TRIBHUVAN UNIVERSITY
INSTITUTE OF SCIENCE AND TECHNOLOGY
SCHOOL OF MATHEMATICAL SCIENCES
# Bachelor in Mathematical Sciences (BMathSc)

**Course of Study**

*Code No.*: MSCS 201 *Full Mark*: 75

*Paper*: **Introduction to Programming II** *Pass Mark*: 30

*Nature*: Theory + Lab *Credit*: 3

***Course description:***

The aim of this course is to develop the object oriented programming skills using C++ programming language. The course helps the students to discover the basic concepts of object-oriented programming concept such as object, class, inheritance, polymorphism, abstraction and encapsulation

***Course objectives:***

The main objective of this course is to provide students knowledge of different concepts C++ programming so that they will be able to develop small to medium size computer programs using object-oriented concepts of C++.

***Mode of Delivery*:**

The course will be taught by lecture (48 hrs), and lab work (24 hrs). The students are encouraged to develop computer programs related to the concepts of the C language after completion of each chapter.

***Course content*:**

**Unit 1. Introduction** **2 hrs.**

Object-Oriented Programming Paradigm; Basic Concepts of Object-Oriented Programming; Benefits of OOP; Object-Oriented Languages; Applications of OOP; What is C++?; A Simple C++ Program

**Unit 2. Tokens, Expressions and Control Structures** **6 hrs.**

Tokens; Keywords; Identifiers and Constants; Basic Data Types; User-Defined Data Types; Storage Classes; Derived Data Types; Symbolic Constants; Type Compatibility; Variable Declaration; Dynamic Initialization of Variables; Reference Variables; Operators; Scope Resolution Operator; Member Dereferencing Operators; Memory Management Operators; Manipulators; Type Cast Operator; Expressions; Operator Overloading; Control Structures

**Unit 3. Functions** **4 hrs**

Introduction; The Main Function; Function Prototype; Call by Reference; Return by Reference; Inline Function; Function Arguments; Function Overloading; Friend and Virtual Functions; Library Function

**Unit 4. Classes and Objects** **10 hrs**

Specifying a Class; Defining Member Functions; A C++ Program with Class; Making an Outside Function Inline; Nesting of Member Functions; Private Member Functions; Arrays within a Class; Memory Allocation for Objects; Static Data Members; Static

Member Functions; Arrays of Objects; Objects as Function Arguments; Friendly Functions; Returning Objects; const Member Functions

**Unit 5. Constructors and Destructors** **4 hrs.**

Constructors; Parameterized Constructors; Multiple Constructors; Default Constructors; Dynamic Initialization of Objects; Copy Constructor; Dynamic Constructors; Destructors

**Unit 6. Operator Overloading and Type Conversions** **4 hrs.**

Overloading Unary Operators; Overloading Binary Operators; Overloading Binary Operators Using Friend Functions; Type Conversions

**Unit 7. Inheritance: Extending Classes** **6 hrs.**

Defining Derived Classes; Single Inheritance; Multilevel, Multiple Inheritance and Hierarchical Inheritance; Hybrid Inheritance; Virtual Base Classes; Abstract Classes; Constructors in Derived Classes; Member Classes

**Unit 8. Pointers, Virtual Functions and Polymorphism** **4 hrs.**

Pointers; Pointers to Objects; this Pointer; Pointers to Derived Classes; Virtual Functions; Pure Virtual Functions; Virtual Constructors and Destructors

**Unit 9. Templates and Exception Handling** **4 hrs.**

Concept of Template; Function overloading and problems; Function Template; Overloading function template; Class Template; Derived class template; Concept of error handling; Basic of exception handling Exception handling mechanism: throw, catch and try

**Laboratory Work:**

After completing this course, students should have practical knowledge on different conceprs of C++ programming so that they will be able to develop a small mini project on their interested field.

**Recommended Books:**


1. Object oriented programming with C++; E Balagurusamy; 6e
2. Object-Oriented Programming in C++; Fourth Edition; Robert Lafore
3. C++ Primer; Fifth Edition; Stanley B. Lippman, Josee Lajoie, Barbara Moo

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# SCHOOL OF MATHEMATICAL SCIENCES

# Bachelor in Mathematical Sciences (B.Math.Sc.)

**Course of Study**

*Course No*.: MSMT 201 *Full Marks*: 75
*Course Title*: **Linear Algebra with Applications II** *Pass Marks*: 30
*Nature of the Course*: Theory *Credit*: 3

*Course Description*:

This course develops eigenvalues and eigenvectors and their applications, Finite Element Method, Computations with Matrices, Linear Programming and Game Theory..

*Objectives*

On completion of this module, students will be able to

- Understand the concepts and methods of linear algebra
- Solve problems using linear algebra.
- Connect linear algebra to other fields both within and without mathematics
- Use the concepts and algorithms of linear algebra in an interactive computer environment
- Use computational tools for important applications of linear algebra

*Mode of Delivery*:

The course will be taught by lecture (48 hrs), and problem solving and class discussion (24 hrs). The use of software (MATLAB) will be encouraged.

