Far Western University
Mahendranagar, Kanchanpur
Faculty of Science and Technology

B. Sc. Seventh Semester Biology Group

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Analytical Chemistry F.M.: 100
Course No.: CHM475 P.M.: 45%
Nature of Course: Theory (Elective) Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Seventh Teaching Hours: 45

1. Course Description:

The course intends to enable the students to be acquainted with the basic concepts of analytical chemistry including analytical methods and applications.

2. Course Objectives:

The general objectives of the course are as follows:

- To explain the scope and applications of analytical chemistry.
- To understand broad classification of analytical methods.
- To be able to interpret the measurement for analytical use.
- To have an idea about errors in analytical measurements and to minimize it.
- To develop a broad understanding involving some importance analytical procedures.
- To appreciate the theory and practice of methods used to determine the composition of matter.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• To explain the scope and application of analytical chemistry. • To describe the different aspects methodology of analytical chemistry. • To explain the different type of sampling techniques. • To explain the use of proper weighing and interpretation of analytical data.	**Unit I: Introduction (5 hrs)** Scope and application, broad classification of analytical methods, qualitative and quantitative analysis, analytical methodology, sampling for solids, liquid and gases, titrimetric, gravimetric and instrumental analysis, interpretation of measurements, the analytical balance and calibration.
• To understand the different aspects of errors in analytical procedures. • To explain the statistical treatment of analytical data. • To understand the criteria for rejection of data.	**Unit II: Errors & Analytical Data Treatment (8 hrs)** Errors, determinate and indeterminate errors, accuracy and precision, the normal error curve, statistical treatment of finite sample, t-test, confidence level, testing for significance, criteria for rejection of an observation, least square methods.
• To understand the principle and application of titrimetric analysis.	**Unit III: Titrimetric Methods of Analysis (4 hrs)** General principle, reactions used for titration, requirements for reactions used in titrimetric analysis, standardization of solution, aliquots, theory of indicators.
• To understand the principle and application of gravimetric analysis.	**Unit IV: Gravimetric Methods of Analysis (4 hrs)** General principle, requirements for reactions to be used for gravimetric analysis, precipitation, co-precipitation, post precipitation, colloids,

	drying and ignition of precipitate, use of organic precipitants, applications of gravimetric analysis.
• To understand the basic principle of chromatography and the broad classes of chromatographic techniques. • To explain the chromatographic techniques like GLC, HPLC, ion exchange, column, thin layer, and paper chromatography.	**Unit V: Chromatography (8 hrs)** Classification of chromatographic methods, adsorption and partition chromatography: general principle, instrumentation and application of gas liquid chromatography, high performance liquid chromatography, theory and technique of thin layer chromatography, column chromatography, paper chromatography, exclusion and affinity chromatography.
• To describe the basic principle of spectrophotometry and explain about UV-visible and atomic absorption spectroscopy.	**Unit VI: Spectrophotometry (6 hrs)** General principle, instrumentation and application of UV-visible spectrophotometry, atomic absorption spectroscopy.
• To describe the principle and application of some selected electrometric methods of analysis.	**Unit VII: Electrometric Methods of Analysis (6 hrs)** Principle and application of ion selective electrodes, potentiometry, polarography.
• To appreciate the analytical method to be chosen for the desired analysis.	**Unit VIII: Choice of Analytical Methods (4 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

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 CHM475:

1. R. A. Day Jr. & A. L. Underwood, **Quantative Analysis**, 6th Edition, Prentice Hall of India, New Delhi,2009.
2. S. M. Khopkar, **Basic Concept of Analytical Chemistry**,3rdEdition, New Age International Publishers, 2008.
3. Douglas A. Skoog, F. James Holler & Timothy A. Nieman, **Principles of Instrumental Analysis**, 5thEdition, Thomson Brooks/Cole, 1998.

6. References for CHM475:

1. S. K. Gautam, B. R. Poudel & H. R. S. Poudel, **Concise Analytical Chemistry**, National Book Centre, Kathmandu, 2016.
2. B. Sivasankar, **Instrumental Methods of Analysis**, Oxford University Press, 2012.
3. H. Kaur, **Analytical Chemistry**, Pragati Prakashan, 2013.
4. A. L. Gupta, **Modern Analytical Chemistry**, Pragati Prakashan, 2015.
5. **Vogel's Textbook of Quantitative Chemical Analysis**, 6th Edition, Pearson Education, 2008.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Applied Chemistry F.M.: 100
Course No.: CHM474 P.M.: 45%
Nature of Course: Theory (Elective) Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Seventh Teaching Hours: 45

1. Course Description:

The course intends to enable the students to be acquainted with the basic concepts of industrial application of chemistry and chemistry behind the different chemical process industries.

2. Course Objectives:

The general objectives of the course are as follows:

- To develop an insight in the different applications of chemistry in chemical process industries.
- To appreciate and understand the possible application of natural resources of Nepal for the industrial application.
- To understand the requirements for the technical production of materials in bulk.
- To understand the different unit processes involved in the different industries.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• To describe the industrial application of chemistry. • To understand the concept of unit operation and unit process. • To understand the stages in producing a new product. • To explain the factors involved in the economics of technical production. • To appreciate the method of understanding profitability analysis.	**Unit I: Introduction (5 hrs)** Industrial chemistry as applied chemistry, application of chemistry, industrial chemistry as chemistry involved in chemical process industries, unit operations and unit processes, importance of chemical industry, the economics of production, profitability analysis.
• To understand the chemistry behind the different chemical process industries. • To explain the importance and feasibility of different industries. • To explain the unit operations and unit operations involved in selected industries. • To understand the major engineering problems encountered in selected industries. • To understand the economics of production of selected industrial products. • To understand how process of various chemical industries can be broken down in to different unit operations and unit processes. • To understand how the presentation of the chemical industries around the flow sheet lead to a logical following through a connected series of unit operation and unit processes.	**Unit II: Chemical Industries (40 hrs)** Some of the typical industries are selected and discussed in terms of raw materials, unit operation and unit process involved, manufacturing procedure, flow sheet diagram, major engineering problems, economics. **(i) Inorganic Based Industries (15 hrs)** a) Cement, lime and glass b) Soda ash and caustic soda c) Sulphur and sulphuric acid d) Nitrogen industries **(ii) Natural Product Based Industries (15 hrs)** a) Oils and fats b) Soaps and detergents

	c) Sugar and starch d) Fermentation industries e) Pulp and paper industries **(iii) Ferrous & Non Ferrous Metal Based Industries (10 hrs)** a) Ferrous material: Steel, Stainless steel, wrought iron, cast iron and high silicon iron b) Non ferrous materials: copper, aluminum and zinc.

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		Assignments	20%		Report and Presentation on any topic	50%	
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
	60	Attendance	20%	20	Viva	25%	20
		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 CHM474:

1. Charles E. Dryden, **Outlines of Chemical Technology,** edited and revised by M. Gopala Rao and Marshall Sittig, affiliated East-West Press Pvt. Ltd., New Delhi, 2010.

6. References for CHM474:

1. K. H. Davi & F. S. Berner, **Handbook of Industrial Chemistry,** Vol. 1 and 2 (Edited by S.C. Bhattia), CBS Publishers and Distributors, New Delhi, 2000.
2. Philip Matthews, **Advanced Chemistry,** Cambridge University Press, 1997.
3. Thankamma Jacob, **A Textbook of Applied Chemistry,** Macmillan India Limited, 1997.
4. **Mineral Resources of Nepal,** Department of Mines and Geology, Government of Nepal, 2004.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Chemistry IX — F.M.: 100
Course No.: CHM472 — P.M.: 45%
Nature of Course: Theory — Credit: 4
Level: B. Sc. — Number of hours per week: 4
Year: Fourth, Semester: Seventh — Teaching Hours: 60

1. Course Description:

The course intends to enable the students to be acquainted with the basic concepts of chemistry in all three branches of physical, organic and inorganic chemistry. Students will be familiarized with the quantitative treatments of ion-ion & ion-solvent interactions, principles & applications of commercial batteries and fuel cells, nucleic acids, lipids & organic chemistry of metabolic pathways, organometallics and bioinorganic chemistry.

2. Course Objectives:

The general objectives of the course are as follows:

- To enable the students with quantitative treatments of the ion-ion & ion-solvent interactions, working principles & applications of commercial batteries and fuel cells.
- To familiarize the students with nucleic acids, lipids and organic chemistry of metabolic pathways.
- To acquaint the students with fundamentals knowledge of organometallics and bioinorganic chemistry.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Enable the students with basic concept of ion-ion interactions, true & potential electrolytes. • Discuss the quantitative treatment of Debye-Hückel (ion cloud) theory of ion-ion interactions. • Describe the concept of work of charging, potential due to charge distribution; potential vs distance relation & Debye length. • Discuss the Debye-Hückel theory of activity coefficient with considering mean activity coefficient & Debye-Hückel limiting law. • Explain the extension of the limiting law. • Enable the students to solve the numericals related with ion-ion interactions & activity coefficient.	**Physical Chemistry** **Unit I: Ion-Ion Interactions (8 hrs)** Introduction, true and potential electrolytes, quantitative treatment of Debye-Hückel (ion cloud) theory of ion-ion interactions: the work of charging, the potential due to the charge distribution, potential vs distance relation, Debye length, Debye-Hückel theory of activity coefficient and its limitations: mean activity coefficient, discussion on Debye-Hückel limiting law and extension of the limiting law, related numericals.
• Enable the students with basic concept of ion-solvent interactions. • Explain the phenomena of solvation & importance of ion-solvent interaction. • Explain the structure of solvent (water) & solution. • Explain the ion-dipole model. • Discuss the solvation process with the help of thermodynamic properties like heat of solvation, free energy & entropy. • Describe the solvation process with the help of some spectroscopic techniques (IR, Raman, NMR & neutron diffraction). • Explain about the dielectric constant of solutions & their measurements.	**Unit II: Ion-Solvent Interactions (7 hrs)** Introduction of solvation, importance of ion-solvent interaction, structure of the most common solvent (i.e., water) only and near an ion, ion-dipole model for ion-solvent interaction, tools for solvation study: thermodynamic approach (heat of solvation, free energy & entropy of solvation) and spectroscopic approach (using IR, neutron diffraction, Raman & NMR techniques), dielectric effects: dielectric constant of solutions, measurement of dielectric constant of ionic solutions.
• Enable the students with basic concept of some commercial electrochemical cells or batteries. • Describe the working principles of primary cell	**Unit III: Commercial Electrochemical Cells (5 hrs)** Principles and applications of primary (Leclanche cell) and

