Far Western University
Mahendranagar, Kanchanpur
Faculty of Science and Technology

B. Sc. Seventh Semester Physical Group

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Mathematical Analysis I** F.M.: 100
Course No.: MTH 471 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Seventh Teaching Hours: 45

(1). Course Description

This course is designed for B. Sc. fourth year a continuation of second year real analysis (MTH221). The main aim of thiscourse is to provide advanced knowledge of real analysis.

(2). Course Objectives

The general objectives of this course are as follows:

- To enable the students to develop good theoretical background of analysis and its applications.
- To enable the students to take up higher studies in related fields.
- To enable the students to make capable for teaching in some related fields of analysis.

(3). Specific Objectives and Course Contents

Specific Objectives	Contents in Detail
• Define a real number and its absolute value with illustrations. • Define sets with their union, intersection (arbitrary and finite), difference andcomplement • State basic properties of countable and uncountable sets. • Define one to one and onto functions with some examples. • Define a sequence of real numbers with examples.	**Unit 0: Review of Basic Concepts** Real number system, absolute value Sets and set operations Sequence
• Define Euclidean space $\mathbf{R}^n$ and algebraic operations on $\mathbf{R}^n$. • State and prove some properties of norm. • Define open sets in $\mathbf{R}^n$ with examples. • Prove the theorem showing how open sets in $\mathbf{R}^n$ can be constructed fromgiven open sets. • Define closed sets with examples. • Define adherent points, accumulation points and isolated points withexamples. • State and prove some theorems on adherent points and accumulation points. • State Bolzano-Weierstrass theorem and prove it for n > 1 only. • Solve some problems on open sets, closed sets, adherent points and accumulation points.	**Unit 1: Elements of Point Set Topology (11 ho** Euclidian space $\mathbf{R}^n$ Open balls and open sets in $\mathbf{R}^n$ Closed sets Adherent points, accumulation points and isola points Closed sets and adherent points The Bolzano-Weierstrass theorem The Cantor intersection theorem
• Explain open covering with some examples. • State Leindelof covering theorem without proof. • State and prove Heine-Borel covering theorem. • Define a compact set with an example. • State and prove some theorems related to compactness in $\mathbf{R}^n$. • Define a metric on a set and give some examples. • State and prove some theorems related to point set topology in metric spaces. • Define a compact set in a metric space. • State and prove some theorems related to compact subsets of a metric spacewith examples. • Define the boundary of a metric space with examples.	**Unit 2: Compactness (8 ho** Leindelof covering theorem The Heine-Borel covering theorem Compactness in $\mathbf{R}^n$ Metric spaces Point set topology in metric spaces Compact subsets of metric spaces Some theorems concerning point set topology metric spaces and compact sets Boundary of a set

• Solve some problems of compactness.	
• Define a sequence in a metric space with various examples. • Define a Cauchy sequence in a metric space with examples. • Give the concept of convergent sequences in metric spaces. • Give the concept of Cauchy sequences in a metric space. • Differentiate between convergent and Cauchy sequence in metric spaces • State and prove some theorems on convergent sequences. • Define divergent sequence in a metric space with examples. • State and prove some theorems on Cauchy sequences. • Clarify more examples on Cauchy sequences. • Define complete and incomplete metric spaces with examples. • Prove some theorems on complete metric spaces. • Some problems on limits of sequences in metric spaces. • Define a fixed point of a function with examples. • Define a contraction mapping as a metric space with examples. • Solve some problems related to fixed points and contraction mapping. • State fixed point theorem for contraction mapping without proof.	**Unit 3: Sequences in Metric Spaces and Compl** **MetricSpaces (6 hours)** Convergent sequences in a metric space Divergent sequences in a metric space Cauchy sequences Complete metric spaces Fixed point theorem for contraction mappings
• Define a limit of function from one metric space to another. • State and prove the theorem that relates limits of functions to limits of	**Unit 4: Limits, Continuity and Uniform Contin**
sequences. • State and prove some basic rules for calculating with limits of vector-valued function. • Define continuity of a function at a point with examples. • Prove every function is continuous at every isolated points. • State and prove necessary and sufficient condition for a function to be continuous at a point. • Define inverse image and establish its properties. • State and prove necessary and sufficient condition for a function to be continuous on a set. • State and prove some properties of continuous functions on compact sets. • Define topological mappings, topological property and isometry with examples. • State and prove sign preserving property. • State Bolzano's theorem on continuous functions without proof. • State and prove intermediate value theorem. • Define uniform continuity of a function on a set with examples. • Prove uniform continuity implies continuity but not conversely. • State and prove Heine theorem on uniform continuity.	**(13 hours** Limit of a function Limits of vector-valued functions Continuous functions Necessary and sufficient condition for continuity Continuity and inverse images of open or closedsets Functions continuous on compact sets Topological mappings Sign-preserving property of continuous function Bolzano's theorem Intermediate value theorem Uniform Continuity
• Define pointwise convergence of sequences of functions with examples. • Define uniform convergence of sequences of functions with examples. • Prove uniform convergence implies pointwise but not conversely. • State and prove the theorem related to uniform convergence and continuity. • State and prove necessary and sufficient condition (Cauchy condition) for uniform convergence for	**Unit 5: Sequences and Series of Functions hours)** Pointwise convergence Uniform convergence Uniform convergence and continuity Cauchy condition for uniform convergence fo sequences Uniform convergence of series of functions Cauchy condition for uniform convergence fo

sequence. • Define uniformly convergent series of functions. • State and prove Cauchy condition to uniform convergence for series. • State and prove Weierstrass M-test. • Prove the theorem related to the continuity of sum of uniformly convergent series. • State and prove the theorems related to uniform convergence and integration. • State the theorems related to uniform convergence and differentiation without proof. • Solve some problems related to pointwise and uniform convergence.	series Uniform convergence and integration Uniform convergence and differentiation

(4). Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	40
(Details are given in the separate table at the end)		Quizzes	10%	
		Attendance	10%	
		Presentation	10%	
		Term papers	10%	
		Mid-Term exam	40%	
		Group work	10%	
Total External	60	Total Internal	100 %	40
Full Marks 60+40 = 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.

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.

Term paper: Term paper must be prepared by using computer in a standard format of technical writing and must contain the required number of pages. It should be prepared and submitted individually. The stipulated time for submission of the paper will be seriously taken as one of the major criteria of the evaluation.

