Department of Mathematics
First Year Syllabus
B. Sc(Hons.) Mathematics
B.Sc(Physical Science)
B. A.(Programme)

2022-23

CNC-II/093/1(22)/2022-23/216
Dated: 10.10.2022

N O T I F I C A T I O N

Sub: Amendment to Ordinance V

[E.C Resolution No. 18-1/ (18-1-4) dated 18.08.2022]

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

Syllabi of Semester-I of the following departments under Faculty of Mathematical Sciences based on Under Graduate Curriculum Framework -2022 to be implemented from the Academic Year 2022-23.

FACULTY OF MATHEMATICAL SCIENCES

DEPARTMENT OF MATHEMATICS

B.SC. (H) MATHEMATICS

Category-I

DISCIPLINE SPECIFIC CORE COURSE – 1: ALGEBRA

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Algebra	4	3	1	0	Class XII pass with Mathematics	Nil

Learning Objectives

The primary objective of this course is to introduce:

- The basic tools of theory of equations, number theory, and group theory.
- Symmetry group of a plane figure, basic concepts of cyclic groups.
- Classification of subgroups of cyclic groups.

Learning Outcomes:

This course will enable the students to:

- Determine number of positive/negative real roots of a real polynomial.

- Solve cubic and quartic polynomial equations with special condition on roots and in general.
- Employ De-Moivre's theorem in a number of applications to solve numerical problems.
- Use modular arithmetic and basic properties of congruences.
- Recognize the algebraic structure, namely groups, and classify subgroups of cyclic groups.

SYLLABUS OF DSC-1

Theory

Unit – 1 (24 hours)
Theory of Equations and Complex Numbers
General properties of polynomials and equations, Fundamental theorem of algebra, Relations between the roots and the coefficients, Upper bounds for the real roots; Theorems on imaginary, integral and rational roots; Newton's method for integral roots, Descartes' rule of signs; De-Moivre's theorem for integer and rational indices and their applications, The nth roots of unity, Cardan's solution of the cubic, Descartes' solution of the quartic equation.

Unit – 2 (16 hours)
Basic Number Theory
Division algorithm in $\mathbb{Z}$, Divisibility and the Euclidean algorithm, Fundamental theorem of arithmetic, Modular arithmetic and basic properties of congruences.

Unit – 3 (20 hours)
Basics of Group Theory
Groups, Basic properties, Symmetries of a square, Dihedral group, Order of a group, Order of an element, Subgroups, Center of a group, Centralizer of an element, Cyclic groups and properties, Generators of a cyclic group, Classification of subgroups of cyclic groups.

Practical component (if any) - NIL

Essential Readings
1. Andreescu, Titu & Andrica, D. (2014). Complex numbers from A to...Z. (2nd ed.). Birkhäuser.
2. Dickson, Leonard Eugene (2009). First Course in the Theory of Equations. John Wiley & Sons, Inc. The Project Gutenberg eBook: http://www.gutenberg.org/ebooks/29785
3. Gallian, Joseph. A. (2017). Contemporary Abstract Algebra (9th ed.). Cengage Learning India Private Limited, Delhi. Indian Reprint 2021.
4. Goodaire, Edgar G., & Parmenter, Michael M. (2006). Discrete Mathematics with Graph Theory (3rd ed.). Pearson Education Pvt. Ltd. Indian Reprint 2018.

Suggestive Readings
- Burnside, W.S., & Panton, A.W. (1979), The Theory of Equations, Vol. 1. Eleventh

Edition, (Fourth Indian Reprint. S. Chand & Co. New Delhi), Dover Publications, Inc.

- Burton, David M. (2011). Elementary Number Theory (7th ed.). McGraw-Hill Education Pvt. Ltd. Indian Reprint.
- Rotman, Joseph J. (1995). An Introduction to The Theory of Groups (4th ed.). Springer-Verlag, New York.

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

DISCIPLINE SPECIFIC CORE COURSE – 2:
ELEMENTARY REAL ANALYSIS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Elementary Real Analysis	4	3	1	0	Class XII pass with Mathematics	NIL

Learning Objectives
The course will develop a deep and rigorous understanding of:
- Real line $\mathbb{R}$ with algebraic.
- Order and completeness properties to prove the results about convergence and divergence of sequences and series of real numbers.

