SEMESTER I

DEPARTMENT OF MATHEMATICS

B.A/ B.Sc. (Prog.) with Mathematics as Non-Major

Category III

DISCIPLINE SPECIFIC CORE COURSE: TOPICS IN CALCULUS

Learning Objectives

The primary objective of this course is to:

- Introduce the basic tools of calculus which are helpful in understanding their applications in many real-world problems.
- Understand/create various mathematical models in everyday life.

Learning outcomes

This course will enable the students to:

- Understand continuity and differentiability in terms of limits and graphs of certain functions.
- Describe asymptotic behaviour in terms of limits involving infinity.
- Use of derivatives to explore the behaviour of a given function locating and classify its extrema and graphing the function.
- Apply the concepts of asymptotes, and inflexion points in tracing of cartesian curves.
- Compute the reduction formulae of standard transcendental functions with applications.

B.Sc. (Physical Sciences/ Mathematical Sciences) with Mathematics as one of the Core Disciplines

Category III

DISCIPLINE SPECIFIC CORE COURSE: TOPICS IN CALCULUS

Learning Objectives

The primary objective of this course is to:

- Introduce the basic tools of calculus which are helpful in understanding their applications in many real-world problems.

- Understand/create various mathematical models in everyday life.

Learning outcomes

This course will enable the students to:

- Understand continuity and differentiability in terms of limits and graphs of certain functions.

- Describe asymptotic behaviour in terms of limits involving infinity.

- Use of derivatives to explore the behaviour of a given function locating and classify its extrema and graphing the function.

- Apply the concepts of asymptotes, and inflexion points in tracing of cartesian curves.

- Compute the reduction formulae of standard transcendental functions with applications.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY DEPARTMENT OF MATHEMATICS CATEGORY-IV

GENERIC ELECTIVES: FUNDAMENTALS OF CALCULUS

Learning Objectives

The Learning Objectives of this course is as follows:

- Understand the quantitative change in the behaviour of the variables and apply them on the problems related to the environment.

Learning Outcomes

Upon completion of this course, students will be able to:

- Understand continuity and differentiability in terms of limits.

- Describe asymptotic behavior in terms of limits involving infinity.

- Understand the importance of mean value theorems and its applications.

- Learn about Maclaurin's series expansion of elementary functions.

- Use derivatives to explore the behavior of a given function, locating and classifying its extrema, and graphing the polynomial and rational functions.

GENERIC ELECTIVES: THEORY OF EQUATIONS AND SYMMETRIES

Learning Objectives

The goal of this course is to acquaint students with certain ideas about:

- Integral roots, rational roots, an upper bound on number of positive or negative roots of a polynomial.
- Finding roots of cubic and quartic equations in special cases using elementary symmetric functions.
- Using Cardon's and Descartes' methods, respectively.

Learning outcomes

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

- Understand the nature of the roots of polynomial equations and their symmetries.
- Solve cubic and quartic polynomial equations with special condition on roots and in general.
- Find symmetric functions in terms of the elementary symmetric polynomials.

DEPARTMENT OF COMPUTER SCIENCE

BSc. Physical Sciences/ Mathematical Sciences with Computer Science as one of the Core disciplines

Learning Objectives

The Learning Objectives of this course are as follows:

- Introduce programming concepts using C++ to students.
- Develop structured as well as object-oriented programming skills using C++ programming language.
- Achieve competence amongst its students to develop correct and efficient C++ programs to solve problems spanning multiple domains.

Learning outcomes

This course will enable the students to:

- Write simple programs using built-in data types of C++.
- Implement arrays and user defined functions in C++.
- Write programs using dynamic memory allocation, handling external files, interrupts and exceptions.
- Solve problems spanning multiple domains using suitable programming constructs in C++.
- Solve problems spanning multiple domains using the concepts of object oriented programming in C++.

