of an interested audience having some knowledge about the subject together with the experts of the field. Dissemination of result findings, discussion and conclusion are equally important and carry a high value of research. Thus, every steps of performance is documented in a written form as per initially planned methodological design in a standard format where all the steps of the project works are discussed and described in systematic ways and clarity.

Activities performed in accordance with planned methodological research design and documented systematically in an approved format is may be called 'A Research Project'. Proper sequential documentation of main matter should be done in the following order:

- Title/Topic
- Literature Review
- Motivation and Objectives
- Methodology
- Results
- Discussions
- Conclusion and Future Extension of Works
- References
- Appendix

The front matter should be prepared in this way:

- Acknowledgement
- Recommendation
- Evaluation
- List of Figures
- List of Tables

- Content
- Abstract
- Main Matter

A committee of four examiners including the Head of concerned department, External Examiner, Internal Examiner and the Supervisor(s) be formed. Marking scheme is regulated as approved by the Faculty Board of Science Faculty of FWU.

The eligibility criteria of Supervisor and external examiner will be decided by the concerned faculty board. The faculty board will take opinion from the concerned department.

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Disaster Risk Management**	Full Marks: **100**
Course Code: **ENV 486**	Pass Marks: **45**
Nature of Course: **Elective course (Theory -Interdisciplinary)**	Credit: **3**
Level: **B. Sc.**	Number of hours per week: **3**
Year: **Fourth**, Semester: **Eight**	Teaching Hours: **45**

Course Objectives

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

1. Understand the concept of hazard, disaster, vulnerability, exposure and risk.
2. Identify key stakeholders involved in DRM in Nepal.
3. Acquire the knowledge of DRR practices and policies.
4. Assess vulnerability and risk assessment
5. Know the criteria for building risk resilient community

Specific Objectives	Contents
• Understand the terminology on DRR.	**Unit I: Understanding DRM (5Hrs)** Definition of hazard, vulnerability, exposure, risk; DRR and DRM; Hazard typology; Environmental degradation and disaster; DRR and climate change adaptation linkages.
• Develop ideas on disaster scenario and DRR stakeholders in Nepal.	**Unit II: Disaster in Nepal (5Hrs)** Spatial distributions of disasters; Documentations of disaster events in Nepal; Loss and damage scenario of disaster in Nepal; Disaster stakeholders in Nepal.
• Assess vulnerability and disaster risk.	**Unit III: Vulnerability and Risk Assessment (10 Hrs)** Conceptual framework of hazard, vulnerability and risk; Elements at risk; Types of vulnerability; Vulnerability and risk assessment approaches and methods.
• Understand key mitigations measures for reducing disaster risk.	**Unit IV: Disaster Mitigation Measures (10 Hrs)** Disaster risk and its influencing factors; Structural and non-structural mitigation measures; Coping and adaptation measures for risk reduction.
• Acquire the knowledge of building risk resilient community.	**Unit V: Risk Resilience (5 Hrs)** DRR and biodiversity conservation; DRR and sustainable development; Community

	based and ecosystem based approach for risk resilience; DRR and Gender; Mainstreaming DRR into Development; Minimum characteristics of risk resilient community.
• Acquire knowledge on global and national initiatives on DRR.	**Unit VII: DRM Practices and Policy in Nepal (10 Hrs)** Global and National evolution of DRM; DRM cycle; Comprehensive and community based DRR; Participatory disaster risk assessment tools; Cluster Approach on DRM; Legislation on DRM in Nepal; Hyogo and Sendai Framework for Action.

References

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4. Sharma, A. P. (2011). Integrating climate change adaptation and disaster risk reduction. NGO Network Bulleting on Climate Change, Issue 4, October 2011, LIBIRD, Pokhara.
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FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Ecosystem Services Management**		Full Marks:	**100**
Course Code: **ESM 484**		Pass Marks:	**45**
Nature of Course: **Theory (Interdisciplinary)**		Credit:	**3**
Level: **B. Sc.**		Number of hours per week:	**3**
Year: **Fourth**, Semester: **Eight**		Teaching Hours:	**45**

Course Objectives

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

- Understand the basic concepts of ecosystem theories, ecosystem services, resilience & adaptability, payment for ecosystem services
- Develop ecological indicator, analyze and evaluate ecosystem services, asses human environmental system and landscape capacities to provide ESs,
- Understand the role of ecosystem service approach in natural resource management and effect on human beings
- ware on key national and international institutional Framework/ Policy/Program related to ecosystem services

Specific Objectives	Contents
• Understand the basic concepts of ecosystem theories	**Unit I: Introduction (7 Hrs)** Ecosystem: structural components, functional components; Energy sources for ecosystem dynamics; Ecosystem metabolism (Primary and secondary production); Biogeochemical cycles; Ecological stability; Homeostasis and feedback mechanism; Human impacts on ecosystem
• Understand ecosystem services along with typology • Understand the relation between ecosystem services, ecological resilience and adaptability	**Unit II: Ecosystem Services (8 Hrs)** Concepts of ecosystem services and evolution of the concept; Typology of ecosystem services; Overview of ecosystem service cascade; Biodiversity and ecosystem services; Relation between ecosystem services, ecological resilience and adaptability; challenges of ecosystem services; issues/threats to the ecosystem
• Know various techniques and methods for valuation and quantification of ecosystem services	**Unit III: Evaluation and Quantification of Ecosystem Services (10 Hrs)** Ecosystem functions; Major ecosystem services; Services from various types of ecosystems; Classification for valuation of ecosystems services: types of evaluation of ecosystem services (ecological and economic

	valuation); Economic value of ecosystem service; Consumptive use; productive use; Assessment/analysis of ecosystem services; Quantification of ecosystem services; Analysis of ecosystem services tradeoffs
• Acquaint with the piloting and implementation of PES (Payment for Ecosystem Services)	**Unit IV: Payment for Ecosystem Services (PES) (10 Hrs)** Definition of PES; PES practices in national and international level; Development of PES mechanism; Stakeholders: service providers, beneficiaries & intermediaries; Guidelines of piloting and implementation of PES mechanism; PES as a viable option for financing biodiversity conservation and management
• Know different categories of Protected in Nepal • Understand the role of protected areas for ecosystem services	**Unit V: Protected Areas and Ecosystem Services (6 Hrs)** Protected areas in Nepal; Categorization of protected areas in Nepal; IUCN Management Categories of Protected Areas; Need and importance of protected areas for ecosystem services; Ecosystem services and ecotourism; Pollution and impact on ecosystem services; Ecological restoration
• Understand policy perspectives on ecosystem services management	**Unit VI: Policy Perspectives on Ecosystem Services Management (4 Hrs)** Relevant policies and laws (PES Policy); Ecosystem service governance; Challenges, limitations and opportunities for ecosystem services management; Involved institutions

References

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2. Bennett, J. (2011). The International Handbook on Non-market Environmental Valuation. Edward Elger Publishing Ltd., ISBN 978-1-84844-425-6
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4. Burkhard, B., F. Kroll, F. Müller and W. Windhorst. (2009). Landscapes' Capacities to Provide Ecosystem Services – a Concept for Land-Cover Based Assessments. *Landscape Online* 15: 1-22
5. Carl Folke, C. (2006). Resilience: The Emergence of a Perspective for Social–Ecological Systems Analyses. *Global Environmental Change* 16: 253–267.