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
- ☐ Self-study
- ☐ Assignments
- ☐ Presentation by Students
- ☐ Term Paper writing
- ☐ 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 Books and References

1. *Mathematical Analysis* – T. M. Apostol, Narosa Publishing House, 2nd Edition
2. *A Textbook of Mathematical Analysis* – Dr. N. P. Pahari, Sukunda Pustak Bhawan, Kathmandu
3. *Mathematical Analysis* – S. C. Malik and Sabita Arora, New Edition, New Age International Publishers, New Delhi
4. *Real Analysis* – N. L. Carothers, Cambridge University Press, South Asian Edition

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Advanced Algebra I** F.M.: 100
Course No. : MTH 472 P.M.: 45%
Nature of Course: Theory Credit:
Year: Four, Semester, Seven Teaching Hours: 45

Specific objectives	Contents in Detail
*Define vector space, subspace, linear combination, generators. *Define linear dependence & independence, basis, maximal subset of linearly independent element of vector space *To obtain if two linear combinations of linearly independent elements of vector space are equal, then corresponding scalars are equal. *To discuss properties related with maximal subset of linearly independent vectors. *To prove if $\{v_1,v_2,\ldots,v_m\}$ be a basis of vector space V over the field K & if $w_1,w_2,\ldots,w_n$ be the elements of V such that n > m, then $w_1, w_2, \ldots,w_n$ are linearly dependent. *To obtain if one basis of vector space have n elements & another has m elements, then n = m. *Define dimension of vector space & maximal set of linearly independent elements. *Discuss properties related with maximal set of linearly independent elements of vector space. *To prove various theorems related with finite dimensional vector space.	**Unit 01**:Vector spaces, matrices &linear equations 10Hrs 1.1 Definition of vector spaces 1.2 Bases & Dimension of a vector spaces 1.3 Sums & Direct sums 1.4 The space of matrices 1.5 Linear equations.
*Define mapping & linear mapping *To prove space of linear maps is vector space over the field. *To develop the concept of theorems related with composition & inverse of mappings. *To prove, if matrices give rise to the same linear map, then matrices are equal. *To prove various theorems related with linear map associated with a matrix, matrix associated with a linear map &bases, matrices &linear maps.	**Unit 02**:Linear maps & matrices 9Hrs 2.1 Mappings & linear mappings. 2.2 The kernel & image of a linear map. 2.3 Composition & inverse of linear mappings. 2.4 Linear map associated with a matrix. 2.5 The matrix associated with a linear map. 2.6 Bases, matrices & linear maps.
*To define scalar product on vector space over a field. *To prove the Pythagoras theorem, the parallelogram law, Schwarz inequality, Triangle inequality, Bessel inequality and related theorem.	**Unit 03**:Scalar product & orthogonality 12 Hrs 3.1 Scalar product 3.2 Orthogonal bases 3.3 The real positive definite case 3.4 Bilinear maps &matrices

*To prove the theorem related with orthogonal basis and theorem related with dimensions of vector space. *Define hermitian product and theorems related with hermitian product. *To prove theorem related with linear equation. *To prove theorem related with bilinear map. *Define dual space and to prove some theorem related to it.	3.5 General orthogonal bases 3.6 Dual spaces & scalar products
*To define bilinear forms and quadratic forms *Define symmetric operators, hermitian operators and unitary operators and to prove related theorems *State and prove Sylvester's theorem	**Unit-04** Bilinear forms and the standard operators 7 Hrs 4.1 Bilinear forms 4.2 Quadratic form 4.3 Symmetric operators 4.4 Hermitian operators 4.5 Unitary operators 4.6 Sylvester's theorem
*To define eigen vector, eigen values and related theorems. *To prove the theorems related with characteristic polynomials. *To recall the polynomial and related theorems. *To prove theorem related with triangulation. *State and prove Hamilton Cayley theorem.	**Unit-05** Eigen vectors and Eigen values, triangulation, polynomials of matrices 7Hrs 5.1 Eigen vectors and Eigen values 5.2 The Characteristic Polynomials 5.3 Polynomials and Polynomials of matrices and linear maps 5.4 Existence of Triangulations 5.5 Theorem of Hamilton-Cayley

Reference books

Serge Lang; Linear Algebra, Second Edition ,Addison- Wesley Publishing Company

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Advanced Calculus** F.M.: 100
Course No.: MTH 473 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Seventh Teaching Hours: 45

(1). Course Description

(2). Course Objectives

The general objectives of this course are as follows:

(3). Specific Objectives and Course Contents

Specific Objectives	Contents in Detail
After studying this unit, students will be able to • be introduced with a family of curves, its envelope and various methods of finding the envelope of a family of curves • prove that in general the envelope touches each member of the family • to have the concept of the singular points on a curve and their types • to have the concept of double points of a curve, their types and the condition for the existence of double points • know about concavity, its various aspects and points of inflexion	**Unit 1: Envelopes and Singular Points (8 ho** Introduction of a family of curves, its envelope and various methods of finding the envelope Envelope as a tangent of each member of a family of curves Introduction of the singular points of a curve their types Double points, their types and necessary condi for their existence Concavity and points of inflexion
After studying this unit, students will be able to • be introduced with the concept of jacobian and various facts about it • know the concept of jacobian of function of function and the reciprocity property of jacobian • have the concept of the jacobian of implicit function and a particular case of this result • know and prove the theorem $f(u_1, u_2, u_3, \ldots, u_n) = 0$ • know and prove the theorem $J = 0$	**Unit 2: Jacobians (8 ho** Introduction of jacobian and its various properties Case of functions of function and reciprocity property of jacobian Jacobian of implicit functions and a particular case A theorem giving the necessary and suffic condition that a functional relationship of the f $f(u_1, u_2, u_3, \ldots, u_n) = 0$ may exist where $u_1, u_2, \ldots, u_n$ are the functions of $x_1, x_2, x_3, \ldots, x_n$ A theorem for the equation $J = 0$
After studying this unit, students will be able to • be introduced with curves, curves in spaces, various ways to represent them and length of arc from any one point to the other of a curve (without derivation) • have the concept of the unit tangent vector and tangent line at a point on a curve and equations of tangent line in various forms • know about osculating plane and derive its equations in various forms • have the concept of normal and rectifying planes and their equations • have the concept of principal normal and binormal • be introduced with the concept of three mutually orthogonal vectors **t**, **n**, **b** and three fundamental planes • have the concept of curvature, torsion & skew-	**Unit 3: Curves in Space (Application of Calculu in Geometry) (9 hours)** Introduction of curves in space and the arc length Tangent line Osculating plane (plane of curvature) Normal plane and rectifying plane Principal normal and binormal Orthogonal trials and fundamental planes Curvature, torsion and skew-curvature and finding them Serret-Frenet formulae Necessary and sufficient condition for a curve t be a straight line and to be a plane curve Helices, the necessary and sufficient condition f

curvature and their respective formulae • know and derive Serret-Frenet formulae • state the respective theorems and prove them • be introduced with helices, condition for a space curve to be a helix and circular helix	a space curve to be a helix, a circular helix
After studying this unit, students will be able to • recall all elementary concepts of complex number & complex variables and have the knowledge that $e^{i\theta} = \cos\theta + i \sin\theta$ • have a concept of functions of complex variables, their limits,	**Unit 4: Elementary Concepts of Complex Variables (Application of Calculus in Comple Analysis) (10 hours)** 4.1 Introduction and elementary concepts of complex numbers and complex variables
continuity, differentiability and derivatives, know a condition for differentiability which is necessary but not sufficient and have a little concept about the mapping and transformations in complex numbers • be familiar with the concept of analytic function and derive the necessary and sufficient condition for a function f(z) to be analytic known as Cauchy-Riemann condition • convert Cauchy-Riemann conditions in polar form • have the concept of harmonic functions and harmonic conjugate, techniques of determining the conjugate functions and Thosmon method of finding analytic function	Functions of a complex variable, their limit continuity, differentiability and derivatives, neces condition for differentiability, a brief introductio mapping Introduction of analytic functions and necessar sufficient conditions for f(z) to be analytic (Cauc Riemann conditions) Polar form of Cauchy-Riemann condition Harmonic functions, harmonic conjuga determination of conjugate functions, Thosn method for finding analytic functions
After studying this unit students will be able to • be introduced with nature, historical aspects and applications of Fourier series • have the concept of periodic functions, even & odd functions, orthogonal set of functions, their properties and other aspects about them • know about trigonometric series and Fourier series as its special case, determination of Fourier coefficients and fundamental theorem of Fourier series • obtain the concepts of Fourier cosine series, Fourier sine series and half range Fourier series • obtain the concepts of Fourier series in an arbitrary interval (–l, l) and Fourier series in exponential form • know the various principles involved in testing the convergence of a Fourier series	**Unit 5: Fourier Series (10 ho** Introduction Periodic functions and their properties, even odd functions, orthogonal set of functions Trigonometric series and Fourier series as a spe case of trigonometric series, determination of Fou coefficients, fundamental theorem of Fourier series Fourier cosine series, Fourier sine series and range Fourier series Fourier series in an arbitrary interval and Fou series in exponential form Convergence problem of Fourier series, Riema Lebesguse lemna, Dirichlet's integrals, n convergence theorem

(4). Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	40
(Details are given in the separate table at the end)		Quizzes	10%	
		Attendance	10%	
		Presentation	10%	
		Term papers	10%	
		Mid-Term exam	40%	
		Group work	10%	
Total External	60	Total Internal	100 %	40
Full Marks 60+40 = 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.