Learning Objectives

The Learning Objectives of this course are as follows:

- Introduce programming concepts using C++ to students.
- Develop structured as well as object-oriented programming skills using C++ programming language.
- Achieve competence amongst its students to develop correct and efficient C++ programs to solve problems in their respective domains

Learning Outcomes

Upon completion of this course, students will be able to:

- Write simple programs using built-in data types of C++.
- Implement arrays and user defined functions in C++.
- Solve problems in the respective domain using suitable programming constructs in C++.
- Solve problems in the respective domain using the concepts of object oriented programming in C++.

GENERIC ELECTIVES: PROGRAMMING WITH PYTHON

Learning Objectives

The Learning Objectives of this course are as follows:

- Introduce programming concepts using Python to students.
- Develop structured as well as object-oriented programming skills using Python.

- Achieve competence amongst its students to develop correct and efficient Python programs to solve problems in their respective domains.

Learning outcomes

On successful completion of the course, students will be able to:

- Write simple programs using built-in data structures in Python.
- Implement arrays and user defined functions in Python.
- Solve problems in the respective domain using suitable programming constructs in Python.
- Solve problems in the respective domain using the concepts of object oriented programming in Python.

DEPARTMENT OF OPERATIONAL RESEARCH

BSc. Physical Sciences/ Mathematical Sciences with Operational Research as one of the Core Disciplines

Learning Objectives

The Learning Objective of the course is to introduce:

- Basic concepts of Operational Research and Linear Programming to the students.

Learning Outcomes:

After completion of the course, students will possess knowledge and skills required to:

- Gain an understanding of key concepts of Operational Research and Linear Programming and their role in various organizations.

- Describe the basic concepts of convex analysis and explain the theoretical foundations of various issues related to linear programming modelling.

- Formulate real-world problems as a linear programming model and describe the theoretical workings of the graphical and simplex method, demonstrate the solution process by hand and solver.

- Implement advanced and more economic algorithm to solve linear programming problems.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY DEPARTMENT OF OPERATIONAL RESEARCH

Learning Objectives

The Learning Objective of the course is to introduce:

- Basic concepts of Operational Research and Linear Programming to the students.

Learning Outcomes:

After completion of the course, students will possess knowledge and skills required to:

- Gain an understanding of key concepts of Operational Research and Linear Programming and their role in various organizations.

- Describe the basic concepts of convex analysis and explain the theoretical foundations of various issues related to linear programming modelling.

- Formulate real-world problems as a linear programming model and describe the theoretical workings of the graphical and simplex method, demonstrate the solution process by hand and solver.

- Implement advanced and more economic algorithm to solve linear programming problems.

SEMESTER II

DEPARTMENT OF MATHEMATICS

B.Sc. (Prog.)/ BA (Prog.) with Mathematics as Non-Major
Category-III

DISCIPLINE SPECIFIC CORE COURSE – 2 (Discipline A-2): Elementary Linear Algebra

Learning Objectives: The objective of the course is:
- To introduce the concept of vectors in R^n.
- Understand the nature of solution of system of linear equations.
- To view the $m \times n$ matrices as a linear function from R^n to R^m and vice versa.
- To introduce the concepts of linear independence and dependence, rank and linear transformations has been explained through matrices.

Learning Outcomes: This course will enable the students to:

- Visualize the space R^n in terms of vectors and the interrelation of vectors with matrices.
- Familiarize with concepts of bases, dimension and minimal spanning sets in vector spaces.
- Learn about linear transformation and its corresponding matrix.

GENERIC ELECTIVES (GE-2(i)): ANALYTIC GEOMETRY

Learning Objectives: The course aims at:
- Identifying and sketching curves, studying three dimensional objects, their geometric properties and applications.
- Use of vector approach to three-dimensional geometry makes the study simple and elegant.

Learning Outcomes: This course will enable the students to:
- Learn concepts in two-dimensional geometry.
- Identify and sketch conics namely, ellipse, parabola and hyperbola.
- Learn about three-dimensional objects such as straight lines and planes using vectors, spheres, cones and cylinders.

GENERIC ELECTIVES (GE-2(ii)): INTRODUCTION TO LINEAR ALGEBRA

Learning Objectives: The objective of the course is:
- To introduce the concept of vectors in R^n.
- Understand the nature of solution of system of linear equations.
- To view the $m \times n$ matrices as a linear function from R^n to R^m and vice versa.
- To introduce the concepts of linear independence and dependence, rank and linear transformations has been explained through matrices.