(Leclanche), secondary cells (lead-acid & nickel-cadmium) and their applications. • Introduce basic concept of fuel cells, types of fuel cells and their efficiency. • Discuss the working principle of hydrogen-oxygen fuel cell and its uses.	secondary (lead-acid & nickel-cadmium) cells, introduction of fuel cell, fuel cell efficiency, principle and applications of hydrogen-oxygen fuel cell.
• Explain the term nucleotide, nucleoside and nucleic acid with their structures. • Describe the chemistry of DNA. • Explain the Watson- Crick model of DNA. • Discuss the replication and transcription of DNA. • Describe the chemistry of heredity and genetic code, DNA sequencing and DNA synthesis and DNA fingerprinting. • Discuss the structure and translation of RNA. • Explain the chemistry of protein biosynthesis and polymerase chain reaction.	**Organic Chemistry** **Unit IV: Bio-molecules–Nucleic Acids (6 hrs)** Nucleotide and nucleic acids, nucleoside, base pairing in DNA: Watson- Crick model, replication of DNA, transcription of DNA, chemistry and heredity, genetic code, translation of RNA: protein biosynthesis, DNA sequencing, DNA synthesis, polymerase chain reaction, DNA fingerprinting.
• Describe the chemistry of waxes, fats and oils. • Discuss the chemistry of soap and detergents and their manufacture. • Explain the structure and functions of phospholipids. • Describe the types, chemistry and function of prostaglandins. • Discuss the applications of steroids, terpenoids, fats, cholesterol in biological system.	**Unit V: Bio-molecules–Lipids (5 hrs)** Waxes, fats and oils, hydrolysis of fats, soap and detergents, phospholipids, cell membrane, prostaglandins and other eicosanoids, steroids, steroid hormone, biosynthesis of steroids, saturated fats, cholesterol and heart disease, terpenoids.
• Discuss the chemistry of metabolism and biological energy in living system. • Describe the catabolism of triacylglycerols. • Discuss the reactions involved in catabolism of bio-molecules. • Describe the chemistry of glycolysis, citric acid cycle, biosynthesis of carbohydrates and catabolism of proteins. • Discuss thr reaction and mechanism of biological oxidation and reduction of ethanol and acetaldehyde. • Explain the mechanism of enzyme action of chymotrypsin. • Describe the structure and medicinal importance of dopamine.	**Unit VI: Organic Chemistry of Metabolic Pathways (9 hrs)** Overview of metabolism and biochemical energy, catabolism of triacylglycerols: the fate of glycerols, catabolism of triacylglycerols: *β*-oxidation, biosynthesis of fatty acids, catabolism of carbohydrates: glycolysis, conversion of pyruvate to acetyl CoA, the citric acid cycle, carbohydrate biosynthesis: gluconeogenesis, catabolism of proteins: transamination, biological oxidation and reduction (ethanol and acetaldehyde), stereochemistry and mechanism of biological oxidation and reduction, mechanism of enzyme action (chymotrypsin), structure and medicinal uses of dopamine.
• Explain the term organometallic compounds. • Describe the different ways of classifying organometallic compounds. • Explain the term kinetic and thermodynamic stability of organometallic compound and point out why compounds which should not behave as stable compound can behave as stable compound. • Describe important methods of forming metal-carbon bonds. • Describe the nature of some non-classical compounds like sandwich compounds. • Explain the mode of bonding in metallocenes. • Describe the important biological applications of organometallic compounds.	**Inorganic Chemistry** **Unit VII: Organometallics (10 hrs)** Introduction, classification of organometallic compounds based on the nature of metal, classification based on hapticity, thermodynamic and kinetic stability of organometallic compounds, some typical preparative routes for metal carbon bond formation, oxidative addition reaction, transmetallation, metallation, metal hydride addition to akenes, methylene insertion reaction, preparation, properties of metallocenes,

• To understand the environmental aspect of organometallic compound. • Explain the application of organometallic compounds as catalyst in important chemical reactions. • To describe the catalytic hydrogenation process involving organometallic compound.	bonding and structure of ferrocene, biological application and environmental aspect of organometallic compounds, organometallic compounds as catalytic reagent (homogenous hydrogenation).
• To explain the scope of bioinorganic chemistry. • Describe the elements which are essential and those required in trace amount. • To explain the function of metalloporphyrins. • Describe the structure of chlorophyll. • To explain the biological role of iron. • To describe the iron containing heme proteins and its role as oxygen carrier. • To understand the role of hemoglobin myoglobin. • To explain the oxygen affinity of Hb and Mb with pH of the medium. • To explain the nature of cytochrome. • To describe the different type of non heme iron proteins. • To explain the role of nitrogenase. • To describe the different models for synthetic nitrogen fixation. • To explain the role of metals in chelation therapy. • Describe the different anticancer drugs and mode of action of cis-platin. • To explain the role of some metal as anti-arthrities drug. • To explain use of metal as imaging agents for example in Magnetic Resonance Imaging. • To describe the role of Na^+, K^+, Ca^{++} and Mg^+.	**Unit VIII: Bioinorganic Chemistry (10 hrs)** Bioinorganic as a study of role of metals in biological system, essential and trace elements, metalloporphyrins, chlorophyll, bioinorganic chemistry of iron, heme proteins, hemoglobin, cytochromes, Bohr effect, non heme iron proteins, ferredoxins, rubredoxins, high potential iron protein, nitrogen fixation, bacterial nitrogenase system and synthetic nitrogen fixation. Medicinal chemistry, chelation therapy, cancer treatment, anti-arthritis drug, imaging agents. Biological role of Na^+, K^+, Mg^+ and Ca^{++}, ion pumps.

(4). Evaluation System

Undergraduate Programs

External Evaluation	Marks	Internal Evaluation	Weightage	Marks	Viva-voce	Weightage	Mark
End semester examination		Assignments	20%		Report and Presentation on any topic	50%	
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
	60	Attendance	20%	20	Viva	25%	20
		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 CHM472

1. J. O'M Bockris & A. K. N. Reddy, **Modern Electrochemistry**, Vol. 1, 2nd Edition, Kluwer/Plemum Publishers, New York/London/Moscow, 1998.
2. S. H. Maron & C. Prutton, **Principles of Physical Chemistry**, Oxford and IBH Publication and Co., 1992.
3. John McMurry, **Introduction to Organic Chemistry**, Brookes/Cole, 2007.
4. R. T. Morrison & R. N. Boyd, **Organic Chemistry**, Prentice- Hall of India Pvt. Ltd., 2008.
5. 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.
6. J. D. Lee, **Concise Inorganic Chemistry**, 5th Edition, John Wiley and sons. Inc., 2007.
7. F. A. Cotton, G. Wilkinson & C. **Gaus, Basic Inorganic Chemistry,** 3rdEdition, John Wiley & Sons (Asia), Pvt., Ltd., 2007.
8. M. R. Pokhrel & B. R. Poudel, **A Textbook of Inorganic Chemistry**, 2ndEdition, National Book Centre, Kathmandu, 2011.
9. W. U. Malik, G. D. Tuli & R. D. Madan, **Selected Topics in Inorganic Chemistry,** .S. Chand & Company, New

Delhi, 1995.

6. References for CHM 472

1. J. O'M Bockris, A. K. N. Reddy & M. Gamboa-Aldeco, **Modern Electrochemistry: Fundamentals of Electrodics**, Vols 2A, 2nd Edition, Kluwer/Plemum Publishers, New York/London/Moscow, 2000.
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. D. Alberty, **Physical Chemistry**, 6th Edition, Wiley Eastern Ltd., New Delhi, 1992.
4. Bahl, B. S. Bahl & G. D. Tuli, **Essential of Physical Chemistry**, Revised Multicolour Edition, S. Chand & Co. Ltd., New Delhi, 2012.
5. J. S. H. Pine, **Organic Chemistry**, McGraw Hill International Edition Series, New York, USA, 1987.
6. K. Bhagi & G. R. Chatwal, **Bioinorganic and Supramolecular Chemistry**, Himalaya Publishing House, Mumbai.
7. G. E. Coates, M. L. H. Green, P. Powell & K. Wade, **Principles of Organometallic Chemistry,** Chapman and Hall, London, 1997.
8. R. C. Mehrotra & A. Singh, **Organometallic Chemistry (A Unified Approach)**, Wiley Estern Limited, 2000.
9. J. E. Huheey, Ellen A. Keiter & Richard L. Keiter, **Inorganic Chemistry**, 4th Edition, Harper Collins College Publishers, 1993.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Chemistry Lab 7
Course No.: CHM473
Nature of Course: Practical — Credit: 2
Level: B. Sc. — Number of hours per week: 6
Year: Fourth, Semester: Seventh — 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 viscosity, colloidal, chemical kinetics, thermo-chemistry, pH meter, potential and conductance measurement methods.
- To enable the students to perform experiments for determining glucose, cholesterol, values of acid, iodine & saponification of fats/oil and for studying characteristic reactions of carbohydrates, fats, oil and protein.
- To enable the students to perform the experiment on chemical oxygen demand (COD), volumetric analysis and paper chromatography.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Enable the students to estimate the size of a given compound by viscosity measurement. • Enable the students to find out the precipitation value & precipitating power of cations. • Enable the students to estimate the activation energy of the reaction using Arrhenius equation. • Enable the students to determine the transition temperature of the given compound by thermometrically. • Enable the students to estimate the phosphoric acid in locally available cola beverage using pH meter. • Enable the students to determine the solubility product of AgCl by potential measurement method. • Enable the students to determine the cell constant of the given conductivity cell.	**Unit I: Physical Chemistry Practical (30 hrs)** 1. To determine the size of a molecule of the given compound by viscosity measurement. 2. To determine the precipitation values and precipitation power of monovalent and bivalent cations for arsenic sulfide sol. 3. To determine the activation energy for the reaction between potassium persulfate and potassium iodide by iodine clock method. 4. To determine the transition temperature of $Na_2S_2O_3.5H_2O$ by thermometric method. 5. To determine the concentration of phosphoric acid in cola beverage using pH meter. 6. To determine the solubility product of silver chloride at room temperature by potential measurement method. 7. To determine the cell constant of the given conductivity cell.
• Enable the students to estimate the glucose in unknown sample, acid, iodine & saponification values of fats/oil. • Enable the students to study the characteristic reactions of carbohydrates, fats, oil & proteins.	**Unit II: Organic Chemistry Practical (30 hrs)** 1. Estimation of amount of glucose in unknown sugar sample. 2. Determination of acid value of fats or oil. 3. Determination of iodine value of fats or oil. 4. Determination of saponification value of fats or oil. 5. Study of characteristic reactions of carbohydrates, fats, oil, and proteins.

• Enable the students to determine the cholesterol in a given sample. • Enable the students to carry out experiments on PCR.	6. Detection and determination of cholesterol in cholesterol sample. 7. Experiments on PCR.
• Enable the students to perform experiment to determine the amount of arsenic in water by colorimetric method. • Enable the students to perform experiment to determine the percentage purity of potassium bromide by adsorption indicator. • Enable the students to perform experiment to determine residual chlorine in water sample. • Enable the students to perform experiment to determine the amount of copper and iron in a given mixture solution. • Enable the students to perform experiment to separate chloride, bromide and iodide by paper chromatography. • Enable the students to perform experiment to determine the lead as dithiozone complex colorimetrically. • Enable the students to perform experiment on preparation of ammonium phosphate fertilizer.	**Unit III: Inorganic Chemistry Practical (30 hrs)** 1. Determination of arsenic in water by spectrophotometric method. 2. Determination of percentage purity of potassium bromide by using adsorption indicator. 3. Determination of residual chlorine in water sample. 4. Determination of amount of copper and iron in a given mixture solution by $K_2Cr_2O_7$. 5. Separation of chloride, bromide and iodide by paper chromatography. 6. Determination of lead as dithiozone complex colorimetrically. 7. Preparation of ammonium phosphate fertilizer.

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. (Latest Edition).
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. M. K. Sthapit & R. R. Pradhananga, **Experimental Physical Chemistry**, Taleju Prakasan, Kathmandu, 1998.
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, USA , 1980. (Latest Edition).
7. N. S. Gnanapragasam & G. Ramamurthy, **Organic Chemistry– Lab Manual,** S. Viswanathan Co., Pvt., India, 1998.
8. P. N. Yadav, M. R. Pokhrel & S. Shrestha, **Advanced Practical Inorganic Chemistry,** Kshitiz Publication, Kahmandu, 2017.
9. N. M. Khadka, S. D. Gautam & P. N. Yadav, **A Core Experimental Chemistry for B. Sc.***,* Heritage Publication, Kathmandu, 2016.
10. K. N. Ghimire, M. R. Pokhrel & K. P. Bohara**, University Experimental Inorganic Chemistry**, Quest Publication, Kirtipur, Kathmandu, 2008.
11. A. K. De, **Environmental Chemistry**, New Age International Publishers, New Delhi, India, 2008.
12. K.R. Subedi, Experimental Chemistry, Graphic Solution, Pokhara, 2014.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Chemistry VIII F.M.: 100
Course No.: CHM471 P.M.: 45%
Nature of Course: Theory Credit: 4
Level: B. Sc. Number of hours per week: 4
Year: Four, Semester: Seven Teaching Hours: 60

1. Course Description:

The course intends to enable the students to be acquainted with the basic concepts of chemistry in all three branches of physical, organic and inorganic chemistry. Students will be familiarized with the fundamentals of the entropy change, third law of thermodynamics, free energy change, thermodynamics of chemical equilibrium, carbohydrates, amino acids, peptides & proteins, non-aqueous solvent, inorganic polymers and actinides.