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 assignmentwill be seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests willbe 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.

Term paper: Term paper must be prepared by using computer in a standard format of technical writing and must contain therequired number of pages. It should be prepared and submitted individually. The stipulated time for submission of the paper will be seriously taken as one of the major criteria of the evaluation.

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

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

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
- ☐ Self-study
- ☐ Assignments
- ☐ Presentation by Students
- ☐ Term Paper writing
- ☐ 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 Books and References

For Units 1 and 2

1. *Differential Calculus* – M. Ray, Shiv Lal Agrawal & Co., Agra, India
2. *Differential Calculus* – P. N. Chatterji, Rajhans Prakashan Mandir, Meerut
3. *Differential Calculus* – Gorakh Prasad

For Unit 3

4. *Differential Geometry* – C. E. Weatherburn
5. *Differential Geometry* – Mittal and Agrawal

For Unit 4

6. *Complex Variables* – Chirchil and Brown
7. *Complex Analysis* – J. N. Sharma, Krishna Prakashan Mandir, Meerut

For Unit 5

8. *Mathematical Analysis* – T. M. Apostol
9. *Mathematical Analysis* – Shanti Narayan

For Units 3, 4 and 5

10. *A Textbook of Advanced Calculus* – Koirala and Shah, Bhundipuran Prakashan, Kathmandu

For general reference

11. *Advanced Calculus* – D. C. Agrawal
12. *Advanced Calculus* – D. V. Widder

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Applied Mathematics** F.M.: 100
Course No.: MTH 474 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Seventh Teaching Hours: 45

1. Course Description

This course of mathematics is designed to gain the knowledge about power series, Laplace transform and numerical methods in algebra. Chapter 1 and 2 deal with more advanced theory of second order linear equations with series solution and chapter 3 provides the supplementary approach. Chapter 4 is the closest in spirit to the mathematical interest of our own times. And chapter 5 deals how to apply numerical methods in linear algebra problems.

2. Course Objectives

- To study power series and use it in different types of special functions.
- To introduce about Legendre polynomial and know about it's different properties.
- Apply the Laplace transforms to solve certain linear differential equation.
- To state and prove the existence and uniqueness of some theorems.
- Study numerical method to solve system of linear algebraic equations.

3. Course Contents

Specific Objects	Contents in Detail
• Define power series with examples • Explain the procedure to solve first order equation • Use power series to solve second order equation • Determine regular and irregular points • Locate and classify singuar points • Study the solution near to point of infinity • Determine the point and nature of the point at ∞ for Legender and Besseis equation	**Unit 1: Power Series Solutions and Special Functions** **10** Introduction Series solution of First order equations. Second order linear equations. Ordinary points. Regular singular points Regular singular points (continued) The point at *infinity*
• Define Legender polynomial • Establish the properties of Legender polynomial • Define Bessel function and its order. • Write general solution in terms of Bessel's function • Establish the properties of Bessel's function	**Unit 2: Some Special Function of Mathematical Physics** **8H** Legendre polynomials Properties of Legendre polynomials Bessel function, the gamma function. Protection of Bessel functions
• Define Laplace transform with notation and evaluate the integrals • Test the convergence • Use Laplace transform in differential equations • Find the derivative and integration of Laplace transform	**Unit 3: Laplace Transform** **10** Introduction A few remark on the theory Application to differential equation. Derivatives and integrals of Laplace transform.

• To find the exact solution of initial value problems • State and prove Picard's theorem • Apply Picard method to system of first orderequations	**Unit 4: The Existence and Uniqueness of Solution** **7H** The method of successive approximations. Picard's Theorem. Systems. The second order linear equation
• Apply numerical methods for linear algebra problems • Find LU decomposition of any matrix • Use Gramm Schmidt orthogonalization process to find orthogonal and orthonormal basis • Extending scalar function to matrix function • Classify the matrix function	**Unit 5: Numerical Methods for Linear Algebra** **10** Numerical methods for Linear algebra problem. Gaussian elimination LU decomposition Projections Gram Schmidt orthogonalization and the method of least squares Matrix functions

(4). Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	40
(Details are given in the separate table at the end)		Quizzes	10%	
		Attendance	10%	
		Presentation	10%	
		Term papers	10%	
		Mid-Term exam	40%	
		Group work	10%	
Total External	60	Total Internal	100 %	40
Full Marks 60+40 = 100				

(I). External evaluation

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and submitted individually. The stipulated time for submission of the paper will be seriously taken as one of the major criteria of the evaluation.

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 classroomdiscussions.

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

- ☐ Lecture and Discussion
- ☐ Group work and Individual work
- ☐ Self-study
- ☐ Assignments
- ☐ Presentation by Students
- ☐ Term Paper writing
- ☐ Quizzes
- ☐ Guest Lecture

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5. References

1. G. Strang: Linear Algebra and Its Applications(4^{th} edition)
2. George F. Simmons: Differential Equations (with application and historical notes): Tata McGraw-Hill
3. David C. Lay: Linear Algebra and Its Application (5^{th} edition), Pearson Education India
4. Phil Dyke: An Introduction to Laplace Transforms and Fourier Series (2^{nd} edition) 2014 edition
5. William Ford: Numerical Linear Algebra with Application

FAR WESTERN UNIVERSITY

FACULTY OF SCIENCE AND TECHNOLOGY

Course Title	**Remote Sensing and Geographic InformationSystem**	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 toprovide the students with an understanding of the methods and theories of Remote Sensingand spatial-temporal analysis that will allow students to apply GIS knowledge and skills invarious 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 orbitalcharacteristics.	**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 structuresin 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 andpresenting 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 iftime permits. Lab will begin with a guest speaker when appropriate; otherwise the instructorwill be available to assist students with the weekly lab assignment. This Lab assignment isintegral part of class lecture.

Assignments for Remote Sensing

- Basics of Remote Sensing Software, downloading satellite image data from variousplatform, 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 andManual 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	**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 environmentalModelling,
- 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 environmentalmodels; 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 EnvironmentalSystem (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), DOI10.1007/978-90-481-8608-2_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 RemoteSensing and GIS

Thematic Area B: Water and Hydrology

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

Thematic Area C: Disaster and Land Use

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

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

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

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

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

Note: For the Internship Program Department of Environmental Science have to sign MoU with various organization and Industries.
There will be two supervisor for a student for the Internship. One will be Academic Supervisor and one will be organizational supervisor. Objective for Internship will be developed from the discussion of Internship supervisor team and Student will conduct their Internship with already defined Objective.