Learning Outcomes: This course will enable the students to:

- Visualize the space R^n in terms of vectors and the interrelation of vectors with matrices.
- Understand important uses of eigenvalues and eigenvectors in the diagonalization of matrices.
- Familiarize with concepts of bases, dimension and minimal spanning sets in vector spaces.
- Learn about linear transformation and its corresponding matrix.

DEPARTMENT OF OPERATIONAL RESEARCH

BSc. (Physical Sciences/ Mathematical Sciences) with Operational Research as one of the Core Disciplines

Learning Objectives

The Learning Objectives of this course are as follows:
- To enrich the knowledge of students with advanced concepts and techniques of linear programming problem along with real life applications
- To make students understand the theoretical basics of different computational algorithms used in solving linear programming and related problems.

Learning outcomes

Students completing this course will be able to:
- Explain the relationship between a linear program and its dual, including strong duality and complementary slackness, and understand the economic interpretation of duality.
- Learn an alternative method for solving linear programming problems.
- Perform sensitivity analysis to identify the direction and magnitude of change of a linear programming model's optimal solution as the input data changes.
- Formulate specialized linear programming problems, namely transportation and assignment problems and describe theoretical workings of the solution methods for transportation and assignment problems, demonstrate solution process by hand and solver.

Common Pool of Generic Electives (GE) Courses offered by Department of Operational Research

GENERIC ELECTIVES (GE-2): Production and Inventory Management

Learning Objectives

The objective of this course is to introduce fundamental concepts in production and inventory management and at the same time, develop the students' modelling and analytical skills.

Learning outcomes

After completion of the course, students will possess knowledge and skills required to
- Gain an understanding of key concepts of Production and Inventory management and its role in various organizations.

- Apply selective inventory control techniques and understand its significance.
- Determine optimal order quantity for various deterministic and probabilistic inventory models.
- Understand quantity discount models in inventory management.
- Formulate and develop Production Planning and Scheduling models.
- To apply and extend production and inventory models to analyse real world systems.

DEPARTMENT OF COMPUTER SCIENCE

BSc. (Physical Sciences/ Mathematical Sciences) with Computer Science as one of the Core Disciplines

Learning Objectives

The course aims at developing the ability to use basic data structures like arrays, stacks, queues, lists, trees to solve problems. C++ is chosen as the language to understand implementation of these data structures.

Learning outcomes

On successful completion of the course, students will be able to:

- Compare two functions for their rates of growth.
- Understand abstract specification of data-structures and their implementation.
- Compute time and space complexity of operations on a data-structure.
- Identify the appropriate data structure(s) for a given application and understand the trade-offs involved in terms of time and space complexity.
- Apply recursive techniques to solve problems.

Common Pool of Generic Electives (GE) Courses Offered by Department of Computer Sciences

Learning Objectives

This course is designed to introduce the students to real-world data analysis problems, their analysis and interpretation of results in the field of exploratory data science using Python.

Learning outcomes

On successful completion of the course, students will be able to:

- Apply descriptive statistics to obtain a deterministic view of data

- Apply basic and advanced level statistical function on data

- Perform data handling using Numpy arrays

- Do data cleaning and transformation before extracting useful information

- Visualize data for ease of understanding the revealed information

Learning Objectives

This course is designed to inculcate statistical thinking about data to the students who have studied Mathematics up to Class 10th ONLY. It gently introduces the students to basic statistics, and builds gradually to cover advanced functionalities for data analysis in spreadsheets. The objective is to enhance the knowledge of statistics and enable students to make sense of data by analyzing and visualizing it using spreadsheets, interpreting the results and gaining insights.