6. Costanza, R. (2009). Handbook of ecological indicators for assessment of ecosystem health, CRC Press/ Taylor and Francis, ISBN 1439809364, 9781439809365.
7. Daily, G.C. (1997). Introduction: What are ecosystem services? In G. Daily, editor. Nature Services: Societal Dependence on Natural Ecosystems. Island Press, Washington, D.C Costanza.
8. de Groot, R.S., Wilson, M.A. and Boumans, R.M. (2002). A Typology for the Classification, Description and Valuation of Ecosystem Functions, Goods and Services. *Ecological Economics,* 41: 393–408.
9. R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, O.V., Paruelo, J.M., Raskin, R.G., Sutton, P. and van den Belt, M. (1997). The Value of the World's Ecosystem Services and Natural Capital. *Nature,* 387: 253–260.

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

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

Course Objectives

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

Carry out environmental assessment (IEE/EIA) of development projects
Identify and analyze the environmental consequences due to developmental projects
Prepare Environmental Management Plan (EMP) of development works
Review IEE/EIA reports and comment on the quality of environmental assessment reports

Practical

1. Carry out environmental assessment (IEE/EIA) of any development projects (identify impacts, predict impacts, rank impacts and compare alternatives).
    a. Road construction
    b. Dumping/landfill site construction
    c. Hospital construction
    d. Hotel construction

    (*The practical involves Case Study approach. It essentially involves preparation of baseline information related to physical, biological, socio-economical and cultural environments. Further, it also identifies mitigation measures for the identified impacts and prepares environmental monitoring and auditing plan*.)
2. Prepare Environmental Management Plan (EMP) of Development Works (as mentioned in Practical 1)
3. Review of IEE/EIA reports
    (*Students will go through available IEE/EIA reports and critically/thoroughly examine the different sections of reports, prepare review reports and comment upon the quality of the reports. This will familiarize students with the different components of the IEE/EIA reports and help them prepare better quality reports in their future endeavours/assignments*.)

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FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Environmental Assessment and Management System**	Full Marks:	**100**
Course Code: **ENV 481**	Pass Marks:	**45**
Nature of Course: **Theory (Core Course)**	Credit:	**4**
Level: **B. Sc.**	Number of hours per week:	**4**
Year: **Fourth**, Semester: **Eight**	Teaching Hours:	**60**

Course Objectives

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

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

Specific Objectives	Contents
• Understand linkages between development and environment • Understand importance of environmental assessment in reconciling development and environment	**Unit I: Introduction to Environmental Assessment (7 Hrs)** Development and environmental consideration; Tools for the environment inclusion in Development; Initiation of Environmental Assessment; History of Environmental Assessment; Legal requirement of Environmental Assessment; Project development; Components of project cycle; Environmental inclusion on various steps of project cycle;
• Acquaint with environmental assessment process (in context of Nepal) • Differentiate between IEE and EIA • Know methods of collecting baseline information	**Unit II: Environmental Assessment Process (12 Hrs)** Environment Assessment (EA) and its types; The EA Process; Environmental screening; Scoping to determine the Terms of Reference (TOR); Terms of Reference; Initial Environmental Examination (IEE)/Environmental Impact Assessment (EIA)(differences); Types of impact; Baseline information (physical, biological, social, economic and cultural environment); Methods of collecting baseline information; Issues identification; Mechanism to give the weightage for issues; Prioritization of issues; Project Alternatives Analysis; Potential Impact Identification
• Understand different	**Unit III: Impacts Assessment Techniques (10**

methods of impact identification • Know methods of impact prediction	**Hrs)** Methods of impact identification: Checklist, interaction matrix, overlay mapping, networks, GIS, task specific computer model, expert system; Impact prediction: introduction, method of impact prediction, uncertainty of impact prediction, impact ranking and comparison of alternatives; Evaluation and determination of significance; Categorization of impacts
• Understand various impact mitigation measures including public participation	**Unit IV: Impact Mitigation Measures (5 Hrs)** Mitigation measures; Public participation and consultations; Challenges and opportunities of public involvement; Environmental Management Plan (EMP)
• Get insights on environmental monitoring and auditing • Take insights on quality and review of EIA reports	**Unit V: Environmental Monitoring and Auditing (7 Hrs)** Monitoring: introduction and types of monitoring, monitoring criteria and methodologies, monitoring indicators and monitoring processes; Environmental auditing: introduction, types of audit, timeframe for conducting audit, environment auditing plan; Quality and review of EIA reports
• Understand environmental management system with different tools and their application • Introduce quality management system • Know different stages of EMS implementation and certification process of EMS	**Unit VI: Environmental Management System (12 Hrs)** Environmental management tools and their application: Green Productivity (GP), Environmental Management System (EMS), Cleaner Production (CP) and Life Cycle Assessment (LCA); Introduction to International Organization for Standardization (ISO) and ISO 14000 series; Historical development of EMS; Introduction and requirements of EMS; Introduction of Quality Management System (QMS); Stages of EMS implementation; environmental review, identification of significant environmental aspects, documentation requirements of EMS, environmental policy, objectives, targets and programs, operation control, review; Certification process of EMS; EMS auditing and Mechanism for certification in Nepal
• Understand Environmental Assessment related legal aspects in Nepal	**Unit VII: Legal Aspects in Environmental Assessment (7 Hrs)** Environmental Assessment related legal aspects in Nepal; National legislative framework: Environment Protection Act (EPA), Environment Protection Rule (EPR); Sectoral environmental

	legislations: national strategy, plans and polices, guidelines, manuals and standards; Legislative framework; International convention and treaties; Major international conventions adopted by Nepal

References

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4. ISO, 2015. ISO 14001:2015. International Organization of Standardization, Geneva, Switzerland. ISBN: 978-67-10648-9.
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FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

