Far Western University
Mahendranagar, Kanchanpur
Faculty of Science and Technology

Bachelor of Science
(Mathematics)

FAR WESTERN UNIVERSITY

Faculty of Science and Technology

Course Structure of B. Sc. Mathematics

Course Code	Course Title	Credit Hours
Semester I		
MTH 111	Calculus	3
Semester II		
MTH 121	Calculus of Several Variables	3
Semester III		
MTH 231	Real Analysis I	3
MTH 232	Ordinary and Linear Algebra	3
Semester IV		
MTH 241	Real Analysis II	3
MTH 242	Modern Algebra	3
Semester V		
MTH 351	Geometry	3
MTH 352	Vector Analysis	3
Semester VI		
MTH 361	Differential Equations	4
MTH 362	Mechanics	3
Semester VII		
MTH 471	Mathematical Analysis I	4
MTH 472	Advanced Algebra I	3
MTH 473	Advanced Calculus	3
MTH 474	Applied Mathematics	3
Semester VIII		
MTH 481	Mathematical Analysis II	4
MTH 482	Advanced Algebra II	3
MTH 483	Discrete Mathematics	3
MTH 484	Linear Programming	2

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Calculus** F.M.: 100
Course No.: MTH 111 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: First, Semester: First Teaching Hours: 45

(1). Course description

The course aims to acquaint the students with basic concept of Limit, continuity and derivative which is considered to be the cornerstone of Calculus. After in-depth study of these terms students will be able to understand the subject matter and find its applications.

(2). Course objectives

The general objectives of the course are as follows:

- To acquaint the students with basic concepts of limit, continuity and derivative.
- To enable the students to understand the applications of Differentiation and Integration.
- To enable the students to understand the application of integration in applied mathematics, physics and Biological sciences.

(3). Specific objectives and course contents

Specific objectives	Contents in Detail
• Explain the meaning of limit, continuity and derivative. • Clarify the concept of limits and continuity to understand calculus in better way. • Explain the equation of tangent to a curve at any point and then derive the equation for cartesian subtangent, subnormal and their length. • Define and derive the Arc length in Cartesian form. • Obtain the polar equation to a curve. • Enable to student knowing about the precise definition of pedal equation and able to derive pedal equations of same curves.	**Unit 1: Limit and Derivative (7 hours)** Rate of change and limits (Review) Calculating the limits using limit laws (Review) The precise definition of limits and continuity (Review) One sided limit and limit at infinity (Review) The Derivative as a function (Review) The Derivative as a rate of change (Review) Infinite limits and horizontal and vertical Asymptotes Tangent and Normal Equation of tangent to the curve at any point (Review) Cartesian subtangent, subnormal and their length Derivative of Arc length in Cartesian form Polar equations to curve Derivative of Arc length in polar form Pedal equation of some special curves
• Discuss the meaning of successive derivative of a function with notation. • Could be able to compute higher order derivative of some special functions. • Derive the Leibnitz theorem. • Discuss the applications of successive derivatives.	**Unit 2: Higher Order Derivatives (3 hours)** Successive derivatives of some typical functions Leibnitz theorem (with proof) Application of Leibnitz theorem
• Introduce the extreme values of a function of two or three variables with conditions.	**Unit 3: Application of Differentiation (9 hours)** Extreme values of a function of two or three variables The Mean value theorems (Revision)

• Compare the difference between various Mean Value theorems. • Discuss the Taylor's theorem. • Differentiate between Taylors and Maclurins series. • Explain the concept of derivative to sketch the various curves. • Describe the concept of Derivative for obtaining solutions in optimization problems. • Explain the method for estimating a solution of an equation f(x) = 0 is to produce a sequence of approximations that approach the solution.	Taylor's theorem with Cauchy's forms of remainder Taylor's series Maclurins series of trigonometric, exponential and logarithmic functions Applications of mean value theorems to monotonic functions and inequalities Curve sketching Applied optimization problems Newton's method
• Explain the difference between indefinite and definite integral. • Explain the properties of definite integral and use it for the even and odd functions. • Discuss various cases of improper integral ad properties of Beta and Gamma function.	**Unit 4: Integration (5 hours)** The definite integral (Review) The properties of definite integral Reduction formula
• Describe the method for obtaining reduction formula for the trigonometric function of higher order.	Fundamental theorem of calculus Improper integrals
• To review the area between the curves. • Explain the derivation for volume of a solid of revolution and surfaces of solid of revolution. • Describe how the concept of definite integral can be applied for moments of centre of mass. • Assess the applications definite integral in Physics, Engineering and Biology.	**Unit 5: Applications of Definite Integral (6 hours)** Area between curves (Review) Volumes and surface Arc length Moments and centre of mass Work Applications to physics, Engineering and Biology
• Discuss various problems that can be formulated mathematically as differential equation. • To prove an existence uniqueness theorem and determined all solution by explicit formula. • Discuss the non-homogeneous equation of the form y" + ay' + by = R and its solution obtained by operating with an operator L. • Describe the method of solving simple harmonic motion, Damped vibrations, Electric circuit, motion of rocket with variable mass.	**Unit 6: Differential Equations (7 hours)** Linear differential equation (Review) Some physical problems leading to first order linear differential equation Linear equations of second order with constant coefficients Existence of solution of the equation y" + by = 0 Reduction of the general equation to the special case y" + by = 0 Uniqueness theorem for the equation y" + by = 0 Complete solution of the equation y" + by = 0 and y" + ay' + by = 0 Non homogeneous linear equation of second order with constant coefficients Special method for determining a particular solution of the no homogeneous equation y" + ay' +

	by = R 6.5 Some geometrical and physical problems leading to first order equation
• Explain the algebraic and order properties of R. • Introduce the meaning of absolute value to solve many properties on R. • Explain the definition of l u b and g l b and its further uses to understand the suprimum and infimum of a set. • Describe the various applications of suprimum and infimum property.	**Unit 7: The Real numbers (8 hours)** Algebraic and order properties of R Absolute value and real line The completeness property of R Application of the suprimum or infimum property

(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). Prescribes Books and References Prescribed

Books

1. Apostol, T.M. (2011), Calculus (Volume I). IInd Edition.Wieley India.
2. Strauss M. J. , G. L., Bradley and K.J. Smith, (2007)., Calculus. (3rd edition) Dorling Kindersley (India) Pvt. Ltd,(Pearson Education), Delhi.
3. Thomos G. B. and R. L. Finney (2007, Calculus. Pearson Education, New Delhi.

References

1. Bartle G.R. and Donald R. Sherbert (2002), Introduction to Real Analysis, John Wiley and Sons, New Delhi.
2. Anton H,. I. Bivens and S. Davis (2002) Calculus (7th edition) John Wiley and Sons
3. Stewart, J., Calculus with early Transcendental Functions, (6th Ed) Cengage Learning India, Delhi.

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Calculus of Several Variables** F.M.: 100
Course No.: MTH121 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: First, Semester: Second Teaching Hours: 45

(1). Course description

The course intends to enable the students the basics of calculus in order to jump for advanced calculus. In this course, students will be familiar with the concept that how the partial derivative differs with ordinary derivative. At the same time, students get much idea to solve double and triple integral.

(2). Course objectives

The general objectives of the course are as follows:

- To acquaint the students with basics of calculus which helps to further study advanced calculus.
- To enable the students to understand the geometry of spaces.
- To enable the students differentiate between partial and ordinary differentiation.
- To enable the students to understand multiple integral concept.

(3). Specific objectives and course contents

Specific objectives	Contents in Detail
• Explain the meaning of parametric equation and their relation. • Discuss the calculus with parametric curves. • Discuss polar coordinates. • Describe the areas and length in polar coordinates. • Define conic section. • Explain conic section in polar coordinates.	**Unit 1: Parametric Equation and Polar Coordinates (10 hours)** Curves defined by parametric equations Calculus with parametric curves Polar coordinates Areas and length in polar coordinates Conic section Conic section in polar coordinates
• Explain the concept of functions of several variables. • Explain the meaning of limit and continuity. • Define partial derivatives. • Compare directional derivatives and partial derivatives. • State the chain rule with proof. • Explain the Lagranges multiplier method. • Describe the homogenous method. • Compute the total differential of a function. • Obtain the solution of composite and implicit function. • Calculate the repeated limits.	**Unit 2: Partial Differentiation (14 hours)** Functions of several variables Limit and continuity in higher dimensions Partial derivatives Directional derivative and gradient vectors Tangent planes and differentials The chain rule Extreme values and saddle points Lagranges multiplier Homogenous functions Eulers theorem on homogenous functions of two or three variables Total differential Approximation calculation Composite functions Implicit function