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Biodiversity Conservation and Management** Credit: **3**

Course Code: **ENV 474** Number of hours per week: **3**

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

Year: **Fourth** Semester: Seven

Level: **B.Sc.**

Course Objectives

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

Understand the current state of global and national biodiversity

Get extensive knowledge on major threats to biodiversity and threatening processes

Understand the practices and approaches to biodiversity conservation

Analyze the conservation policies leading to sustainable development

Specific Objectives	**Contents**
• Understand the fundamental concepts related to biodiversity and its importance • Know various factors affecting distribution of biodiversity	**Unit I: Introduction** Biodiversity: concepts, levels of biodiversity; Scope and importance of biodiversity; Patterns in distribution of biodiversity; Factors affecting distribution of biodiversity; Gradients of biodiversity: Major hypotheses in biodiversity gradients; Biodiversity crisis (ecocrisis); Conservation of biodiversity: history, conservation today, future of biodiversity
• Understand current state of global and national biodiversity • Understand importance and values of biodiversity	**Unit II: State of Biodiversity** Current state of biodiversity: Global, regional and national; Biodiversity and ecosystem functioning; Value of biodiversity: Instrumental value and intrinsic value; State of biodiversity in Nepal: Forests, wetlands, rangelands, agro-biodiversity; Rare, endangered, endemic and protected species of Nepal (flora and fauna)
• Understand biodiversity crisis • Understand major threats to biodiversity and threatening process	**Unit III: Threats to Biodiversity** Biodiversity crisis: endangerment and extinction; Impacts of species endangerment and extinction; Major threats and threatening processes; Economic and social contexts of endangerment;

	Major threats to biodiversity: Habitat degradation and loss, Habitat fragmentation, Overexploitation, Invasive species as threat to biodiversity, Pollution and its impacts on biodiversity; Climate change as a threat to biodiversity
• Understand the nature of biodiversity problems in developing and developed world • Acquaint with different practices and approaches to conserve biodiversity	**Unit IV: Conservation of Biodiversity** Nature of biodiversity problems between developed and developing worlds; Responses to the biodiversity crisis: Approaches to global habitat conservation; Sustainable resource use; Management of invasive species; *In-situ* and *ex-situ* conservation; genetic, species, ecosystem and landscape approaches to conservation, Protected areas (goals, limitation and designs; Restoration of damaged ecosystems and endangered species; Community-based conservation; Indigenous knowledge and practices in biodiversity conservation; concept of holistic management in biodiversity conservation; Biodiversity conservation and sustainable development
• Understand shifting paradigm in biodiversity conservation in Nepal • Analyze different challenges and opportunities of biodiversity conservation in Nepal	**Unit V: Biodiversity Conservation in Nepal** Shifting paradigm in biodiversity conservation in Nepal; Protected areas of Nepal; Conservation management in buffer zone; Challenges and opportunities of biodiversity conservation outside protected areas; Conservation of agro-biodiversity; Contribution of community forestry in biodiversity conservation
• Understand role and importance of national and international policies and convention on biodiversity conservation	**Unit VI: Policy Perspectives on Biodiversity** Conservation challenges in 21st century: Problems of commons; International efforts in biodiversity conservation: Convention on Biological Diversity (CBD), Convention on International Trade in Endangered Species (CITES), Ramsar Convention, Intellectual Property Rights (IPR) and Patent Rights (PR); National efforts in biodiversity conservation: National policy for conservation of biological diversity in Nepal; Institutional arrangements for biodiversity conservation in Nepal

References

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2. Chaudhary, RP. (1998). Biodiversity in Nepal: Status and Conservation. S.Devi, Shanpur (UP), India and Tecpress Books, Bangkok.
3. Groom, MJ, GK Meffe and CR Carroll. (2006). Principles of ConservationBiology. Sinauer Associates Publication, Sunderland.
4. Jordan, CF. (1995). Conservation: Replacing Quantity with Quality with aGoal for Global Management. John Wiley and Sons, Inc., New York.
5. Leopold, A. (1949). A Sand County Almanac and Sketches Here and There.Oxford University Press, New York, NY.
6. MoFSC. (2014). Nepal Fifth National Report to Convention on BiologicalDiversity. Ministry of Forests and Soil Conservation, Kathmandu, Nepal.
7. Primack, RB, Paudel, PK, and Bhattarai, BK. (2013). Conservation Biology:A Primer for Nepal, 1st Edition. Dreamland Publications, Kathmandu.
8. Sodhi, NS and PR Ehrlich. (2010). Conservation Biology for All. OxfordUniversity Press, Oxford.
9. Wilson, EO and FM Peter, eds. (1988). Biodiversity. National Academy Press,Washington, DC.

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 itsEnvironment. 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
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.
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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

PHYSICS CURRICULUM (B.Sc.)

SEVENTH SEMESTER

SEMESTER	COURSES	CH
SEVENTH SEMESTER (One-Major)	**Core Course:** any one discipline (Physics)	-
	PHY471: **Math Physics**	4
	PHY472 : **Classical Mechanics**	4
	PHY473: **Physics Lab**	2
	Applied Science Courses: *Leading to core subject any one from subject pool*	-
	PHY474: **Astronomy**	3
	PHY475: **Material Science**	3
	PHY476: **Biophysics**	3
Total Credit		**19**

FAR WESTERN UNIVERSITY FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Math Physics** Credit: **4**
Course Code: **PHY 471** Number of hours per week: **4**
Nature of the Course: **Theory** Total hours: **60**
Year: **Fourth**, Semester**: 7th** Full Marks: **100**
Level: Undergraduate (**B.Sc.)** Pass Marks: **45**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of mathematics that is frequently used in physics. Students will be familiarized with the details of vector analysis, tensors, linear vector space, fourier and laplace transform and differential equation with special functions.

2. Course Objectives

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

- to acquire sufficient basic knowledge in mathematical physics
- to apply this knowledge base for studying major courses in physics.
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.

3. Specific Objectives and Contents

Specific Objectives	Contents
• Developing the idea of vector transformationtechniques and its uses. • Delivering the concepts of various types of vectors, e.g., polar, axial, solenoidal, rotationaland irrotational vectors • Students should understand the idea ofcurvilinear coordinate system. • Describe various types of orthogonal curvilinear coordinates for example cylindrical, spherical, ellipsoidal, hyperbolicand parabolic coordinates • Problem solving skill should be developed • Students should learn the idea regarding use ofthese tools of vector analysis in the theoretical physics.	**Unit I: Vector analysis (12 hrs)** Scalar and vector fields, law of transformation of vectors, polar and axial vectors, solenoidal vectors, rotational and irrotational vectors, vortex lines, Curvilinear coordinates: direction cosines, scale factors, curvature of co-ordinate lines, volume element, rotation of axes, contravarient andcovariant vectors, Gradient, divergence, curl and Laplacian in curvilinear co-ordinates, Special orthogonal curvilinear coordinates: cylindrical, spherical, ellipsoidal,hyperbolic and parabolic co-ordinates
• Describe the idea, formulation, properties and important techniques of tensor analysis to the student • Problem solving skill should be developed.	**Unit II: Tensor analysis (13 hrs)** Contravariant, covariant and mixed tensors, Kronecker delta, tensors of rank greater than two, scalars or invariants, Tensor fields, symmetric and skew symmetric tensors, fundamental operations with tensors, stress tensor, Line element and metric tensor, reciprocal tensors, associated tensors, length of a vector, angle