2. Course Objectives:

The general objectives of the course are as follows:

- To acquaint the students with knowledge of third law of thermodynamics and thermodynamic parameters of entropy change, free energy change and thermodynamics of chemical equilibrium.
- To familiarize the students with carbohydrates, amino acids, peptides and proteins.
- To acquaint the students with fundamental knowledge of different types of solvents and reactions of non-aqueous NH_3 and SO_2.
- To familiarize the students with basics of inorganic polymers, detail of some important polymers of boron, silicon, phosphorus and actinides.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Explain the entropy change in isolated system. • Describe the dependence of entropy on temperature, volume & pressure. • Explain the entropy of mixing. • State, explain & significances of third law of thermodynamics. • Show how evaluation of absolute entropy is done. • Enable the students to solve numerical problems related with entropy, entropy of mixing and third law.	**Physical Chemistry** **Unit I: Entropy & Third Law of Thermodynamics (6 hrs)** Entropy, entropy change in isolated system, dependence of entropy on temperature, volume and pressure, entropy change in ideal gas, entropy of mixing for ideal gases, third law of thermodynamics and its significance, evaluation of absolute entropy, related numericals.
• Describe the Gibbs free energy change & its significances. • Derive Gibbs-Helmholtz equation and explain its significances. • Discuss the effect of pressure to Gibbs free energy change. • Enable the students to calculate free energy changes. • Explain about fugacity and activity. • Derive Clapeyron and Clausius-Clapeyron equations. • Enable the students to solve numerical problems related with free energy change.	**Unit II: Free Energy Change (9 hrs)** Free energy change for a reaction, Gibbs free energy change, properties and significance of Gibbs free energy change with temperature (Gibbs-Helmholtz equation) and pressure, calculation of free energy changes, fugacity and activity, thermodynamic criterion of equilibrium, physical equilibrium involving pure substances (Clapeyron equation), uses of Claperyron equation, Clausius-Clapeyron equation, related numericals.
• Explain the relation between K_p & K_c, and their variation with temperature. • Explain the thermodynamic treatment of Le-Chatelier's principle quantitatively.	**Unit III: Chemical Equilibrium (5 hrs)** Thermodynamics equilibrium constant of K_p and K_c for gaseous reactions, variation of K_p and K_c with temperature, quantitative

• Enable the students to solve numerical problems related with aforementioned topics.	thermodynamic treatment of Le-Chatelier's principle, related numericals.
• Explain the structures of bio-molecules. • Describe the structures and classification of carbohydrates. • Explain the Fischer projection and D, L sugars. • Discuss the configuration of the carbohydrates. • Describe the cyclic structure of glucose fructose and their significance. • Discuss the meaning of anomer and epimers and osazone formation reaction with mechanism. • Explain the reaction and mechanism of monosaccharides with different reagents. • Describe chain lengthening and shortening of carbohydrates. • Discuss the different types of monosaccharides and disaccharides with their structures. • Explain the classification and synthesis of polysaccharides with their economic importance.	**Organic Chemistry** **Unit IV: Bio-molecules– Carbohydrate (11 hrs)** Classification of carbohydrates, depicting carbohydrate stereochemistry: Fischer projection, D,L sugars, configurations of the aldoses, cyclic structure of monosaccharides: anomers, osazone formation, epimers, reactions of monosaccharides, ester and ether formation, glycoside formation, biological ester formation: phosphorylation, reduction of monosaccharides, oxidation of monosaccharides, chain lengthening: The Kiliani-Fischer synthesis, chain shortening: The Wohl degradation, the eight essential monosaccharides, disaccharides, cellobiose and maltose, lactose, sucrose, polysaccharides and their synthesis, cellulose, starch and glycogen, polysaccharide synthesis, some other important carbohydrates, cell surface carbohydrates and carbohydrate vaccines.
• Discuss the different types of amino acids and their classification. • Describe the applications of Henderson-Hesselbalch equation in amino acids. • Explain about the isoelectric point of amino acids. • Describe the different methods of synthesis of amino acids. • Discuss about the N-terminal and C-terminal amino acids. • Explain the structure of peptides and proteins. • Describe the analysis of peptides. • Explain the conjugated proteins and secondary structure of proteins. • Discuss the methods of peptide sequencing. • Discuss the structure and synthesis of peptides. • Discuss about the structure of proteins. • Explain the structure and functions of enzyme and co-enzymes.	**Unit V: Bio-molecules– Amino Acids, Peptides and Proteins (9 hrs)** Structures of amino acids, amino acids, Henderson-Hesselbalch equation and isoelectric point, synthesis of amino acids, the amidomalonate synthesis, reductive amination of α-keto acids, enantioselective synthesis, peptides and proteins, N-terminal and C-terminal amino acids residue, amino acid analysis of peptides, conjugated proteins, secondary structure of proteins, peptide sequencing: Edman degradation, peptide synthesis, automated peptide synthesis: Merrifield solid-phase method, protein structure, enzyme and coenzymes, citrate synthesis.
• Explain the nature of non aqueous solvent. • Describe the different ways of classifying non aqueous solvent. • Explain the criteria to be used for choosing the non aqueous solvent. • Describe the different types of reactions involving liquid NH_3 as solvent. • Describe the different types of reactions involving liquid SO_2 as solvent.	**Inorganic Chemistry** **Unit VI: Non Aqueous Solvent (7 hrs)** Classification of solvents, protic and non protic solvents, protogenic, protophilic and amphiprotic solvents, factors contributing to choice of non aqueous solvents: temperature range, dielectric constant, donor and acceptor properties, protonic acidity, basicity, nature and extent of autoionization, reactions of NH_3 and reactions of SO_2.
• Explain the concept of an inorganic polymer. • Describe the classification of inorganic polymer based on composition.	**Unit VII: Inorganic Polymers (8 hrs)** Classification of polymers: classification based on backbone structure, organic polymers, inorganic polymers. Classification of inorganic polymers: homoatomic inorganic

• Explain the factors contributing to stability of inorganic polymer. • Describe some important heteroatomic inorganic polymers based on B, Si, P and S and their important applications. • Describe the biomedical applications of polyphosphazenes. • Describe the highly conducting properties of polythiazyls.	polymers, heteroatomic inorganic polymers, condensation polymer, addition polymer, coordination polymer, organic inorganic polymers, metal chelate polymers, stability of inorganic polymers. Hetero atomic polymers: polymer based on boron-borazines, polymer based on silicon-silicones (silicone rubber, silicone fluids, silicone grease), polymer based on phosphorous-phosphazenes or phosphonitrilic compounds, biomedical applications of polyphosphazenes, polymer based on sulphur-tetra sulphurtetranitride, disulphurdinitride, polythiazyls.
• Explain the position of actinides. • Describe the main sources of actinides and their main reactions. • Describe the methods of separating Np, Pu and Am from uranium present in spent reactor fuel material. • Describe the actinide elements which lie beyond uranium. • Describe the similarities between actinides and lanthanides.	**Unit VIII: Actinides (5 hrs)** Position of actinides in periodic table, sources of actinides, properties of actinides, separation of Np, Pu and Am from uranium, transuranium elements, comparative study of actinides and lanthanides.

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		Assignments	20%		Report and Presentation on any topic	50%	
(Details are given in the separate table at the end)		Quizzes	10%		Presentation	25%	
	60	Attendance	20%	20	Viva	25%	20
		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 471:

1. S. H. Maron & C. Prutton, **Principles of Physical Chemistry**, Oxford and IBH Publication and Co., 1992.
2. R. P. Rostagi & R. R. Mishra, **An Introduction to Chemical Thermodynamics**, 6th Edition, Vikash Publ. House, India, 1996.
3. John McMurry, **Introduction to Organic Chemistry**, Brookes/Cole, 2007.
4. R. T. Morrison & R. N. Boyd, **Organic Chemistry**, Prentice- Hall of India Pvt. Ltd., 2008.
5. 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.
6. F. A. Cotton, G. Wilkinson & C. Gaus, **Basic Inorganic Chemistr*y***, 3rdEdition, John Wiley & Sons (Asia), Pvt., Ltd., 2007.
7. M. R. Pokhrel & B. R. Poudel, **A Textbook of Inorganic Chemistry**, 2ndEdition, National Book Centre, Kathmandu, 2011.
8. S. Pimplapure, R. Jain, A. Sahai & U. Soni, **Inorganic Polymer Chemistry**, Pragati Prakashan, Meerut, 2012.

6. References for CHM 471:

1. 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.
2. S. Negi & S. C. Anand, **A Textbook of Physical Chemistry**, New Age International Pvt. Ltd., New Delhi, 1999.
3. A. Bahl, B. S. Bahl & G. D. Tuli, **Essential of Physical Chemistry**, Revised Multicolour Edition, S. Chand & Co. Ltd., New Delhi, 2012.

4. F. Daniels & R. F. Alberty, **Physical Chemistry**, John Wiley & Sons, Latest Edition.
5. J. S. H. Pine, **Organic Chemistry**, McGraw Hill International Edition Series, New York, USA, 1987.
6. D. F. Shriver & P. W. Atkins, **Inorganic Chemistry**, W. H. Freeman and Co., London, 2014.
7. James E. Huheey, Ellen A. Keiter & Richard L. Keiter, **Inorganic Chemistry: Principles of Structure and Reactivity**, Addison Wesley Publishing House.
8. W. U. Malik, G. D. Tuli & R. D. Madan, **Selected Topics in Inorganic Chemistry**, S. Chand & Company, New Delhi, 2014.
9. R. D. Madan & Satya Prakash, **Modern Inorganic Chemistry,** S. Chand & Company Ltd., New Delhi, 1994.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: Natural Product Chemistry F.M.: 100
Course No.: CHM476 P.M.: 45%
Nature of Course: Theory (Elective) Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Seventh Teaching Hours: 45

1. Course Description:

The course intends to enable the students to be acquainted with the fundamental concepts of natural products chemistry. This course covers the fundamentals of basic natural products chemistry, history of natural products, biosynthetic approaches of natural products, drug discovery from natural products, structure elucidation of some natural products and some detailed study of different classes of natural products.

2. Course Objectives:

The general objectives of the course are as follows:

- To enable the students with basic knowledge of natural products chemistry.
- To familiarize the students with the historical development of drugs from natural products.
- To acquaint the students with basic concept of biosynthetic process of natural products.
- To enable the students to understand the chemistry of natural products.

3. Specific Objectives and Course Contents:

Specific Objectives	Contents
• Explain the scope of natural resource in drug discovery. • Discuss the techniques of phytochemical and biological screening of natural products. • Describe the drug development and design from natural sources. • Explain the scope of biodiversity in drug discovery and medicinal plants of Nepal.	**Unit I: Introduction to Natural Product Chemistry (5 hrs)** Introduction, history of natural products chemistry, an outline on discovery of some important drugs from natural products, drug development and design from natural sources, phytochemical screening, bioactivity screening of natural products, an overview of medicinal plants of Nepal.
• Describe different techniques of extraction, purification of natural products. • Explain the applications of chromatographic techniques in natural products chemistry. • Discuss the applications of spectroscopic techniques in structure elucidation of new natural products.	**Unit II: Extraction, Isolation, Purification & Characterization of Natural Products (10 hrs)** General techniques of extraction, separation, and purification, soxhelt extraction, cold percolation, solvent extraction, steam distillation, extraction of essential oils, column chromatography, thin-layer chromatography (TLC), preparative TLC, gas chromatography, high performance liquid chromatography (HPLC), characterization of pure natural products by modern spectroscopic techniques.
• Explain the term biosynthesis and biogenesis. • Describe the methods of biosynthesis of secondary metabolites. • Discuss the biosynthesis of acetyl CoA, fatty acids, terpenes, steroids, alkaloids and acetogenins.	**Unit III: Biosynthesis of Natural Products (10 hrs)** Introduction, biosynthesis and biogenesis, methods of investigation of the biosynthesis of secondary metabolites, biosynthesis of natural products, biosynthesis of acetyl CoA, biosynthesis of fatty acids, biosynthesis of terpenes, biosynthesis of steroids, biosynthesis of alkaloids, biosynthesis of acetogenins.