*Course Contents*:

**Unit 1 Eigenvalues and Eigenvectors** **14 hr**

Diagonalization of a Matrix, Difference Equations and Powers $A^k$, Differential Equations and $e^{At}$ , Complex Matrices, Similarity Transformations

**Unit 2 Positive Definite Matrices** **12 hr**

Minima, Maxima, and Saddle Points, Tests for Positive Definiteness, Singular Value Decomposition, Minimum Principles, The Finite Element Method

**Unit 3 Computations with Matrices** **8 hr**

Matrix Norm and Condition Number, Computation of Eigenvalues, Iterative Methods for $Ax = b$.

**Unit 4 Linear Programming and Game Theory** **14 hr**

Linear Inequalities, The Simplex Method, The Dual Problem, Network Models, Game Theory.

*Textbooks*

1. Gilbert Strang, *Introduction to Linear Algebra*, 4th Edition, Wellesley- Cambridge Press.

*Reference Books*


1. David C. Lay, *Linear Algebra and its applications*,Pearson Education, 2012,
2. Howard Anton, Chris Rorres, *Elementary Linear Algebra*: *Applications Version*, Wiley, 2014.

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## Course of Study

*Code No*.: MSMT 202 *Full Mark*: 75
*Paper*: **Differential Equations** *Pass Mark*: 30
*Nature*: Theory *Credit*: 3

*Course Description*:

This course is designed for third semester of B.Math.Sc. program. The main aim of this course is to provide knowledge of Differential Equations.

*Objectives*

The objective of this course is to acquaint students with the basic concepts of differential equation like first order linear and nonlinear differential equations, second order differential equations and higher order linear equations as well as partial differential equation. It aims at enabling students to build good knowledgebase in the subject of ordinary differential equations and partial differential equation.

*Mode of Delivery*:

The course will be taught by lecture (48 hrs), and problem solving and class discussion (24 hrs). The use of computers/laptops for problem solving will be encouraged as far as possible..

*Contents*:

**Unit 1 Applications of integration** 8 hr

Definition and classification of differential equations, Solutions of differential equations, Some mathematical models and direction fields.

**Unit 2 First Order Linear and Nonlinear Differential Equations** 10 hr

Integrating factors, Separable equations, Modeling with first order equations, Difference between the linear and nonlinear equations, Autonomous equations and population dynamics, Exact equations and integrating factors, Numerical approximations, Euler's method, Existence and uniqueness theorem, First order difference equations.

**Unit 3 Second Order Linear Equations** 10 hr

Homogeneous equations with constant coefficients, Solutions of linear homogeneous equation, The Wronskian, Complex roots of the characteristic equation, Repeated roots, Reduction of order, Nonhomogeneous equations, Method of undetermined coefficients, Variation of parameters, Mechanical and electric vibrations, Forced vibrations.

**Unit 4 Higher Order Linear Equations** 10 hr

General theory of nth order linear equations, Homogeneous equations with constant coefficients, Method of undetermined coefficients, Method of variation of parameters.

**Unit 5 System of First Order Linear Equations** 10 hr

Introduction, Review of matrices, Linear algebraic equations; Linear independence, Eigenvalues, Eigenvectors, Basic theory of first order linear equations.

*Text Book*:

1. Boyce, W. and DiPrima, R.; *Elementary Differential Equations and Boundary Value Problems*, 9th Ed., Wiley India.

*Reference Books*:

1. James C. Robinson; *An Introduction to Ordinary Differential Equations*, Cambridge University Press
2. Differential Equations, Third Edition, Shepley L. Rose, James Wieley India, 2010.

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### Course of Study

*Code No*.: MSMT 203 *Full Mark*: 75
*Paper*: General Logic *Pass Mark*: 30
*Nature*: Theory and Lab Work *Credit*: 3

***Course description:***

Logic is concerned with good reasoning; as such, it stands at the core of the science. This course will discuss the forms and functions of language, theories of deductive logic, and inductive methods. The course will emphasize on the skills of understanding complex materials by analyzing their logical structures, and the skills of constructing clear and convincing arguments by following the basic logical principles. A computer program will be used in the course to help students to grasp the skills of logical analysis.

***Course objectives:***

Students will

- Acquire knowledge of the principles of correct reasoning
- Gain practice in exploring the questions, methods and approaches of the discipline of logic,
- Acquire the abilities to recognize, analyze, and criticize arguments in the contexts of reading, writing, thinking, and discussion.
- Acquire skill in emphasize balanced argument and critical thought.

***Mode of Delivery*:**

The course will be taught by lecture (48 hrs), and problem solving and class discussion (24 hrs). The use of computer lab for problem solving will be encouraged.