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

Objectives

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

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

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

	Credit, Clean Development Mechanism (CDM), Reducing Emission from Deforestations and Forest Degradations (REDD); Experience and examples from Nepal on Carbon Credit, CDM and REDD
• Know various types of natural resources • Understand scarcity of natural resources and its consequences	**Unit III: Economics of Natural Resources (8 Hrs)** Types of resources: Renewable and non renewable; Theories of natural resource use: Elementary capital theory, Models for renewable resources with logistic growth and maximum sustainable yield, Models for non renewable resources; Natural resource scarcity; Resource substitutability and consequences of increasing resource scarcity; Social welfare function and optimal allocation of natural resources; Example of commercial forestry economics from Nepal
• Acquaint with various instruments for achieving pollution control targets	**Unit IV: Economics of Pollution Control (10 Hrs)** Criteria for choice of pollution control instruments; Cost efficiency and cost-effective pollution abatement instruments; Instruments for achieving pollution abatement targets; Economic incentive (quasi-market) instruments; Comparison of relative advantages of command and control, emissions tax, emission abatement subsidy and marketable permit instruments
• Know various methods and techniques for valuation of environmental goods and services • Understand the importance of payment for ecosystem services (PES) in Nepalese context	**Unit V: Ecosystem Services and Natural Capital (16 Hrs)** Introduction to ecosystem services and goods; Types of ecosystem services; Valuation of environmental goods and services: Dimensions of value, Benefit Cost Analysis (BCA) (Meaning, Components and Steps) with examples and calculations, Market vs. non market valuation; Theory of environmental valuation; Methods for valuing environmental costs and benefits: Contingent Valuation method (CVM), Willingness to Pay (WTP) and Willingness to Accept (WTA), Travel Cost Method (TCM), Hedonic Pricing Method) with examples and calculations; Payment

	for ecosystem services: Theoretical perspectives, Opportunities, Approaches and Deals; Examples of PES from Nepal
• Know theory and practice of accounting for environment	**Unit VI: Accounting for Environment (6 Hrs)** Environmental indicators; Environmental accounting theory; Environmental accounting practice; Sustainability indicators; Alternative measures of economic welfare and Green accounting; Green economy and green governance

References

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FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Integrated Water Resource Management**		Full Marks:	**100**
Course Code: **ENV 484**		Pass Marks:	**45**
Nature of Course: **Theory (Core Course)**		Credit:	**4**
Level: **B. Sc.**		Number of hours per week:	**4**
Year: **Fourth**, Semester: **Eight**		Teaching Hours:	**60**

Course Objectives

Upon completion of this course Student will able to

- Acquaint with the principles and applications of IWRM.
- Make an understanding of relation between disaster and climate change with water resources.
- Provide knowledge on wise use of water in various sectors.
- Provide knowledge on water resources planning and management.

Specific Objectives	Units, Contents and Credit Hours
• Understand the basics of integrated water resource management (IWRM)	**Unit I: Basics of IWRM (5 hours)** Concept of Integration; Principle of IWRM; Pillars of IWRM; Factors affecting IWRM; Concept of Integrated Watershed Management; Concept of Integrated River Basin Management
• Understand the wise use freshwater resources in agriculture and aquaculture • Understand the wise use freshwater resources in hydropower • Acquaint with the scenario of water supply and sanitation • Understand the urban and industrial water management	**Unit II: Wise use of Freshwater Resources (15 hours)** **Agriculture and Aquaculture** Water use efficiency of crop and its improvement : crop water requirements and practical irrigation scheduling , irrigation types, irrigation water quality and environmental impacts aquaculture technique and its water quality **Hydropower Development** Types and components of hydropower plants; reservoir design and function storage zones; capacity yields relation; fixation of reservoir capacity with mass curve determination of reservoir capacity for a given yield from a reservoir of given capacity; estimation of demands and optimized reservoir operations; flood

	routing : sedimentation , trap efficiency and life of a reservoir; silting control and water quality management; environmental flow: concept, estimation and Nepalese perspectives; **Water supply and Sanitation** Water sources and availability; Water supply and sanitation: trend and status; factors affecting water demand; water supply design criteria and distribution system; problem for supply of water; key principles of ecological sanitation; simplified sewerage; decentralized water and sanitation systems. **Urban and Industrial Water Management** Water ecosystem in urban areas; effects of urbanization on water resources; water footprint; management of urban water; industrial water use; hydrological view point for feasibility for industrial development new technologies applied in water use and waste water in industrial sectors.
• Understand climate change impacts on water resources	**Unit III: Climate Change (5 hours)** Climate change impacts on Water resource; Projection of changes in availability of drinking water and its demand; Estimation of Changes in Hydrological Parameters: Rainfall, Snow, Evapo-transpiration, Soil Moisture and Runoff; Vulnerability of water resources due to climate change; Mitigation and Adaptation measures and their effectiveness
• Understand various aspects of water induced disasters	**Unit IV: Water Induced Disasters (5 hours)** Landslides and Erosion; Flood and Inundation; Glacial Lake outburst Floods; Landslide dam Outburst Floods; Drought; Cloud burst; Effect of changes in monsoon pattern on water resources; Hazard probability and risk; Risk and Vulnerability Mapping of water induced disasters; Cases studies in water induced disasters
• Take knowledge on water governance and policy in regional, national and global contexts	**Unit V: Water Governance and Policy (5 hours)** Water Governance: Introduction; Riparian Rights; Trans-boundary aspects of Water governance; Issues of water Governance; Water Governance Initiatives (International): Millennium Development Goals and other water course laws; Water Governance (Nepal): water Policy of Nepal, water Resources strategy, Nepal water Plan; Water Treaties: National and International

• Understand the fundamentals of water resources planning and management	**Unit VI: Water Resources Planning and Management (10 hours)** Water Resource Planning: Basic Concepts; Multipurpose project: Objectives and Economics; Water demand Assessment; Cost Benefit Analysis in water resource planning; Water resources management tools and approaches: Inter Basin Transfer, Taping Groundwater, Rainwater harvesting, Construction of Dam , indigenous technologies; Institutional Arrangements in water resources management; Case studies Water Resource planning and Management in Nepal

Reference Books

1. Miller, Jr. G.T., 2010. Environmental Science. Thirteen Edition. Brooks/Coles Ceenage learning, USA
2. APHA, 1998. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington, DC.
3. Goel, P.K., 2001. Water pollution: Causes, Effects and Control, New age International publishers
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FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Chemistry Lab 8
Course No.: CHM483
Nature of Course: Practical — Credit: 2
Level: B. Sc. — Number of hours per week: 6
Year: Fourth, Semester: Eighth — Teaching Hours: 90
(In laboratory course, 1 credit will amount to 3 hours of classes per week)

1. Course Description:

The course intends to enable the students to be skilful in the basic chemical laboratory techniques of physical, organic and inorganic branches of chemistry. Students will be introduced to scientific method of experimentation. They will develop skill on performing an experiment, observing and recording results and judiciously interpreting the results.