Learning outcomes

On successful completion of the course, students will be able to:
- Analyze and visualize data using spreadsheets
- Apply basic and advanced level statistical functions in spreadsheets
- Gain practical, hands-on experience of data analysis using spreadsheet

DEPARTMENT OF COMPUTER SCIENCE

(Computer Science Courses for Undergraduate Programme of study with Computer Science discipline as one of the three Core Disciplines)

DSE 01a PYTHON Programming for Data Handling

Learning Objectives

The course introduces students to the concept of data handling using files and GUI designing. This would equip the students with knowledge to work on real world data from various applications and GUI development for effective data handling.

Learning outcomes

On successful completion of the course, students will be able to:

· Learn constructs of Python language

· Perform data handling with files using Python.

· Design and implement GUI applications using Tkinter.

Android Programming using Java

Learning Objective

The course enables the students to understand Android architecture and its key features, making them competent to develop Android applications using Java.

Learning outcomes

On successful completion of the course, students will be able to:

- logically organize Java classes and interfaces using packages.
- understand the design of the Android operating system.
- design user interfaces using various dialog boxes, menus, etc.
- design Android applications with interaction among various activities/applications.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES

GENERIC ELECTIVES : Database Management Systems

Learning Objectives

The course introduces the students to the fundamentals of database management systems and their applications. Emphasis is given to the popular relational database system. Students will learn about the importance of database structure and its design using entity relationship diagrams and a formal approach using normalization. Basic concepts of file indexing and transaction processing will be taught. The course would give students hands-on practice with structured query language to create, manipulate, and implement a relational database.

Learning outcomes

On successful completion of the course, students will be able to:

- Use relational database management software to create and manipulate the database.

- Create conceptual data models using entity relationship diagrams for modeling real-life situations and map it to corresponding relational database schema.

- Use the concept of functional dependencies to remove redundancy and update anomalies.

- Apply normalization theory to get a normalized database scheme to get anomalies free databases.

- Write queries in relational algebra.

- Implement relational databases and formulate queries for data retrieval and data update problems using SQL.

- Learn the importance of index structures and concurrent execution of transactions in database systems.

GENERIC ELECTIVES : Java Programming

Learning Objectives

This course is designed to develop understanding of object-oriented programming concepts like Classes, Objects, Inheritance and Polymorphism using Java. The course provides understanding of multithreading and exception handling in Java. It also introduces how to create Java applications with graphical user interface (GUI).

Learning outcomes

On completion of this course, the student will be able to:

- Understand the object-oriented concepts – Classes, Objects, Inheritance, Polymorphism– for problem solving.

- Create and handle multithreading.

- Handle program exceptions.

- Handle input/output through files.

- Create Java applications with a graphical user interface (GUI).

DISCIPLINE SPECIFIC CORE COURSE (DSC-3): Computer System Architecture

Learning Objectives

This course introduces students to the fundamental concepts of digital computer organization, design, and architecture. It aims to develop a basic understanding of the building blocks of a computer system and highlights how these blocks are organized together to architect a digital computer system.

Learning outcomes

On successful completion of the course, students will be able to:

- Design combinatorial circuits using basic building blocks. Simplify these circuits using Boolean algebra and Karnaugh maps. Differentiate between combinational circuits and sequential circuits.
- Represent data in binary form, convert numeric data between different number systems, and perform arithmetic operations in binary.
- Determine various stages of the instruction cycle and describe interrupts and their handling.
- Explain how the CPU communicates with memory and I/O devices.
- Simulate the design of a basic computer using a software tool.

DEPARTMENT OF OPERATIONAL RESEARCH

BSc. Physical Sciences/ Mathematical Sciences with Operational Research as one of the three Core Disciplines

Learning Objectives

To acquaint students with different mathematical modelling techniques applicable in various businesses viz., inventory control, marketing management, and network flow analysis.

Learning outcomes
On successful completion of the course, students will be able to:
- Explain the meaning of Inventory control, its various forms, and the functional role of Inventory.
- Calculate the Economic Order Quantity (EOQ) for various Deterministic Inventory models.
- Comprehend inventory models with All Units Quantity Discounts
- Gain an understanding of the basic concepts and issues in marketing and their application in business decisions.
- Gain an understanding of network analysis and related mathematical models.
- Use standard methodologies for solving network flow problems.