Learning Outcomes
This course will enable the students to:
- Understand the fundamental properties of the real numbers, including completeness and Archimedean, and density property of rational numbers in $\mathbb{R}$.
- Learn to define sequences in terms of functions from $\mathbb{N}$ to a subset of $\mathbb{R}$ and find the limit.
- Recognize bounded, convergent, divergent, Cauchy and monotonic sequences and to calculate the limit superior and limit inferior of a bounded sequence.
- Apply limit comparison, ratio, root, and alternating series tests for convergence and absolute convergence of infinite series of real numbers.

SYLLABUS OF DSC - 2

Theory
Unit – 1   **(16 hours)**

Real Number System

Algebraic and order properties of ℝ, Absolute value of a real number, Bounded above and bounded below sets, Supremum and infimum of a non-empty subset of ℝ, The completeness property of ℝ, Archimedean property, Density of rational numbers in ℝ.

Unit – 2 (24 hours)
Sequences

Sequences and their limits, Convergent sequence, Limit theorems, Monotone sequences, Monotone convergence theorem, Subsequences, Bolzano-Weierstrass theorem for sequences, Limit superior and limit inferior for bounded sequence, Cauchy sequence, Cauchy's convergence criterion.

Unit – 3 (20 hours)
Infinite Series

Convergence and divergence of infinite series of real numbers, Necessary condition for convergence, Cauchy criterion for convergence, Tests for convergence of positive term series, Integral test, Basic comparison test, Limit comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test, Alternating series, Leibniz test, Absolute and conditional convergence.

Practical component (if any) – NIL

Essential Readings
1. Bartle, Robert G., & Sherbert, Donald R. (2011). Introduction to Real Analysis (4th ed.). John Wiley & Sons. Wiley India Edition 2015.
2. Bilodeau, Gerald G., Thie, Paul R., & Keough, G. E. (2010). An Introduction to Analysis (2nd ed.). Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.
3. Denlinger, Charles G. (2011). Elements of Real Analysis. Jones and Bartlett India Pvt. Ltd. Student Edition. Reprinted 2015.

Suggestive Readings
- Aliprantis C. D., & Burkinshaw, O. (1998). Principles of Real Analysis (3rd ed.). Academic Press.
- Ross, Kenneth A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.
- Thomson, B. S., Bruckner, A. M., & Bruckner, J. B. (2001). Elementary Real Analysis. Prentice Hall.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Probability and Statistics	4	3	0	1	Class XII pass with Mathematics	NIL

Learning Objectives

The Learning Objectives of this course are as follows:

- To make the students familiar with the basic statistical concepts and tools which are needed to study situations involving uncertainty or randomness.
- To render the students to several examples and exercises that blend their everyday experiences with their scientific interests to form the basis of data science.

Learning Outcomes

This course will enable the students to:

- Understand some basic concepts and terminology - population, sample, descriptive and inferential statistics including stem-and-leaf plots, dotplots, histograms and boxplots.
- Learn about probability density functions and various univariate distributions such as binomial, hypergeometric, negative binomial, Poisson, normal, exponential and lognormal.
- Understand the remarkable fact that the empirical frequencies of so many natural populati ons, exhibit bell-shaped (i.e., normal) curves, using the Central Limit Theorem.
- Measure the scale of association between two variables, and to establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression.

SYLLABUS OF DSC – 3

Theory

Unit – 1   **(15 hours)**
Descriptive Statistics, Probability, and Discrete Probability Distributions
Descriptive statistics: Populations, Samples, Stem-and-leaf displays, Dotplots, Histograms, Qualitative data, Measures of location, Measures of variability, Boxplots; Sample spaces and events, Probability axioms and properties, Conditional probability, Bayes' theorem and independent events; Discrete random variables and probability

distributions, Expected values; Probability distributions: Binomial, geometric, hypergeometric, negative binomial, Poisson, and Poisson distribution as a limit.

Unit – 2 (15 hours)
Continuous Probability Distributions
Continuous random variables, Probability density functions, Uniform distribution, Cumulative distribution functions and expected values, The normal, exponential and lognormal distributions.