2. Course Objectives:

The general objectives of the course are as follows:

- To enable the students to perform experiments on conductometric & potentiometric titrations, buffer solution, spectrophotometric analysis, phase diagram and surface properties.
- To enable the students to perform experiments on spectra analysis, preparation & synthesis, estimation of organic compounds.
- To enable the students to perform the experiment on chemical oxygen demand (COD), volumetric analysis, colorimetric analysis and paper chromatography.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Enable the students to find the concentrations of acids in a mixture of strong & weak acid by conductance measurement. • Enable the students to estimate the concentrations of halide ions in a mixture of KCl & KI solution by potential measurement. • Enable the students to prepare acid buffer solution from a mixture of acidic acid & sodium acetate using Henderson's equation and check their values by a pH meter. • Enable the students to estimate the rate constant & half-life time of a oxidation reaction of ethyl alcohol and potassium dichromate in presence of acid. • Enable the students to find out the λ_{max} & ε for ferric-thiocynate complex and also estimate the iron in a locally collected water sample. • Enable the students to determine the CMC of the locally available soap/detergent powder by surface tension measurement. • Enable the students to estimate the freezing point curve and construct a	**Unit I: Physical Chemistry Practical (30 hrs)** 1. To carry out conductometric titration between a mixture of sulfuric & acetic acids against sodium hydroxide solution. 2. To determine concentrations of Cl^- and I^- in mixture of KCl & KI solution potentiometrically. 3. To prepare standard buffer solutions of 4.0, 4.5, 5.0, 5.5 pH using CH_3COOH and CH_3COONa solutions and measure the pH of solution by a pH-meter. 4. To determine rate constant and half-life time of the oxidation of ethyl alcohol with potassium dichromate in acidic media. 5. To determine the λ_{max} and molar absorbtivity coefficient (ε) for ferric-thiocynate complex and also to determine the concentration of iron in a given sample of water using spectrophotometer. 6. To determine the critical micelle concentration (CMC) of a soap or detergent by surface tension method using a stalagmometer.

phase diagram of a mixture of naphthalene & biphenyl.	7. To determine the freezing point curve of the mixture of naphthalene and biphenyl and also to construct a phase diagram.
• Enable the students to elucidate the structure of some simple organic compounds by spectral Analysis. • Enable the students to synthesize cinnamic acid by Perkin reaction. • Enable the students to prepare pure aspirin in laboratory and to estimate the aspirin in the given 50 gram tablet. • Enable the students to analyze the naturally occurring organic or synthetic compounds from recorded UV spectra. • Enable the students to carry out an experiment on green chemistry. • Enable the students to estimate the ascorbic acid in the given Vitamin-C tablet iodometrically.	**Unit II: Organic Chemistry Practical (30 hrs)** 1. Structure elucidation of some simple organic compounds by spectral Analysis (spectra of simple organic compounds including aliphatic and aromatic hydrocarbon, alcohols, aldehydes, ketones, carboxylic acid, amines, etc will be provided and students are required to interpret the given spectra and find out the structures of organic compounds). 2. Synthesis of cinnamic acid by Perkin reaction 3. Preparation of aspirin. 4. Determination of the amount of aspirin present in the given 150 mg aspirin tablet by indirect titration against the standard HCl. 5. Record and analysis of UV spectra of some naturally occurring organic compound (quercetin) or synthetic compounds. 6. An experiment on green chemistry. 7. Estimation of ascorbic acid in vitamin C tablet iodometrically.
• Enable students to perform experiment to determine chemical oxygen demand (COD) in water sample. • Enable the students to perform experiment to determine the amount of manganese and magnesium in a mixture. • Enable the students to perform experiment to determine the amount of copper and cadmium in a mixture volumetrically and gravimetrically. • Enable the students to perform experiment to determine the available chlorine in bleaching powder. • Enable the students to perform experiment on spot test analysis of salt mixture containing two cations and two anions. • Enable the students to perform experiment on qualitative analysis of group I cations by thin layer chromatography.	**Unit III: Inorganic Chemistry Practical (30 hrs)** 1. Determination of chemical oxygen demand (COD) in a given sample of water. 2. Determination of amount of magnesium and manganese in a given mixture solution by EDTA. 3. Determination of amount of copper and cadmium in a mixture volumetrically. 4. Determination of amount of copper and cadmium in a mixture gravimetrically. 5. Determination of available chlorine in bleaching powder by using potassium bromate. 6. Spot test analysis of a given salt mixture (two cations and two anions). 7. Qualitative analysis of Group I cations by thin layer chromatography.

Note: Before the start of an experiment, the teacher presents a lecture on the details of the experiment including the safety considerations. Each student will perform independently all the experiments prescribed in both practical class and examination. Students should complete all the experiments prescribed.

Students need to write a laboratory report on each experiment they perform and get them duly checked and signed by the concerned teacher. They should write their reports in a chemistry practical copy and to keep them neat and properly.