• Describe the classification of terpenoids. • Discuss the isoprene and special isoprene rule. • Explain the general methods of structure elucidation of terpenoids. • Describe the sources, uses, and structure elucidation of menthol, juvenile hormone and caryophyllene.	**Unit IV: Terpenoids (5 hrs)** Introduction, classification, isoprene rule, isolation of terpenoids, general methods of determining structure, menthol, juvenile hormone, caryophyllene, polyterpenoids.
• Describe the classification of carotinoids. • Explain the general methods of structure elucidation of carotinoids. • Describe the sources, uses, and structure elucidation b-carotene and vitamin A. • Discuss the biosynthesis of carotinoids.	**Unit V: Carotenoids (5 hrs)** Introduction, classification, isolation, stereochemistry, general methods of structure elucidation, *β*-carotene, vitamin A, biosynthesis of carotenoids.
• Discuss the sources and isolation of steroids. • Describe the general methods of structure elucidation of steroids. • Explain the spectral properties of steroids. • Explain the structure elucidation of cholesterol. • Discuss the source, structure, structure and recommendation dose of vitamin D. • Explain the structure, function of steroidal hormone and cardiac glycosides.	**Unit VI: Steroids (5 hrs)** Introduction, occurrence, isolation, sterols, general methods of structure elucidation, spectral properties of steroids, cholesterol, stereochemistry of steroids, vitamin D, steroidal hormones, cardiac glycosides.
• Discuss the definition, classification, properties, and extraction of alkaloids. • Describe the structure elucidation and physiological action of alkaloids nicotine and quinine.	**Unit VII: Alkaloids (5 hrs)** Definition, extraction, general properties, general methods for determining structure, classification of the alkaloids, nicotine, quinine.

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 CHM476

1. I. L. Finar, **Organic Chemistry Volume 2: Stereochemistry and Chemistry of Natural Products**, 5th Edition, Longman Scientific and Technical (Pearson Education Asia), New Delhi, 2000.
2. Paul M. Dewick**, Medicinal Natural Products, A Biosynthetic Approach**, 2nd Edition, J. Wiley and Sons, Chichester, 2002.
3. R. B. Herbert, **Biosynthesis of Secondary Metabolism**, Chapmann and Hill Ltd., 1981.

6. References for CHM476

1. O. P. Agrawal, **Organic Chemistry of Natural Products**, Vols I & II, Krishna Educational Publisher, India, 2013.
2. G. R. Chatwal, **The Chemistry of Organic Natural Products**, Vols I & II, Himalaya Publishing House, Bombay, 1983.
3. J. Singh, S. M. Ali & J. Singh, **Natural Products Chemistry**, Pragati Prakashan, India, 2015.

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Climate Change** Credit: **3**
Course Code: **ENV 476** Number of hours per week: **3**
Nature of the Course: Applied Science Course (**Theory)** Total hours: **45**
Year: **Fourth** Semester: **Seventh**
Level: **B.Sc.**

Objectives

To develop understanding of climate change
To enable student to use CC vulnerability assessments tools
To understand climate change resilience and mitigation
To acquaint students with adaptation modules and approaches

Specific Objectives	Units, Contents and Lecture Hours
• Understand basic of climate, climate system and climate change	**Unit I: Introduction (7 Hrs)** Concept of climate and weather; Introduction to the climate system; Surface energy balance; Climate archives, climate data and models; Global warming and science of climate change; Causes and major impacts of climate change; Climate change scenario in Nepal
• Understand climate change risk and vulnerability • Know different vulnerability assessment methods and tools	**Unit II: Climate Change Risk and Vulnerability Assessment (7 Hrs)** Concept and terminologies related to climate change risk and vulnerability; Criteria to identify vulnerability; Climate change vulnerability index; Vulnerability assessment methods and tools; Implication of vulnerability assessment; Framework for developing CCA strategies
• Differentiate between CbA and EbA • Acquaint with Nepal's national plans, policies and strategies related to climate change adaption • Understand links between adaptation, economic growth and poverty	**Unit III: Climate Change Adaptation and Strategies (10 Hrs)** Concept of climate change adaptation, adaptation characteristics and processes; Types of adaptation; Community based adaptation (CbA) and Ecosystem based adaptation (EbA); Climate Change adaptation plans, policies and strategies; National plans, policies and strategies: Nepal's NAPA, climate change policy, LAPA and NAP process; Clean Development Mechanism (CDM): REDD, REDD+ and payment for carbon; Links between adaptation, economic growth and poverty

	reduction; the role of public policy in promoting adaptation, including financing adaptation
• Understand climate resilience with criteria and indicators of resilient communities	**Unit IV: Climate Resilience (5 Hrs)** Concept of climate resilience; Factors affecting resilience; Adaptive cycle; Community resilience; Resilience analysis; Criteria of resilient community and their indicators; Comprehending relation between ecosystem services, ecological resilience and adaptability
• Understand relationship between economic growth, competitiveness and carbon emissions • Know mitigation challenges and ways to reduce emission	**Unit V: Climate Change Mitigation (8 Hrs)** Concept of climate change mitigation; Greenhouse gas emission: scenario and projections; relationship between economic growth, competitiveness and carbon emissions; Mitigation Strategies and Global effort to reduce emission; Responding to mitigation challenges and ways to reduce emission: technologies to reduce emissions and their costs; policy instruments, including emissions trading and carbon markets
• Understand key concepts of climate-change economics and governance • Understand risks and opportunities created by climate change for different organizations	**Unit VI: Politics and Economics of Climate Change (8 Hrs)** Climate change as a social scientific issue; Climate change skeptics and controversies; climate-change economics and governance: market failure, pricing carbon, and the tragedy of the commons; political bargaining at the international and national levels; policy-making and policy implementation by governments, non-governmental organizations, businesses and communities; risks and opportunities created by climate change for different organizations

References:

1. Dazé, A., Ambrose, K., & Ehrhart, C. (2009). Climate Vulnerability and Capacity Analysis (Handbook). CARE International, London.
2. Houghton, J., (2004). Global Warming: The Complete Briefing. Cambridge University Press, Cambridge. w
3. Intergovernmental Panel on Climate Change (IPCC). (2007). Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, eds. M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson. Cambridge , UK : Cambridge University Press, 976 pp.
4. Intergovernmental Panel on Climate Change (IPCC). 2014: *Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to*

the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

5. Lal, D. S. (2013). Climatology, Revised Edition. Sharda Pustak Bhawan, Allahabad.
6. MOE-GON. (2010). Climate Change Vulnerability Mapping for Nepal. Ministry of Environment, Government of Nepal, Kathmandu
7. MOE-GON. (2010). Review of Community Based Vulnerability Assessment Methods and Tools. Ministry of Environment, Government of Nepal, Kathmandu
8. MOE-GON. (2010). National Adaptation Programme of Action (NAPA) to Climate Change. Ministry of Environment, Government of Nepal, Kathmandu
9. Morgan, C.L. (2011). Vulnerability Assessment: A Review of Approaches. IUCN, Gland, Switzerland.

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Freshwater Environment** Credit: **3**

Course Code: **ENV 475** Number of hours per week: **3**

Nature of the Course: **Theory (Applied Science)** Total hours: **45**

Year: **Fourth** Semester: **Seven**

Level: **B.Sc.**

Learning Objectives:

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

- Exhibit broad knowledge on freshwater environment
- Collect, record and analyze data using appropriate scientific techniques in the field and laboratory and for statistical analysis
- Describe river and wetland ecosystems and their structure and function, organisms that live within them and the main ecological concepts that comprise our understanding of them.
- Explore bioassessment as a tool for measuring stream/lake water quality and habitat health (biological integrity) based on physical, chemical and biological metrics.

Objectives	**Units, Contents and Lecture Hours**
• Understand fundamentals of freshwater environment • Know various types of lakes with their characteristics • Understand different methods for assessment of aquatic ecosystems	**Unit I: Introduction to Freshwater Ecosystems (8 Hrs)** Freshwater Environment: Types and Limiting Factors; Ecological classification of freshwater organisms; Freshwater biota (Flora and Fauna): lentic communities, lotic communities; Longitudinal zonation in streams; Lake zonation; Lake types: Holomictic lake, Monomictic lake, Dimictic lake, Polymictic lake Eutrophication and sedimentation; Assessment of aquatic ecosystems; Biomonitoring; Ecosystem services of wetlands and their economic valuation methods.
• Understand relation between land-use and hydrology • Understand fundamentals of groundwater flow	**Unit II: Land-Use Hydrology and Hydrogeology (7 Hrs)** Interaction between vegetation and water; Effects of land use on the hydrology of watersheds; Hydrological effects of clear felling, regrowth of forest (tree planting),

	grazing, cultivation, irrigation, and wildland fire. Introduction to the theory of groundwater flow; Flow nets; Regional groundwater resource evaluation; Well hydraulics; Role of groundwater in geologic processes.
• Understand structural and functional ecology of shallow and large lakes • Understand management and restoration approaches to lakes	**Unit III: Structural and Functional Ecology of Shallow and Large Lakes and their Restoration (10 Hrs)** Shallow lakes: General characteristics, hydrologic features; Biotic component: phytoplanktons, zooplanktons, benthic invertebrates, fishes; Role of nutrients; Trophic states; Management approach: Maintenance, in-lake management, watershed management; Economic importance of the lake Large lakes: General characteristics; Hydrologic features; Major groups of organisms; Lake thermal structures; Role of nutrients; Trophic states; Factors impacting the state of lake; Management approach: Eutrophication and water quality;
• Understand ecology of running waters	**Unit VI: Ecology of Running Waters (6 Hrs)** Low and highland river systems – processes, forms and functions; Hydrology, sediment transport and water chemistry, From spring to river – patterns and mechanisms; Aquatic plants; Macroinvertebrates and biotic interactions; Stream fish; Streams and their future inhabitants
• Take insights on river restoration and ecological principles	**Unit V: River Restoration and Ecology (5 Hrs)** Restoration principles; Ecosystem based principles- hydrological, geomorphological and ecological; Effective Monitoring; Restoring process; Self recovery; Criteria judgment for success of river restoration
• Understand impacts of anthropogenic activities on freshwater ecosystems	**Unit VI: Human Impacts on Freshwater Ecosystems (4 Hrs)** Hydrological alteration; Sedimentation and siltation; Biological invasions, Habitat fragmentation; Community assemblages.

• Describe freshwater resource issues and integrated approach to management	**Unit VI: Freshwater Resource Issues and Management (5 Hrs)** Integrated approach to freshwater resource issues and management and their place in environmental science; Topical issues in freshwater resources with emphasis on management options and consequences.

References

1. Marten Scheffer (2013). Ecology of shallow lakes. Springer Netherlands
2. Ikens GE (ed.) (1985). An Ecosystem Approach to Aquatic Ecology: Mirror Lake and its Environment. New York: Springer-Verlag
3. Rami J. P. and Reddy (2008). A Text Book of Hydrology, University Science Press.
4. Frey, D.G. and Fry, F.E.J. (1963). Fundamentals of Limnology. Toronto University Press, Canada.
5. Adoni, A.D. (1985). Workbook on Limnology, Pratibha Publishers, Sagar, India.

FAR WESTERN UNIVERSITY

ZOOLOGY CURRICULUM (B.Sc.)

2074

SEVENTH SEMESTER

Semester	Course Nature	Course Code	Course Title	Credits	Instruction hrs
VII (One major)	Theory	ZOO471	Genetics & Molecular Biology	4	60
	Theory	ZOO472	Wild Life & Conservation Biology	4	60
	Practical	ZOO473	Related to ZOO471 & ZOO472	2	90
Any one	Theory (Applied nature)	ZOO474	Animal Biotechnology	3	45
	Theory (Applied nature)	ZOO475	Toxicology	3	45
	Theory (Applied nature)	ZOO476	Ecosystem Services & Geoinformatics	3	45

Far-Western University

Faculty ofScience and Technology

B. Sc. Syllabus of Zoology

Course Title: Genetics & Molecular Biology **Credit 4**
Nature of the Course: Theory **Number of inst. hours per week: 4**
Course No: ZOO471 **Total instruction hours: 60**
Year: Fourth
Semester VII

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

- Understand the basic concepts of genetics
- Provide the knowledge on structural and informational molecules such as DNA and RNA and their role in information transfer.