Unit – 3 (15 hours)
Central Limit Theorem and Regression Analysis
Sampling distribution and standard error of the sample mean, Central Limit Theorem and applications; Scatterplot of bivariate data, Regression line using principle of least squares, Estimation using the regression lines; Sample correlation coefficient and properties.

Practical (30 hours)

Software labs using Microsoft Excel or any other spreadsheet.

1) Presentation and analysis of data (univariate and bivariate) by frequeny tables, descriptive statistics, stem-and-leaf plots, dotplots, histograms, boxplots, comparative boxplots, and probability plots ([1] Section 4.6).

2) Fitting of binomial, Poisson and normal distributions.

3) Illustrating the Central Limit Theorem through Excel.

4) Fitting of regression line using the principle of least squares.

5) Computation of sample correlation coefficient.

Essential Reading
1. Devore, Jay L. (2016). Probability and Statistics for Engineering and the Sciences (9th ed.). Cengage Learning India Private Limited. Delhi. Indian Reprint 2020.

Suggestive Reading
- Mood, A. M., Graybill, F. A., & Boes, D. C. (1974). Introduction to the Theory of Statistics (3rd ed.). Tata McGraw-Hill Pub. Co. Ltd. Reprinted 2017.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

B.A. (Prog.) with Mathematics as Major

Category II

> ### DISCIPLINE SPECIFIC CORE COURSE – 1: ELEMENTS OF DISCRETE MATHEMATICS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	**Tutorial**	**Practical/ Practice**		
Elements of Discrete Mathematics	4	3	1	0	Class XII pass with Mathematics	Nil

Learning Objectives

Students are introducing to:

- Order (or partial order) and related properties.
- Notion of a lattice which is also a step towards abstract algebra.
- Concept of Boolean algebra and its applications to minimizing a Boolean polynomial and switching circuits, which has further applications in computer science.

Learning outcomes

This course will enable the students to:

- Understand the basic concepts of sets, relations, functions, and induction.
- Understand mathematical logic and logical operations to various fields.
- Understand the notion of order and maps between partially ordered sets.
- Minimize a Boolean polynomial and apply Boolean algebra techniques to decode switching circuits.

SYLLABUS OF DSC - 1

Theory

Unit – 1 (24 hours)

Sets, Relations and Functions

Sets, Propositions and logical operations, Conditional statements, Mathematical induction, Relations and equivalence relation, Equivalence classes, Partial order relation, Partially ordered set, Hasse diagrams, Chain, Maximal and minimal elements, least and greatest elements, Least upper bound, Greatest lower bound, Zorn's lemma, Functions and bijective functions, Functions between POSETS, Order isomorphism.

Unit – 2 (16 hours)

Lattices

Lattice as a POSET, Lattice as an algebra and their equivalence, Bounded lattices, Sublattices, Interval in a lattice, Products and homomorphism of lattices, Isomorphism of lattices; Distributive, Complemented, Partition and pentagonal lattices.

Unit – 3   **(20 hours)**
Boolean Algebra and Switching Circuits

Boolean algebra, De Morgan's laws, Boolean expressions, Truth tables, Logic diagrams, Boolean functions, Disjunctive normal forms (as join of meets), Minimal forms of Boolean polynomials, Quine Mc-Cluskey method, Karnaugh maps, Switching circuits, Applications of switching circuits.

Practical component (if any) – NIL

Essential Readings

- Rudolf Lidl, & Gunter Pilz (2004). Applied Abstract Algebra (2nd ed.). Undergraduate text in Mathematics, Springer (SIE), Indian Reprint.
- Bernard Kolman, Robert C. Busby, & Sharon Cutler Ross (2009). Discrete Mathematical Structures (6th ed.). Pearson education Inc., Indian reprint.

Suggestive Reading

- Rosen, Kenneth H. (2017). Discrete Mathematics and its applications with combinatorics and Graph Theory (7th ed.). McGraw Hill Education.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 2: TOPICS IN CALCULUS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Topics in Calculus	4	3	1	0	Class XII pass with Mathematics	Nil

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.

SYLLABUS OF DSC - 2
Theory

Unit – 1 (20 hours)
Limits, Continuity and Differentiability

Limit of a function, $\varepsilon - \delta$ definition of a limit, Infinite limits, Continuity and types of discontinuities; Differentiability of a function, Successive differentiation: Calculation of the nth derivatives, Leibnitz theorem; Partial differentiation, Euler's theorem on homogeneous functions.