4. Prescribed Texts for CHM473

1. David P. Shoemaker, Carl W. Garland & Joseph W. Nibler, **Experiments in Physical Chemistry,** 5th Edition, McGraw-Hill Book Company, 1989.
2. B. P. Levitt, ed. **Findlay's Practical Physical Chemistry**, Longman, London, 1973. (Latest Edition).
3. J. N. Gurtu & A. Gurtu, **Advanced Physical Chemistry Experiments**, 4th Edition, Pragati Prakashan, 2008.
4. N. M. Khadka, S. D. Gautam & P. N. Yadav, **A Core Experimental Chemistry for B.Sc.***,* Heritage Publication, Kathmandu, 2016.
5. B. S. Furniss, A. J. Hannaford, P. W. G. Smith & A. R. Tatchel, **Vogel's Text Book of Practical Organic Chemistry**, 5th Edition, Person Education, 2005.
6. L. Shriner, R. C. Fusion & D. Y. Curtin, **The Systematic Identification of Organic Compounds, A Laboratory Manual**, John Wlley and Sons Inc, New York, 1980. (Latest Edition).
7. N. S. Gnanapragasam & G. Ramamurthy, **Organic Chemistry– Lab Manual,** S. Viswanathan Co., Pvt., India, 1998.
8. **Vogel's Text Book of Inorganic Qualitative Analyses**, 4th Edition, ELBS, London, 1974. (Latest Edition).
9. P. N. Yadav, M. R. Pokhrel & S. Shrestha, **Advanced Practical Inorganic Chemistry,** Kshitiz Publication, Kahmandu, 2017.
10. M. K. Sthapit & R. R. Pradhananga, **Experimental Physical Chemistry**, Taleju Prakasan, Kathmandu, 1998.
11. K. N. Ghimire, M. R. Pokhrel & K. P. Bohara**, University Experimental Inorganic Chemistry**, Quest Publication, Kirtipur, Kathmandu, 2008.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Chemistry X — F.M.: 100
Course No.: CHM481 — P.M.: 45%
Nature of Course: Theory — Credit: 4
Level: B. Sc. — Number of hours per week: 4
Year: Fourth, Semester: Eighth — Teaching Hours: 60

1. Course Description:

The course intends to enable the students to be acquainted with the knowledge of advanced chemistry in all three branches of physical, organic and inorganic chemistry. Students will be familiarized with the fundamentals of the classification of solids based on band theory, structure determination & defects of solid crystals, quantum chemistry & statistical mechanics, structural determination of different organic compounds using various spectroscopic methods, coordination complexes especially their IUPAC nomenclature, isomerism, bonding, spectra and magnetism.

2. Course Objectives:

The general objectives of the course are as follows:

- To familiarize the students with fundamental knowledge of the classification of solids based on band theory, structure determination & defects of solid crystals, fundamentals of quantum chemistry & statistical mechanics.
- To enable the students to elucidate the structure of organic compounds by mass spectrometry, infrared, nuclear magnetic resonance and ultraviolet spectroscopic methods and conjugated compounds.
- To enable the students with basic knowledge of IUPAC naming of coordination complexes and acquaint them with different types of isomerism.
- To familiarize the students with basic concept of valence bond theory and crystal field theory to explain the nature of bonding, spectra and magnetism of coordination complexes.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Explain the salient features of band theory of solid. • Describe different types of bands in solids/crystals. • Discuss the classification of solids on the basis of band formation and properties of conductor, semiconductor, insulator and superconductors.	**Physical Chemistry** **Unit I: Band Theory of Solids (3 hrs)** Band theory of solid, types of bands in solid/crystal, classification of conductor, semiconductor, insulator and superconductor solids based on the formation of band and their properties.
• Describe the interplanar distance in cubic system. • Explain the Bragg's method of crystal analysis. • Derive the Bragg's equation & discuss its application to determine the interplanar distance, wave length of X-ray & structure of NaCl and KCl crystals. • Qualitative discussion on different types of crystal defects like point, line & plane defects. • Explain the color centers & F-center formation.	**Unit II: Structure and Defects of Crystals (7 hrs)** Interplanar distance in cubic system, Bragg's method of crystal analysis, Bragg's equation and its applications, calculation of interplanar distance (d) and wave length of X-ray (λ), structure of NaCl and KCl crystals, crystal defects: point defects- Frenkel, Schottky & self-interstitial, line defects- edge & screw dislocations, plane defects- grain boundary & stacking faults, color centers and formation of F-centre.
• Introduce the quantum chemistry and describe its historical background. • Describe about the wave-particle duality. • Derive the time independent Schrödinger	**Unit III: Quantum Chemistry (6 hrs)** Introduction, historical background of quantum mechanics (Max Planck to Schrödinger), wave-particle duality, time independent Schrödinger

wave equation. • Show that $\|\Psi\|^2 = \Psi^*\Psi$ is the probability distribution function of the system. • Describe the terms of orthogonality & normalization and their conditions. • State & explain briefly the postulates of quantum mechanics.	wave equation, wave function and probability, concept of orthogonal and normalized wave functions, postulates of quantum mechanics.
• Introduce and explain the history of the statistical mechanics. • Explain the concepts of phase space, ensemble. • Derive an equation showing the relation between entropy & thermodynamic probability. • Obtain a final expression of Maxwell-Boltzmann distribution equation & evaluate the Maxwell-Boltzmann constants.	**Unit IV: Statistical Mechanics (4 hrs)** Introduction, history of statistical mechanics, concept of phase space, ensemble, entropy and thermodynamic probability, distribution of identical but distinguishable particles, Boltzmann distribution law.
• Explain the modern spectroscopic techniques of structure elucidation of organic compounds. • Discuss about the principle and techniques of mass spectrometry in structure elucidation. • Explain the mass spectra of small molecules. • Describe the instrumentation of mass spectrometer. • Describe the mass spectra of different functional groups. • Discuss the properties of electromagnetic spectrum. • Explain the principle and instrumentation of IR spectrophotometer. • Explain the IR spectrum of different functional groups.	**<u>Organic Chemistry</u>** **Unit V: Structure Determination– Mass Spectrometry and Infrared Spectroscopy (7 hrs)** Mass spectrometry of small molecules: magnetic-sector instruments, interpreting mass spectra, mass spectrometry of some common functional groups, mass spectrometry in biological chemistry: time of flight (TOF) instruments, spectroscopy and the electromagnetic spectrum, infrared spectroscopy, interpreting infrared spectra, infrared spectra of some common functional groups.
• Discuss the principle, instrumentation and application of NMR spectroscopy in structure elucidation of organic compounds. • Explain the NMR phenomenon and chemical shift value. • Describe the applications of 13C-NMR spectroscopy in structure elucidation of organic compounds. • Discuss the meaning and applications of chemical shift, spin- spin coupling and coupling constant in structure elucidation. • Explain the spectra of some simple organic compounds. • Describe the meaning of integration value in NMR. • Discuss the some more complex spectra of organic compounds.	**Unit VI: Structure Determination– Nuclear Magnetic Resonance Spectroscopy (5 hrs)** Nuclear magnetic resonance spectroscopy, the nature of NMR absorption, chemical shift, ^{13}C-NMR spectroscopy: signal averaging and FT-NMR, characteristics of ^{13}C-NMR spectroscopy, DEPT ^{13}C-NMR spectroscopy, uses of ^{13}C-NMR spectroscopy, ^{1}H-NMR spectroscopy and proton equivalence, chemical shift in ^{1}H-NMR spectroscopy, integration of ^{1}H-NMR absorption: proton counting, spin-spin splitting in ^{1}H-NMR spectra, more complex spin-spin splitting patterns, uses of ^{1}H-NMR spectroscopy.
• Describe the structure and stability of dienes. • Discuss electrophilic addition reactions of some conjugated dienes. • Explain the stability of allylic carbocation. • Describe the kinetics and thermodynamic control reactions.	**Unit VII: Conjugated Compounds and Ultraviolet Spectroscopy (8 hrs)** Stability of conjugated dienes: molecular orbital theory, electrophilic addition to conjugated dienes: allyliccarbocation, kinetic versus thermodynamic control of reactions, the Diels-Alder cyclo-addition reaction, characteristics of Diels-Alder reaction, diene polymers: natural

