# Tribhuvan University
## Institute of Science and Technology
## Course of Study for Four Year Mathematics

**Course Title:** Modern Algebra **Full Marks:** 100
**Course No. :** MAT 401 **Pass Mark:** 35
**Level :** B.Sc. **Year:** IV
**Nature of Course:** Theory **Period per week:** 9 Lecture Hrs.

**Course Description**
This course is designed for fourth year of B.Sc. four years level. The main aim of this course is to provide knowledge of modern algebra and Theory of equations.

**Course Objective**
The main objectives of this course structure is to enable the students to;

(i) develop in-depth knowledge and good theoretical background in algebra,
(ii) make interest in and promote enjoyment of algebra and its applications in various branches of mathematics and physical and social sciences,
(iii) get associated with teaching in the field related to algebra,
(iv) compare with graduates from various other universities in the field of algebra.

**Course Contents**

**Unit 1 Groups and Subgroups**: Introduction and examples, Binary operations, Isomorphic binary structures, Groups, Subgroups, cyclic groups, Generating sets and Cayley diagraphs. [15 Lectures]

**Unit 2 Permutations, Cosets, and Direct Product**: Groups of permutations, Orbits, Cycles, and the alternating groups, Cosets and Theorem of Lagrange's, Direct products. [15 Lectures]

**Unit 3 Homomorphism and Factor Groups**: Homomorphisms, Factor groups, Factor group computations and simple groups. [15 Lectures]

**Unit 4 Rings and Fields**: Rings and fields, Integral domains, Fermat's and Euler's theorems, The field of quotients of an integral domain, Rings of polynomials, Factorization of polynomials over a field. [15 Lectures]

**Unit 5 Ideals and Factor Rings**: Homomorphisms and factor rings, Prime and maximal ideals. [15 Lectures]

**Unit 6 Extension Fields**: Introduction to extension fields, Algebraic extensions. [15 Lectures]

**Unit 7 Advanced Group Theory**: Isomorphism theorem, Sylow theorem ( No Proof ), Applications of Sylow theory. [15 Lectures]

**Unit 8 Factorization**: Unique factorization domains, Euclidean domains, Gaussian integers. [15 Lectures]

**Unit 9 Theory of Polynomial Equations**: Polynomial over an integral domain, division algorithm, division of a polynomial, zero of a polynomial, Rolle's theorem(no proof),properties of equations,

Descartes rule of signs, relation between roots and coefficients, application to the solution of an equation, symmetric function of roots, transformation of equations, transformation in general, multiple roots, sum of the power of roots, reciprocal equations, Binomial equation.

[15 Lectures]

**Unit 10 Cubic and Biquadratic Equations**: Algebraic solution, algebraic solution of the cubic, nature of roots of cubic, equation of square difference of cubic, nature of roots from Cardan's solution and application to the numerical examples, solution by symmetric functions of roots, solution of the biquadratic and the radical. [15 Lectures]

**Text Books**


1. John. B. Fraleigh; *A First Course in Abstract Algebra*, Seventh Edition, Pearson.
2. R.M. Shrestha & S. Bajracharya; *Linear Algebra, Groups, Rings & Theory of Equations*, Sukunda Pustak Bhavan, Kathmandu.
3. T.P. Nepal, C.R. Bhatta & Ganga Ram D.C.; *A Text Book on Algebra*, Pradhan Book House Exhibition Road, Kathmandu.

**Reference Books**

4. H.N. Bhattarai & G.P. Dhakal; *Undergraduate Algebra,* Vidharthi Pustak Bhandar, kathmandu.
5. I.N. Herstein; *Topics in Algebra*, Vikas Publication, India.
6. N.S. Gopal Krishan; *University Algebra*, Orient Longman, India.
7. P. B.Bhattacharya, S.K. Jain & S.R. Nagpaul; *Basic Abstract Algebra*, Cambridge, 1995.

A.R. Vasishtha; *Modern Algebra*, Krishna Prakashan Mandir,Meerut.


## Tribhuvan University
Institute of Science and Technology
Course of Study for Four Year Mathematics

**Course Title:** Mathematical Analysis **Full Marks:** 100
**Course No. :** MAT 402 **Pass Mark:** 35
**Level :** B.Sc. **Year:** IV
**Nature of Course:** Theory **Period per week:** 9 Lecture Hrs.