Course Description:

A: Genetics

Specific Objectives	Units & Course Contents
• Describe the scope and importance of genetics. • Discuss the fundamental principles of heredity and variation.	**Unit 1: Introduction (1 hr)** Scope and importance of genetics, Heredity and variation.
• Describe the Mendel's laws of inheritance. • Describe the principles of segregation and independent assortment. • Explain the chromosome theory of inheritance. • Discuss the laws of Probability.	**Unit 2: Laws of Inheritance (4 hrs)** Mendel's Laws, Concept of segregation and independent assortment, Chromosome theory of inheritance, Laws of Probability.
• Describe complete dominance, incomplete dominance and co-dominance. • Explain the multiple alleles and lethal alleles. • Describe the epistasis. • Discuss the pleiotropy. • Explain Penetrance and expressivity. • Describe the polygenic inheritance.	**Unit 3: Genetic Interactions/ Allelic and Non-allelic interactions (4 hrs)** Concept of alleles, types of dominance- complete dominance, incomplete dominance and co-dominance, multiple alleles, lethal alleles, Epistasis. Pleiotropy. Penetrance and expressivity, Polygenic inheritance.

• Discuss the theories and types of linkage. • Discuss the characteristics and types of crossing over. • Enumerate the significance of linkage and crossing over.	**Unit 4: Linkage and Crossing over (3 hrs)** Concept, Chromosome theory of linkage, types of linkage, linkage groups, types of crossing over, mechanism of Meiotic Crossing over, theories about the mechanism of Crossing over, cytological basis of Crossing over, significance of Crossing over.
• Describe the characteristics of sex-linked inheritance. • Discuss sex influenced traits. • Describe mechanism of sex determination.	**Unit 5: Sex-Linked Inheritance (3 hrs)** Concept, sex influenced traits, mechanism of sex Determination.
• Describe the non-Mendelian inheritance.	**Unit 6: Non-Mendelian Inheritance (3hrs)** Cytoplasmic inheritance, extra-nuclear inheritance (mitochondrial, chloroplast), non-chromosomal inheritance, maternal inheritance, uniparental inheritance.
• Describe euploidy, aneuploidy, and polyploidy. • Discuss the types of chromosomal rearrangements with their consequences. • Explain the role of chromosomal aberrations in evolution.	**Unit 7: Chromosomal Variations (5 hrs)** Euploidy, aneuploidy, polyploidy, chromosomal rearrangements - deletion, duplication, inversion, and translocation. , Position Effect, Centromeric and Non-centromeric breaks in chromosomes, chromosomal rearrangements in Human being, Chromosomal aberrations and evolution.
• Classify the mutation. • Describe the mechanism of mutation. • Explain the role of mutation in genetic analysis and evolution.	**Unit 8: Mutation (3 hrs)** Types of mutations, mechanism of mutation, role of mutation in genetic analysis and evolution.
• Explain pedigree analysis and how pedigree charts are used in human genetics. • Describe some specific human traits controlled by heredity. • Explain various disorders due to mutant genes. • Discuss eugenics and euphenics. • Distinguish between positive and negative eugenics.	**Unit 8:Human Genetics (4 hrs)** Pedigree analysis, human traits, sex-linked diseases, disorders due to mutant genes, Eugenics and Euphenics.

B: Molecular Biology

Specific Objectives	Units & Course Contents
• Describe the structure, properties and functions of DNA and RNA. • Explain the organization of DNA. • Describe the various forms of DNA. • Discuss the DNA denaturation and renaturation kinetics.	**Unit 1: Structure of Nucleic Acids (5 hrs)** Structure, properties and functions of DNA and RNA, Organization of DNA, Various DNA forms, Conformation, Super coiling, Denaturation and Renaturation.
• Describe the general principles of bidirectional, Semi- conservative and Semi discontinuous DNA replication in Prokaryotes and Eukaryotes. • Describe the Different models of replication for linear and circular DNA. • Explain replication features of single stranded phages. • Discuss the enzymes involved in replication. • Discuss the regulation of DNA replication	**Unit 2: DNA Replication in Prokaryotes and Eukaryotes (6 hrs)** General principles - bidirectional replication, Semi-conservative, Semi discontinuous, Different models of replication for linear and circular DNA, replication features of single stranded phages. Enzyme involved in DNA replication - DNA polymerases, DNA ligase. Primase, Regulation of replication.
• Explain the Transcriptional unit. • Describe the RNA polymerase. • Describe the mechanism of transcription in prokaryotes and eukaryotes. • Discuss post transcriptional modification. • Discuss the regulation of transcription.	**Unit 3: Transcription (5 hrs)** Transcriptional unit, RNA polymerase, Mechanism of transcription in prokaryotes and eukaryotes, post transcriptional modification (splicing- mRNA, modifications at 3' and 5' end). Regulation of transcription
• Describe the process of translation including mechanism of initiation, elongation and termination in prokaryotes and eukaryotes. • Discuss the concept of post translational modification (glycosylation). • Explain the regulation of translation.	**Unit 4: Translation (5 hrs)** Translation process in prokaryotes and eukaryotes including mechanism of initiation, elongation and termination, concept of post translational modification (glycosylation). Regulation of translation.
• Discuss the regulation of gene expression.	**Unit 5: Regulation of Gene Expression (4 hrs)** Control of gene expression in prokaryotes and eukaryotes, Operon model- lac and trp operon.
• Explain the various types of DNA damages. • Discuss the different DNA repair systems.	**Unit 6 DNA Damage and Repair (5 hrs)** Different types of DNA damages, Different DNA repair systems: Nucleotide excision repair, Base excision repair, mismatch repair, recombination repair, Double strand break repair, transcriptional coupled repair.

Far-Western University
Faculty of Science and Technology
B. Sc. Syllabus of Zoology

Course Title: Wildlife & Conservation Biology **Credit 4**
Nature of the Course: Theory **Number of inst. hours per week: 4**
Course No: ZOO472 **Total instruction hours: 60**
Year: Fourth
Semester VII

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

- Understand basic knowledge on wildlife ecology and management.
- Know the faunal chordate diversity of Nepal.
- Explain proximate and ultimate threats to biodiversity.
- Know foundational knowledge on science of conservation biology,
- Understand major theoretical and empirical approaches and strategies in conservation biology,
- Know theories and practices of wildlife conservation.

Course Description:

A. Wildlife

Specific Objectives	Units & Course Contents
• Discuss the scope, values, ethics and attitudes of wildlife.	**Unit 1: Wildlife Fundamentals (1 hr)** Concept, Scope, values, Ethics and attitudes about wildlife
• Explain the components of wildlife habitat with characteristic fauna. • Describe the protected areas. • Discuss the impacts of human on wildlife habitat. • Discuss the conservation and restoration of habitat.	**Unit 2: Wildlife Habitat (6 hrs)** Habitat components, Characteristic fauna, Protected Area concept: National Parks, Sanctuaries and Reserves, cores and Buffers, Nodes and corridors. Human impacts on wildlife habitat, Habitat Conservation and Restoration
• Describe the habitat selection patterns in wild vertebrates. • Explain spatial organization. • Discuss the demographic structure, population growth and factors that regulate the population growth. • Describe the competition, predation and community dynamics.	**Unit 3: Wildlife Ecology (6 hrs)** Habitat selection, spatial organization, demography, population growth and regulation, competition, predation, and community dynamics

• Discuss human wildlife conflicts.	**Unit 4: Ecology of Human-Wildlife Conflicts (2 hrs)** Ecological approaches to managing wild vertebrates that cause problems for agriculture, public health, or conservation of biodiversity.
• Describe the principles and techniquesof wildlife management. • Explain about wildlife trade and legislation in Nepal. • Describe the Distribution, population dynamics, habitat utilization pattern, conservation and management of wild mammals, Birds and herpetofauna (tiger, rhinoceros, elephants, snow leopard, blue sheep, sloth bear, swamp deer, dolphin, crocodiles, game birds, waterfowls and birds of prey)	**Unit 5: Wildlife Management (15 hrs)** Principles and techniques, Wildlife trade and legislation in Nepal, Distribution, population dynamics, Habitat utilization pattern, conservation and management of wild mammals, Birds and herpetofauna (tiger, rhinoceros, elephants, snow leopard, blue sheep, sloth bear, swamp deer, dolphin, crocodiles, game birds, waterfowls and birds of prey)
• Explain the principle and recent trends in biodiversity conservation.	**Unit 6: Introduction to Conservation Biology (1hr)** Introduction to conservation biology and biodiversity, Principles and recent trends in biodiversity conservation.
• Describe vulnerability, extinction and rarity. • Explain extinction processes of biodiversity. • Discuss the causes of biodiversity declines. • Discuss threatened species based on IUCN Red list category and assessment procedures.	**Unit 7: Threats to Biodiversity (8 hrs)** Vulnerability, Extinction and Rarity, Extinction Processes- deterministic and stochastic, Natural and human induced threats- Human Population Growth and its impact , Environmental Degradation and Pollution, Global Climate Change, Overexploitation, Invasive Species, Disease. Threatened species: IUCN Red List Category and Assessment procedures.
• Discuss the current status of fish fauna of Nepal and causes of decline in diversity and abundance. • Explain the threatened amphibians and reptiles of Nepal with their distribution and conservation practices with reference to Crocodile and Himalayan Newt. • Describe the threatened bird species of Nepal and explain conservation	**Unit 8: Major Faunal Diversity and their Conservation in Nepal (10 hrs)** Status of fish fauna in Nepal. Causes of decline in fish diversity and abundance in Nepal. Threatened herpetofauna (Amphibia and Reptilia) of Nepal and their distribution and conservation practices with reference to Crocodile and Himalayan Newt. Threatened bird species of Nepal and conservation

practices with reference to vulture. • Discuss the threatened mammals of Nepal and their conservation practices.	practices with reference to vulture. Threatened mammals of Nepal and their conservation practices.
• Explain the traditional, conventional and community based approaches of conservation. • Describe the in-situ and ex-situ conservation approaches. • Discuss the population and species level approaches of biodiversity conservation. • Explain the ecosystem and landscape approaches of conservation.	**Unit 9: Conservation Approaches (8 hrs)** Traditional, conventional and community-based approaches, *In-situ* and *ex-situ* conservation approaches-,Population and species level approaches, Ecosystem and landscape approaches
• Explain the International and National conservation policies and legislation.	**Unit 10: Conservation Policy and Legislation (3 hrs)** International convention: RAMSAR, UNESCO's WH Convention, CITES, CMS, CBD (WCS), National legislation, policy and strategies.

Far-Western University

Faculty ofScience and Technology

B. Sc. Syllabus of Zoology

Course Title: Genetics, Mol. Bio., Wild Life & Con. Biology **Credit 2**
Nature of the Course: Practical **Number of inst. hours per week: 6**
Course No: ZOO473 **Total instruction hours: 90**
Year: Fourth
Semester VII

- **Course Objectives:** To impart practical knowledge and better understanding on topics related to ZOO471 & ZOO472
- **Course Contents :**

Genetics and Molecular Biology Practical

1. Preparation and study of Polytene and Lampbrush chromosome.
2. Frequency of the following genetic traits in human: Widow's peaks, attached ear lobe, dimple in chin, color of eye etc.
3. Study of human karyotypes and numerical alterations (Down syndrome, Klinefelter syndrome and Turner syndrome).
4. Preparation of short community/family based survey report on human genetic traits.
5. Isolation of DNA.
6. Gel electrophoresis of DNA.
7. Isolation of RNA.
8. Gel electrophoresis of RNA.

Wild Life & Conservation Biology Practical

1. Estimation of abundance: Censes, sampling, Capture- Mark- recapture, Distance sampling
2. Biodiversity assessment
3. Estimation of population density of animals from aquatic and terrestrial habitat.
4. Determination of sample size and efforts (eg Transect, quadrats, etc.)
5. Population viability analysis
6. Threat assessment of species using IUCN criteria
7. Gap analysis of protected areas of Nepal for the selected species
8. Habitat evaluation.
9. Measuring conservation status
10. Measuring species diversity
11. Population measurement: Population structure and composition. Population growth/increase. Construction of life table

Practical note book preparation as regular study.