• Explain the meaning of double integral and evaluation of double integral. • Describe the process of changing of order of integration. • Define the term iterated integral and triple integral. • Explain the method of evaluating triple integral. • Study Jacobean's method. • Give the application of multiple integral to obtain area and volume.	**Unit 3: Multiple Integrals (11 hours)** Double integral, evolution of double integral Change of order of integration for two variables Double integration in polar coordinates Iterated integral Triple integral Evaluation of triple integral Jacobean's, change of variables (results without proof) Application to area and volume
• Explain the meaning of vector function and space curve. • Explain the concept of limit and continuity in vector valued function. • Obtain the derivative and integral of vector function. • Calculate the arc length and curvature of some curves.	**Unit 4: Vector Valued Functions (10 hours)** Vector functions and space curves Limit and continuity Derivative and integral of vector function
• Describe the concept of motion in space as velocity and acceleration.	Arc length and curvature Motion in space: velocity and acceleration

(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). Prescribes Books and References Prescribed

Books

1. Stewart J., *Calculus with Early Transcendental Functions*, 6th Edition, Cengage Learning India, New Delhi
2. Thomas G. B. and Finney R. L., *Calculus and Analytical Geometry*, Pearson Education
3. Widder D. V., *Advanced Calculus*, 2nd Edition, Prentice Hall of India, New Delhi

References

1. Apostol T. M., *Calculus Volume II*, 2nd Edition, Wiley India, 2007
2. Anton H., Bivens I. and Davis S., *Calculus*, 97th Edition, Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002
3. Strauss M. J., Bradely G. L. and Smith K. J., *Calculus*, 3rd Edition, Doorling Kindersley India Pvt. Ltd., Pearson Education, Delhi, 2007

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Real Analysis I** F.M.: 100
Course No.: MTH231 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Second, Semester: Third Teaching Hours: 45

1. **Course Description:**
This course aims to enable the students to gain basic knowledge about sets, functions, symbolic logic, real numbers, absolute values of real numbers, open sets, closed sets, sequence and series of real numbers which are considered to be backbone of real analysis. After the study of topics, the students will familiarize and able to understand the subject matter and their applications in further studies.

2. **Course Objectives:**
The general objectives of the course are as follows:
- To enable the students with basic concepts of sets, functions, symbolic logic and real number system.
- To enable the students about basic knowledge of open sets, closed sets and other related topics.
- To enable the students to gain the basic knowledge about infinite sequences and infinite series of real numbers.

3. **Specific Objectives and Contents of Study:**

Specific Objectives	Contents in Detail
* Define sets and illustrate different types of sets with examples. * Give concepts of set operations (union, intersection, complement of sets, difference of sets). * Define Cartesian products of two sets.	**Unit 00: Review of Basic Concepts** Sets and Set Operations Cartesian Products and Relations
* Define relation from a set to another set and state domain, co-domain and inverse relation of a relation. * Define function and state different types of functions. * Define composition of functions and illustrate some examples of composition of functions. * Define inverse of a function. * Define cardinality of sets. * State countable and uncountable sets and state their properties. * Define sentence and mathematical statement. * State compounds statement, negation, conjunction, disjunction, conditional and biconditional statements with examples. * Clarify the meaning of tautology and	**Unit 01: Sets, Functions and Logic 8 Hrs** Functions and Types of Functions Composition of Functions Inverse of a Function Cardinality of a Set Countable and Uncountable Sets and Their Properties Sentence and Statement Compound Statements with Connectives Tautology and Contradiction Quantifiers Basic Laws of Logic Techniques of Proof Proof by Mathematical Induction

contradiction. * Define quantifiers. * State basic laws of logic. * Explain about techniques of proof.	
* Define natural numbers, whole numbers, set of integers, rational and irrational numbers with examples. * Explain Peano's axioms. * State field axioms. * State order axioms. * Explain the meaning of absolute values of real numbers and explain some properties of real numbers. * Define bounded above, bounded below and bounded sets with examples. * State completeness axioms. * Define supremum and infimum of set of real numbers and state some of their properties. * State and prove Archimedean property of real numbers.	**Unit 02: Real Number Systems 7 Hrs** Introduction of Different Number Systems Peano's Axioms Field Axioms Order Axioms Absolute Values of Real Numbers and Their Properties Bounded Sets and Completeness Axioms Supremum and Infimum of Sets and Their Properties Archimedean Property Rational Density Theorem and Irrational Density Theorem
* State and prove rational density theorem and irrational density theorem. * Explain the meaning of countable and uncountable subset of real numbers with their properties. * Solve some related problems.	Countable and Uncountable Subsets of Real Numbers Geometrical Representation of Real Numbers Extended Real Number System
* Explain the open, closed, semi-open and semi-closed sets. * Define neighborhood of a point and interior of a point. * Define open sets with examples. * State and prove some theorems related to open sets. * Define closed sets. * State and prove some theorems related to closed sets. * Define adherent point of a set. * Define limit point of a set. * Define boundary point of a set. * State Bolzano – Weierstrass Theorem. * State nested interval theorem without proof. * Define perfect set with examples.	**Unit 03: Point Set Topology of Real Line 6 Hrs** Open and Closed Intervals Neighborhoods and Interior Points Open Sets Closed Sets Some Theorems Concerning Open and Closed Sets Adherent, Limit and Boundary Points of a Set Bolzano – Weierstrass Theorem Nested Interval Theorem without Proof Perfect Sets

* Define infinite sequences with examples. * State convergence and divergence of sequences of real numbers. * State and prove theorems related to convergent sequences. * Definition of increasing and decreasing sequences and hence monotone sequences also. * Some theorems related to monotone sequences. * Clarify the meanings of bounded sequences. * Explain the meanings of sub-sequences with examples. * State and prove Bolzano – Weierstrass theorem for sequences. * Define Cauchy's sequences. * State and prove some theorems related to Cauchy's sequences.	**Unit 04: Sequence of Real Numbers 11 Hrs** Sequences; Sequences of Real Numbers Convergence and Divergence of Sequence of Real Numbers Operations on Convergent Sequences Convergence of Monotone Sequences Bounded Sequence Sub – sequences Bolzano – Weierstrass Theorem for Sequence Cauchy's Sequences and Convergence
* Explain the meaning of infinite series of real numbers with examples. * Clarify the meaning of partial sums and sequence of partial sums of given infinite series. * State convergence and divergence of infinite series. * Explain about Cauchy's criteria for convergence of series. * Define series of positive terms and alternating series. * State and prove different test of convergence or divergence of series as ➢ p-series test ➢ Leibnitz's test ➢ Direct comparison test ➢ Limit comparison test ➢ D' Alembertz ratio test ➢ Cauchy's root test etc * Define absolute and conditional convergence of infinite series. * Solve some related problems of infinite series.	**Unit 05: Infinite Series of Real Numbers 13 Hrs** Series of Real Numbers Convergence and Divergence of an Infinite Series Cauchy's Criteria of Convergence Series of Positive Terms Alternating Series Different Tests for Convergence and Divergence of Infinite Series (p-series Test, Leibnitz's Test, Direct Comparison Test, Limit Comparison Test, D' Alembertz Ratio Test, Cauchy's Root Test) Absolute and Conditional Convergence Exercises

4. Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	
(Details are given in the separate table at the end)		Quizzes	10%	
		Attendance	10%	
		Presentation	10%	40

		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 semesterexamination. 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 theassignment 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:**
   i. Real Analysis – P. M. Bajracharya, Buddha Publication
   ii. Mathematical Analysis – R. M. Shrestha, Sukunda Pustak Bhawan
   iii. Real Analysis – S. M. Maskey
   iv. Mathematical Analysis – N. P. Pahari
   v. Mathematical Analysis – T. M. Apostol
   vi. Real Analysis – Shanti Prasad, S. Chand and Company Ltd., New Delhi

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Ordinary and Linear Algebra** F.M.: 100
Course No.: MTH 232 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Second, Semester: Third Teaching Hours: 45

1. **Course Description:**
   This course of Mathematics is designed to provide students to use linear algebra and its skills in different fields of mathematics, physics and engineering etc of general sciences and technical sciences. The course emphasizes both quantitative and qualitative aspects of ordinary and linear algebra involving the topics matrices and determinants, vectors in real n-space, vector spaces and subspaces, linear transformations and different types of polynomial equations
2. **Course Objectives:**
   The general objectives of the course are as follows:
   - To enable the students to gain basic knowledge of matrices and determinants.
   - To enable the students to know about vectors in real n-space, vector spaces and sub-spaces and linear transformation.
   - To enable the student to solve the different types of polynomial equations such as cubic and biquadratic equations.
   - To enable the students, the applications of different topics in applied mathematics, general sciences and technical sciences etc.
3. **Specific Objectives and Contents of Subject Matter:**

Specific Objectives	Contents in Detail
* Explain the meaning of matrix with different examples. * Define some standard matrices with examples. * Clarify about the algebra of matrices. * Define transpose of a matrix and explain the properties of transpose of a matrix. * Define symmetric and skew-symmetric matrices with examples. * Explain the meaning of determinant of square matrices with examples. * Explain the properties of order 3×3. * Define adjoint of a square matrix. * Define inverse of a square matrix. * Explain the properties of square and adjoint of a matrix.	**Unit 01: Matrices and Determinants 8 Hrs** Matrices, Some Standard Matrices Algebra of Matrices Transpose of a Matrix and Its Properties Symmetric and Skew Symmetric Matrix Determinant of a Square Matrix Minors and Cofactors Properties of Determinants Adjoint of a Square Matrix Inverse of a Square Matrix Properties of Adjoint and Inverse of a Matrix