• Students should learn the concept regardinguse of these tools of tensor analysis in the theoretical physics.	between vectors, physical components, Christoffel's symbols, transformation laws of Christoffel's symbols, geodesics, covariant derivatives, Tensor form of gradient,divergence, curl and Laplacian
• Describe the idea, formulation and important techniques of linear vector space to the student • Problem solving skill should be developed. • Students should learn the idea regarding use ofthese tools of linear vector space in the theoretical physics.	**Unit III: Linear vector spaces (10 hrs)** Vectors in n-dimensions, linear independence, inner product, Schwartz inequality, Representation of vectors and linear operators with respect to a basis, change of basis, Schmidt orthogonalization process, Linear operators and their matrix representation: symmetric, Hermitian, orthogonal, unitary (normal) matrices, Determination of eigen values and eigen vectors of the matrix, diagonalization
• Describe the idea, formulation, properties and important techniques of Fourier series, Fouriertransform and Laplace transform to the student • Illustrate the examples of various types of waves, e.g., square, triangular, saw-tooth, etc • Problem solving skill should be developed. • Students should learn the idea regarding use of these tools of Fourier and laplace transforms in the theoretical as well as experimental physics.	**Unit IV: Fourier series and transforms (11 hrs)** Fourier series representation, even and odd functions, Fourier series expansion of square, triangular, saw-toothwaves and out put of full wave rectifier, Complex representation of Fourier series, Dirac delta function, Parseval relation, Fourier transform and convolutiontheorem, Laplace transform, Laplace transform of derivatives and integrals, Use of Fourier and Laplacetransform in solving partial differential equations.
• Describe the idea, formulation, properties andimportant techniques of special functions to the student • Problem solving skill should be developed. • Students should learn the idea regarding use ofthese tools of special functions in the theoretical physics.	**Unit V: Differential equations (8 hrs)** Series solutions of Bassels's, Legendre's, Hermite's, Laguerre's differential equations, Rodrigue's formula, Recurrence relations, associated Legendre and Laguerre polynomials.
• Describe the idea, formulation, properties andimportant techniques of partial differential equations to the student • Problem solving skill should be developed. • Students should learn the idea regarding use ofthese tools of partial differential equation in the theoretical as well as in the experimental physics.	**Unit VI: Partial differential equations (6 hrs)** Wave equations, Laplace, Poisson and diffusion equations, boundary value problems, Method of separation of variables

Prescribed Text Books:

1. *Mathew, J. & Walker, R.* - **Mathematical Methods in Physics**, Benjamin Menlo Park,Second Edition (1970).

2. *Spiegel, Murray R.* - **Vector Analysis (Schaum Series)**, McGraw Hill, London (1992).

3. *Harper C.* - **Introduction to Mathematical Physics**, Prentice Hall of India Pvt. Ltd. (1990).

Reference Books:

1. *Gupta B. D.*- **Mathematical Physics**, Vikas Pub. House Pvt. Ltd., India (1994).

2. *Rajput B. S.*- **Elementary Mathematical Physics**, Pragati Prakashan, India (1997).

3. *Arfken G.*- **Mathematical Methods for Physicists**, Academic Press, New York (1970).

4. *Margenau H. and Murphy G. M.* - **The Mathematics of Physics and Chemistry**, Krieger,New York, (1976).

5. *Pipes L. A.* - **Applied Mathematics for Engineers and Physicists**, McGraw-Hill (1970).

6. *Hinchey F. A*.- **Vectors and Tensors for Engineers and Scientists**, Wiley Eastern (1976).

7. *Joshi W.* - **Matrices and Tensors in Physics**, Wiley Eastern (1995).

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Classical Mechanics**
Course No: **PHY 472**
Nature of the Course: **Theory**
Year: **Fourth,** Semester: **7th**
Level: Undergraduate **(B.Sc.)**

Credit: **4**
Number of hours per week: **4**
Total hours: **60**
Full Marks: **100**
Pass Marks: **45**

1. Course Introduction

The course intends to enable the students to be familiar with description and formulation of classicalmechanics.

2. Objectives

At the end of this course the students should be able to understand and apply;

- Basic concepts of main features of central force problem.
- Basic concepts of scattering angles and cross-section in centre of mass and laboratorycoordinate system.
- Basic concept of generalized coordinate system and Lagrangian formulation.
- Basic concept of calculus of variation and Hamilton's principle.
- Basic concept of the kinematics and dynamics of rigid body motion.
- Basic concept of relativistic classical mechanics.

3. Specific Objectives and Contents:

Specific Objectives	Contents
• To understand the basic concept ofone body problem. • To understand the concept of mainfeatures of central force problem. • To gain knowledge aboutclassification of orbits.	**Unit I: Motion Under Central Force (6 hrs)** Reduction to the Equivalent One Body Problem. General Features of Central force Motion. The Equation of Motion and First Integrals. The Equivalent One Dimensional Problem and Classification of Orbits. The Kepler Problem: Inverse Square Law of Force.
• To understand about centre of massand laboratory coordinate systems. • To gain knowledge about Scatteringangle and differential cross section.	**Unit II: Elastic and Inelastic Collision (6 hrs)** Collision of Particles. Centre of Mass and Laboratory Coordinate Systems. Scattering in a Central Force Field: Rutherford Scattering. Transformation of Scattering Problem to Laboratory Coordinates.
• To gain knowledge about generalizedcoordinate systems. • To gain knowledge about Lagrangianformulation.	**Unit III: Elementary Principles (10 hrs)** Constraints. Generalized Coordinates, GeneralizedDisplacement, Generalized Velocity, Generalized Acceleration,Generalized Kinetic Energy, Generalized Momentum, Generalized Force and Generalized Potential, D'Alembert's Principle and Lagrange's Equations.

• To understand how to solve mechanical problem using Lagrange's equation.	
• To understand about the concept of calculus of variations and its application to solve mechanical problem. • To understand about the Lagrangian formulation, conservation theorem and symmetry properties.	**Unit IV: Variational Principles and Lagrange's Equation ofMotion (14 hrs)** Some Techniques of Calculus of Variations: Euler's Differential Equations of Motion and its Applications (Geodesics, Minimum Surface of Revolution, and The Brachistocrone Problem). Hamilton's Variational Principle for Conservative and Holonomic System, Derivation of Lagrange's Equation of Motion. Some Applications of Lagrangian Formulation. Extension of Hamilton's Principle to Non-holonomic System (Method of Lagrange Undetermined Multiplier).Conservation theorems and Symmetry properties. Energy Function and the Conservation of Energy.
• To understand about the translating and rotating coordinate system. • To gain knowledge of the euler's angles, euler's theorem and coriolisforce.	**Unit V: The Kinematics of Rigid Body Motion (10 hrs)** Inertial and Non-Inertial Systems. Translating and rotating Coordinate System. The Euler Angles. Euler's Theorem on theMotion of Rigid Body. Rate of Change of Vector. Effect ofCoriolis Force on the Moving Bodies on Earth. Free Fall of aBody on Earth Surface. Derivation of Coriolis Force fromLagrangian Formulation. Focault Pendulum.
• To understand about the inertia tensor, the moment of inertia and principal axis transformation. • To gain knowledge of the motion of Heavy Symmetrical Top.	**Unit VI: The Rigid Body Equations of Motion (10 hrs)** Angular Momentum and Kinetic Energy of Motion. The Inertia Tensor and the Moment of Inertia. The Eigenvalues of theInertia Tensor and Principal Axis Transformation. Equation ofMotion of a Rigid Body (Euler's equations). Torque Freemotion of a Rigid Body. The Heavy Symmetrical Top With OnePoint Fixed.
• To understand about the basic concept of relativistic classical mechanics.	**Unit VII: Special Relativity in Classical Mechanics (4 hrs)** Basic Postulates of the Special Theory. Lorentz Transformation.Relativistic Generalization of Newton's law. RelativisticGeneralization of Lagrange's Equation of Motion andHamiltonian.