**Course description**

This course is designed for fourth year of Four years B.Sc. program. The main aim of this course is to provide advanced knowledge of analysis to students offering mathematics as a major subject. Pre-requisite for this course is Real Analysis, which the students have studied in the third year.

**Course objectives**

The general objectives of this course is

a) To develop theoretical knowledge and analytical skill in the emerging areas of mathematics
b) To raise interest of students in the field of analytical world so that they can take up any course easily in modern mathematics.
c) To acquire and develop skill in the use and understanding of mathematical language.

d) To acquire knowledge an understanding of the language of mathematical terms, symbols, statements formulae, definitions, logic etc.
e) To construct solutions and proofs with their own independent efforts.
f) To prepare a sound base for higher studies in Mathematics.

**Course Contents**

**Unit 1. Euclidean spaces and metric spaces**

Set $\mathbf{R}^n$, Algebraic structure of $\mathbf{R}^n$, Metric structure of $\mathbf{R}^n$, Cauchy-Schwarz Inequality, Topology in $\mathbf{R}^n$, Metric spaces, Pointset topology in metric spaces. [12 Lectures]

**Unit 2. Compactness**

Bolzano-Weierstrass theorem, Cantor intersection theorem, Lindelof covering theorem, Heine-Borel covering theorem, Compactness in $\mathbf{R}^n$, Compactness ofa metric space

[8 Lectures]

**Unit 3. Limits and Continuity**

Convergent sequence in a metric space, Cauchy sequences, Complete metric spaces, Sequences and Compactness, Bolzano-Weierstrass theorem for sequences, Limits of a function, Continuous functions, Continuity and inverse images, Functions continuous on compact sets, Bolzano's theorem and intermediate value theorem, Uniform continuity, Uniform continuity and compact sets. [20 Lectures]

**Unit 4. Multivariable Differentiation**

Linear operator and its matrix representation, Total derivative,Partial Derivatives, Directional derivatives, Jacobean matrix, Mean Value theorem, Higher order partial derivatives,Equality of mixed partial derivatives. [16 Lectures]

**Unit 5. Functions of Bounded Variation**

Properties of monotonic functions, functions of bounded variation, Total variation, Its additive property. Total variation on $[a, x]$ as a function of $x$, Functions of bounded variation expressed as the difference of increasing functions, Continuous function of bounded variation.

[9 Lectures]

**Unit 6. Riemann-Stieltjes Integration**

Riemann-Stieltjes integrals, Linear properties, Integration by parts, Change of variable, Reduction to a Riemann integral, Step-functions as integrators, Increasing integrators, Upper and lower integrals, Riemann's condition, Comparison theorems, Necessary and sufficient conditions for existence of Riemann-Stieltjes integrals, Mean Value theorem, Integral as a function of the interval, Second Fundamental theorem, Second Mean Value theorem.

[22 Lectures**]**

**Unit 7. Sequences and series of functions**

**Sequences of Functions**: Pointwise convergence, Uniform convergence, Criterion for non-uniform convergence, Cauchy Condition for Uniform Convergence, Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation.

**Series of functions**: Uniform convergence of series of functions, Cauchy condition, Weierstrass *M*-test, Dirichlet's test, and Abel's test for uniform convergence. Uniform convergence and continuity, Uniform convergence and integration, Uniform convergence and differentiation

[19 Lectures]

**Unit 8. Improper Integrals**

Classification of improper integrals, Convergence, Divergence, Application of Fundamental Theorem of calculus, Simple properties, Conditions and tests for convergence, Absolute convergence, Abel's test and Dirichlet's test [18 Lectures]

**Unit 9. Complex Numbers and Functions**

Algebraic and Geometric properties of complex numbers, Polar coordinates and Eulers formula, Products and quotients in exponential form, Roots of complex numbers, Regions in the complex plane, Complex functions, Complex functions as mappings. [10 Lectures]

**Unit 10. Analytic Functions**

Limits and Continuity, Differentiability, Cauchy-Riemann Equations, Sufficient conditions for differentiability, Analytic functions, Reflection principles, Harmonic functions [16 Lectures

**Text books**


1. Tom Apostol, *Mathematical Analysis*, Narosa Publishing House, India.
2. David V. Widder, *Advanced Calculus*, Prentice Hall.
3. James Ward. Brown and Ruel V.Churchill, *Complex Variables and its Applications*,McGraw-Hill.Inc.