* Define vectors in n-space with examples. * Explain about algebraic operations of points in n-space. * Define scalar product with some of the standard properties of scalar product. * Define norm of a vector. * Clarify the meaning of distance between two vectors. * Define angle between two vectors in terms of scalar product. * Explain the scalar and vector projections of a vector on another vectors. * Clarify the meaning of orthogonality.	**Unit 02: Vectors in Real n-space 5 Hrs** Vectors in n-space Algebraic Operations of Points in n-space Scalar Product Norm, Distance and Angle Scalar and Vector Projections Orthogonality
* Define vector spaces with some examples. * Explain some standard properties of vector spaces. * Define vector subspaces. * Explain the meaning of sums and direct sums of vector subspaces. * Clarify the concept of linear combinations, dependent and independent of vectors in a vector space. * Define basis and dimensions of a vector space. * Define scalar product of vectors. * Discuss about norm and distance. * Clarify the meaning of orthogonality and orthonormality with examples. * Discuss about orthogonal and orthonormal basis of vector spaces. * Solve some related problems.	**Unit 03: Vector Spaces and Subspaces 7 Hrs** Vector Spaces Properties of Vector Spaces Vector Sub-spaces Sums and Direct Sums of Vector Subspaces Linear Combinations, Dependent and Independent Vectors Basis and Dimensions Scalar Product Norm and Distance Orthogonality and Orthonormality Orthogonal and Orthonormal Basis and Related Problems
* Define linear transformation with examples. * Discuss about kernel and image of linear transformation. * Verify algebra of linear transformations. * Explain about composition of two linear transformations. * Verify that composition of two linear transformation is also linear. * Define inverse of linear transformation and prove that inverse of linear transformation is also linear. * Explain the meaning of matrix representation of linear transformation.	**Unit 04: Linear Transformations 5 Hrs** Linear Transformations Kernel and Image of Linear Transformations Algebra of Linear Transformations Matrix Representation of Linear Transformations

* Define polynomials and polynomial equation of different degrees. * Discuss about properties of polynomial equations. * Explain about 'Descartes' rules of signs. * Discuss about relation between roots and coefficients of polynomial equations of degree n in x. * Discuss about different transformations of equations with examples. * Clarify the multiple roots of polynomial equations. * Explain about sum of powers of roots. * Discuss about reciprocal equations.	**Unit 05: Polynomial Equations 10 Hrs** Polynomials Properties of Polynomials Equations General Properties of Equations 'Descartes' Rules of Signs Relations between Roots and Coefficients Symmetric Functions of Roots Transformation of Equations Multiple Roots Sum of Powers of Roots Reciprocal Equations
* Define general cubic equation. * Explain about the method of solution of cubic equation by Cardon's method with examples. * Clarify the method of solution of cubic equation by symmetric function of roots. * Define biquadratic equation with examples. * Explain about the method of solution of biquadratic equation by Ferrari's method. * Clarify about the method of solution of biquadratic equation by Euler's method with examples. * Discuss about the method of solution of biquadratic equation by Descartes method. * Solve some related problems.	**Unit 06: Cubic and Biquadratic Equations 12 Hrs** Cubic Equations Algebraic Solutions of Cubic Equations (Cardon's Method) Solutions of Cubic Equations by Symmetric Function of Roots Biquadratic Equation Solutions of Biquadratic Equations by Ferrari's Method Solutions of Biquadratic Equations by Euler's Method Solutions of Biquadratic Equations by Descartes Method

4. Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	
(Details are given in the separate table at the end)		Quizzes	10%	
		Attendance	10%	
		Presentation	10%	40
		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:**
   i. Linear Algebra – R. M. Shrestha and S. Bajracharya, Sukunda Pustak Bhawan
   ii. Algebra – I. N. Hertain
   iii. Algebra – Dr. Chandika Prasad, Pothishala Pvt. Ltd.
   iv. Algebra – Jeevan Kafle, etc
   v. Linear Algebra – S. Lang

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Real Analysis II** F.M.: 100
Course No.: MTH 241 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Second, Semester: Fourth Teaching Hours: 45

1. **Course Description:**
   This course aims to enable the students to gain basic knowledge about functions, limit and continuity of function, differentiability and integrability of functions, Riemann integral and fundamental theorem of calculus which areconsidered to be back bone of real analysis.

2. **Course Objectives:**
   The general objectives of this course are as follows:

   - To enable the students about functions, limits, continuity of functions.
   - To enable the students about basic knowledge of differentiability and continuity and mean value theorem.
   - To enable the students about basic knowledge of Riemann integration and fundamental theorems of calculus.

3. **Specific Objectives and Contents of Study:**

Specific Objectives	**Contents in Detail**
* Define a function in different forms. * State types of function with description and examples. * Define composition of functions. * Define inverse of a function. * Discuss about functional values of functions at differentpoints in IR.	**Unit 01: Functions (Revision) 3 Hrs** Functions and types of functions Composition of functions Inverse of a function. Meaning of functional values at different points in realline
* Define limit of a function at a point on set and oninterval. * Discuss about sequential criterion for limits. * Define one sided limits. * State different properties of limits. * State continuity of function and its sequential criterion. * Define discontinuous function. * State continuity in closed interval. * State sign preserving property. * State and prove Bolzano's theorem. * Define uniform continuity. * State Lipsclritz condition. * Define monotone function. * State and prove continuous inverse theorem.	**Unit 02: Limits and Continuity 13 Hrs** Limits (definition) Sequential criterion for limits One sided limits Properties of limits Continuity of functions and sequential criterion forcontinuity Discontinuities Continuity in closed interval Sign preserving property Intermediate value theorem Bolzano's theorem Uniform continuity Lipschitz condition Monotone function Continuity of monotone inverse function

* Define derivative of a real valued function of single variable. * Discuss derivative of a function at a point and in an interval. * State sequential criteria for derivatives. * State relation between differentiability and continuity. * State and prove Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem with their geometrical interpretation. * Define higher order derivatives. * Define monotonic functions. * Discuss extreme values of a function. * State and prove Taylor's Theorem. * State Maclaurin's theorem in finite form and infinite form. * Taylor's theorem in infinite form and applications.	**Unit 03: Differentiation 14 Hrs** Derivative of a function of single variable Differentiability at a point and in an interval Sequential criterion for derivatives Differentrability and continuity Mean value theorems - Rolle's theorem with geometrical interpretations - LMVT with geometrical interpretations - CMVT with geometrical interpretations Higher order derivatives Monotonic functions Extreme values Taylor's theorem with remainder Maclaurin's theorem in finite form Taylor's and Maclaurin's infinite series Application of Taylor's theorem in extreme value problems and related examples
* Define partition, norm and refinement of partitions. * Define bounded function with examples. * Define upper and lower Riemann sums and integrals. * State Riemann integrability and conditions ofintegrability. * Mention elementary properties of Riemann integrals. * State Riemann integral of step functions.	**Unit 04: Riemann Integration 11 Hrs** Partitions and refinement of partitions Bounded functions with examples Upper and lower Riemann sums Riemann integrable functions Relation between lower and upper integrals Conditions of integrability Elementary properties of Riemann integrals Riemann integral of step function
* State and prove first mean value theorem form Riemannintegrals and its generalized form. * State and prove generalized second mean value theoremof Riemann integral. * Discuss about primitives of a function. * State and prove first fundamental theorem of integralcalculus. * State and prove second fundamental theorem of integralcalculus. * Discuss about integration by parts. * State change of variable in an integral. * Solve some related problems.	**Unit 05: Fundamental Theorem of Calculus 4 Hrs** First mean value theorem for Riemann integraland its generalized form Generalized second mean value theorem ofRiemann integral Primitives and fundamental theorem of integralcalculus - First fundamental theorem of integral calculus - Second fundamental theorem of integralcalculus Integration by parts Change of variable in an integral and relatedexamples

4. Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	
(Details are given in the separate table at the		Quizzes	10%	

end)				
		Attendance	10%	40
		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 askedcovering 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 theassignment 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 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:

i. Real Analysis – P. M. Bajracharya, Buddha Publication
ii. Mathematical Analysis – R. M. Shrestha, Sukunda Pustak Bhawan
iii. Real Analysis – S. M. Maskey
iv. Mathematical Analysis – N. P. Pahari
v. Mathematical Analysis – T. M. Apostol
vi. Real Analysis – Shanti Prasad, S. Chand and Company Ltd., New Delhi

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Modern Algebra** F.M.: 100
Course No.: MTH 242 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Second, Semester: Fourth Teaching Hours: 45

1. **Course Description:**
This course of Mathematics is designed to gain the knowledge about binary operations, groups, rings and fields as well as system of linear equations and their skills are used in different fields of general and technical sciences. The course emphasizes both theoretical and applicable aspects of groups, rings and fields as well as system of linear equations.

2. **Course Objectives:**
The general objectives of the course are as follows:

- To enable the students to gain basic concepts about binary operations, equivalence relations.
- To enable the students to know about groups, rings and fields.
- To enable the student to know about system of linear equations.