Prescribed Text Books:

1. *Goldstein H., Poole C. and Safko John**, Classical Mechanics,*** Pearson Education (2002).

Reference Books:

1. *Mathur D.S.,* ***Mechanics,*** S. Chand and Company Ltd., New Delhi (2008).
2. *Aruldas G.,* ***Classical Mechanics***, Prentice-Hall of India, Private Limited, New Delhi-110001(2008).
3. *Gupta S.L., Kumar V. and Sharma H.V.,* ***Classical Mechanics,*** Pragati Prakashan (1998).

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Physics Laboratory** Credit: **2**
Course No.: **PHY 473** Number of hours per week: **6**
Nature of the Course: **Practical** Total hours: **90**
Year: **Fourth**, Semester**: 7th**
Level: Undergraduate **(B.Sc.)**

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of general andelectronics experiments.

2. Course Objectives

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

- To provide students with skill and knowledge in the experimental methods of electronics, opticaland semiconductor experiments.
- To make them able to apply knowledge to practical applications.
- To make them capable of presenting their results/conclusions in a logical order.

3. Specific Objectives and Contents

Specific Objectives	Contents
	Unit I: General Lab (45)
• Understand the role of filter whenperforming experiments with the light.	**1.** Calibrate the experimental set-up of photoelectriceffect using yellow filter, standard value of planck's constant and work function of the given photocell. Findcalibration factor.
• Understand how photoelectric effectexperiments can be performed • How photoelectric effect help us to understand the planck constant.	**2.** Study photoelectric effect and estimate the value of Planck's constant using various color filters. **3.** Study photoelectric effect and find the wavelength of the unknown color filters using calculated value of planck's constant *h*.
• Develop the skill to analyse the data andperform error analysis	**4.** Use the measured dataset of photoelectric effect and calculate the standard deviation, standard error and probable error with significant figures. Generate theoretical data using photoelectric equation for given filters and photocell. Test how well the measured data agrees with the theoretical data in this experiment. Show the trend of measured and theoretical data in a graph and interpret it.
• Understand the interference effect usingvisible light	**5.** To study the Michelson Interferometer to determine thewavelength of monochromatic light.
• Understand microwave radiation by performing experiments to verify it as a electromagnetic radiation.	**6.** To use the microwave source for studying the phenomenon of (a) Refraction, (b) Interference, (c) Diffraction, and (d) Polarization.
• Understanding the level (range) of band	**7.** To study the band gap of semiconductor using leakage

gap in the semiconductor • Understanding the technique of determination of specific charge of an electron by magnetron method • Understanding the technique of determination of specific charge of an electron by using fine beam method • Develop the skill to analyse the data and perform error analysis *Note: Student should perform the error propagation and hence error analysis in each experiment.*	current method. **8.** To determine the specific charge of an electron (e/m) by magnetron tube method. **9.** To determine specific charge of an electron (e/m) by using fine beam method. **10.** Perform the experiment 5 or 6 or 7 and compile a dataset and show the histogram and calculate the standard deviation and standard error. Interpret the result.
• Understand current gain of common emitter amplifier • Understand voltage gain of common emitter amplifier • Understand voltage gain of common collector amplifier • Understand voltage gain of CS amplifier • Understand inverting and non-invertingoperational amplifier and its use • Understand the working of operationalamplifier as a integrator • Understand the working of operationalamplifier as a differentiator • Understand the construction and workingof half adder and subtractor circuit. • Understand the construction and workingof 1 bit digital comparator • Understand the construction and workingof astable multivibrator • Understand the construction and workingof phase shift oscillator	**Unit II: Electronics Lab (45)** **11.** To estimate the current gain (β) in a Common-EmitterConfiguration. **12.** Construct CE amplifier and determine the voltage gainof the amplifier with phase relation. **13.** Construct CC amplifier and determine the voltage gain,input and output impedance with phase relation. **14.** Construct CS amplifier and determine the voltage gainof the amplifier with phase relation. **15.** Study the characteristic of inverting and non-invertingoperational amplifier (Using IC). **16.** To study operational amplifier for integrator (UsingIC). **17.** To study operational amplifier for differentiator (UsingIC). **18.** To study the working of half-adder and half-subtractorcircuit. **19.** Design and constructs the 1-bit digital comparator. **20.** To study the astable multivibrator by using transistorsand find its frequency and duty cycle. **21.** To study the characteristics of phase shift oscillator.

• Understand the construction, working andcharacteristic of JFET. • Understand the construction, working andcharacteristic uni-junction transistor. *Note: Precession test should be performed ineach experiments.*	**22.** To study the drain and transfer characteristics of junction field effect transistor (JFET). **23.** To study the characteristics of uni-junction transistor.

Note: Students have to perform at least 10 experiments in 90 working hours. Students need to cover both sections by performing at least 5 from each group. 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 separate sheet, and to keep them neat and properly filed.

The practical exam will be graded on the basis of the following marking scheme: In-Semester Evaluation 20%
Final Exam Written 60%
Final Exam Oral 20%

Prescribed Text Books:

1. *Arora C. L.* - **B.Sc. Practical Physics**, S. Chand and Company Ltd. (2010).
2. *Squires G. L.* - **Practical Physics,** Cambridge University Press (1999).
3. Shukla, P. K. and Srivastava, A. - **Practical Physics**, New Age International (P) Limited,Publishers (2006).

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Astronomy**
Course No: **PHY 474**
Nature of the Course: **Theory (Elective)**
Year: **Fourth,** Semester: **7th**
Level: Undergraduate **(B.Sc.)**

Credit: **3**
Number of hours per week: **4**
Total hours: **45**

1. Course Introduction

The course intends to enable the students to be familiar with the basic concepts and principles of biophysics related science and technology. This course will focus on the basic principles of molecular biophysics, thermodynamics, cell and membrane physics, nuclear medicine and radiation protection.

2. Objectives

At the end of this course, the students should be able to understand and apply the basic concepts of evolution, molecular biophysics: structures and dynamics, bioenergetics and thermodynamics, cell and membrane physics, nuclear medicine, etc.

3. Specific Objectives and Contents:

Specific Objectives	Contents
• Understanding evolution of Astronomy • Describe about the classifications of star on the basis of their spectra • Explain various types of time scales use in the stellar and galaxy evolution	**Unit I: General Astronomy (8 hrs)** History & developments of Astronomy, great debate, Classification of star, population I, II and III stars, Stellar spectra, Harvard classification, Yerkes classification, Astronomical time scales: nuclear time scale, Thermal and dynamical time scales, binary star
• Understand the magnitude and hence photometry	**Unit II: Stellar Photometry (7 hrs)** Distance-magnitude-extinction relation, Interstellar extinction curve, Opacity in the interstellar medium, distance-magnitude- extinction relation, UVB photometry, Colour index: Reddening of light, Colour excess: Photometry.
• Know about the various types of pressures exerted by the gases and radiation in the stellar interior	**Unit III: Pressure Exerted by the Stellar Interior (6 hrs)** Non-degenerate gas pressure: chemical composition of the star, Degenerate (both relativistic and non-relativistic) gas pressure, Pressure exerted by the photons in the star: radiation pressure.
• Understand the internal equilibrium condition due to which star survives for a very long period • Know the energy transport mechanism in the stellar interior.	**Unit IV: Internal Equilibrium Conditions (6 hrs)** Hydrostatic equilibrium: pressure gradient, Mass-continuity relation: mass gradient, Radiative and convective energy transport: temperature gradient, Luminosity gradient.