Text and Reference Books:

Genetics and Molecular Biology

Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G.P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

Gardner, E.J., Simmons, M.J., Snustad, D.P. 2008. VIII ed. Principles of Genetics. Wiley India Lewin: Genes IX,Jones & Bartlett.

Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th ed., John Wiley & Sons. Inc.

Klug, W.S., Cummings, M.R., Spencer, C.A.. 2009. Concepts of Genetics. XI Edition.

Rastogi, S. C. 2001. Cell and Molecular biology. New Age International (P) Limited, Publishsers: New Delhi, Banglore, Calcutta, Chennai, Lucknow, Mumbai; India.

Singh, B.D. 2006. Fundamentals of Genetics. Kalyani Publishers, Ludhiana, New Delhi, Noida (UP), India.

Snustad & Simmons. 2006. Principles of Genetics. John Wiley.

Verma, P.S. and Agarwal, V.K. Latest ed. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. Published by S.Chand & Company LTD,New Delhi India.

Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R. 2008. Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.

Winter, P.C., Hickey, G.I. and Fletcher, H.L. 2000. Instant Notes in Genetics. Bios Scientific Publishers Ltd, 9 Newtec Place, Magdalen Road, Oxford 0X4 IRE, UK.

Wild Life & Conservation Biology

Braun, C.E. 2003. Techniques for Wildlife Investigations and Management. The Wildlife Society, USA.

Braun, C.E. and Robioson, W.L. 2003. Wildlife Ecology and Management. Prentice- Hall, Upper Saddle River, New Jersey.

Bolen, E.G. and Robinson, W.L. 2003. Wildlife Ecology and Management. 5th ed. Prentice Hall. New Jersey.

Groom, M.J., Meffe G.F., and Carroll, C.R. 2006. Principles of Conservation Biology.Sinauer Associates, Inc, Sunderland, MA, USA. 38

Koh, L.P., Dunn, P.R., Sodhi, N.S., Colwell, R.K., Proctor, H.C. and Smith, V.S. 2004. Species co extinctions and the biodiversity crisis. Science, 305 (5690), 1632-1634.

Morris, W.F. and Doak, D.F. 2002. Quantitative Conservation Biology: Theory and Practice of Population Viability Analysis. W. H. Freeman Publishers.

Nova, J.S. (Ed). 2012. The Wildlife Techniques Manual (Volume 1: Research and Volume 2: Management). 7th ed. Johns Hopkins University Press, Baltimore, Maryland, USA.

Primack, R. B. 2014. Essentials of Conservation Biology (Sixth Edition). Sinauer Associates, Inc., USA

Primack, R.B. 2010. Essentials of Conservation Biology. 5th ed. Sinauer Associates.

Primack, R.B., Poudel, P.K. and Bhattarai, B.P. 2013. Conservation Biology: a primer for Nepal.

Dreamland Publication, Kathmandu.
Shah, K.B. and Tiwari, S. 2004. Herpetofauna of Nepal: A Conservation Companion, IUCN Nepal.
Shrestha, T.K. 2008. Ichthyology of Nepal Himalayan Ecosphere, Kathmandu.
Shrestha, T.K. Mammals of Nepal, Latest Ed. Kathmandu.
Sinclair, A.R.E., Fryxell, J.M. and Caughly, G. 2006. Wildlife Ecology, Conservation and Management. 2nd ed. Blackwell Publishing, USA.
Sodhi, N.S. and Ehrlich, P.R. 2010. Conservation Biology for All. Oxford University Press, New York. http://www.mongabay.com/conservation-biology-for-all.html.
Thompson, W.L. (Ed.). 2004. Sampling Rare or Elusive Species: concepts, designs, and techniques for estimating population parameters. Island Press.
Van Dyke, F. 2008. Conservation Biology Foundations, Concepts, Applications. 2nd Edition, Springer.
Williams, B.K., Nichols, J.D. and Conroy, M.J. 2001. Analysis and Management of Animal Populations. Academic Press.

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Far-Western University
Faculty of Science and Technology
B. Sc. Syllabus of Zoology

Course Title: Animal Biotechnology **Credit 3**
Nature of the Course: Theory **Number of inst. hours per week: 3**
Course No: ZOO474 **Total Instruction Hours: 45**
Year: Fourth
Semester VII

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

- Understand the overall basic overview of animal biotechnology.
- Know some techniques of animal cell and tissue culture
- Explain what is transgenic animal technology.

Course Description:

Specific Objectives	Units & Course Contents
• Familiarize with basic overview of animal biotechnology including various techniques and processes so as to understanding the other impending topics more clearly.	**Unit 1. Animal Biotechnology: An Overview (2 hrs)** Origin and Definition: Old vs new biotechnology definitions Transgenic animal technology: Transfectgenic and Somatotransgenic amimals and their applications.
• Describe various techniques of animal cell and tissue culture procedures.	**Unit 2: Techniques of Animal Cell and Tissue Culture (12 hrs)** Sources of cell: Cell bank Techniques of cell culture: Mechanical technique and Biochemical technique, Types of animal cells. Equipments: Sterile handling and support services, Laminar flow cabinet, Incubators, Cell handling equipments. 2.4.Cell growing substrate, Cryopreservation equipment, Roller apparatus, Spinner vessels, Media handling equipment. 2.5 Cell culture media: Sources, Functions of main

	ingredients culture media 2.6. Animal tissue culture media: Culture medical containing naturally occurring ingredients, Tissue extracts, Complex natural media, Chemically defined media, Other tissue culture media. Culture procedures: Preparation and sterilization of glassware and apparatus, Preparation and sterilization of reagents and media, Preparation of animal material. Primary culture, cell line and cloning: Disaggregation of tissue and primary culture,isolation of tissue, enzymatic disaggregation, Mechanical disaggregation, Separation of viableand non-viable cells, Somatic cell fusion Tissue cultures: Primary explanation techniques, Slide or cover slide cultures, , Culture of embryonic organs, Culture of whole chicken embryo
• Have knowledge of the different techniques of artificial animal breedings and its harzards.	**Unit 3: Artificial Animal Breeding (8 hrs)** Genetic engineering: single genes, Gene mapping. Artificial insemination and germ cell storage Ectogenesis, Anniocentesis, Transplantation, Cloning technique, Gene therapy, In vitro fertilization and embryo transfer. Superovulation, Factors influencing superovulation, Freezing of embryos, Frozen embryos, Embryo sexing, Micromanipulation of embryos, Simple method of splitting embryos. Techniques of nuclear transplantation, Sources of eggs and embryos, gene injection. Hazards of artificial breeding.

• Describe the transgenic animal technology with various techniques of productions of transgenic animals with examples of mice, swine, sheep, cattle etc.	**Unit 4: Transgenic Animal Technology (10 hrs)** Concept of transgenes and transgenics: Integration of microinjected sequence intoembryo-a case study of mice. Genotyping transgenic mice by PCR, Rodent cloning and transgenesis, Expression of foreign genes in transgenic mice, Specific applications of transgenic mice, Transgenic mice as a model for genetic enginnering Use of Transgenics in Animal agriculture andresearch models: Transgenic swine. Production of transgenic sheep for growth hormone genes: Insertion and expression of genes. Production of transgenic cattle by pronuclear injection: Collection of embryos, pronuclearinjection, Preparation of DNA, Culture and transfer of embryos, Collection and analysis of tissue Methods for the introduction of recombinant DNA into chicken embryos Problems after developing transgenic animals with the question and nature of patents.
• Understand the basic concept of transgenic fish production with various techniques and procedures as well as the characterization and application of transgenic fish in human life.	**Unit 5: Fish Biotechnology (6 hrs)** Genetic requirements for transgenic fish production: Transgenic constructs and selection of fish species Gene transfer technology in fish: General steps for developing transgenic fishes, Gene transfer by microinjection, Electroporation, Transfer of transgenes by infection with pantropic retroviral vectors Fish antifreeze protein gene promoter in the production of growth hormone Characterization of transgenic fish: Identification of transgenic fish Expression of transgenes, Patterns of transgene integration, Inheritance of transgenes Application of transgenic fish in biotechnology: Biosynthetic growth hormone and Gene transfer in common carp and channel catfish

• Recognize significance of animal health and the use of biotechnology for the protection of animal health.	**Unit 6: Animal Health Biotechnology (7hrs)** Wildlife population and health Immunity: Innate immunity, Non-specific defense mechanisms, Phagocytosis Vaccines: Killed vaccine, Live vaccine, Genetic vaccine Toxoids: Diphtheria toxoid, Tetanus toxoid, DPT vaccine (Diphtheria, Pertusis and Tetanus) Interferon or antiviral substances: Nature of interferon, Assay of interferon, Nature of interferon genes, Biological activity of interferon. Interference: Interference within inoculated leaf. Gene therapy: Gene transfer system.

Text Books

Ranga, M.M. 2013. Animal Biotechnology, 2nd Edition. Behind Nasarani Cinema, Chopasani Road, Jodhpur 342 003, India.

Singh, B., Gautam, S.K., Chauhan, M.S. 2015. Text Book of Animal Biotechnology. Published by Energy and Resource Institute, Sept. 30 and sold by Amazon Digital Services LLC.

References:

Kanakraj, P. 2001 A Text Book on Animal Genetics. International Book Distributing Company, Lucknow, U.P., India.

Verma, A. and Singh, A. 2013. Animal Biotechnology: Models in Discovery and Translation, 1st Edition. Academic Press, India

Journal of Animal Science and Biotechnology; ISSN: 2049-1891: https://jasbsci.biomedcentral.com/

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Far-Western University
Faculty of Science and Technology
B. Sc. Syllabus of Zoology

Course Title: Toxicology **Credit 3**
Nature of the Course: Theory **Number of inst. hours per week: 3**
Course No: ZOO475 **Total instruction hours: 45**
Year: Fourth
Semester VII

Course Objectives:

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

- Understand the fundamentals of toxicology and ecotoxicology.
- Understand the mechanism behind the chemical-induced toxicities
- Comprehend the impact and risk of toxicants to human health

Course Description:

Specific Objectives	Units & Course Contents
• Define toxicology and discuss how it evolved with its scope and branches.	**Unit 1 : Introduction (1hr)** Definition of toxicology, Scope and branches, History
• Describe basic toxicological principles.	**Unit 2 : Principles of Toxicology (2 hrs)** Types of Toxic agents, Spectrum of undesired effects, Characteristics of exposure, Dose-Responses Relationships, Variation in toxic Responses.
• Describe the mechanisms of toxicity.	**Unit 3 : Mechanisms of Toxicity (4 hrs)** Delivery: From the site of exposure to the target, Reaction of the toxicant with target molecule, Cellular dysfunction and resultant toxicities, Inappropriate repair and adaptation.
• Describe the methods of assessing toxicity of chemicals. • Describe the dose-response assessment approaches and discuss the interpretation of toxicity.	**Unit 4: Risk Assessment (4 hrs)** Hazard identification, Dose-response assessment, Risk characterization, Exposure Assessment, Risk perception and comparative analysis.
• Describe the disposition (absorption, distribution and excretion) of toxicants in	**Unit 5: Toxicant Processing *in vivo* (4 hrs)**