**Reference books**


4. Pahari,N.P., *A Textbook of Mathematical Analysis*, Sukunda Pustak Bhawan, **Kathmandu.**
5. **Brian S. Thomson, Judith B. Bruckner, Andrew M. Bruckner, *Elementary real analysis***
6. **R. G. Bartle, *The Elements of Real Analysis*, John Wiley and Sons.**
7. S. Ponnusamy, *Foundations of Mathematical Analysis*, Springer.
8. V. A. Zorich, *Mathematical Analysis* I and II, Springer.
9. Dennis G.Zill and Patrick D.Shanahan,*Complex Analysis with Applications* , Jones and Bartlett Publisher.
10. John H.Mathews and Russel W.Howell, *Complex Analysis for Mathematics and Engineering*, Jones and Bartlett Learning.


## Tribhuvan University
Institute of Science and Technology
Course of Study for Four Year Mathematics

**Course Title**: Mechanics **Full Marks**: 50
**Course No**. : MAT 403 **Pass Marks**: 17.5
**Level** : B.Sc. **Year**: IV
**Nature of Course**: Theory **Period per week**: 5 Lecture Hrs.

**Course Description**
This course is designed for fourth year of Four years B.Sc. program. The main aim of this course is to provide knowledge of mechanics.

**Course Objectives**

The objective of this course is to acquaint students with the concept of mechanics like coplanar forces, virtual work, catenary, centre of gravity, kinematics in two dimensions, rectilinear motion, moments and product of inertia. It aims at enabling students to build good knowledgebase in the subject of mechanics.

## Course Contents:

**Unit 1. Coplanar Forces & Virtual Work**:

Resultant of coplanar forces, Equation to the resultant, Equivalent force and couple, General condition of equilibrium, Work done by the resultant, Virtual displacement, Virtual work, Principle of virtual work for a system of coplanar forces acting on a particle. 20 Lectures

**Unit 2. Catenary**:

Definition, Equation of common catenary in intrinsic and Cartesian forms, Properties of common catenary, Approximations to the common catenary, Sag of a tightly stretched wire 12 Lectures

**Unit 3. Center of Gravity**:

Center of mass, Center of gravity, Center of gravity by integration, Center of gravity of an arc, Center of gravity of a plane area, Center of gravity of a solid revolution, Center of gravity of a surface of revolution, Center of gravity of the sum or difference of two bodies. 16 Lectures

**Unit 4. Kinematics in Two Dimensions**:

Motion in plane- velocity and acceleration, Radial and transverse components, of velocity and acceleration, Angular velocity and acceleration, Tangential and normal components of acceleration 13 Lectures

**Unit 5. Rectilinear Motion, Moments and Products of Inertia**:

Simple harmonic motion, Motion under inverse square law, Motion under laws of forces, Definition of moments and product of inertia, Motion of inertia in some simple case 14 Lectures

**Text books**


1. R.S. Verma; *Text Book on Statics,* Pothishala Pvt. Ltd. Allahabad, India
2. M.Ray; *Text Book on Dynamics,* S. Chand & Company Ltd. India


**Reference Book**


3. C.M. Joshi, J.C. Joshi & R.D. Joshi ; *A Text Book on Mechanics*, Buddha Academic Publishers & distributers, Kathmandu.

# Tribhuvan University
## Institute of Science and Technology
## Course of Study for Four Year Mathematics

**Course Title**: Linear Programming
**Course No**.: MAT 404
**Level:** B.Sc.
**Nature of the Course**: Theory

**Full Marks**: 50
**Pass Marks**: 17.5
**Year**: IV
**Period per week**: 5 Lecture Hrs.

**Course Description**
This course is designed for fourth year of Four years B.Sc. program.

**Course Objectives:** Linear Programming is the first course in optimization. This course aims at introducing techniques of linear programming and informs students the solution status of the related problems in LP. After the completion of this study, students will be familiar with LP models and their real life applications. They will be able to tackle the LP solution algorithms.