• Understand the structure, inner dynamics, kinematics and formation of our own galaxy where solar system exists.	**Unit V: Milky Way (6 hrs)** Structure, bulge, disc, arms, stellar halo, globular clusters, dark matter halo, differential rotation, formation scenario of Milky way: monolithic collapse model, hierarchy model
Knowledge about other galaxies,their type and aggregates	**Unit VI: Galaxies (5 hrs)** Classifications, galaxy rotation curve, dark matter in the galaxy, redshift, Hubble law, clusters of galaxies, superclusters of galaxies,large scale structure formation
Knowledge regarding the origin of Universe and its evolution, its fossils and their impacts for thefuture.	**Unit VI: Standard Big Bang Model (7 hrs)** Inflation of the Universe, neutrino background, last surface of scattering, cosmic microwave background radiation (CMBR). Fluctuation in CMBR, dark epoch, LCDM model, dark energy

Prescribed Text Books::

1. *Karttunan H., Kröger P., Oja H., Poutanen M., Donner K.J.,* **- Fundamental Astronomy**, fifthedition, Springer (2007).
2. *Harwit Martin* - **Astrophysical Concepts**, fourth edition, Springer (2006).

Reference Books:

1. *Palene S.* - **Schaum Outline Series: Astrophysics,** McGraw Hill (2004).
2. *Choudhuri A. R.* - **Astrophysics for Physicists**, Cambridge University Press (2010).

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Material Science**
Course Code: **PHY 475**
Nature of the Course: **Theory**
Year: **Fourth**, Semester**: 7th**
Level: **B.Sc.**

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

1. Course Description

The course intends to enable the students to be acquainted with the basic concepts of material science. Students will be familiarized with the fundamentals of properties of materials and their uses in daily life and their industrial applications.

2. Course Objectives

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

- to acquire sufficient basic knowledge in physics of materials
- to apply this knowledge base for studying major courses in physics or apply other course'sknowledge to understand this course
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.
- to understand the different materials properties used in daily life

3. Specific Objectives and Contents

Specific Objectives	**Contents**
• List six different property classifications ofmaterials that determine their applicability. • Describe the four components that are involved inthe design, production, and utilization of materials, and briefly describe the interrelationships between these components. • Cite three criteria that are important in theMaterial selection process. • Discuss significance of materials around us	**Unit I: Introduction (5 hrs)** Historical Perspective, Importance of Materials Science, Classification of Materials, Materials of Importance, Carbonated Beverage Containers, Advanced Materials, Modern Materials' Needs, Processing/Structure Properties/Performance,Correlations
• Define engineering stress and engineering strain. • State Hooke's law and note the conditionsunder which it is valid. • Define Poisson's ratio. • Given an engineering stress–strain diagram, determine (a) the modulus of elasticity, (b) the yield strength and (c) the tensile strength, and (d)estimate the percent elongation.	**Unit II: Mechanical Properties of metals (10 hrs)** Concept of stress and strain, Elastic deformation, Plastic deformation, Hardness, Fundamentals of fracture, Principles of fracture mechanics, Crack initiation and propagation
• Discuss hardness of metal • Explain fracture and hence principles of fracturemechanics • Describe crack initiation and how does itpropagate	

• Distinguish electrical and ionic conduction • Discuss energy band structure and hence its role inelectrical properties of a solid • Explain main characteristics of commercial alloysused in house hold wiring • Obtain an expression for variation of concentrationof careers in semiconductor as a function of temperature • Describe the factors which affect carrier mobility ina semiconductor hence compare mobility of electrons and holes in various semiconductors • Explain dielectric strength. Also describe the mainproperties of dielectric materials • Outline main characteristics of Ferroelectric &piezoelectric materials	**Unit III: Electrical Properties of Materials (14 hrs)** Electrical conductivity, Electrical and ionic conduction Energy band structures in solid, Conduction in terms of bands and atomic bonding models, Electrical characteristics of commercial alloys, Materials of importance - Aluminum electrical wires, Semiconductors; Temperature dependence of carrier concentration, factors that affect carrier mobility, Dielectric strengths, Dielectric materials, Ferroelectricity,Piezoelectricity
• Outline main characteristic of dia, para, ferro,antiferro and ferri magnetic materials • Discuss main applications of magnetic materialsfocusing as storage devices • Distinguish between hard & soft magnetic materials. • Explain magnetic properties of An Iron–Silicon Alloy That Is Used in Transformer Cores and hencedescribe why it is so suitable in the Transformer cores.	**Unit IV: Magnetic Properties of Materials (6 hrs)** Diamagnetism and paramagnetism, Ferromagnetismand antiferromagnetism, Ferrimagnetism, Magneticstorage, Soft magnetic materials: Materials ofImportance—An Iron–Silicon Alloy That Is Used inTransformer Cores, Hard magnetic materials
Discuss heat capacity of solid Explain applications of thermal expansion in dailyuses of materials Discuss why Invar and Other Low-Expansion Alloys	**Unit V: Thermal Properties of Materials (4 hrs)** Heat capacity, Thermal expansion: Materials ofImportance—Invar, and Other Low-Expansion Alloys,Thermal conductivity, Thermal stress

possess important properties of thermal expansion What types of materials have high/low thermalconductivity Outline the significance of thermal stress	
Outline the significance of optical properties of solid Discuss the interactions of light with solid Describe Atomic and electronic interactions withincident light Explain luminescence and the Materials ofImportance—Light-Emitting Diodes Outline main features of photoconducting materials Discuss significance of laser Describe the materials suitable in Optical fibers	**Unit VI: Optical Properties of Materials (6 hrs)** Electromagnetic radiation, Interaction of light withsolids Atomic and electronicinteractions,Luminescence: Materials of Importance - Light-Emitting Diodes, Photoconductivity, Lasers, Optical fibers in communications

Prescribed Text Books:

1. *Callister W.D., Rethwisch D.G.*, **Callister's Material Science and Engineering**, 2nd Edition,Wiley India, New Delhi (2014).

Reference Books

1. *Tiley R.J.D.,* **Understanding solids**, The Science of Materials, John wiley & Sons, England(2004).
2. *Raghavan V.,* **Materials Science and Engineering**, 4th Edition, , Prentice-Hall of India, NewDelhi (2003).

FAR WESTERN UNIVERSITY
FACULTY OF SCIENCE AND TECHNOLOGY

Course Title: **Biophysics**
Course No: **PHY 476**
Nature of the Course: **Theory (Elective)**
Year: **Fourth,** Semester: **7th**
Level: Undergraduate **(B.Sc.)**

Credit: **3**
Number of hours per week: **4**
Total hours: **45**

1. Course Introduction

The course intends to enable the students to be familiar with the basic concepts and principles of biophysics related science and technology. This course will focus on the basic principles of molecular biophysics, thermodynamics, cell and membrane physics, nuclear medicine and radiation protection.