the body. • Describe the two general phases of xenobiotic metabolism.	Absorption and Distribution of Toxicants, Metabolism of Toxicants-Phase I and Phase II reactions, Excretion of toxicants
• Explain the principles of xenobiotic biotransformation.	**Unit 6: Biotransformation of Xenobiotic (1 hr)** Principles of xenobiotic biotransformation
• Describe mechanism of acute toxicity. • Describe the classes of agents associated with carcinogenesis. • Discuss the mechanism of chemical carcinogenesis. • What are teratogens? Discuss the principles of teratology and approaches for safety evaluation of drugs for human use.	**Unit 7: Toxic Action (3 hrs)** Acute toxicity, chemical carcinogenesis, teratogenesis
• What are the hepatotoxicants? Describe the mechanism and types of toxin-induced liver injury. • Describe the pathophysiological responses of the kidney (mechanism of reduction of glomerular filtration rate (GFR) and mechanisms that contribute to decreased GFR in acute renal failure) and discuss the susceptibility of the kidney to toxic injury. • Describe the functional manifestation and mechanism of neurotoxicity. • Describe the mechanisms of endocrine disruption. • Discuss the effects of toxicants on male and female reproductive physiology.	**Unit 8: Organ Toxicity (5 hrs)** Hepatotoxicity, Nephrotoxicity, Neurotoxicity, Endocrine system, Reproductive system
• Identify the different types of pesticides with their mechanisms of action. • Discuss the mechanisms of toxic action of heavy metals. • Explain the toxic effects of food additives to human health. • Describe the effects of radioactive substances to human health • Discuss the principle air, water and soil pollutants with their effects. • Describe the effects of major environmental contaminants (chlorinated hydrocarbons, aromatic hydrocarbons, alcohols, glycols, glycol ethers, fuels and	**Unit 9: Toxicants of Public Health and Hazards (10 hrs)** Pesticides, heavy metals, food additives, radioactive substances, Pollutants (air, water and soil), solvents and vapors, plants and animal venoms

fuel additives, carbon disulfide) to human health. • Discuss the toxic effects of bioactive substances from some plants. • Describe the toxic effects of different animal venoms.	
• Explain how toxicants get into the environment. • Describe the process of transport of toxicants in the environment. • Describe how the toxicants accumulate and increase in concentrations in organisms. • Describe how environmental chemicals are metabolized • Give examples of the factors that affect xenobiotic action. • Identify the damage process and action of toxicants. • Predict the defense response to toxicants. • Identify potentially toxic local sites and predict environmental outcomes.	**Unit 10: Ecotoxicology (8 hrs)** Introduction, Occurrence of Toxicants, Transport of toxicants in the environment, Bioaccumulation, Metabolism/Biotransformation, Biomagnification, Toxicants effects- Populations' effects, Communities' effects, Landscape and Global effects, Ecological Risk Assessment
• Discuss how can toxicity be prevented.	**Unit 11: Prevention of Toxicity (3 hrs)** Legislation and Regulation, Prevention in Different Environments, Education.

Text and Reference Books

Casarett & Doull. 2008. Toxicology,7th ed., Klaassen ed. McGraw Hill.

Cupp and Karch, eds. 2000. Toxicology and Clinical Pharmacology of Herbal Products, Springer-Verlag.

Frank and Ottoboni. 2011. The Dose makes the Poison: A Plain-language Guide to Toxicology, 3rd ed. eBook, J Wiley & Sons.

Gaby, Batz, Chester and Constantine, eds.2006. A-Z Guide to Drug-Herb-Vitamin Interactions, 2nd ed.Three Rivers Press.

Gilbert. 2004. A Small Dose of Toxicology: The health effects of common chemicals, CRC Press.

Gibson. 2000. Multiple Chemical Sensitivities: A survival guide,New Harbinger Publications.

Harvey, Clark, Finkel, Rey, and Whalen. 2012. Pharmacology,5th ed. Lippincott Williams & Wilkins.

Hayes, A.W. and Kruger, C. L. (Editor). 2014. Hayes' Principles and Methods of Toxicology,

Taylor and Francis, 6th edition.
Hodgson. 2010. A Textbook of Modern Toxicology ,4th ed. J Wiley & Sons.
Lawson. 2000. Staying Well in a Toxic World, Lynwood Press.
M. Yu. Environmental Toxicology: Biological and Health Effects of Pollutants, Second Edition.
Ottoboni. 1997. The Dose makes the Poison: A Plain -language Guide to toxicology,2nd ed., J Wiley & Sons.
Ropeik, D.2010. How Risky is It, Really? McGrawHill.
Rachel Carson. Silent Spring [ISBN: 0-39-568329-7]
Smart and Hodgson eds. 2008. Molecular and Biochemical Toxicology, 4th ed.,J Wiley & Sons.

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Far-Western University
Faculty of Science and Technology
B Sc Syllabus of Zoology

Course Title: Ecosystem Services & Geo-informatics **Credit 3**
Nature of the Course: Theory **Number of inst. hours per week: 3**
Course No: ZOO476 **Total Instruction Hours: 45**
Year Fourth
Semester VII

Course Objectives:

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

- Understand the overall basic concept of ecosystem services.
- Acquaint with the fundamental concept of geoinformatics.

Course Description:

A. Ecosystem Services **1.5 credits**

Specific Objectives	Units & Course Contents
• Understand the basic knowledge of ecology, ecosystem and ecosystem services in general.	**Unit 1: Basic Concept of Ecology, Ecosystem and Ecosystem Services (4 hrs)** Concepts and principles of ecology, Significance of ecology for human being. Concepts of ecosystem, Biodiversity and ecosystem functioning, Understanding the valueecosystems.
	1.3 Introduction to ecosystem services, Origin and evolution of the Concept and practices of Ecosystem services, Significance of ecosystem services to human being.

• Familiarize with basically four categories of ecosystem services.	**Unit 2: Categories of Ecosystem Services (8 hrs)** **Provisioning services:** (a) Food (seafood and game), crops, wild foods, and spices, (b) Water, (c) Pharmaceutical, biochemical, and industrial products, (d) Energy (hydropower, biomass fuels) **Regulating services:** (a) Carbon sequestration and climate regulation, (b) Waste decomposition and detoxification, (c) Purification of water and air, (d) crop pollination, (e) Pest and disease control **Supporting services:** (a)Nutrient dispersal and cycling, (b) Seed dispersal, (c) Primary production, (d) Generation and maintenance of biodiversity **Cultural services**: (a)Cultural, intellectual and spiritual inspiration, (b)Recreational experiences and ecotourism, (c) Scientific discovery
• Explain what are the threats to ecosystem services along with the impacts of climate change on it.	**Unit 3: Threats to Ecosystem Services (4 hrs)** Destruction of natural habitats, Invasion of non- native species, Over exploitation of renewable resources (aquatic and terrestrial), loss of native biodiversity, Alteration of earth's carbon, nitrogen, and other biogeochemical cycles, Heavy use of nitrogen fertilizers, Degradation of farmland, Squandering of fresh water resources, Toxification of land and waterways Impact of climate change on ecosystem services
• Realize the valuation of ecosystem services and the well-being of humanity at the cost of ecosystem services.	**Unit 4: Valuation of Ecosystem Services (4 hrs)** 4.1Ecosystem services and their Monetary value. 4.2The Ecosystem Services Valuation Tool and its Future Developments. 4.3Global values of ecosystem services. 4.4Ecosystem services, human well-being and human civilization
• Understand the macroscopic risks and opportunities of ecosystem	**Unit 5: Ecosystem Services and Business (2 hrs)**

services and business in the world.	Risks and opportunities of ecosystem servicesand business in the world. Five types of risks and opportunities ofecosystem services and business: **(a)** Operational risks and opportunities**,** (b) Regulatory and legal risks and opportunities, (c) Reputational risks and opportunities, (d) Market and product risks and opportunities, (e) Financing risks and opportunities

B. Geo-informatics: 1.5 credits

Specific Objectives	Units and Course Contents
• Describe fundamental mechanism of aerial photographic system, stereoscopic vision, radial line methods and map compilation process and finally the aerial mosaics.	**Unit 1: Photogrammetry (5 hrs)** Aerial photographs: Types of photographs, Image displacements, Comparison of aerial photograph and map Aerial photography: Specifications for aerial photography. Stereoscopic vision: Binocular observation, Types of stereoscope, Stereo model. Radial line methods and map compilation: Types of radial triangulation, Map compilation by graphical method, Accuracy of Radial line method. Aerial mosaics: Planning for mosaics and mosaic compilation.
• Understand basic concept of remote sensing and its applications.	**Unit 2: Remote Sensing (7 hrs)** Basic concepts of remote sensing: Interaction ofEMR with atmosphere and earth's surface. Data acquisition system: Sensors and platforms. Multispectral remote sensing: Multispectral photography and scanning. Remote sensing in thermal infrared region: Emissivity, Thermal infrared sensors and characteristics of thermal images. Remote sensing in microwave region: Active and passive system, Satellite Radar system and Radar image interpretation. Satellite remote sensing: Landsat, IRS and other satellites. Satellite image interpretation: Visual interpretation and digital image processing.

• Know the Concept of Global Positing System (GPS), map projection, components of GPS and its applications.	**Unit 3: Global Positioning System (GPS) (5 hrs)** Map: Map numbering and rectangular gridsystem. Map projection: Classification of map projections, Georeferencing. Global positioning system: Components ofGPS, Operational principles. Differential GPS: DGPS concepts, Types ofGPS. GPS applications: Areas of application.
• Describe the process of GIS and its functions and applications in various areas.	**Unit 4: Geographical Information System (GIS) (6 hrs)** Database management system: Introduction andDBMS Geographical information system: GIS Conceptand components, Spatial data representation, Relationship of spatial objects Remote sending and GIS GIS functions GIS applications

Text & Reference Books

Bhatta, B. 2016. Remote Sensing and GIS. 11th Impression, 2016. Oxford University Press, YMCA Library Building, 1 Jai Singh Road, New Delhi 110001, India.

Ecosystem Services. edited by Jetske A. Bouma, Pieter J. H. van Beukering, Cambridge University Press

Ecosystem Services, Global Issues, Local Practices (Editors: Sander Jacobs, Nicolas Dendoncker ,Hans Keune) Elsevier Inc.

Kremen, C. 2005. *Managing ecosystem services: what do we need to know about their ecology?* Ecology Letters 8: 468-479.

Mark Everard, Ecosystem Services, Key issues, CSIRO publishing, Earthscan from Routledge, ISBN: 9781138692725

Millennium Ecosystem Assessment (MEA). 2005. *Ecosystems and Human Well-Being: Synthesis.* Island Press, World Resource Institute, Washington. 155pp.

Robert Costanza, Ralph d'Arge, Rudolf de Groot, Stephen Farber, Monica Grasso, Bruce Hannon et al. 1997. *The Value of the World's Ecosystem Services and Natural Capital.* Nature, vol.387, May 15.

Srivastava, G.S. (2014). An Introduction to Geoinformatics. McGraw Hill Education, India

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FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

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

Course Objectives

Upon completion of this course, the students will able to

- Understand basic scientific knowledge about various type of environmental Modelling,
- Understand the process behind the modeling
- Incept the knowledge and theory of modeling in GIS.