Unit – 2 (20 hours)
Mean Value Theorems and its Applications

Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities; Taylor's theorem, Taylor's series, Maclaurin's series expansions of e^x, $\sin x$, $\cos x$, $\log(1+x)$ and $(1+x)^m$; Indeterminate forms.

Unit – 3 (20 hours)
Tracing of Curves and Reduction Formulae

Asymptotes (parallel to axes and oblique), Concavity and inflexion points, Singular points, Tangents at the origin and nature of singular points, Curve tracing (cartesian and polar equations). Reduction formulae for $\int \sin^n x \, dx, \int \cos^n x \, dx,$ and $\int \sin^m x \cos^n x \, dx$ and their applications.

Practical component (if any) – NIL

Essential Readings
- Prasad, Gorakh (2016). Differential Calculus (19th ed.). Pothishala Pvt. Ltd. Allahabad.
- Prasad, Gorakh (2015). Integral Calculus. Pothishala Pvt. Ltd. Allahabad.

Suggestive Readings
- Apostol, T. M. (2007). Calculus: One-Variable Calculus with An Introduction to Linear Algebra (2nd ed.). Vol. 1. Wiley India Pvt. Ltd.
- Ross, Kenneth. A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE: TOPICS IN CALCULUS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Topics in Calculus	4	3	1	0	Class XII pass with Mathematics	Nil

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.

SYLLABUS OF DSC

Theory

Unit – 1   **(20 hours)**
Limits, Continuity and Differentiability
Limit of a function, $\varepsilon - \delta$ definition of a limit, Infinite limits, Continuity and types of discontinuities; Differentiability of a function, Successive differentiation: Calculation of the nth derivatives, Leibnitz theorem; Partial differentiation, Euler's theorem on homogeneous functions.

Unit – 2   **(20 hours)**

Mean Value Theorems and its Applications

Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities; Taylor's theorem, Taylor's series, Maclaurin's series expansions of e^x, $\sin x$, $\cos x$, $\log(1+x)$ and $(1+x)^m$; Indeterminate forms.

Unit – 3 $\hfill$ **(20 hours)**

Tracing of Curves and Reduction Formulae

Asymptotes (parallel to axes and oblique), Concavity and inflexion points, Singular points, Tangents at the origin and nature of singular points, Curve tracing (cartesian and polar equations). Reduction formulae for $\int \sin^n x \, dx, \int \cos^n x \, dx,$ and $\int \sin^m x \cos^n x \, dx$ and their applications.

Practical component (if any) – NIL

Essential Readings

- Prasad, Gorakh (2016). Differential Calculus (19th ed.). Pothishala Pvt. Ltd. Allahabad.
- Prasad, Gorakh (2015). Integral Calculus. Pothishala Pvt. Ltd. Allahabad.

Suggestive Readings

- Apostol, T. M. (2007). Calculus: One-Variable Calculus with An Introduction to Linear Algebra (2nd ed.). Vol. 1. Wiley India Pvt. Ltd.
- Ross, Kenneth. A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

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

Category III

DISCIPLINE SPECIFIC CORE COURSE: TOPICS IN CALCULUS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Topics in Calculus	4	3	1	0	Class XII pass with Mathematics	Nil

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.

SYLLABUS OF DSC

Theory

Unit – 1   **(20 hours)**
Limits, Continuity and Differentiability
Limit of a function, $\varepsilon - \delta$ definition of a limit, Infinite limits, Continuity and types of discontinuities; Differentiability of a function, Successive differentiation: Calculation of the nth derivatives, Leibnitz theorem; Partial differentiation, Euler's theorem on homogeneous functions.

Unit – 2 **(20 hours)**

Mean Value Theorems and its Applications

Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities; Taylor's theorem, Taylor's series, Maclaurin's series expansions of

e^x, $\sin x$, $\cos x$, $\log(1+x)$ and $(1+x)^m$; Indeterminate forms.