DISCIPLINE SPECIFIC ELECTIVE (DSE): SIMULATION MODELLING & APPLICATIONS

Learning Objectives

The Learning Objectives of this course are as follows:

- To acquaint students with the fundamentals of Simulation modelling
- Develop the students' analytical skills
- Introduce simulation techniques applicable in different situations

Learning outcomes

On successful completion of the course, students will be able to:

- Know the basics of simulation modelling and its scope.
- Gain knowledge of Event Type Simulation and its applications in real life.
- Understand the various methods of random number generation.
- Understand and use Monte Carlo Simulation.
- Apply Simulation Technique in Inventory Control, Queuing Systems.
- Use Simulation in Finance and Investment, Maintenance Problems and Networks.

DISCIPLINE SPECIFIC ELECTIVE (DSE):
PRODUCTION AND OPERATIONS MANAGEMENT

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students understand the strategic significance of Production and Operations Management in service and manufacturing organizations.
- To acquaint them with fundamental concepts, functions and applications of discipline, so as to deal with different types of problems faced by operations managers, and common decision-making approaches.

Learning Outcomes

On successful completion of the course, students will be able to:

- Gain an understanding of basic concepts of Production and Operations management and differentiate between them.
- Analyse the factors affecting Facility Capacity, Location, and Layout.
- Understand the Production planning and Material Requirement Planning techniques.
- Comprehend basic concepts in Just in time (JIT) Manufacturing System, Operations scheduling and Quality management.

DISCIPLINE SPECIFIC ELECTIVE : BUSINESS FORECASTING

Learning Objectives

The objective of this course is to introduce both managerial and technical aspects of business forecasting to students and expose them to its practical applications.
The Learning Objectives of this course are as follows:

- To introduce both managerial aspect of business forecasting
- Develop the students' ability to understand the technical aspect for business forecasting and its applications
- Introduce various forecasting techniques helpful for better decision making

Learning outcomes
On successful completion of the course, students will be able to:
- Gain an understanding of key concepts of Business Forecasting and its applications.
- Develop analytical methodologies that make prediction of future events of interest to business and industry.
- Make well-informed decisions that require forecasting of relevant variables.
- Identify relevant information to support model selection in scenarios where issues of time
- Predict relationships among business and economic variables for supporting short-term and long-term planning.

GENERIC ELECTIVES (GE): QUEUING AND RELIABILITY THEORY

Learning Objectives

The Learning Objectives of this course are as follows:

- To make students understand the basic idea of random variables and their associated probability distributions as it is a prerequisite.
- To enrich students with the concept of stochastic processes and its applications in the field of queuing theory.
- To make students learn the mathematical theory of queuing systems.
- To introduce students with the concept of system reliability and make them learn to evaluate reliability of various system configurations.
- To provide students hands-on experience of the queuing and reliability models through practical sessions using certain software.

Learning outcomes

On successful completion of the course, students will be able to:

- Understand the concepts and mathematical theory related to queuing systems & system reliability required to understand, analyse and solve any real-world problem.

- Learn the concepts of stochastic processes, Markov processes, Markov chains and apply these mathematical models in real-life problems.
- Evaluate the performance metrics of any queuing system.
- Compute the system reliability of any type of system-configuration.
- Make use of software for problem analysis.

DEPARTMENT OF MATHEMATICS

B.Sc. (Physical Sciences/Mathematical Sciences) with Mathematics as one of the Core Discipline

> ### DISCIPLINE SPECIFIC CORE COURSE – A-3:
> ### DIFFERENTIAL EQUATIONS

Learning Objectives

The primary objective of this course is to introduce:

- Ordinary and partial differential equations.
- Basic theory of higher order linear differential equations, Wronskian and its properties.
- Various techniques to find the solutions of above differential equations which provide a basis to model complex real-world situations.

Learning Outcomes

This course will enable the students to:

- Solve the exact, linear, Bernoulli equations, find orthogonal trajectories and solve rate problems.
- Apply the method of undetermined coefficients and variation of parameters to solve linear differential equations.
- Solve Cauchy-Euler equations and System of linear differential equations.
- Formulate and solve various types of first and second order partial differential equations.