## Course Contents

**Unit 1. Mathematical Background**:

System of linear equations and inequalities, Basic solutions, Lines and hyper planes, Convex sets and functions, Convex sets and hyper planes, Convex cones, Polyhedron, Concepts on graphs, Time complexity and reduction relations. 15 hrs

**Unit 2. LP-Models and Complexity**

Variables and constraints, Cost function, Two-variable LP models and graphical solution methods, General, Canonical and standard forms of LP models, Slack and surplus variables, The equivalency of different LP-forms, Decision versions of the optimization problems. 15 hrs

**Unit 3. Simplex Algorithm**

Extreme points, Basic feasible solutions, Solution of LP problems by simplex method, Complexity of simplex method, Relation of extreme points and basic feasible solutions 15 hrs

**Unit 4. LP Duality Theory**

Alternate formulations of LPs, The dual LP formulation, Complementary slackness conditions, The dual simplex algorithm. 15 hrs

**Unit 5. Applications**

Models of transportation problem, Assignment problem, Maximal flows in a network, Minimum cost flow problem, Transshipment problem, Diet problem, LP models of scheduling problems, Production planning, Scheduling problems. 15 hrs

**Text/Reference Books**


1. G. Hadley; *Linear Programming*, Narosa, Publishing House.
2. Hamdy A. Taha; *Operations Research*, Prentice Hall-Pearson.
3. Lueberger, D.G; *Linear and Nonlinear Programming*, Addison-Wesley.

# Tribhuvan University
## Institute of Science and Technology
## Course of Study for Four Year Mathematics

Course Title: Project Work — Full Marks: 100
Course No. : MAT 406 — Pass Mark: 35
Level : B.Sc. — Year: IV
Nature of Course: Project .

**Course Guidelines: -** The project work must have connection with mathematics course taught in the B.Sc. Level in Mathematics.

For example, application of differential equations, Linear Programming, Algebra, Analysis, Mechanics, Geometry and so on in real life problems.

# Tribhuvan University
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## Course of Study for Four Year Mathematics

**Course Title:** Teaching Methodology (Elective) — **Full Marks:** 100(75 Theory+ 25 practical)
**Course No:** MAT 405 — **Pass Marks:** 35(26.25 Theory + 8.75 Practical)
**Level:** B. Sc — **Year:** IV
**Nature of course**: Theory and practical — **Period per Week**: 9 Lecture Hrs.

**Introduction**

This course is designed for fourth year of Four years B.Sc. program as an elective subject..What we teach and how we teach mathematics are inextricably linked and very much dependent on one another. Even though both are tightly linked, they are still separate. Growth of content knowledge doesn't automatically improve teaching efficiency. The present course supports questioning about teaching and learning mathematics. This course provides an introduction to teaching mathematics in schools. It introduces effective teaching of mathematics combining an understanding of how children learn, how to promote that learning by teaching through problem solving, and how to plan for and assess that learning on a daily basis. Thus, this course is designed to help students develop pedagogical strategies for teaching in the future.

**Learning outcomes**

At the end of this chapter the student will be able to:

• Recall various theories of learning

• Make links between these theories and the teaching of mathematics

• Appreciate the importance of teaching the skills and concepts in math as well as problem-solving.

• Appreciate the importance of the teacher-pupil relationship

• Choose the most appropriate teaching strategy for the classes

• Design the most appropriate unit lesson plan for a particular topic

• Ensure the key issues of good classroom management

• Use intrusive strategies to control the class.

•Appreciate the role of practical work in school maths;

• Discuss the pedagogical approaches used for teaching school math.

• Plan for and understand the needs of gifted students in your class

•Promote learning by teaching through problem solving

• Discuss strengths and weaknesses of different contexts

• Describe a variety of ICT resources suitable for use in the math classroom

• Discuss factors which influence the decision on the type of ICT being used

**Examination:** There will be a final examination of the theory part of 75 marks for the period of three hours. However practical part of 25 marks will be conducted by the concerned Department of Mathematics and the marks will be submitted to office of the controller of examination. The candidate must pass in theory and Practical part separately.