Unit – 3 **(20 hours)**

Tracing of Curves and Reduction Formulae

Asymptotes (parallel to axes and oblique), Concavity and inflexion points, Singular points, Tangents at the origin and nature of singular points, Curve tracing (cartesian and polar equations). Reduction formulae for $\int \sin^n x\, dx, \int \cos^n x\, dx,$ and $\int \sin^m x \cos^n x\, dx$ and their applications.

Practical component (if any) – NIL

Essential Readings
- Prasad, Gorakh (2016). Differential Calculus (19th ed.). Pothishala Pvt. Ltd. Allahabad.
- Prasad, Gorakh (2015). Integral Calculus. Pothishala Pvt. Ltd. Allahabad.

Suggestive Readings
- Apostol, T. M. (2007). Calculus: One-Variable Calculus with An Introduction to Linear Algebra (2nd ed.). Vol. 1. Wiley India Pvt. Ltd.
- Ross, Kenneth. A. (2013). Elementary Analysis: The Theory of Calculus (2nd ed.). Undergraduate Texts in Mathematics, Springer. Indian reprint.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

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

GENERIC ELECTIVES: FUNDAMENTALS OF CALCULUS

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Fundamentals of Calculus	4	3	1	0	Class XII pass with Mathematics	NIL

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.

SYLLABUS OF GE

Theory

Unit – 1 (20 hours)
Continuity and Differentiability of Functions
Limits and continuity, Types of discontinuities; Differentiability of functions; Successive differentiation: Calculation of the nth derivatives, Leibnitz theorem; Partial differentiation, Euler's theorem on homogeneous functions.

Unit – 2   **(20 hours)**
Mean Value Theorems and its Applications
Rolle's theorem, Mean value theorems and applications to monotonic functions and inequalities; Expansion of functions: Taylor's theorem, Taylor's series, Maclaurin's series expansion of $e^x, \sin x, \cos x, \log(1 + x)$ and $(1 + x)^m$; Indeterminate forms.

Unit – 3   **(20 hours)**
Tracing of Curves
Concavity and inflexion points, Asymptotes (parallel to axes and oblique), Relative extrema, Tracing graphs of polynomial functions, rational functions, and polar equations.
Practical component (if any) – NIL
Essential Readings

- Anton, Howard, Bivens, Irl, & Davis, Stephen (2013). Calculus (10th ed.). Wiley India Pvt. Ltd. New Delhi. International Student Version. Indian Reprint 2016.
- Prasad, Gorakh (2016). Differential Calculus (19th ed.). Pothishala Pvt. Ltd. Allahabad.

Suggestive Reading

- Thomas Jr., George B., Weir, Maurice D., & Hass, Joel (2014). Thomas' Calculus (13th ed.). Pearson Education, Delhi. Indian Reprint 2017.

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**

GENERIC ELECTIVES: THEORY OF EQUATIONS AND SYMMETRIES

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Theory of Equations and Symmetries	4	3	1	0	Class XII pass with Mathematics	NIL

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.

SYLLABUS OF GE

Theory

Unit - 1 (24 hours)

Polynomial Equations and Properties

General properties of polynomials and equations; Fundamental theorem of algebra and its consequences; Theorems on imaginary, integral and rational roots; Descartes' rule of signs for positive and negative roots; Relations between the roots and coefficients of equations, Applications to solution of equations when an additional relation among the roots is given; De Moivre's theorem for rational indices, the nth roots of unity and symmetries of the solutions.

Unit - 2 (16 hours)

Cubic and Biquadratic (Quartic) Equations

Transformation of equations (multiplication, reciprocal, increase/diminish in the roots by a given quantity), Removal of terms; Cardon's method of solving cubic and Descartes' method of solving biquadratic equations.

Unit - 3 (20 hours)

Symmetric Functions

Elementary symmetric functions and symmetric functions of the roots of an equation; Newton's theorem on sums of the like powers of the roots; Computation of symmetric functions such as $\sum \alpha^2 \beta, \ \sum \alpha^2 \beta^2, \ \sum \alpha^2 \beta\gamma, \ \sum \dfrac{1}{\alpha^2 \beta\gamma}, \ \sum \alpha^{-3}, \ \sum (\beta + \gamma - \alpha)^2, \ \sum \dfrac{\alpha^2 + \beta\gamma}{\beta + \gamma}, ...$ of polynomial equations; Transformation of equations by symmetric functions and in general.