DISCIPLINE SPECIFIC ELECTIVE -1(i): COMBINATORICS

Learning Objectives

The primary objective of this course is to:
- Introduce various techniques of permutations, combinations and inclusion-exclusion.
- Learn basic models of generating functions and recurrence relations in their application to the theory of integer partitions.

Learning Outcomes

After completing the course, student will:
- Enhance the mathematical logical skills by learning different enumeration techniques.
- Be able to apply these techniques in solving problems in other areas of mathematics.
- Be trained to provide reasoning and arguments to justify conclusions.

DISCIPLINE SPECIFIC ELECTIVE COURSE-1(ii): ELEMENTS OF NUMBER THEORY

Learning Objectives

The primary objective of this course is to introduce:

- The Euclidean algorithm and linear Diophantine equations, the Fundamental theorem of arithmetic and some of the open problems of number theory viz. the Goldbach conjecture.
- The modular arithmetic, linear congruence equations, system of linear congruence equations, arithmetic functions and multiplicative functions, e.g., Euler's Phi-function.
- Introduction of the simple encryption and decryption techniques, and the numbers of specific forms viz. Mersenne numbers, Fermat numbers etc.

Learning Outcomes

This course will enable the students to:

- Get familiar with the basic number-theoretic techniques.
- Comprehend some of the open problems in number theory.
- Learn the properties and use of number-theoretic functions and special types of numbers.
- Acquire knowledge about public-key cryptosystems, particularly RSA.

DISCIPLINE SPECIFIC ELECTIVE COURSE - DSE-1(iii): THEORY OF EQUATIONS AND SYMMETRIES

Learning Objectives
The goal of this paper is to acquaint students with certain ideas about:
- Integral roots, rational roots, an upper bound on number of positive or negative roots of a polynomial.
- Finding roots of cubic and quartic equations in special cases using elementary symmetric functions.
- Using Cardon's and Descartes' methods, respectively.

Learning Outcomes
After completion of this paper, the students will be able to:
- Understand the nature of the roots of polynomial equations and their symmetries.
- Solve cubic and quartic polynomial equations with special condition on roots and in general.
- Find symmetric functions in terms of the elementary symmetric polynomials.

COMMON POOL OF GENERIC ELECTIVES (GE) COURSES OFFERED BY DEPARTMENT OF MATHEMATICS

Learning Objectives

The primary objective of this course is to introduce:

- Ordinary and partial differential equations.
- Basic theory of higher order linear differential equations, Wronskian and its properties.
- Various techniques to find the solutions of above differential equations which provide a basis to model complex real-world situations.

Learning Outcomes

This course will enable the students to:

- Solve the exact, linear, Bernoulli equations, find orthogonal trajectories and solve rate problems.
- Apply the method of undetermined coefficients and variation of parameters to solve linear differential equations.
- Solve Cauchy-Euler equations and System of linear differential equations.
- Formulate and solve various types of first and second order partial differential equations.

GENERIC ELECTIVES-GE-3(ii): LATTICES AND NUMBER THEORY

Learning Objectives
The primary objective of this course is to introduce:
- The concepts of ordered sets, lattices, sublattices and homomorphisms between lattices.
- Distributive lattices along with Boolean algebra and their applications in the real-world.
- Divisibility theory of congruences along with some applications.
- The number-theoretic functions and quadratic reciprocity law.

Learning Outcomes
This course will enable the students to:
- Understand the notion of ordered sets. Learn about lattices, distributive lattices, sublattices and homomorphisms between lattices.
- Become familiar with Boolean algebra, Boolean polynomials, switching circuits and their applications.
- Learn the concept of Karnaugh diagrams and Quinn–McCluskey method which gives an aid to apply truth tables in real-world problems.

- Learn about some fascinating properties of prime numbers, and some of the open problems in number theory, viz., Goldbach conjecture etc.
- Know about modular arithmetic and number-theoretic functions like Euler's Phi-function.
- Find quadratic residues and nonresidues modulo primes using Gauss's Quadratic Reciprocity Law.