3. **Specific Objectives and Contents of Subject Matter:**

Specific Objectives	Contents in Detail
* Discuss about binary operation and algebraic structure. * State elementary properties of integrals and prime numbers. * Define equivalence relation and equivalence classes. * Define divisors and greatest common divisors. * Discuss about prime factors. * State unique factorization theorem (not proof). * Discuss congruences and residue classes. * Solve some related problems.	**Unit 01: Equivalence Relations and Classes 6 Hrs** Binary operations and algebraic structure Properties of integers and prime numbers Equivalence relations and equivalence classes Divisors and greatest common divisors Prime factors Unique factorization theorem (without proof) Congruences and residue classes Related problems
* Define seimi-groups with examples. * Define groups with examples. * State some elementary properties of groups (with proof). * Define integral power of an element. * Define sub-group and their properties. * Define cosets and order of an element. * State and prove Lagrange's theorem. * Define centralizer and normalizer.	**Unit 02: Groups 10 Hrs** Introduction of algebraic structure Semi-groups Groups with examples Elementary properties of groups Integral power of an element Cyclic groups Subgroups and their properties Cosets, order of an element Lagrange's theorem Centralizer, normalizer and related problems

* Define permutation group. * Discuss about cyclic, even and odd permutations. * Define normal subgroups, quotient groups and their properties. * Define homomorphism, automorphism and group isomorphism. * State properties of group homomorphism (with proof). * State properties of group isomorphism (with proof). * Solve related problems	**Unit 03: Groups (continued)** **9 Hrs** Permutation groups Cyclic, even and odd permutations Normal subgroup Quotient groups and their properties Homomorphism Kernel and image of homomorphism Isomorphism and properties
* Discuss about algebraic structures with two binary operations. * Define ring with examples.	**Unit 04: Rings** **9 Hrs** Algebraic structures with two binary operations Rings with examples
* Discuss some special classes of rings. * Define integral domain, division ring and field. * State elementary properties of rings (with proof). * Define Boolean rings, sub-rings and ideals. * State and prove some theorems on special classes of rings. * Define ring homomorphism and isomorphism with properties. * Define quotient ring. * State and prove first isomorphism theorem for rings. * Define maximal ideal of rings.	Special classes of rings Integral domain, division ring and field Elementary properties of rings Boolean ring Subrings and ideals Some theorems on special classes of rings Ring homomorphism Quotient rings First isomorphism theorem for rings Maximal ideal of rings
* Define linear equations and system of homogeneous and non-homogeneous linear equations. * Solve the system of homogeneous and non- homogeneous linear equations. * Define rank of matrices related to linear systems, Echelon form, properties of rank, row rank and column rank. * State elementary row operations. * State consistency and inconsistency of a system of linear equations. * Solve homogeneous linear equations. * Discuss about characteristic equation of a matrix. * State Caley-Hamilton theorem for a square matrix (without proof). * Solve some related problems.	**Unit 05: System of Linear Equations** **11 Hrs** Linear equations System of homogeneous and non-homogenous linear equations Solution of a system of linear equations Rank of matrices related to linear systems, Echelon form, linearly dependence and independence Elementary row operations of matrix Rank, properties of rank, row rank and column rank of a matrix Rank of the product matrices Consistency and inconsistency of a system of linear equations Solution of non-homogeneous system of equations by using inverse Solution of homogeneous linear equations Characteristic equation of a matrix Caley-Hamilton theorem for a square matrix (without proof) Related problems

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 theend)		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 semesterexamination. 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 theassignment 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:**
   i. Linear Algebra – R. M. Shrestha and S. Bajracharya, Sukunda Pustak Bhawan
   ii. Algebra – I. N. Hertain
   iii. Algebra – Dr. Chandika Prasad, Pothishala Pvt. Ltd.
   iv. Algebra – Jeevan Kafle, etc
   v. Linear Algebra – S. Lang

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Geometry** F.M.: 100
Course No.: MTH 351 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Third, Semester: Fifth Teaching Hours: 45

1. **Course Description:**
This course of Mathematics is designed to gain the knowledge about transformation of coordinates, conic sections and their properties, polar equation of conic, general equation of the second degree, coordinates in 3D, plane, straight line, sphere and cone and cylinder and their skills are used in different fields of general and technical sciences. The course emphasizes both theoretical and applicable aspects of transformation of coordinates, conic sections, sphere, cone and cylinder etc.

2. **Course Objectives:**
The general objectives of this course are as follows:

- To enable the students to gain the basic concepts about transformation of coordinates in 2D, conic sectionsin plane.
- To enable the students to know about general equations of second degree.
- To know about coordinates in space plane, straight lines in plane.
- To enable the students to know about sphere, cone and cylinders in space.

3. **Specific Objectives and Contents of Subject Matter:**

Specific Objectives	Contents in Detail
* Describe about to change the origin of coordinates withoutchanging the directions of the axes. * Describe about to change the direction of the axes withoutchanging the origin. * Describe about to change the direction of the axes along withchange of origin. * Describe about invariants.	**Unit 01: Transformation of Coordinates 3 Hrs** Translation of coordinates Rotation of coordinates Combination of translation and rotation Invariants in orthogonal transformation Exercises

* Discuss about conic sections of different types. * Derive the standard equation of ellipse in detail. * State the different terminologies related to ellipse. * Discuss about sum of focal distances of a point. * State about polar equation of ellipse. * Write the definition of tangent and normal at a point on a curve and derive the equations of tangent and normal for ellipse and hyperbola. * Define hyperbola and derive standard equations of hyperbola. * Discuss about chord of contact. * Define pole and polar of a conic and state their properties. * Discuss about asymptotes of hyperbola. * Discuss about relations between the equations of hyperbola, its asymptotes and the conjugate hyperbola. * Derive polar equation of conic section with focus being pole.	**Unit 02: Conic Sections 10 Hrs** Introduction Ellipse Standard forms of ellipse and terminologies Sum of the focal distances of a point. Polar equation of the ellipse Tangent and normal (equation) Hyperbola Standard forms of hyperbola Equations of tangent and normal Chord of contact Pole and polar and their properties Asymptotes of hyperbola Relations between the equation of the hyperbola, itsasymptotes and the conjugate hyperbola Polar equation of conic section with focus being apole
* Discuss about general equation of second degree andthe conic represented by them. * Discuss about nature and centre of conic. * Derive equation of tangent and find condition oftangency. * Discuss about director circle of conic. * Derive equation of normal to the conic. * Derive equation of pole and polar of a conic.	**Unit 03: General Equation of the Second Degree 3 Hrs** General equation of second degree and the conicrepresented by them. Nature of conic Centre of conic Equation of tangent and condition of tangency Director circle Equation of normal to a conic Equation of pole and polar with respect to a conic
* Introduce coordinates in space in detail and revise some important formulae related to coordinates in	**Unit 04: Coordinates in Space and Plane 7 Hrs** 4.1 Introduction
space like distance formula, section formula and mid-point formula etc. * Find the angle between two straight lines. * Define direction cosines of a line and state relationbetween direction cosines of a line. * Define direction ratios and state relation betweendirection ratios. * Define plane in detail. * Derive equation of plane in normal and interceptforms. * Reduce the linear equation of plane to a normal form. * Derive equation of plane through three points. * Derive equation of plane through intersection of twoplanes. * Discuss about pair of planes and find angle	Distance formula, section formula and mid pointformula Angle between the straight lines Direction cosines of a line and relation betweendirection cosines of a line. Direction ratios Projection Introduction of plane Equation of plane in normal and intercept form Reduction of linear equation of plane to a normalform Angle between two planes Plane through three points Plane through intersection of two planes Pair of planes and angle between two planesrepresented by $ax^2 + by^2 + cz^2 + 2fyz + 2gzx + 2hxy = 0$

between two planes represented by $ax^2 + by^2 + cz^2 + 2fyz + 2gzx + 2hxy = 0$	
* Discuss about introduction of straight lines in space. * Derive equation of straight line in symmetrical form. * Find length of perpendicular from a point to a line. * Transform the equation of line from general form to the symmetrical form. * Find a relation for angle between a line and a plane. * Derive a condition for a line to lie in a plane. * Discuss about coplanar lines. * Discuss about shortest distance between lines.	**Unit 05: Straight Lines in Space** **7 Hrs** Introduction of straight lines in space Equation of a line in symmetrical form Length of perpendicular from a point to a line Transformation of the equation of line from general from to the symmetrical form Angle between a line and a plane Condition for a line to lie in a plane Co-planar lines The shortest distance Exercises
* Discuss about introduction of sphere. * Derive different equations of sphere. * Discuss about general equations of sphere. * Derive equation for sphere passing through four points. * Discuss about plane section of a sphere. * Derive equations of sphere in diameter form. * Discuss about intersection of two spheres. * Derive equation of tangent plane. * State condition of tangent with derivation.	**Unit 06: The Sphere** **7 Hrs** Introduction Equation of a sphere General equation of sphere Sphere through four given points Plane section of sphere Equation of a sphere in diameter form Intersection of two spheres Equation of tangent plane Condition of tangency
* Define cone and cylinder in detail. * Derive the equation of cone with given vertex at origin. * Discuss about condition for the given equation of second degree to represent a cone. * Find angle between lines in which a plane cuts a cone. * Find the condition that the cone has three mutually perpendicular generators. * Discuss about tangent lines and tangent planes. * State and derive condition of tangency. * Discuss reciprocal, enveloping and right circular cones. * Derive equation of the cylinder through a given conic. * Discuss about enveloping and right circular cylinders.	**Unit 07: Cone and Cylinder** **8 Hrs** Definition Cone with given vertex at origin Condition for the given equations of second degree to represent a cone Angle between lines in which a plane cuts a cone Condition that the cone has three mutually perpendicular generators Tangent lines and tangent planes Condition of tangency Reciprocal, enveloping and right circular cones Cylinder Equation of the cylinder through a given cone Enveloping and right circular cylinders

4. Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	
(Details are given in the separate table at the end)		Quizzes	10%	

		Attendance	10%	
		Presentation	10%	40
		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 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:

i. A Textbook of 3d Geometry – Y. R. Sthapit and B. C. Bajracharya, Sukunda Pustak Bhawan
ii. Analytical Geometry (2D) – M. R. Joshi and Jeevan Kafle, Sukunda Pustak Bhawan
iii. Analytical Geometry – S. P. Koirala et. al., Pragya Pustak Bhawan, Tahachal, Kathmandu

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Vector Analysis** F.M.: 100
Course No.: MTH 352 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Third, Semester: Fifth Teaching Hours: 45

1. **Course Description:**
This course of Mathematics is designed to gain the knowledge about product of three or four vectors, differentiation and integration of vectors, gradient, divergence and curl, line, surface and volume integrals, as well as integral transformation theorems and their skills are used in different fields of general and technical sciences. This course emphasizes both theoretical and applicable aspects of differentiation and integration of vector function, line surface and volume integrals etc.

2. **Course Objectives:**
The general objectives of the course are as follows:

- To enable the students to gain the knowledge about product of three or four vectors.
- To enable the students to gain the knowledge about differentiation and integration of vectors.
- To know about the gradient, divergence and curl.
- To enable the students to know about line, surface and volume integrals and integral transformation theorems.

3. **Specific Objectives and Contents of Subject Matter:**

Specific Objectives	Contents of Subject Matter in Detail
* Revise some important definitions, formula and product(scalar and vector) of two vectors in short. * Discuss about product of three vectors. * Discuss about scalar triple product in detail with geometrical interpretation. * Discuss about vector triple product in detail with geometrical interpretation. * Discuss about scalar and vector product of four vectors. * Define reciprocal system of vectors and state and prove their some properties and solve related exercises.	**Unit 01: Product of Three or Four Vectors** **9 Hrs** Revision Product of three vectors Scalar triple product Vector triple product Product of four vectors Reciprocal system of vectors Exercise

* Discuss about vector function of a scalar variable * Discuss about limit, continuity and derivative of a vector function of scalar variable with geometrical interpretation. * Discuss about successive derivatives in brief. * Define constant vector and find derivative of constant vector function. * Discuss about important techniques of differentiation of vector function of scalar variable. * Discuss about derivative of a function of function. * Find the derivative of scalar and vector product of three vectors. * Discuss about partial derivative of vector function. * Discuss about vector integration in brief.	**Unit 02: Differentiation and Integration of Vectors 11 Hrs** Vector function of a scalar variable Limit of a vector function Continuity of a vector function Derivative of a vector function and geometrical interpretation Successive derivatives Constant vector and derivative of constant vector Techniques of differentiation of vector functions Derivative of a function of function Derivative of scalar and vector triple product Partial derivative of a vector function Vector integration
* Define scalar point functions and vector point functions with examples. * Discuss about vector differential operator. * Define gradient of a scalar function. * Define divergence of a vector function and define solenoidal. * Define curl of vector function and define irrotaional. * Discuss about level surface and directional derivatives. * Discuss about geometrical interpretations of the gradient of a scalar function. * Discuss about physical concepts of the divergence of a vector function. * Discuss about physical concept of curl of vector function. * State and prove some identities involving first order differential operator. * Discuss about use of vector differential operator for product functions. * Discuss about second order differential operator and related problems.	**Unit 03: Gradient, Divergence and Curl 8 Hrs** Point functions Gradient of scalar functions and G. I. Divergence and curl of vector function Level surface Directional derivatives Physical concepts of divergence and curl of vector functions. Use of vector differential operator for product functions Second order differential operator
* Define smooth curve and simple closed curve. * Define line integral and discuss the line integral $\int_c \vec{f} \cdot d\vec{r}$ and some other expressions. * Discuss about line integral is the independent of path. * Define irrotational vector field. * Define surface integral in different form. * Discuss about applications of surface integrals. * Define volume integrals of vector function and solve some related problems.	**Unit 04: Line, Surface and Volume Integrals 8 Hrs** Line integrals Irrational vector field Surface integrals Volume integrals

* State and prove Green's theorem in the plane use it to find area. * State and prove Stoke's theorem. * Discuss about a special case of Stoke's theorem. * Discuss about some deductions from Stoke's theorem. * State and prove Gauss's divergence theorem. * Discuss about deductions from Gauss's theorem. * Discuss about expressions for grad ϕ, div $\vec{F}$ and curl $\vec{F}$ in terms of surface integral. * Solve some related problems.	**Unit 05: Integral Transformation Theorems 9 Hrs** Green's theorem in plane Area using Green's theorem Stoke's theorem and deduction Gauss's divergence theorem Expression for grad ϕ, div $\vec{F}$ and curl $\vec{F}$ in terms of surface integrals Green's 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 askedcovering all the units of the course.

Each student must secure at least 50% marks in internal evaluation in order to appear in the end semesterexamination. 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 theassignment will be seriously taken.

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

i. A Textbook of Vector Analysis – M. B. Singh and B. C. Bajracharya, Sukunda
ii. Pustak Bhawan
iii. Vector Analysis – Prof. Dr. Siddhi Prasad Koirala et. al., Cambridge Publication
iv. Vector Analysis – Lalji Prasad
v. Vector Analysis – B. L. Baidya

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Differential Equations** F.M.: 100
Course No.: MTH361 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Third, Semester: Sixth Teaching Hours: 45

(1). Course description

The course of Mathematics is designed to gain the knowledge about basic concepts of differential equations like first order linear and non-linear differential equations, second order differential equations and higher order linear equations as well as partial differential equations. The course emphasizes both theoretical and applicable aspects of ordinary differential equations and partial differential equations.

(2). Course objectives

The general objectives of the course are as follows:

- To enable the students to gain the basic concepts of solution of differential equations.
- To enable the students to know about linear and non-linear differential equations of first order.
- To know about second order linear equations.
- To enable the students to know about partial differential equations.

(3). Specific objectives and course contents

Specific objectives	Contents in Detail
• Define differential equation with examples. • Classify the differential equations. • Solve the differential equations by different methods. • Describe about some mathematical modules and directional fields.	**Unit 1: Introduction (4 hours)** Definition and classification of differential equations Solution of differential equations Some mathematical modules and directional fields
• Discuss about separable equations and solve them. • Describe about integrating factors. • Discuss about moduling with first order differential equations. • Discuss about differences between linear and non-linear differential equations. • Solve autonomous equations and discuss about population dynamics. • Discuss about exact equations and integrating factors. • Discuss about numerical approximations. • Solve the differential equations by Euler's method. • State and prove existence and uniqueness theorem. • Solve different types of first order differential equations.	**Unit 2: First Order Linear and Non Linear Differential Equations (9 hours)** Separable equations Integrating factors Moduling with first order differential equations Differences between the linear and non-linear equations Autonomous equations and population dynamics Exact equations and integrating factors Numerical approximation Euler's method Existence and uniqueness theorem First order differential equations

• Discuss about homogeneous equation with constant coefficients. • Solve linear homogeneous differential equations. • Discuss about the wronskian, complex roots of characteristic equations. • Discuss about repeated roots and reduction of order. • Discuss about non-homogeneous equations. • Solve the equations of method of undetermined coefficients. • Discuss about variations of parameters.	**Unit 3: Second Order Linear Equations (12 hours)** Homogeneous equations with constant coefficients Solutions of linear homogeneous equations The wronskian, complex roots of characteristic equation Repeated roots and reduction of order Non-homogeneous equations Method of undetermined coefficients Variations of parameters
• Discuss about partial differential equations (PDE) of first order. • Discuss about surface and curves in three dimensions. • Solve the equations of the type $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$. • Discuss about orthogonal trajectories of system of curves on a surface. • Solve the differential equations by Charpit's method.	**Unit 4: Ordinary Differential Equations in More than Two Variables (8 hours)** Partial differential equations of the first order Surface and curves in three dimensions Method of solution of the equation $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ Orthogonal trajectories of system of curves on a surface Charpit's differential forms and equations
• Define partial differential equations of first order. • Discuss about origin of PDEs. • Discuss about Cauchy problems of first order PDEs. • Solve the linear PDEs of first order. • Discuss about integral surface passing through a given curved surface.	**Unit 5: Partial Differential Equations (12 hours)** Partial differential equations of first order Origin of first order PDEs Cauchy problems for first order equations Linear equations of first order
• Solve PDEs by Charpit's method. • Solve the special types of first order PDEs.	Integral surface passing through a given curved surface Charpit's method Special types of first order equations

(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. Bayce, W. and DiPrima, R., Elementary Differential Equations and Boundary Value Problems, 9th Edition, Wiley India
2. Ian Sneddon, Elements of Partial Differential Equations, McGraw Hill International Edition
3. James C. Robinson, An Introduction to Ordinary Differential Equations, Cambridge University Press

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Mechanics** F.M.: 100
Course No.: MTH 362 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Third, Semester: Sixth Teaching Hours: 45

(1). Course description

The course of Mathematics is designed to enable the students about to gain the basic knowledge about coplanar forces, virtual work, catenary, centre of gravity, kinematics in two dimensions, rectilinear motion, moments and products of inertia. After the study of these topics, the students will familiarize and able to understand the subject matter and their applications in other fields.