• Explain the mechanism of Diels-Alder reaction and cyclo-addition reaction. • Discuss the properties of diene polymers. • Discuss the theory, instrumentation and applications of ultraviolet spectra. • Describe the applications of UV spectroscopy in diene. • Discuss the effects of conjugation in organic molecules. • Discuss the UV spectra of some organic compounds. • Discuss the applications of UV spectroscopy in structure elucidation of some simple molecules.	and synthetic rubber, structure determination of conjugated dienes: ultraviolet spectroscopy, interpreting ultraviolet spectra: the effect of conjugation, conjugation, color, and the chemistry of vision, applications of UV spectroscopy.
• To explain the naming of coordination compounds based on the revised rules of IUPAC. • To describe the different types of isomerism that exists in coordination compounds. • To work out the number of isomers for compounds of the type $[M(AA)a_2b_2]$, $[M(AB)_3]$, $[Ma_4b_2]$, $[Ma_3b_3]$	**Inorganic Chemistry** **Unit VIII: Coordination Compounds (5 hrs)** IUPAC nomenclature of coordination compounds including bridged complex, isomerism in coordination complexes: a) conformation isomerism b) ionization isomerism c) hydrate isomerism d) coordination isomerism e) linkage isomerism f) coordination position isomerism g) ligand isomerism h) polymerization isomerism i) geometrical isomerism j) optical isomerism k) valency isomerism.
• To develop a general understanding of basic concepts of valence bond theory and crystal field theory. • To understand the modification needed in simple crystal field theory. • To explain the different parameters which affect the magnitude of crystal field splitting. • To understand the applications of crystal field stabilization energy. • To know the selection rules for electronic transitions. • To understand the concept of hole formalism. To explain the nephelauxetic effect and to understand the role of ligand. • To be familiar with the different tools employed for characterization of coordination compounds including magnetic methods. • To explain the thermodynamic aspectsof complexes with an understanding of thermodynamic and kinetic stability, stepwise and overall stability constants.	**Unit IX: Coordination Chemistry (15 hrs)** Bonding, Spectra and Magnetism: Bonding in coordination compounds, valence bond theory, d^2sp^3 hybridization in inner orbital complexes, sp^3d^2 hybridization in inner orbital complexes, sp^3, dsp^2 and dsp^3 hybridization. Crystal field theory: important features, factors affecting the magnitude of Δ, application of crystal field theory. Jahn Tellor distortion, application of crystal field stabilization energies (CFSE). Introduction to molecular orbital theory and ligand field theory, selection rules for electronic transition, hole formalism and nephelauxetic effect. Characterization of coordination compounds by spectroscopic and magnetic methods, thermodynamic and kinetic aspects of metal complexes.

Note: The figures in the parentheses indicate the approximate periods for the respective units.

(4). Evaluation System

Undergraduate Programs							
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**	**Viva-voce**	**Weightage**	**Mark**
End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

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

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

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

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

5. Prescribed Texts for CHM481

1. H. V. Keer, **Principles of the Solid State**, New Age International (P) Ltd., New Delhi, 2002.
2. I. N. Levine, **Quantum Chemistry**, 6th Edition, PHI Learning Pv. Ltd., New Delhi, 2012.
3. S. Glasstone, **Theoretical Chemistry**, 1st Edition (reprinted in 1955), D. Van Nostrand Company, Inc., New York, 1944.
4. John McMurry, **Introduction to Organic Chemistry**, Brookes/Cole, 2007.
5. R. T. Morrison & R. N. Boyd, **Organic Chemistry**, Prentice- Hall of India Pvt. Ltd., 2008.
6. S. K. Gautam, S. K. Kalauni, K. R. Sharma, B. R. Poudel & D. Wagle, **Text Book of Chemistry**, Vols 1 & 2, National Book Centre, Kathmandu, 2016.
7. J. D. Lee, **Concise Inorganic Chemistry**, 5th Edition, John Wiley and sons. Inc., 2007.
8. M. R. Pokhrel & B. R. Poudel, **A Textbook of Inorganic Chemistry**, 2nd Edition, National Book Centre, Kathmandu, 2011.

6. References for CHM481

1. S. H. Maron & C. Prutton, **Principles of Physical Chemistry**, Oxford and IBH Publication and Co., 1992.
2. P. Atkins & J. de Paula, **Elements of Physical Chemistry**, 5th Edition, Oxford University Press Inc., New York (Printed in India by Saurabh Printers Pvt. Ltd., New Delhi), 2009.
3. S. Negi & S. C. Anand, **A Textbook of Physical Chemistry**, New Age International Pvt. Ltd., New Delhi, 1999.
4. A. K. Chandra, **Introductory Quantum Chemistry**, 4th Edition, Tata McGrawn-Hill, New Delhi, India, 1994.
5. J. S. H. Pine, **Organic Chemistry**, McGraw Hill International Edition Series, New York, USA, 1987.
6. F. A. Cotton, G. Wilkinson & C. Gaus**, Basic Inorganic Chemistry**, John Wiley & Sons (Asia) Pvt. Ltd., 2007.
7. D. F. Shriver & P. W. Atkins, **Inorganic Chemistry**, W. H. Freeman and Co., London, 1999.
8. B. R. Puri, L. R. Sharma & K. C. Kalia, **Principles of Inorganic Chemistry**, Shoban Lal Nagin Chand and Co., Delhi, India, 1996.
9. W. U. Malik, G. D. Tuli & R. D. Madan, **Selected Topics in Inorganic Chemistry**, 8th Revised Edition, S. Chand and Company Pvt. Ltd., 2014.
10. J. E. Huheey, Ellen A. Keiter & L. Richard Keiter, **Inorganic Chemistry**, 4th Edition, Addition-Wishley Publishing Company, 1993.
11. R.M. Silverstein, F.X. Webster, D.J. Kiemle & D.L. Bryce, **Spectrometry Identification of Organic Compounds**, 8th Edition, John Wiley and Sons Inc. USA, 2014.
12. G. R. Chatwal & S. K. Anand, **Instrumental Methods of Chemical Analysis**, Himalaya Publishing House, India, 2016.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Chemistry XI — F.M.: 100
Course No.: CHM482 — P.M.: 45%
Nature of Course: Theory — Credit: 4
Level: B. Sc. — Number of hours per week: 4
Year: Fourth, Semester: Eighth — Teaching Hours: 60

1. Course Description:

The course intends to enable the students to be acquainted with the knowledge of advanced chemistry in all three branches of physical, organic and inorganic chemistry. Students will be familiarized with the reaction dynamics & mechanisms, basics of corrosion & corrosion control, pericyclic reactions, organic synthesis, supramolecular & green chemistry, inorganic reaction mechanism, metal carbonyls and nitrosyls.