2. Objectives

At the end of this course, the students should be able to understand and apply the basic concepts of evolution, molecular biophysics: structures and dynamics, bioenergetics and thermodynamics, cell and membrane physics, nuclear medicine, etc.

3. Specific Objectives and Contents:

Specific Objectives	Contents
• Know about how the life of livingorganism starts. • Implement the physicochemical rules in the evolution of cellularlife.	**Unit I: Origins and Evolution of Life (4 hrs)** Initiation, Machinery of prokaryotic cells, The photosynthetic revolution, Origins of diploidal eukaryotic cells, Summary: further stages of evolution.
• Understand the macromolecular interactions. • Know about conformations of polypeptide chains: the proteins. • Know about the structures and biophysical principles of nucleic acids and constituents.	**Unit II: Structures of Biomolecules (11 hrs)** Elementary building blocks, Generalized ester bonds, Directionality of chemical bonds, Weaker intratomic interactions: Ionic interactions, Covalent bonds, Free radicals, Van der Waals bonds; Hydrogen bonds and hydrophobic interactions: Polysaccharides, Amphiphilic molecules in water environments. Structures of proteins: Polypeptide chains, Protein folding, Electrophoresis of proteins, Protein interactions with environment, Electron transfers in proteins. Structures of nucleic acids: Electrostatic potential of DNA, DNA-information and damage,Fluorescence in biomolecules.
• Know about the theory of diffusion and transport of molecules and ions. • Introduce the principles of polymer biophysics.	**Unit III: Dynamics of Biomolecules (10 hrs)** Diffusion, Diffusional flow across membranes, Vibrations versus conformational transitions, Stochastic theory of reaction rates, Conformational transitions of proteins, Models of random walks on fractal lattices, Elastic properties of polymers, Bioenergetics, Biological coherence, Ionic currents through electrolytes, Electron conduction and tunneling, Proton transport, Interactions with

	electromagnetic radiation.
• Understand the laws of thermodynamics. • Know about different biophysicalstates concerning thermodynamics. • Know about chemical kinetics andcatalysis of biological systems.	**Unit IV: Nonequilibrium Thermodynamics and Biochemical Reactions (8 hrs)** Second law of thermodynamics, Non-equilibrium thermodynamics, Rates of non-equilibrium thermodynamic processes, Single unimolecular chemical reaction, Bimolecular reactions: protolysi, Redox reactions, The steady state approximation: the theory of reaction rates, Chemical mechanisms of enzymatic catalysis, Michaelis-Menten kinetics, Control of enzymatic reactions
. • Know about the structure and functioning of cell membrane. • Understand the generation and propagation of nerve impulse.	**Unit V: Cellular Biophysics (7 hrs)** General characteristics of a cell, Membrane and membrane proteins: Elastic pressure of membrane, Mass diffusion across membranes, Membrane proteins, Electrical potentials of cellular membranes; Ion channels and ion pumps. Anatomy of a nerve cell, Action potential generation: Hodgkin–Huxley equations,
• Understand the radioactive phenomena concerning living organisms. • Understand the biomedical applications of the nuclear radiations. • Knowledge about the hazardous radiations.	**Unit II: Nucleonics in Biology and Medicine (5 hrs)** Elementary particles, Atomic nucleus, Radioactivity, Detection of nuclear radiation, Radioactive decay, Isotopes, X-ray, Detection and measurement of radioactivity, Biological effects of radiation, Radiation damage in the embryo and fetus during pregnancy, Demerits of different diagnostic and therapeutic methods of nuclear medicine during pregnancy, Atmospheric radiation hazards.

Prescribed Text Books:

1. *Tuszynski J., Kurzynski M.,* ***Introduction to Molecular Biophysics,*** CRCPress LLC, US (2003).

Reference Books:

1. *Volkenstein M. V.,* ***Biophysics,*** Mir Publishers, Moscow (1983).
2. *Roy R. N.,* ***A Textbook of Biophysics,*** New Central Book Agency (P) Ltd., India(2001).
3. *Narayanan, P.,* ***Essentials of Biophysics,*** New Age International (P) Ltd., India(2000).
4. *William H.,* ***Aspects of Biophysics,*** John Wiley and Sons, New York (1979).
5. *Hendee W. R.,* ***Medical Radiation Physics,*** 4th edition, Year Book Medical PublishersINC.

   London (2002).

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: Analytical Chemistry F.M.: 100
Course No.: CHM 475 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		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 willbe seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will beconducted 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 thecourse.

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 doesnot attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attenda 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.: CHM 474 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**	**Weigh tage**	**Marks**	**Viva-voce**	**Weigh tage**	**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. Failedstudent 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 MarshallSittig, 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), CBSPublishers 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 VIII F.M.: 100
Course No.: CHM 471 P.M.: 45%
Nature of Course: Theory Credit: 4
Level: B. Sc. Number of hours per week: 4
Year: First, Semester: First 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 parametersof 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 Kp & Kc, 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 Kp and Kc for gaseous reactions, variation of Kp and Kc 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 NH3 as solvent. • Describe the different types of reactions involving liquid SO2 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 NH3 and reactions of SO2.
• Explain the concept of an inorganic polymer. • Describe the classification of inorganic polymer based on composition. • 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.	**Unit VII: Inorganic Polymers (8 hrs)** Classification of polymers: classification based on backbone structure, organic polymers, inorganic polymers. Classification of inorganic polymers: homoatomic inorganic 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**	**Weigh tage**	**Marks**	**Viva-voce**	**Weigh tage**	**Mark**
End semester examination		Assignments	20%		Report and Presentation on any topic	50%	

(Details are given in the separate table at the end)	60	Quizzes	10%	20	Presentation	25%	20
		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. Failedstudent 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 andReactivity**, Addison Wesley Publishing House.
8. W. U. Malik, G. D. Tuli & R. D. Madan, **Selected Topics in Inorganic Chemistry**, S. Chand & Company, NewDelhi, 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: **Chemistry IX** F.M.: 100
Course No.: CHM 472 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 numericalsrelated 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 (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.	**Unit III: Commercial Electrochemical Cells (5 hrs)** Principles and applications of primary (Leclanche cell) and 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.	**<u>Organic Chemistry</u>** **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-arthritis 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	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 willbe seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will beconducted 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 thecourse.

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 doesnot attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attenda 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, NewDelhi, 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 andHall, 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 CollegePublishers, 1993.

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Title: **Chemistry PR** F.M.:
Course No.: CHM 473 P.M.:
Nature of Course: Practical Credit: 2
Level: B. Sc. Number of hours per week: 6
Year: Fourth, Semester: Seventh Teaching Hours: 90

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: **Natural Product Chemistry** F.M.: 100
Course No.: CHM 476 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 isoprenerule. • Explain the general methods of structureelucidation of terpenoids. • Describe the sources, uses, and structureelucidation 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 structureelucidation of carotinoids. • Describe the sources, uses, and structureelucidation 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 structureelucidation of steroids. • Explain the spectral properties of steroids. • Explain the structure elucidation ofcholesterol. • Discuss the source, structure, structure andrecommendation dose of vitamin D. • Explain the structure, function of steroidalhormone 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 andquinine.	**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 willbe seriously taken.

Quizzes: Unannounced and announced quizzes/tests will be taken by the respective subject teachers. Such quizzes/tests will beconducted 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 thecourse.

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 doesnot attend the class(es), it is his/her sole responsibility to cover the topic(s) taught during that period. If a student fails to attenda formal exam/quiz/test, there won't be any provision for re-exam.

6. 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.

7. 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.