**Course Contents**

**Unit 1: Teaching for Understanding: Mathematical Knowledge or Enquiry:** Theories of how children learn, Perspectives on teaching, Twofold nature of math, Mathematics as a mode of enquiry, Mathematics as a body of knowledge. [20 Lectures]

**Unit 2: Being an Effective Mathematics Teacher:** Requirements for an effective teacher of mathematics, Effective lesson planning and its pedagogical analysis, Exemplars/non-exemplars and criterial attributes. Stones' heuristic for teaching subject knowledge, Establishing a positive learning environment, Dealing with underachievement in math, Gender issues in math, Available resources for teaching mathematics. [10 Lectures]

**Unit 3: Classroom Management and Working with Pupils:** Teacher-pupil relationship, Teaching strategies Discipline and behavior management, Flowing lesson, Maintaining a continuous signal, Importance of advance preparation, Sequence of a lesson, Use of the 'tactical ignore', Strategies for classroom control, Structure for dealing with disruptive pupils. [15 Lectures]

**Unit 4: Designing an Effective Lesson Plan:** Components of a Lesson Plan, Planning Paths of Differentiated Instruction, Planning Group Work in the Math Classroom, Teacher-Centered Versus Student-Centered

Instructional Models, Solving Systems of Equations Using the Developmental Lesson Model and the Workshop Model, Designing the Homework Assignment, Routines for Checking Homework, Importance of Planning Board Work, Planning a Series of Lessons (Unit Planning).
[20 Lectures]

**Unit 5: Some Specific Ideas for Teaching Certain Lessons:** Angle Measurement with a Circle by Moving the Circle, Sum of an Arithmetic Progression, Introducing the Product of Two Negatives, Rationalizing the Denominator, Pythagorean Theorem, Introduction to Nonpositive Exponents, Introducing the Notion of a Function, Intuition Versus Justification, Art of Classroom Questioning. [15 Lectures]

**Unit 6: Teaching Number Sense, Algebra and Geometry:** Reasoning and sense making, Teaching of number sense, Sample lesson plan: number sense, Number sense – activities sampler, Teaching of algebra, Sample lesson plan: algebra, Algebra – activities sampler, Teaching of geometry, Sample lesson plan: Geometry, Geometry – activities sampler. [15 Lectures]

**Unit 7: Strategies for Understanding Problem Solving:** *Problem-Solving*: Overview, Difficulty Factors, Teaching the process, *Strategies for Problem Solving*: Drawing a Diagram, Using Concrete Materials, Creating a Table, Looking for a Pattern, Guessing and Checking, Creating an Organized List, Working Backwards, Creating a Tree Diagram, Using Simpler Numbers, Using Logical Reasoning, Analyzing and Investigating Solving Open-Ended Problems. [20 Lectures]

**Unit 8: Mathematics in Context:** Skills for learning mathematics in context, Strengths and weaknesses of different contexts, problems with using contexts in teaching, teaching mathematics in context. [10 Lectures]

**Unit 9: Responsibility of Assessment:** Evaluative Assessment, Diagnostic Assessment Designing the Classroom Test, Informing Students of Their Grades, Improving Their Test Scores, Assessing the Assessment, Remedy of Poor Class performance, Testing Students of Varying Ability Levels, Handling Absentees on Test Days, Comprehensive Assessment. [15 Lectures]

**Unit 10: The Role of ICT in the Mathematics Classroom:** Forms of educational technology, Deciding to use ICT (Information and communication technology), Logistics of using ICT in mathematics, Areas for, and examples of, the incorporation of ICT in secondary mathematics lessons, Enhancing the teaching of mathematics using ICT, Internet as an ICT. [10 Lectures]

**Recommended Books**


1. Pamela Cowan, *Teaching Mathematics a Handbook for Primary and Secondary School Teachers* (for units 1, 2, 3, 10)
2. Alfred S. Posamentier and et al., *Exemplary practices for secondary math teachers* Association for Supervision and Curriculum Development, USA 2007 (for units 4, 5, 9)
3. D. J. Brahier, *Teaching secondary and middle school mathematics*, Pearson 2013 (for units 6)
4. Deborah V. Mink, Ph. D. *Strategies for Teaching Mathematics* Shell Education Publishing Inc. 2010 (for units 7)