(2). Course objectives

The general objectives of this course are as follows:

- To enable the students to gain basic knowledge about coplanar forces and virtual work.
- To enable the students to know about catenary and centre of gravity.
- To enable the students to know about kinematics in two dimensions, rectilinear motion, moments and products ofinertia.

(3). Specific objectives and course contents

Specific objectives	Contents in Detail
• Discuss about resultant of coplanar forces. • Derive the equation to the resultant. • Discuss about equivalent forces and couples. • Find the general condition of equilibrium. • Find the work done by the resultant. • Discuss about virtual displacement and virtualwork. • Discuss about principle of virtual work for a systemof coplanar forces acting on a particle.	**Unit 1: Coplanar Forces and Virtual Work (10 hours)** Resultant of coplanar forces Equation to the resultant Equivalent forces and couples General condition of equilibrium Work done by resultant Virtual displacement Virtual work Principle of virtual work for a system of coplanar forcesacting on a particle
• Define catenary. • Find the equation of common catenary in intrinsicand Cartesian form. • State the properties of common catenary. • Discuss about approximation to the commoncatenary. • Discuss about sag of a tightly stretched wire.	**Unit 2: Catenary (8 hours)** Definition Equation of common catenary in intrinsic and Cartesianform Properties of common catenary Approximation to the common catenary Sag of a tightly stretched wire
• Define centre of mass and centre of gravity. • Find centre of gravity by integration. • Find centre of gravity by an arc, CG of a plane area. • Find centre of gravity of a solid of revolution.	**Unit 3: Centre of Gravity (10 hours)** Centre of mass Centre of gravity Centre of gravity by integration Centre of gravity by an arc Centre of gravity of a plane area Centre of gravity of a solid revolution

• Find centre of gravity of a surface of revolution. • Discuss about centre of gravity of the sum ordifferences of two bodies.	Centre of gravity of a surface of revolution Centre of gravity of the sum or differences of two bodies
• Define velocity and acceleration of particle in plane. • Find radial and transverse components of velocityand acceleration. • Find angular velocity and acceleration. • Find tangentialand normal components of acceleration.	**Unit 4: Kinematics in Two Dimensions (6 hours)** Motion in plane – velocity and acceleration Radial and transverse components of velocity andacceleration Angular velocity and acceleration Tangential and normal components of acceleration
• Define simple harmonic motion. • Discuss about motion under inverse square law. • Define moments and products of inertia.	**Unit 5: Rectilinear Motion, Moments and Products of Inertia (11 hours)** Simple harmonic motion (SHM) Motion under inverse square law
• Discuss about some simple cases on MI and PI ofinertia.	Motion under laws of forces Moments and products of inertia Motion of inertia in some simple cases

(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 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 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

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. C. M. Joshi, J. C. Joshi and R. D. Joshi, A Textbook of Mechanics, Buddha Academic Publishers and Distributors,Kathmandu
2. M. Ray, Textbook of Dynamics, S. Chand and Company Ltd., India
3. R. S. Verma, Textbook of Statics, Pothishala Pvt. Ltd., Allahabad, India

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Mathematical Analysis I** F.M.: 100
Course No.: MTH471 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 this course 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 and complement • 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 from given open sets. • Define closed sets with examples. • Define adherent points, accumulation points and isolated points with examples. • 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 hours)** Euclidian space $\mathbf{R}^n$ Open balls and open sets in $\mathbf{R}^n$ Closed sets Adherent points, accumulation points and isolated 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 space with examples. • Define the boundary of a metric space with examples. • Solve some problems of compactness.	**Unit 2: Compactness (8 hours)** 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 in metric spaces and compact sets Boundary of a set
• 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 Complete Metric Spaces (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 Continuity**
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	**(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 closed sets Functions continuous on compact sets Topological mappings Sign-preserving property of continuous function

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.	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 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.	**Unit 5: Sequences and Series of Functions (13 hours)** Pointwise convergence Uniform convergence Uniform convergence and continuity Cauchy condition for uniform convergence for sequences Uniform convergence of series of functions Cauchy condition for uniform convergence for 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. *To prove the theorem related with orthogonal basis and theorem related with dimensions of	**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 3.5 General orthogonal bases 3.6 Dual spaces & scalar products

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.	
*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.: MTH473 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 hours)** 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 and their types Double points, their types and necessary condition 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(u1, u2, u3, …, un) = 0 • know and prove the theorem J = 0	**Unit 2: Jacobians (8 hours)** 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 sufficient condition that a functional relationship of the form f(u1, u2, u3, …, un) = 0 may exist where u1, u2, u3, …, un are the functions of x1, x2, x3, …, xn 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-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	**Unit 3: Curves in Space (Application of Calculus 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 to be a straight line and to be a plane curve Helices, the necessary and sufficient condition for 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 Complex 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 and continuity, differentiability and derivatives, necessary condition for differentiability, a brief introduction of mapping Introduction of analytic functions and necessary & sufficient conditions for f(z) to be analytic (Cauchy- Riemann conditions) Polar form of Cauchy-Riemann condition Harmonic functions, harmonic conjugates, determination of conjugate functions, Thosmon 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 hours)** Introduction Periodic functions and their properties, even and odd functions, orthogonal set of functions Trigonometric series and Fourier series as a special case of trigonometric series, determination of Fourier coefficients, fundamental theorem of Fourier series Fourier cosine series, Fourier sine series and half range Fourier series Fourier series in an arbitrary interval and Fourier series in exponential form Convergence problem of Fourier series, Riemann- Lebesguse lemna, Dirichlet's integrals, main 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 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 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.: MTH474 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** **10Hrs** 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** **8Hrs** 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	**Unit 3: Laplace Transform** **10Hrs** Introduction A few remark on the theory Application to differential equation. Derivatives and integrals of Laplace

• Find the derivative and integration of Laplace transform	transform.
• To find the exact solution of initial value problems • State and prove Picard's theorem • Apply Picard method to system of first order equations	**Unit 4: The Existence and Uniqueness of Solution** **7Hrs** 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** **10Hrs** 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

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 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

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. 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: **Mathematical Analysis II** F.M.: 100
Course No.: MTH 481 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Eighth Teaching Hours: 45

(1). Course Description

This course is designed for B. Sc. fourth year a continuation of second year real analysis. The main aim of this course 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 real valued functions, complex valued functions with examples. • Define functions, monotonic functions etc. • Define upper and lower integrals and then Riemann integrable functions with some examples. • Define vector valued functions defined on subsets of $\mathbf{R}^n$. • Explain some properties of vectors, dot product, vector product etc.	**Unit 0: Review of Basic Concepts** Functions Riemann Integrable Functions Vector valued Functions Vectors
• Define monotonic functions with examples. • State and prove the value of increasing function that lies between left hand limit and right hand limit. • State and prove inverse of strictly increasing function is also strictly increasing. • State and prove some other properties of monotonic functions. • Explain partition of a closed interval and define a function of bounded variation on closed interval. • Give some examples related to theorems. • Define total variation and explain some properties. • Define the theorems based on algebra of total variation. • State and prove additive property of total variation. • Derive the theorem concerning total variation on [a, x] as a function of x. • Prove that the function of bounded variation is	**Unit 1: Functions of Bounded Variation (6 hours)** Properties of monotonic functions Functions of bounded variation Total variation Additive properties of total variation Total variation as a function of x Functions of bounded variation expressed as the difference of increasing functions Continuous function of bounded variation