Practical component (if any) – NIL

Essential Readings

- Burnside, W.S., & Panton, A.W. (1979). The Theory of Equations (11th ed.). Vol. 1. Dover Publications, Inc. (4th Indian reprint. S. Chand & Co. New Delhi).
- Dickson, Leonard Eugene (2009). First Course in the Theory of Equations. John Wiley & Sons, Inc. The Project Gutenberg eBook: http://www.gutenberg.org/ebooks/29785

Suggestive Reading

- Prasad, Chandrika (2017). Text Book of Algebra and Theory of Equations. Pothishala Pvt Ltd.

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
Financial Database and analysis software	2	0	0	2	12th Pass	NIL

Learning Objectives

The Learning Objectives of this course are as follows:
- To enable students to obtain data from financial database.
- To enable to use R language for statistical & econometric data analysis.
- To develop skills that can help in solving your research problems.

Learning outcomes

The Learning Outcomes of this course are as follows:
- After studying this course, students will be able to understand the utility of a financial database
- After studying this course, students will be extract data from financial database (Prowess IQ)
- After studying this course, students will be perform data analysis using R
- After studying this course, students will be apply 'R' and Prowess IQ in financialanalysis and research.

SYLLABUS

Unit I (Financial Database) (3 weeks)

An Introduction to financial database Prowess IQ from CMIE: Creating company set-, creatingspreadsheets, use of elements in Ribbons – Company address and identity identicators, business segments and products, Ownership structure and governance indicators, Financial Statements, Stock prices and capital changes, Capex and M&A, indices and index number. Formulating queries and advance queries Student is expected to be able to extract different types of data foran index, an industry and company data Selection of company/s, period to be studied. Data extraction from balance sheet, profit & loss statement and cash flow statements

Stock market data- price and volume, BSE/NSE, adjusted prices Saving and exporting data to a spreadsheet for further analysis.

Unit II (Fundamentals of R)   (4 weeks)

Overview of the R language, Input and output of data in R, Help command and Directory in R, In-built functions in R, Operators in R; Assignment, Arithmetic, logical, and Relational operators, Using R studio, Scripts, Text editors for R, Graphical User Interfaces (GUIs) for R, installing packages and libraries, Variable classes (numeric, character, logical, complex, missing), Data Types in R; Vectors, Matrices, Arrays, Lists, Factors, and Data Frames, Important operations of these Data Types, Using data from external files- reading & writing data to external files, Creating and storing R workspaces.

Unit III (Descriptive Analysis and Data Visualizations)   (4 weeks)

Data preparation; Data cleaning and Missing value treatment, Data Exploration and Manipulation, Data Visualization; Bar chart, pie chart, Histogram, Frequency curve, Scatter plot, Box & Whisker plot etc., Important R functions for Describing a data; Mean, Median, Range, Standard deviation, Variance, Five number summary, Correlation coefficients for a bivariate data.

Unit III (Predictive Analysis)   (4 weeks)

Simple and Multiple Regression using R, Estimating Regression Equation by Ordinary Least Squares in R, Violations of Classical Assumptions: multicollinearity, heteroscedasticity, autocorrelation and model specification errors, their identification, their impact on parameters; tests related to parameters and impact on the reliability and the validity of inferences in case of violations of Assumptions; methods to take care of violations of assumptions, goodness of fit. Time Series Analysis using R (Basic idea only).

Essential/recommended readings
- Gardener, M., *Beginning R: The Statistical Programming Language*, Wiley & Sons. 2018
- Wickham, H., et al. *R for Data Science: Import, Tidy, Transform, Visualize, and ModelData,* O'Reilly', 2017
- Motwani, B., Data Analytics with R, Wiley & Sons, Indian edition 2021
- Chang, R Graphics Cookbook- Practical Recipes for Visualizing Data; O' Reilly Media
- Gujarati, D.N. et al. Basic Econometrics, McGraw Hill India, 5e, 2018

Useful web links

- https://prowessiq.cmie.com
- CRAN website: https://cran.r-project.org/ https://rstudio.com/products/rstudio/download/ (R studio)
- http://r-statistics.co

Examination scheme and mode:

Total Marks: 100

Internal Assessment: 25 marks Practical

Exam (Internal): 25 marks

End Semester University Exam: 50 marks

The Internal Assessment for the course may include Class participation, Assignments, Class tests, Projects, Field Work, Presentations, amongst others as decided by the faculty.