**5.** Sue Johnston-Wilder and et al., Learning to Teach Mathematics in the Secondary School: a companion to school experience, Routledge, 2011 (for unit 8)

**References**

1. C. Kyriacou, *Essential, Teaching Skills*, Nelson Thornes Ltd, 2007
2. C. Kyriacou, *Effective Teaching in Schools Theory and practice*, Nelson Thornes Ltd, 2009
3. Anthony Haynes, *The Complete Guide to Lesson Planning and Preparation*, Continuum International Publishing Group, 2010
4. Rosamund Sutherland, *Teaching for Learning Mathematics*, Open University Press, McGraw-Hill, 2007
5. Polya, G., *How to solve it*, Princeton,1973.
6. L. Fazio and R.Siegler, *Teaching fractions*, IAE Educational Practices Series 2011

Tribhuvan University
Institute of Science and Technology
Course of Study for Four Year Mathematics

**Course Title:** Bio Mathematics (Elective) **Full Marks:** 100
**Course No. :** MAT 407 **Pass Mark:** 35
**Level :** B.Sc. **Year:** IV
**Nature of Course:** Theory **Period per week:** 9 Lecture Hrs.

**Course Description**

This course is designed for fourth year of Four years B.Sc. program as an elective subject. The main aim of this course is to provide knowledge of Mathematics in Biology.

**Course Objectives**: The objective of this course is to acquaint students with the basic concepts of mathematics, in population modeling and disease modeling. Also, the idea of solving biological problems.

**Course Contents**

**Unit 1**. **Dynamic Modeling with Difference Equations :** The Malthusian Model , Nonlinear Models Analyzing Nonlinear Models , Variations on the Logistic Model , Comments on Discrete and Continuous Models [20 Lectures]

**Unit 2. Linear Models of Structured Populations:** Linear Models and Matrix Algebra , Projection Matrices for Structured Models , Eigenvectors and Eigenvalues, Computing Eigenvectors and Eigenvalues [20 Lectures]

**Unit 3. Nonlinear Models of Interactions :** A Simple Predator–Prey Model , Equilibria of Multipopulation Models, Linearization and Stability , Positive and Negative Interactions. [20 Lectures]

**Unit 4. Modeling Molecular Evolution:** Background on DNA, An Introduction to Probability, Conditional Probabilities, Matrix Models of Base Substitution , Phylogenetic Distances. [20 Lectures]

**Unit 5. Constructing Phylogenetic Trees:** Phylogenetic Trees, Tree Construction: Distance Methods – Basics, Tree Construction: Distance Methods – Neighbor Joining. [20 Lectures]

**Unit 6. Genetics:** Mendelian Genetics, Probability Distributions in Genetics. [15 Lectures]
**Unit 7. Infectious Disease Modeling:** Elementary Epidemic Models ,Threshold Values and Critical Parameters, Variations on a Theme, Multiple Populations and Differentiated Infectivity. [20 Lectures]
**Unit 8. Curve Fitting and Biological Modeling :** Fitting Curves to Data , The Method of Least Squares, Polynomial Curve Fitting . [15 Lectures]

**Text Books/Reference Books**


1. Elizabeth S. Allman, and John A. Rhodes, *Mathematical Models in Biology An Introduction,* Cambridge University Press**,** 2004.
2. Nicholas F. Britton **,** *Essential Mathematical Biology,* Springer-Verlag London Limited 2003.


Tribhuvan University
Institute of Science and Technology
Course of Study for Four Year Mathematics

**Course Title:** Mathematical Economics (Elective) **Full Marks:** 100
**Course No. :** MAT 408 **Pass Mark:** 35
**Level :** B.Sc. **Year:** IV
**Nature of Course:** Theory **Period per week:** 9 Lecture Hrs.