as the difference of increasing functions as well as strictly increasing functions. • State and prove some theorems related to continuous function of bounded variation. • Solve some problems concerning functions of bounded variation.	
• Define Riemann-Stieltjes sum and then Riemann integrable function. • Prove every constant function is R-S integrable. • State and prove linear properties on both the integrand and the integrator. • Prove the R-S integral is additive with respect to the interval of integration. • State and prove the formula for integration by parts. • State and prove the theorem related to change of variable in R-S integral. • State and prove the theorem related to reduction of R-S integral to Riemann integral. • Prove the theorem concerning the step functions as an integrator. • Explain with the help of suitable examples that existence of R-S integrals can be affected by changing the value of function at a single point. • Define a step function and greatest integer function with examples. • State and prove the theorem concerning reduction of R-S integral to a finite sum. • Prove every finite sum can be written as a R-S integral. • Define upper and lower R-S sums. • Mention some properties and prove them. • Define upper and lower integrals with examples. • Establish the relation between upper and lower integrals. • Define Riemann's condition and prove the theorem associated with it. • State and prove comparison theorems.	**Unit 2: The Riemann-Stieltjes Integrals (13 hours)** The definition of Riemann-Stieltjes integrals Linear properties Integration by parts Change of variable in R-S integral Reduction to a Riemann integral Step functions as integrators Reduction of a R-S integral to a finite sum Upper and lower integrals Riemann's condition Comparison theorem
• State and prove some theorems related to integrators of bounded variation. • State and prove sufficient conditions for existence of R-S integrals. • State and prove sufficient conditions for existence of Riemann integrals. • State and prove necessary conditions for existence of R-S integrals.	**Unit 3: The Riemann-Stieltjes Integrals (contd.) (7 hours)** Integrators of bounded variation Sufficient conditions for existence of R-S integrals
• State and prove first mean value theorem for R-S integrals. • State and prove second mean value theorem for R-S integrals. • State and prove the theorems concerning the integral as a function of the interval. • State and prove the second fundamental of integral calculus. • State and prove some theorems concerning R-S integrals depending on a parameter. • State and prove the theorem related to the differentiation under the integral sign. • State some theorems concerning interchanging the order of integration without proof. • Solve some related problems.	Necessary conditions for existence of R-S integrals Mean value theorems for R-S integrals The integral as a function of the interval Second fundamental theorem of integral calculus R-S integrals depending on a parameter Differentiation under the integral sign Interchanging the order of integration

• Define directional derivatives and discuss its particular cases. • Prove that existence of directional derivatives in all direction implies the existence of all partial derivatives but converse is not true. • Discuss an example showing that a function can have a finite directional derivative but may fail to be continuous. • Define total derivative with the help of first order Taylor's formula. • Prove that if a function is differentiable then the directional derivatives exist in all directions. • State and prove differentiability implies continuity. • Show the total derivative can be expressed in terms of partial derivatives. • Discuss how linear functions is expressed in the form of matrix. • Define Jacobian matrix with some examples. • State and prove the chain rule. • State and prove the mean value theorem for differentiable functions. • State a sufficient condition for differentiability without proof. • Give an example showing mixed partial derivatives may not be equal. • Give an example showing mixed partial derivatives may be equal. • State and prove sufficient conditions for equality or inequality of mixed partial derivatives. • State and prove Taylor's formula for functions from **R** to **R**. • Solve some related problems.	**Unit 4: Multivariable Differential Calculus (11 hours)** Directional derivatives Directional derivatives and continuity Total derivative The matrix form of a linear function The Jacobian matrix The chain rule The mean value theorem for differentiable functions A sufficient condition for differentiability A sufficient condition for equality of mixed partial derivatives Taylor's formula for functions from **R** to **R**
• Define an improper integral with examples. • Discuss improper integrals of first and second kind with examples. • Clarify the concept of convergence and divergence of the improper integral of first kind with some examples. • Give the geometrical meaning of the improper integral of first kind for $f \geq 0$. • State and prove Cauchy criterion for the improper integral of first kind. • State and prove comparison test. • State and prove limit comparison tests. Clarify them with examples. • Define absolutely convergent and conditionally convergent integrals of first kind with examples. • Prove that absolute convergence implies convergence.	**Unit 5: Improper Integrals (8 hours)** Classification of improper integrals Convergence and divergence of the improper integral of first kind Cauchy criterion Tests for convergence Absolute and conditional convergence

(4). Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
End semester examination	60	Assignments	10%	
(Details are given in the separate table at the end)		Quizzes	10%	

		Attendance	10%	40
		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 Pvt. Ltd. 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 II** F.M.: 100
Course No.: MTH482 P.M.: 45%
Nature of Course: Theory Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Eighth Teaching Hours: 45

(1). Course Description

This course of Mathematics is designed to gain the advance knowledge about groups, rings and fields and their skills are used in different fields of general and technical sciences. The course emphasizes both theoretical and applicable aspects of groups, rings and fields.

(2). Course Objectives

The general objectives of this course are as follows:

- To enable the students to gain advance concepts about groups, permutation groups and homomorphism.
- To enable the students to gain advance concept about rings and rings of polynomials.
- To enable the student to gain advance concept about fields.

(3). Specific Objectives and Course Contents

Specific Objectives	Contents in Detail
• Define binary operation and algebraic structure. • Define groups, subgroups and cyclic groups. • To obtain smallest subgroup of a group generated by an element. • To obtain infinite cyclic group isomorphic to a set of integers. • To obtain finite cyclic group of order n isomorphic to **Zn**. • Solve some related problems.	**Unit 1: Groups, Subgroups and Cyclic Groups (6 hours)** Binary Operations and Algebraic Structure Elementary Properties of Cyclic Groups Subgroups of Finite Cyclic Groups Generating Sets and Cayley Digraphs Related Problems
• Define permutation groups and cosets. • Discuss the properties of a group and its image under certain conditions. • State and prove Cayley's Theorem. • Define orbits and cycles of the permutation. • Discuss every permutation of a finite set of product of disjoint cycles. • State and prove some related theorems. • Define direct product of the groups. • Discuss the properties of **Zm** × **Zn** and **Zmn**.	**Unit 2: Permutations, Cosets and Direct Products (8 hours)** Permutation Groups Cayley's Theorem Orbits, Cycles and Alternating Groups Even and Odd Permutations, Transpositions Cosets and Theorem of Lagrange Direct Products Related Problems
• Define group homomorphism with examples. • State and prove some theorems related to homomorphism. • State and prove some theorems related to factor groups. • State and prove the fundamental theorem of homomorphism. • State and prove first, second and third	**Unit 3: Homomorphism, Factor Groups and Automorphism (11 hours)** Homomorphisms Evaluation of Homomorphism Properties of Homomorphism

isomorphism theorems. • Discuss the properties of factor groups of a cyclic. • Discuss about general idea of simple groups. • Solve some related problems.	Normal Subgroup Factor Groups Automorphism Factor Group Computations and Simple Group Related Problems
• Define rings and fields with examples. • State and prove some theorems related to ring. • Prove that every field is an integral domain and every finite integral domain is a field. • Define characteristic of a ring. • State and prove little Fermat's theorem. • State and prove Euler's theorem. • Discuss field of quotients of an integral domain. • Solve some related problems.	**Unit 4: Rings (7 hours)** Rings and Fields Homomorphism and Isomorphism Integral Domains The Characteristic of a Ring Fermat's and Euler's Theorem The Field of Quotients of an Integral Domain Related Problems
• Define rings of a polynomials. • State and prove some related thoerems. • Discuss about division algorithm. • State and prove factor theorem.	**Unit 5: Rings of Polynomials (9 hours)** Rings of Polynomials in an Indeterminate Factorization of Polynomials over a Field
• State and prove some theorems related to reducible and irreducible polynomials. • Discuss about ideals and factor rings. • Discuss about prime and maximal ideal. • State and prove some theorems related to prime ideals and maximal ideals. • Solve some related problems.	Irreducible Polynomials Ideals and Factor Rings Prime and Maximal Ideals Prime Field Related Problems
• Define extension fields. • To develop idea of Kronecker's theorem. • Define algebraic and transcendental elements. • Define algebraic number and transcendental number. • Define simple extension. • Solve some related problems.	**Unit 6: Fields (4 hours)** Introduction to Extension Field Algebraic and Transcendental Elements Simple Extension Related Problems

(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. *A First Course in Abstract Algebra*, 7th Edition – John B. Fraleigh, Pearson Publication
2. *Topics in Algebra* – I. N. Herstein, Vikas Publication, India
3. *University Algebra* – N. S. Gopalkrishnan, Orient Longman, India
4. *Modern Algebra* – H. N. Nath, Dikshanta Pustak Prakashan, Kathmandu

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Discrete Mathematics** F.M.: 100
Course No.: MTH483 P.M.: 45%
Nature of Course: Theory (Elective) Credit: 3
Level: B. Sc. Number of hours per week: 3
Year: Fourth, Semester: Eighth Teaching Hours: 45

(1). Course Description

This course aims to enable the student to gain basic knowledge of the various topics of Discrete Mathematics such as algorithms, counting techniques, relations, graphs and trees which are useful in mathematics as well as computer science.

(2). Course Objectives

The general objectives of this course are as follows:

- To enable the students to be familiar with the concept of algorithms whose application arises frequently in computer programming.
- To enable the students to gain the concepts of counting techniques and relations which are also useful in many occasions.
- To enable the students to gain the basic concepts of graph theorem and trees which are equally useful in mathematics and computer science.