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course
		Lecture	Tutorial	Practical/ Practice		
Vedic Mathematics - I	02	1	0	1	12TH Pass	NIL

Learning Objectives

The Learning Objectives of the course are:

- Foster love for maths and remove its fear through Vedic Mathematics
- Enhance computation skills in students through Vedic Mathematics·
- Develop logical and analytical thinking
- Promote joyful learning of mathematics
- Discuss the rich heritage of mathematical temper of Ancient India

Learning outcomes

The Learning Outcomes of the course are

- Overcome the fear of maths
- Improved critical thinking
- Familiarity with the mathematical underpinnings and techniques
- Ability to do basic maths faster and with ease.
- Appreciate the Mathematical advancements of Ancient India.

SYLLABUS OF VEDIC MATHEMATICS - I

UNIT – I Vedic Maths- High Speed Addition and Subtraction Sessions/Lectures
(5 Weeks)

- Vedic Maths: History of Vedic Maths and its Features
- Vedic Maths formulae: Sutras and Upsutras
- Addition in Vedic Maths: Without carrying, Dot Method

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- Subtraction in Vedic Maths: Nikhilam Navatashcaramam Dashatah
(All from 9 last from 10)
- Fraction –Addition and Subtraction

UNIT – II   Vedic Maths- Miracle Multiplication and Excellent Division   (4 Weeks)

- Multiplication in Vedic Maths: Base Method (any two numbers upto three digits)
- Multiplication by Urdhva Tiryak Sutra
- Miracle multiplication: Any three-digit number by series of 1's and 9's
- Division by Urdhva Tiryak Sutra (Vinculum method)

UNIT – III   Vedic Maths-Lightening Squares and Rapid Cubes   (3 Weeks)

- Squares of any two-digit numbers: Base method
- Square of numbers ending in 5: Ekadhikena Purvena Sutra
- Easy square roots: Dwandwa Yoga (duplex) Sutra
- Square root of 2: Baudhayana Shulbasutra
- Cubing: Yavadunam Sutra

UNIT – IV   Vedic Maths-Enlighten Algebra and Geometry   (3 Weeks)

- Factoring Quadratic equation: Anurupyena, Adyamadyenantyamanty Sutra
- Concept of Baudhayana (Pythagoras) Theorem
- Circling a square: Baudhayana Shulbasutra
- Concept of pi: Baudhayana Shulbasutra
- Concept angle (θ) 0o, 30o, 45o, 60o and 90o: Baudhayana number

Practical component : (If any)   (15 Weeks)

The students are expected to demonstrate the application of Vedic Maths: Sutra and Upsutra
- Conduct workshops under the supervision of the course teacher to spread awareness on the utility of Vedic Mathematics.
- Students are required to visit nearby retail shops/local vendors to purchase stationery/vegetables/bread and butter and use tricks of Vedic maths of addition and subtraction to calculate the amount to pay and receive the difference.
- Students may share their experience with the class teacher in the form of audio-video presentations of 15 minutes.
- If required, students can share their experiences in the form of a Project Report.
- Any other Practical/Practice as decided from time to time

Essential Readings
- The Essential of Vedic Mathematics, Rajesh Kumar Thakur, Rupa Publications, New Delhi 2019.
- Vedic Mathematics Made Easy, Dahaval Bathia, Jaico Publishing, New Delhi 2011
- Vedic Mathematics: Sixteen Simple Mathematical formulae from the Vedas, Jagadguru Swami Sri Bharati Krishna Trithaji, Motilal Banarasidas, New Delhi 2015.
- Learn Vedic Speed Mathematics Systematically, Chaitnaya A. Patil 2018.

Suggested Readings
- A Modern Introduction to Ancient Indian Mathematics, T S Bhanumurthy, Wiley Eastern Limited, New Delhi.
- Enjoy Vedic Mathematics, S M Chauthaiwale, R Kollaru, The Art of Living, Bangalore.
- Magical World of Mathematics, VG Unkalkar, Vandana publishers, Bangalore.

Examination scheme and mode: Subject to directions from the Examination Branch/University of Delhi from time to time