2. Course Objectives:

The general objectives of the course are as follows:

- To enable the students to understand the kinetics of collision & transition state theories, chain & polymerization reactions.
- To introduce the basic concepts of corrosion and its control methods.
- To familiarize the students with basic knowledge of pericyclic reactions, organic synthesis, supramolecular & green chemistry.
- To enable the students with basic knowledge of different types of inorganic reactions in coordination complexes and their mechanism.
- To familiarize the students with basic concept of inertness and labilityof coordination compounds.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Study the kinetics of the collision theory of unimolecular and bimolecular reactions. • Explain the kinetics of the transition state theory. • Describe the kinetics of some chain reactions of the photochemical decomposition of ozone and reaction between hydrogen & bromine molecules. • Study the kinetic salt effect. • Discuss the kinetics of stepwise and chain polymerizations.	**Physical Chemistry** **Unit I: Reaction Dynamics and Mechanisms (8 hrs)** Kinetics of bimolecular and unimolecular collision reactions, transition state theory, kinetics of some chain reactions (photochemical decomposition of ozone and hydrogen & bromine reaction), primary salt effect, polymerization kinetics.
• Define the term of corrosion. • Describe the important components, types, reactions occur and properties of an electrochemical corrosion cell. • Discuss the overall corrosion cost and importance of corrosion study. • Make a brief discussion on types of corrosion (general, pitting, galvanic, selective leaching, intergranular, environmental cracking, crevice, aqueous, atmospheric, soil & concrete corrosion). • Explain briefly the different corrosion control techniques of metallic materials.	**Unit II: Corrosion and its Control (12 hrs)** Introduction, definition, fundamentals of corrosion cells, cost and importance of corrosion study, types of corrosion: based on corroded surfaces and corrosive environments, brief discussion of corrosion control methods (control of corrosive environments, inhibition, coating, cathodic and anodic polarization techniques).
• Explain the concept of molecular orbitals in organic chemistry. • Describe the mechanism of pericyclic reactions. • Explain the concept of electrocyclic reactions. • Discuss the nature of photochemical reactions.	**Organic Chemistry** **Unit III: Orbitals and Organic Chemistry: Pericyclic Reactions (6 hrs)**

• Describe the mechanism of cycloaddition reaction with stereochemistry. • Explain the concepts of sigmatropic rearrangements.	Molecular orbitals & pericyclic reactions of conjugated pi system, electrocyclic reactions, stereochemistry of thermal electrocyclic reactions, photochemical electrocyclic reactions, cycloaddition reaction, stereochemistry of cycloadditions, sigmatropic rearrangements, a summary of rules for pericyclic reactions.
• Discuss the modern concepts of organic synthesis. • Explain the concepts of retrosynthesis, synthon, retron and umpolung in organic synthesis. • Describe the process of monofunctioal and bifunctional disconnection approaches in organic synthesis. • Discuss the microwave synthesis of organic compounds. • Describe the importance of protection and deprotection of functional groups in organic synthesis. • Describe the advantages of solid support synthesis over conventional synthesis. • Discuss the importance of combinatorial synthesis of organic compounds.	**Unit IV: Organic Synthesis (8 hrs)** Gradual development of organic synthesis, retrosynthesis, synthon, retron and umpolung, monofunctional disconnection (examples of alcohol, alkene, ketone, carboxylic acid and their derivative, alkane, amine disconnections), bifunctional disconnection, microwave assisted organic synthesis, protection of functional groups, protection of C-H bond, C=C bond, alcoholic-OH, amino group, aldehydes and ketones, carboxylic group, solid support synthesis, combinatorial synthesis, common solid supports, peptide synthesis on solid support.
• Describe the concept of supramolecules, structure and uses in chemistry. • Discuss the cation and anion binding host molecules. • Explain the uses of cation and anion binding host molecules.	**Unit V: Introduction to Supramolecular Chemistry: Host-Guest Chemistry (4 hrs)** Introduction, cation binding host molecules, selectivity of host molecules, few synthetic cation binding host molecules, some uses of cation binding host compounds, anion binding host compounds, neutral molecule trapping host compounds.
• Explain the term green chemistry and green chemistry approaches in organic synthesis. • Discuss the principles of green chemistry. • Discuss about the green reactions and use of green catalyst in organic synthesis. • Explain the advantages of green chemistry approaches in synthesis.	**Unit VI: Green Chemistry (2 hrs)** Introduction, basic principles of green chemistry, need of green chemistry, green catalyst, phase transfer catalyst, green reactions.
• To describe the different types of inorganic reactions in the coordination complexes. • To explain substitution reactions, electron transfer reactions, isomerization and racemization reaction. • To explain the ligand substitution reaction in octahedral complexes. • To describe electrophilic substitution reaction. • To understand the different parameters involved in ligand substitution reactions. • To introduce the concept of acid hydrolysis and base hydrolysis. • To have an insight in the associative and dissociative mechanism of ligand substitution reaction. • To understand the inertness and lability of coordination compounds in relation to t_2g^x, e_g^y configuration. • To explain ligand substitution reaction in square planar complexes.	**<u>Inorganic Chemistry</u>** **Unit VII: Inorganic Reaction Mechanism (12 hrs)** Broad classification of mechanism of inorganic reactions, ligand substitution reactions in octahedral complexes, nucleophilic (or ligand) substitution reaction (SE reactions), fundamental of ligand substitution reaction, concept of activated complex, labile and inert complexes, acid hydrolysis and base hydrolysis reaction. Mechanism of substitution reaction in octahedral complexes: 1) dissociative (d) unimolecular nucleophilic substitution or $S_N{}^1$ mechanism & 2) associative (a) bimolecular nucleophilic substitution or $S_N{}^2$ mechanism.