Specific Objectives	Units, Contents and Lecture Hours
• Understand the basics concept of environmental modeling and various types of models.	**Unit I: Basics of Environmental Modeling (5 hours)** Basic concepts of Model; Complexity in Environmental System; Application and Scope of Environmental Modeling; Basic Principal of Modeling; Types of Model: Conceptual Model, Deterministic (Mathematical) Model, Statistical Model, Static and Dynamic Model;
• Incept the knowledge about modeling building process and basic principles that drive the model development.	**Unit II: Model Development (25 hours)** Elements of Model development; Model Selection: Principle of Parsimony and Criteria of Model Selection; Modeling Steps and Ingredients; Conceptual Modeling: Steps in development of Conceptual Model; Balance Equation of a State Variables; Dimensional Homogeneity; Consistency of Units Mathematical Modeling: Parts of Mathematical Model – Parameters, Variables; Linkage between Parameters and Variables; Approach to derive Mathematical Model; Differential Equation; Matrix Algebra; Types of Mathematical Model Statistical Modeling: Variables – Dependent and Independent Variables; Linear and Non-Linear

	Regression Analysis; Hypothesis testing
• Analyze the process of model evaluation. • To study the various methods of model evaluation and validation.	**Unit III: Model evaluation (10 hours)** Basics of Model Evaluation; Graphical Analysis; Quantitative Analysis: Analysis of Coincidence, Analysis of Association; Sensitivity Analysis: Methods used in Sensitivity Analysis, Importance of Sensitivity Analysis; Uncertainty Analysis: Importance of Uncertainty Analysis, Methods used in Uncertainty Analysis, Representation of Variation in Input and Output, Expression of Uncertainty, Error Analysis, Residual Analysis
• Understand the basics of GIS based model and formulation process.	**Unit IV: GIS based Models (5 hours)** Basic of GIS Modeling; Types of GIS Models: Structural and Relational Models, Cartographic and Spatial Model; Characteristics of GIS Models: Scale, Extent, Purpose, Approach, Technique, Association and Aggregation; Classification Guide for GIS Models; Techniques of modeling in GISGIS Data for environmental models GIS functions in environmental models; Model validation; Physical environmental models; Human (cultural, social, economic, etc.) environmental models; Selected examples and cases
• Study the basics principles of various modeling platform used in environmental studies.	**Unit V: Modeling Platform (5 hours)** Modeling Principles of Various Software Model: Maximum Entropy Model, HEC-RAS model for Hydrology, SWAT Model; Analytical Hierarchical Process; Multi-Criteria Decision analysis; Artificial Neural Network;
• Study the uses of model and modeling process in various aspects of environmental studies.	**Unit VI: Application of Modeling in Environmental System (10 hours)** Modeling of transportation of Contaminants in atmosphere, Water and Soil; Modeling of subsurface and surface hydrology; Niche Modeling; Modeling of Species and Habitat distribution; Disaster Hazard and Risk Modeling; Modeling of Global and regional Climate and Weather

References

1. M.M. Aral, Environmental Modeling and Health Risk Analysis (ACTS/RISK), DOI 10.1007/978-90-481-8608-2_2, Springer Science Business Media B.V. 2010

2. A Practical Guide to Ecological Modelling Using R as a Simulation Platform Karline Soetaert and Peter M.J. Herman ISBN: 978-1-4020-8623-6 e-ISBN: 978-1-4020-8624-3 Springer Science Business Media B.V. 2010
3. Maguire, Batty, & Goodchild: GIS, Spatial Analysis, and Modeling. ESRI Press, 2005.
4. Clarke, K. et. al.: Geographic Information Systems and Environmental Modeling. Prentice Hall, 2001.
5. DeMers, M.: GIS Modeling in Raster. Wiley, 2002
6. Goodchild et. al.: GIS and Environmental Modeling: Progress and Research Issues. GIS world, Inc., 1996.

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

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

Description

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

This practical section is divided into two sections

1. Field Work
2. Case Studies

Field Work (10 days)

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

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

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

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

Thematic Area A: Ecology

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

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

Thematic Area B: Water and Hydrology

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

Thematic Area C: Disaster and Land Use

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

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

Course Title	**Environmental Remote Sensing and Geographic Information System**	Credit	**4**
Course Code	**ENV 471**	Number of hours per week	**3**
Nature of the Course	**Theory (Core Course)**	Total hours	**60**
Year	**Four**	Semester	**Seventh**
Level	**B.Sc.**		

Course Objectives

Course of Environmental Remote Sensing Geographic Information System is designed to provide the students with an understanding of the methods and theories of Remote Sensing and spatial-temporal analysis that will allow students to apply GIS knowledge and skills in various field of environmental science.

Specific Objectives	Units, Contents and Lecture Hours
• To Understand the basic concept of remote sensing • To familiarize students with electromagnetic radiation and various types of remote sensing	**Unit I: Fundamentals of Remote sensing (4 hours)** Historical Overview; Concept of remote sensing; Electromagnetic radiation: Characteristics, Interaction between matter and electromagnetic radiation, Wavelength regions of electromagnetic radiation; Types of Remote Sensing with respect to wavelength regions; Definition of Radiometry; Black body radiation; Reflectance: Spectral reflectance of land covers; Spectral characteristics of solar radiation; Transmittance of the atmosphere; Radiative transfer equation
• To study the different types of Sensors and characteristics of various types sensors.	**Unit II: Sensors (2 hours)** Types of Sensor: Characteristics of optical sensors; Resolving Power; Dispersing Element; Spectroscopic Filter; Spectrometer; Characteristics of optical detectors; Cameras for remote sensing; Film for remote sensing; Scanner: optical mechanical scanner. Push-broom scanner; Imaging spectrometer; Atmospheric sensors; Sonar; Laser and RADAR

• To study the various platform of remote sensing. • To understand the significance of orbital characteristics.	**Unit 3: Platforms and orbital Characteristics (2 hours)** Types of platform; Atmospheric condition and Altitude; Attitude: Attitude of Platform, Attitude sensors; Orbital elements of satellite; Orbit of satellite; Satellite Positioning system; Remote Sensing satellites: Landsat, Sentinel, IRS, SPOT, NOAA, MODIS; Geostationary meteorological satellites
• To understand the various type of data used in remote sensing analysis. • To study the different characteristics of data used in remote sensing works.	**Unit 4: Data used in Remote sensing (2 hours)** Digital Image data; Characteristics of Image data: Geometric and Radiometric Characteristics; Format of remote sensing image data; Auxiliary data; Calibration and Validation of data; Ground Data; Ground positioning data; Map data; Digital terrain data; Media for data storage, recording and distribution; Satellite data transmission and reception; Retrieval of remote sensing data
• To interpret the satellite images for various environmental works • To study the various technique of image processing. • To apply various classification techniques for further analysis	**Unit 5: Image processing (15 hours)** Image Interpretation: Information extraction in remote sensing, Visual Interpretation of Image, Stereoscopy, Interpretation elements, Interpretation keys, Generation of thematic maps; Image Processing System: Image processing in remote sensing, Image processing systems, Image input systems, Image display systems, Hard copy system; Correction in Remote sensing: Radiometric correction, Atmospheric correction, Geometric distortions of image, Geometric correction, Coordinate transformation, Co-linearity equation, Resampling and interpolation; Conversion of Image: Image enhancement and feature extraction, Grayscale conversion, Histogram conversion, Color display of image data, Color representation - Color mixing system and color appearance system, Operation between images, Image correlation; Image Classification: Classification techniques, Estimation of population clustering, Clustering, Decision Tree classifier, Minimum distance classifier, Maximum likelihood classifier, Classification using fuzzy set theory, Classification using expert system

• Define Geographic Information Systems (GIS) • Identify, compare and contrast vector and raster ; and the appropriate use of each of these data structures in GIS • Understand the importance of scale, projection, and coordinate systems in GIS	**Unit 6: Introduction of Geographic Information Science and Spatial Data Types (5 Hours)** Concepts of GIS: History, Definitions and Basic Principles; Geographic Phenomena and Spatial Representation In GIS: Models, Maps, Data Sources and Storage; Spatial and Temporal Dimensions Of Data; Coordinate system and transformation: Geodesy, Coordinate Systems, Geographic Projections, and Scale; Geographic versus Projected Coordinates; Geo-referencing a digital map or raster data, Geographic Transformation
• List and evaluate the capabilities of various GIS programs. • Explain uncertainty as it relates to scale, resolution and projection; discuss uncertainty propagation within a GIS • Understand the basics of data capture, storage, analysis, and output in a GIS	**Unit 7: Data: processing, quality, management and metadata (8 hours)** Hardware and Software Data Sources: Global Positioning System (GPS), Google Earth, Online and Other Data Sources; Creating and editing data: Spatial data input, Spatial referencing and data preparation, Point data transformations, Advanced data operations and continuous field raster; Basic concepts and definitions for data quality: Types of errors on a map, Error Propagation in spatial data processing; Database management systems (DBMS): Using DBMS, alternatives for data management, DBMS in GIS; Metadata and Data Sharing: Metadata concepts and functionality, spatial data transfers and its standards, data sharing related problems
• Apply spatial analysis functions on a GIS to a Geospatial problem.	**Unit 8: Spatial Analysis (6 hours)** Spatial query: querying data, selecting features, joining and relating data; Concepts of geographic data production; Classification of analytic GIS capabilities; Geographical data production methods: Retrieval Classification and Measurement, Overlay functions, Neighborhood functions, Network analysis; Statistical analysis; GIS as a modeling tool
• Apply cartographic principles of scale, resolution, projection and data management to a problem of a geographic nature.	**Unit 9: Data visualization and Cartography (6 hours)** Principles of cartography; GIS and maps: Visualization process and strategies; The cartographic toolbox; Map making process: Displaying and presenting data

• Discuss the value and applications of GIS and remote sensing in various aspect of Environment.	**Unit 10: Application of RS and GIS (10 hours)** Introduction to application of drone and UAV; Indices development and its use in environmental studies; Land-use/Land-cover Mapping and Survey; Hazard and Risk Assessment; Conservation and resource management; Land-use and Urban planning; Watershed management

Instructional Methodology

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

Assignments for Remote Sensing

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

Assignments for GIS

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

Text Books

1. Geographic Information Systems and Science (4th Edition), Authors: Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind; Publisher: Wiley (March 2015, ©2016), ISBN-13: 978-1118676950; ISBN-10: 1118676955

2. Fundamentals of Remote Sensing. Joseph, G., 2005. University Press (India) Pvt. Ltd., Hyderabad

Reference Books and Materials

1. http://esripress.esri.com/display/index.cfm?fuseaction=display&websiteID=286&moduleID=42

2. *Required:* Getting to Know ArcGIS (4th Edition), Authors: Michael Law, Amy Collins; Publisher: ESRI Press (July 2015, © 2015), ISBN-13: 978- 1589483828; ISBN-10: 1589483820

3. http://as.wiley.com/WileyCDA/WileyTitle/productCd-EHEP003247.html

4. Principles of Geographic Information Systems: An introductory textbook, Editor: Rolf A. de The International Institute for Aerospace Survey and Earth Sciences (ITC), By 2001

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

Course Title	**Internship**	Credit	**1**
Course Code	**ENV 473 .2**	Number of hours per week	**3**
Nature of the Course	**Practical (Core Course)**	Total hours	**45**
Year	**Four**	Semester	**Seventh**
Level	**B.Sc.**		

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

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

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

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

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

Research Methodology II

Course Title: **Research Methodology II**
Course No.: **RSM471**
Nature of the Course: **Theory**
Year: **Fourth**, Semester**: Seventh**
Level: **Undergraduate (B.Sc.)**

Credit: **3**
Number of hours per week: **3**
Total hours: **45**

Course Description

The course intends to enable the students to be acquainted with the basic concepts of Research Methodology. Students will be familiarized with the fundamentals of Research and its methods, Research design, Types of researches, Ethical standards, Proposal writing, etc.

Course Objectives

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

- to understand the importance of ethical standards and methods of scientific research
- to acquire sufficient basic knowledge in research methodology
- to apply this knowledge base for conducting researches
- to prepare research proposals

Course Contents

A. Statistical Data Analysis

1. Sampling: Sampling distribution, Degree of freedom, Standard error, Central limit theorem, statistical inference [4]
2. Testing of Hypothesis: Procedure for testing, Testing for mean, proportion and variance, Approaches of testing, Limitations [6]
3. Chi-Square Tests: Test of independence of attributes, Goodness of fit, Limitations [5]

B. Scientific Communication

1. Scientific Writing: Literature review, Essential components of research proposal, Reports, Thesis, Research papers, Publication in journals [8]
2. Reference Styles: Standard reference styles, Books, Edited books, Thesis, Research papers, Conference / Workshop proceeding, Research reports and online documents [5]
3. Scientific Presentation: Different modes of presentation, Power-point presentation [2]

C. Problems and Exercises [15]

Concerned faculty will design 1CH course to deliver necessary theory, problems and exercises of respective (Physical and Biological science) group.

References and suggested readings

C. R. Kothari and G. Garg, Research Methodology: Methods and Techniques (Third edition), New Age International Publishers, India (reprint 2017)

Murray R. Spiegel and Larry J. Stephens,Statistics (Schaum's Outline Series) 4th edition, Tata McGraw-Hill Pub., India (2010)

Meenakshi Raman and Sangeeta Sharma, Technical Communication: Principles and Practice (Third edition), Oxford University Press (2015)

P.K.Jha, D. D. Shakya, S. D. Joshi, R.P. Chaudhary and S.R. Shakya (eds.), Research Methods and Practice, Buddha Academic Publishers and Distributors, Kathmandu, Nepal (2004)

Mrigendra Lal Singh, Understanding Research Methodology, Published by J. M. Singh, Kathmandu, Nepal (1998)