**Course Objectives:** This course is designed for fourth year of Four years B.Sc. program as an elective subject**.**This course aims to introduce mathematical modes of economic problems in the society and industry. The students will be able to understand modeling techniques of different economic problems and apply mathematical tools to solve them theoretically. The focus has been given to the equilibrium, cooperative-static and dynamic analysis, and optimization techniques in theory and practice.

**Unit 1.** Concept of modeling, meanings of mathematical economics and econometrics, equilibrium analysis, market equilibrium linear, nonlinear and general models, graphical solutions, solution techniques and applications to national-income analysis and finite Markov chains, non singularity of a matrix and applications to market and income models. [30 Lectures]

**Unit 2.** Modeling of the marginal and average revenue functions, relationships between the cost-functions, geometric interpretations of partial derivatives in economic terms, gradient vector of the production function, applications to comparative static analysis, comparative static analysis of general function models and application to economical problems [30 Lectures]

**Unit 3.** Optimization methods for equilibrium analysis, types of extreme points, first, second and nth derivative tests, necessary and sufficient conditions, conditions for profit maximization, the growth function and its variants, extensions to multivariables, conditions to convexity and concavity and economic applications. [30 Lectures]

**Unit 4.** Effects of constraints in optimization methods, stationary values, Lagrange-multiplier method, second order conditions, multivariable and multi constraints, quasiconcavity and quasiconvexity, utility maximization and consumer demand, changes in price and demands, NLP and KKT-conditions, the constraint qualifications, sufficient conditions to nonlinear programming and economic applications.

[30 Lectures]

**Unit 5.** Meaning of economic dynamics, economic applications of integrals, the growth model, dynamics of market price, the qualitative-graphic approach, the market model, Inflation and unemployment models, applications of difference and higher order differential equations to economic problems. [30 Lectures] ]

**Text/Reference Book(s):**


1. A. C. Chiang, Kervin Wainwright; *Fundamental Methods of Mathematical Economics*, McGraw Hill Publishers.
2. Hoy Michael, et al.; *Mathematics for Economics*, Third edition, PHI Learning Private Limited


# Tribhuvan University

Institute of Science and Technology

Course of Study for Four Year Mathematics

Course Title**:** Mathematical Modeling
Course No: MAT 409
Level: B. Sc
Nature of course: Theory

Full Marks: 50
Pass Marks: 17.5
Year: IV
Period per Week: 5 Lecture Hrs.

**Course Objectives:** The objective of this course is to acquaint students with the basic concepts of modeling like modeling change, the modeling process, proportionality and geometric similarity, model fitting, optimization of discrete models and modeling with a differential equation. It aims at enabling students to build good knowledgebase in the subject of modeling.

**Course Contents**

**Unit 1. Modeling Change**

Introduction, Mathematical models, Modeling change with difference equations, Approximating change with difference equations, Solution to dynamical systems, Systems of difference equations. [ 15 Lectures]

**Unit 2. The Modeling Process, Proportionality and Geometric Similarity**

Mathematical models, Modeling using proportionality, Modeling using geometric similarity, Automobile gasoline mileage, Body weight and height, Strength and agility. [15 Lectures]

**Unit 3: Model Fitting**

Fitting model to data graphically, Analytical methods of data fitting, Applying the least squares criterion, Choosing a best model. [15 Lectures]

**Unit 4: Optimization of Discrete Models**

Introduction, An overview of optimization modeling, Linear programming, Geometric, Algebraic, Simplex method [15 Lectures]

**Unit 5: Modeling With a Differential Equation**

Population growth, Prescribing drug dosage, Braking distance revisited, Graphical solutions of autonomous differential equations [15 Lectures]

**Text book**

1. Frank R. Giordano, William P. Fox, Steven B. Horton, Maurice D. Weir; *Mathematical Modeling, Principles and Applications*, Cengage Learning, India Edition.

**Reference books**

2. Sandip Banerjee; *Mathematical Modeling, Models, Analysis and Applications*, A Chapman and HallBoyce, W. and Book.
3. Boyce, W. and DiPrima, R.; *Elementary Differential Equations and Boundary Value Problems*, 9th Ed., Wiley India.

**Note** : It is mandatory for B.Sc. 4th year Mathematics Students to select one paper out of 4 papers( Math 405/ 406/407/ and 408) designed by Mathematics Subject Committee.