• To apply trans effect in square planar complexes. • To explain the outer sphere and inner sphere mechanism for redox reaction..	Lability and inertness of octahedral complexes based on t_{2g}^*, e_g^* configuration of metal ion. Ligand substitution in square planar complexes, trans effect. Oxidation reduction reaction in coordination compounds: basic concept of electron transfer or electron exchange reaction, outer sphere (electron transfer mechanism), inner sphere (atom transfer mechanism) or ligand bridged process.
• To describe the nature of π-acceptor ligands of transition metal complexes. • To explain carbonyls and nitrosyls. • To describe the different ways of classifying metal carbonyls. • To describe the different ways of preparing metal carbonyls. • To introduce the concept of effective atomic number rule and its application in predicting the stability of metal carbonyls. • To understand the different type of bonds in metal carbonyls. • To explain the nature of bonding in metal carbonyls. • To understand the scrambling in metal carbonyls. • To be familiar with metal clusters with reference to metal carbonyls. • To understand the nature of bonding in linear metal nitrosyls. • To explain the nature of bonding in bent nitrosyls.	**Unit VIII: Transition Metal Complexes with π-Acceptor Ligands Carbonyls, Nitrosyls (8 hrs)** Classification of carbonyls, mononuclear and polynuclear carbonyls, bridged and non bridged carbonyls. Bridged and non bridged carbonyls, general methods of preparation of metal carbonyls, E.A.N rule and its application in metal carbonyls, different types of bonds formed in metal carbonyls, nature of bonding in carbonyl, metal carbonyl scrambling, carbonyl clusters. Metal nitrosyls: linear nitrosyls, metal nitrosyls having NO^- (bent nitrosyls).

Note: The figures in the parentheses indicate the approximate periods for the respective units.

(4). Evaluation System

Undergraduate Programs

External Evaluation	Marks	Internal Evaluation	Weightage	Marks	Viva-voce	Weightage	Mark
End semester examination	60	Assignments	20%	20	Report and Presentation on any topic	50%	20
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
		Attendance	20%		Viva	25%	
		Internal Exams	50%				
Total External	60	Total Internal	100%	20		100%	20
Full Marks 60+20+20 = 100							

(I).External evaluation:

End semester examination:

It is a written examination at the end of the semester. The questions will be asked covering all the units of the course.

External Evaluation (Viva):

After completing the end semester theoretical examination, viva examination will be held. External examiner will evaluate report/presentation & take viva exam and will do above mentioned evaluation. Students should make a small report by relating any of the studied topics in the subject to some application areas/examples. Reports can be made in groups. There will be an internal examiner to assist the external examiner. In this examination Students must demonstrate the knowledge of the subject matter.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semester examination. Failed student will not be eligible to appear in the end semester examinations.

(II). Internal evaluation

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

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will be conducted twice per semester. The students will be evaluated accordingly.

Attendance in class: Students should regularly attend and participate in class discussion. Eighty percent class attendance is mandatory for the students to enable them to appear in the end semester examination. Below 80% attendance in the class will signify NOT QUALIFIED (NQ) to attend the end semester examination.

Presentation: Students will be divided into groups and each group will be provided with a topic for presentation. It will be evaluated individually as well as group-wise. Individual students have to make presentations on the given topics.

Mid-term examination: It is a written examination and the questions will be asked covering all the topics in the session of the course.

Discussion and participation: Students will be evaluated on the basis of their active participation in the classroom discussions.

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

- Lecture and Discussion
- Group work and Individual work
- Assignments
- Presentation by Students
- Quizzes
- Guest Lecture

Students are advised to attend all the classes and complete all the assignments within the specified time period. If a student does not attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attend a formal exam/quiz/test, there won't be any provision for re-exam.

5. Prescribed Texts for CHM 482:

1. S. H. Maron & C. Prutton, **Principles of Physical Chemistry**, Oxford and IBH Publication and Co., 1992.
2. P. Atkins & J. D. Paula, **Atkin's Physical Chemistry**, 10th Edition, Oxford University Press, 2014 (reprinted).
3. R. W. Revie & H. H. Uhlig, *Corrosion and Corrosion Control; an Introduction to Corrosion Science and Engineering*, 4th Edition, John Wiley & Sons, Inc., New York, 2008.
4. J. Bhattarai, **Frontiers of Corrosion Science**, 1st Edition, Kshitiz Publication, Kathmandu, 2010.
5. John McMurry, **Introduction to Organic Chemistry**, Brookes/Cole, 2007.
6. R. T. Morrison & R. N. Boyd, **Organic Chemistry**, Prentice- Hall of India Pvt. Ltd., 2008.
7. S. K. Gautam, S. K. Kalauni, K. R. Sharma, B. R. Poudel & D. Wagle, **Text Book of Chemistry**, Vols 1 & 2, National Book Centre, 2016.
8. J. D. Lee, **Concise Inorganic Chemistry**, 5th Edition, John Wiley and sons. Inc., 2007.

9. F. Basolo & R. Pearson, **Mechanisms of Inorganic Reactions, A Study of Metal Complexes in Solution,** 2nd Edition, Wiley Western Limited.
10. W. U. Malik, G. D. Tuli & R. D. Madan, **Selected Topics in Inorganic Chemistry,** *(*8th Revised Edition*),* S. Chand and Company Pvt. Ltd., 2014.
11. M. R. Pokhrel & B. R. Poudel, **A Textbook of Inorganic Chemistry**, 2ndEdition, National Book Centre, Kathmandu, 2011.

6. References for CHM 482:

1. J. O'M Bockris, A. K. N. Reddy and M. Gamboa-Aldeco, **Modern Electrochemistry: Fundamentals of Electrodics***,* Vols 2A & 2B, 2nd Edition, Kluwer/Plemum Publishers, New York/London/Moscow, 2000.
2. S. Negi & S. C. Anand, **A Textbook of Physical Chemistry**, New Age International (P) Ltd., New Delhi, 1999.
3. J. S. H. Pine, **Organic Chemistry**, McGraw Hill International Edition Series, New York, USA, 1987.
4. F.A. Cotton, G. Wilkinson & C. Gaus**, Basic Inorganic Chemistry**, John Wiley & Sons (Asia) Pvt. Ltd., 2007.
5. D. F. Shriver & P. W. Atkins, **Inorganic Chemistry**, W. H. Freeman and Co., London, 2014.
6. B. Douglas, D. McDaniel & J. Alexander, **Concepts and Models of Inorganic Chemistry**, Recent edition.