***Course content*:**

**Unit 1 Language** 9 hrs

Introduction, Arguments, Definition, Fallacies.
**Computer Lab** *LogicCoach*: Analyzing arguments, Definitions.

**Unit 2 Categorical Logic** 10 hrs

Categorical Statements, Venn Diagram, Translating Ordinary Language, Categorical Syllogisms, Arguments in Ordinary Language, Incomplete and Chain Arguments.
**Computer Lab** *LogicCoach*: Venn diagrams, Translating categorical statements.

**Unit 3 Propositional Logic** 10 hrs

The Connectives in Propositional Logic, Truth Tables, Indirect Truth Tables, Truth Trees.
**Computer Lab** *LogicCoach*: Propositional logic, Truth tables.

**Unit 4 Natural Deduction** 10 hrs

The Rules of Inference, The Rules of Replacement, Strategies, Conditional Proofs, Indirect Proofs.
**Computer Lab** *LogicCoach*: Inference rules, Replacement rules, Conditional proofs.

**Unit 5 Induction and Other Applications** 9 hrs

Inductive generalization, Hypothetical reasoning.

**Textbook:**

Patrick J. Hurley, *A Concise Introduction to Logic*, 12th Edition. Wadsworth Publishing Company, 2015.

**Software**: *LogicCoach 11.0*, Cengage Learning, Inc. http://en.freedownloadmanager.org/Windows-PC/LogicCoach-FREE.html

**Reference books**:


1. Irving M. Copi, and Carl Cohen and Kenneth McMahon, *Introduction to logic*. 14th ed. Pearson International edition, 2014.
2. Harry J. Gensler, *Introduction to logic*, Routledge, New York, 2010.

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# Bachelor in Mathematical Sciences (B.Math.Sc.)

**Course of Study**

*Code No*.: MSST 201 *Full Mark*: 75
*Paper*: **Theory of Probability** *Pass Mark*: 30
*Nature*: Theory *Credit*: 3

*Course Description*:

This course begins with Applications of integration, Techniques of integration, Parametric Equations and Polar Coordinates, and is followed by a comprehensive treatment of Infinite sequence and series.

*Learning Objectives*:

The main objective of the course is to impart knowledge to students regarding basic probability theories with applications and probability distributions.

*Mode of Delivery*:

The course will be taught by lecture (48 hrs), and problem solving and class discussion (24 hrs). The use of spreadsheet software for problem solving will be encouraged.

*Contents*:

**Unit 1 Random Variables** **5 hr**

Concept of a random variable, types of random variables: Discrete and continuous random variables; Probability distribution of a random variable: probability mass function and probability density function, distribution function and its properties; Functions of random vriables, examples of linear and nonlinear transformations.

**Unit 2 Mathematical Expectation** **10 hr**

Mathematical expectation of a random variable (discrete and continuous) and its function, properties of mathematical expectation of random variables, addition and multiplicative theorems of expectation, covariance and correlation, conditional expectation, conditional variance, variance of a linear combination of random variables; Moments of random variables: Raw and central moments, Generating functions: Moment generating function, probability generating function, cumulant generating function and characteristic function with their properties.

**Unit 3 Probability Distributions** **18 hr**

Discrete distributions: Bernoulli trial, binomial, Poisson, negative binomial, and hyper-geometric distributions; their mass functions, distribution functions, moment generating functions, characteristic functions, moments, properties.

Continuous distributions: normal, uniform and exponential distributions: their probability density functions, distribution functions, moment generating and characteristic functions, properties and uses, normal distribution as an approximation of binomial and Poisson distributions, standard normal distribution.

**Unit 4 Generalized Linear Models** **10 hr**

Exponential family of distribution, Conversion of various distribution (Binomial,poission exponential, gamma, normal) into exponential family, mean and variance for an exponential Family, variance function and scale parameters, link and canonical function, Variable and factor taking categorical values, linear predictor, Deviance and scaled deviance, parameters of GLM and its estimation, pearson and deviance residuals, determination of the acceptability of a fitted model,( Pearson's chi-square test and likelihood ration test .

**Unit 5 Convergence and Limit Theorems** **5 hr**

Concepts and modes of convergence: convergence in probability, convergence in rth mean, convergence in distribution and convergence almost sure, Chebyshev inequality, law of large numbers and central limit theorem and its applications.

*Reference Books*:


1. Shrestha H. B. (2006) *Statistics and Probability: Concepts and Techniques*, Second Edition, EKTA Books
2. Gupta S. C. and Kapoor V. K. (2007) *Fundamentals of Mathematical Statistics*, Sultan Chand and Sons.
3. Rohatgi V. K. and Ehsanes Saleh, A. K. MD (2005) An Introduction to Probability and Statistics, John Wiley & Sons
4. HWEI P. HSU (2004) *Schaum's Outline of Theory and Problems of Probability, Random Variables, & Random Processes, ,* Tata Mc-Graw Hill Edition