(3). Specific Objectives and Course Contents

Specific Objectives	Contents in Detail
After studying this unit, students will be able to • recall the concepts of set theory and functions studied in previous levels for further application. • have the concept of algorithms, their properties and algorithms used for various purposes. • know how does the growth of functions takes place and concepts of big-o notation, big-omega notation and big-theta notation. • know several facts about prime integers.	**Unit 1: Algorithms and Prime Integers (9 hours)** A brief review of sets and functions Algorithms The growth of functions Prime integers
After studying this unit, students will be able to • recall the concepts of permutation and combination studied in previous levels for further application. • know about pigeonhole principle & its generalized form and its application in various problems. • be familiar with recurrence relations, modelling with recurrence relations and the formula for compound interest. • know various techniques of solving linear recurrence. • have the knowledge of generating functions and several useful facts about them.	**Unit 2: Counting Techniques (8 hours)** Review of permutations and combinations The pigeonhole principle and its generalized form Recurrence relations Solving linear recurrence relations Generating functions
After studying this unit students will be able to • be introduced with relations, their kinds and operations on them. • know about n – ary relations, operations on them and their applications. • have the concept of various techniques of representing the relations.	**Unit 3: Relations (10 hours)** Relations and their properties n – ary relations and their applications Representing relations

• be familiar with closures of various relations and techniques of finding them. • have the concepts of equivalence relation and equivalence classes and various facts about them. • have the concept of partial ordering and various facts about them, representing posets by Hasse diagrams and the concept of hexicographic order.	Closures of relations Equivalence relations Partial ordering
After studying this unit, students will be able to • be introduced with graphs and some models involving the graphs. • to get the knowledge of various terms involved in graph theory and special types of graphs with their properties. • know various techniques of representing graphs and have the concept of graph isomorphism. • have the concepts of connectivity of graphs, paths in graphs and various facts about connectedness. • know about Euler's circuits, Euler's paths, necessary and sufficient conditions for their existence. • have the concept of planar graphs, Euler's formula for a planar graph and related concepts.	**Unit 4: Graphs (10 hours)** Graphs and graph models Graph terminology and special types of graphs Representing graphs and graph isomorphism Connectivity Euler and Hamilton paths Planar graphs
After studying this unit, students will be able to • have the concept of tree as a special undirected graph, condition for its existence, rooted tree & various facts about it, trees as some models and various properties	**Unit 5: Trees (11 hours)** 5.1 Introduction to trees
of trees. • know about some applications of trees. • know about tree transversals, their types and methods for constructing them. • have an introduction with spanning tree, various facts about it, various techniques for finding it. • have an introduction with minimum spanning tree and Prim's algorithm for finding it.	Application of trees Tree transversals Spanning trees Minimum spanning tree

(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. Kenneth H. Rosen, *Discrete Mathematics and Its Applications* (special Indian edition), Tata McGraw Hill Publishing Company Ltd., New Delhi
2. Joe L. Mott, Abraham Kandel, Theodore P. Baker, *Discrete Mathematics for Computer Scientists and Mathematicians*, Prentice Hall of India Pvt. Ltd., New Delhi

FAR WESTERN UNIVERSITY
Faculty of Science and Technology

Course Title: **Linear Programming** F.M.: 50
Course No.: MTH484 P.M.: 45%
Nature of Course: Theory Credit: 2
Level: B. Sc. Number of hours per week: 1.5
Year: Fourth, Semester: Eighth Teaching Hours: 30

(1). Course Description

This course is designed for B. Sc. four years level. The main aim of this course is to provide basic knowledge of linear programming.

(2). Course Objectives

The general objectives of this course are as follows:

- ☐ To enable the students to develop good theoretical background of linear programming and its applications.
- ☐ To enable the students to know about LPP and duality.
- ☐ To enable the students to apply the LPP on real field.

(3). Specific Objectives and Course Contents

Specific Objectives	Contents in Detail
• Define Euclidean space $\mathbf{E}^n$ and some algebraic operations. • Define linearly dependent and independent vectors with examples. • Define a basis with examples. • Prove if any vector $\mathbf{a}_j$ for which $\alpha_i \neq 0$ is removed from the set $\mathbf{a}1, \mathbf{a}2, \ldots \mathbf{a}r$ and $\mathbf{b}$ is added to this set, the new collection of r vectors is a basis for $\mathbf{E}^n$. • Define a vector space and its sub spaces with some examples. • Define the rank of m × n matrix with examples. • State and prove Cramer's rule for finding the solution to a system of n equations in n unknowns. • Define basic solution and degenerate basic solution with examples. • State and prove a necessary and sufficient condition for the existence and non-degeneracy of all possible basic solution of $A\mathbf{x} = \mathbf{b}$. • Define a line segment joining two points and define hyper planes. • Discuss some properties of hyper planes. • Define a convex set and extreme point with examples. • Prove a hyper plane in a convex set. • Prove open and closed half spaces and convex sets. • Prove the intersection of two convex sets is also convex. • Prove the intersection of a finite number of hyper planes or half spaces or of both in a convex set. • Define convex combination and prove the set	**Unit 1: Mathematical Background (4 hours)** Vectors and Euclidean spaces Linear dependence Bases Vector spaces and sub spaces Rank Simultaneous linear equations Basic solutions Lines and hyper planes Convex sets Convex sets and hyper planes Convex cones

of all convex combinations (polyhedron) of a finite number of points in a convex set. • Define supporting hyper plane and state the theorems related to convex sets and hyper planes without proof. • Write any point inside a triangle as a convex combination of the vertices. • Define a cone and prove a cone is a convex cone if it is a convex set. • Define a cone generated by a set of points and prove the cone generated by a convex set is a convex cone.	
• Define linear programming and some basic terms associated with LP with examples. • State general form of LPP, canonical form and standard form of an LPP. • Solve some LPP of two variables by graphical method. • Solve some LPP of two variables by cost line approach. • Define slack and surplus variables. • Prove that different forms of an LPP are equivalent. • Discuss the limitations of LP.	**Unit 2: LP Models (6 hours)** Linear Programming Two variable LP model Graphical solution method Cost line approach Slack and surplus variables Equivalency of different forms of an LPP Limitations of LP
• Define basic feasible solution. • State and prove the theorem concerning reduction of feasible solution into a basic feasible solution. • Discuss the theory related to improvement of a basic feasible solution. • Prove that if an LPP has at least one feasible solution, then it has at least one basic feasible solution. • Prove that if an LPP has an optimal solution, then at least one feasible solution must be an optimal one. • Discuss the theory related to unbounded solutions of an LPP. • Explain the optimality condition. • Discuss the relation of extreme points and basic feasible solution.	**Unit 3: Theory of Simplex Method (10 hours)** Basic feasible solutions Reduction of any feasible solution into a basic feasible solution Improving a basic feasible solution Unbounded solutions Optimality condition Extreme points and basic feasible solutions Selection of the vector to enter the basis
• Discuss how we select the vector to enter the basis. • State and degeneracy and discuss the process of breaking ties. • Solve some problems using big M method and two phase method. • Solve related problems.	Degeneracy and breaking ties Big M-method and two-phase method Tableau formate for simplex computations
• Discuss alternative formulation of an LPP. • Define dual of an LPP with examples. • State and prove that the dual of the dual is primal. • State and prove fundamental properties of dual problems. • Clarify the other formulation of dual problems. • Using dual, solve some linear programming problems. • Prove that if i^{th} constraint in the primal is an equality, then the i^{th} dual variable is unrestricted in sign. • Prove that if some variable x_j in the primal is	**Unit 4: Duality Theory (6 hours)** Alternative formulation of LPP Dual linear programming problems Fundamental properties of dual problems Other formulations of dual problems Complimentary slackness Unbounded solution in the primal The dual simplex algorithm

unrestricted in sign, then the j^{th} constraint of the dual problem will a strict equality. • State and prove the complimentary slackness properties. • Prove that if the primal has an unbounded solution, the dual has no feasible solution. • Discuss the dual simplex algorithm. • Solve some related problems.	
• Define transportation problem and write the LP model of transportation problem. • Define assignment problem and write the LP model of assignment problem. • Define diet problem and write the LP model of diet problem. • Define scheduling problem and write the LP model of scheduling problem. • Define production planning problem and write the LP model of production planning problem. • Discuss the maximal flow in the network and formulate it in LP model. • Describe minimum cost flow problem and formulate it in LP model. • Solve related problems.	**Unit 5: Applications of LP (4 hours)** LP formulations of some LPP Transportation problem Assignment problem Diet problem Scheduling problem Production planning Maximal flow in network Minimum cost flow problem

(4). Evaluation System:

Undergraduate Programs				
External Evaluation	**Marks**	**Internal Evaluation**	**Weightage**	**Marks**
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(Details are given in the separate table at the end)		Quizzes	10%	
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		Presentation	10%	
		Term papers	10%	
		Mid-Term exam	40%	
		Group work	10%	
Total External	30	Total Internal	100 %	20
Full Marks 30+20 = 50				

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(5). Prescribed Books and References

1. *Linear Programming* – G. Hadley, Narosa Publishing House, New Delhi
2. *Linear Programming* – Dr. Bhupendra Singh, Pragati Prakashan, Meerut
3. *An Introduction to Linear Programming* – M. P. Upadhyaya, Sukunda Pustak Bhawan, Kathmandu