Savitribai Phule Pune University

(Formerly University of Pune)

Four Year Graduate Degree Programme in Mathematics

(Faculty of Science & Technology)

New

Syllabi for

S. Y. B. A. / B. Sc. - Mathematics

(For Colleges Affiliated to Savitribai Phule Pune University, Pune)

(As per National Education Policy- 2020)

To be implemented from the Academic Year 2025-2026

Syllabus for S.Y.B.Sc. as per NEP - 2020
Subject: Mathematics

Semester - III

MTS-201-MJ: Calculus of Several Variables

Course type: Major **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Define and analyze functions of several variables.
2. Evaluate limits and continuity of multivariable functions using various techniques.
3. Compute first and higher-order partial derivatives of multivariable functions.
4. Determine extrema of functions using the second derivative test and Lagrange multipliers.
5. Compute double and triple integrals in Cartesian, polar, cylindrical, and spherical coordinates.
6. Apply multiple integrals to calculate areas, volumes, mass, and density.

Course Content

Unit 1: Limits and Continuity **(06 Hours)**

1.1 Functions of Several Variables: Definition, domain, range, level curves, graphs

1.2 Limits of Functions of Several Variables: Definition, evaluating limits along different paths

1.3 Techniques to Evaluate Limits: Direct substitution, Path approach, Squeeze theorem

1.4 Continuity in Functions of Several Variables: Definition, properties

Unit 2: Partial Derivatives **(14 Hours)**

2.1 Definition and examples.

2.2 Higher Derivatives, Clairaut's Theorem (Statement Only)

2.3 Differentiable function - Definition, Necessary condition for differentiability (with proof), sufficient condition for differentiability (without proof), Examples, Differentials

2.4 Chain Rule, Homogeneous Functions, Euler's theorem

2.5 Extreme values of functions of two variables

2.6 Necessary conditions for extreme values

2.7 Second Derivative Test (without proof)

2.8 Lagrange's Multipliers (with one constraint)

Unit 3: Multiple Integrals **(10 Hours)**

3.1 Double Integrals in Cartesian Coordinates: Definition and computation

3.2 Change of order of integration

3.3 Double Integrals in Polar Coordinates: Converting limits to polar form

3.4 Change of Variables in Multiple Integrals: Jacobian transformation

3.5 Applications of Double Integrals: Area calculation

3.6 Triple Integrals in Cartesian Coordinates: Volume computation

3.7 Triple Integrals in Cylindrical & Spherical Coordinates: Conversion and computation

Text Book:

1. Thomas' Calculus, 13th Edition, G. B. Thomas, Revised by Maurice D. Weir, Joel Hass and Christopher Heil, Pearson Edition. Articles: 14.1 to 14.4, 14.7 & 14.8, 15.1 to 15.5, 15.7 & 15.8.

Reference Books:

1. Calculus: Early Transcendentals - James Stewart, Cengage Learning.
2. Basic Multivariable Calculus, J. E. Marsden, A. J. Tromba , A. Weinstein, Springer Verlag (Indian Edition).
3. T. M. Apostol , Calculus Vol. II (2nd Edition), John Wiley, New York, (1967).
4. Multivariable Calculus 7th Edition By James Stewart, Brooks/Cole, Cengage Learning, 2012.

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MTS-202-MJ: Laplace Transform and its Applications

Course type: Major **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Define and understand the Laplace transform, its properties, and continuity requirements.
2. Calculate the Laplace transform of various exponential order functions.
3. Find the inverse Laplace transform using techniques like partial fractions and translation theorems.
4. Solve ordinary differential equations using Laplace transforms, including initial and boundary value problems.
5. Apply Laplace transforms to solve real-world problems, including electrical circuits and periodic functions.
6. Explore advanced applications such as the Laplace transform of Gamma, Beta and Error functions.

Course Content

Unit 1: Laplace Transform **(08 Hours)**

1.1 Introduction to the Laplace Transform

1.2 Continuity Requirements

1.3 Piecewise Continuity

1.4 Exponential Order Functions

1.5 Laplace Transform of Some Exponential Order Functions

1.6 Properties of Laplace Transforms and Some Examples

Unit 2: Inverse Laplace Transform **(09 Hours)**

2.1 Inverse of the Laplace Transform

2.2 Unit Step Function

2.3 Translation Theorems

2.4 Differentiation and Integration of the Laplace Transform

2.5 Use Partial Fractions to find Inverse Laplace Transform

Unit 3: Applications of Laplace Transform **(13 Hours)**

3.1 Gamma Function and its Laplace Transform

3.2 Periodic Functions and their Laplace Transforms

3.3 Laplace Transform of Derivatives

3.4 Applications to solve Ordinary Differential Equations

i. Initial Value Problems

ii. Boundary Value Problems

iii. Systems of Differential Equations

3.5 Applications of Laplace Transform in Electrical Circuits

3.6 Convolution Theorem and its Applications

3.7 Error Function and its Laplace Transform

3.8 Beta Function and its Laplace Transform

Text Book:

1. The Laplace Transform: Theory and Applications, Joel L. Schiff, Springer New York, NY, 1999.

   Section: 1.1, 1.3, 1.4, 1.5 (Except Theorem 1.11), 1.6 (Except Theorem 1.18, Example 1.19 and Theorem 1.20), 1.7, 1.8, 1.9, 1.10, 2.1 (Except Infinite Series), 2.2, 2.3, 2.4 (Except Differential Equations with Polynomial Coefficients), 2.7 (Up to Beta Function).

Reference Books:

1. Schaum's Outline Series- Theory and Problems of Laplace Transform by Murray R. Spiegel, McGraw-HILL
2. Use of Integral Transforms by I. N. Sneddon, Tata McGraw-Hill, New York, 1972.
3. Integral Transforms and Their Applications by Debnath, Lokenath; Bhatta, Dambaru, Chapman and Hall/CRC; 3rd edition, 2014.

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MTS-203-MJP: Practicals on Calculus of Several Variables and Laplace Transform

Course type: Major **No. of Credits: 02(P)**

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[Minor Subjects]

MTS-241-MN: (A) Mathematics for Physical Science-I

Course type: Minor **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Demonstrate a clear understanding of functions of several variables and apply partial differentiation techniques to solve multivariable problems.
2. Analyse and distinguish between exact and inexact differentials and apply the chain rule and total derivatives in changing variables.
3. Perform operations with vectors, including addition, scalar multiplication, and determination of magnitudes and angles between vectors.
4. Solve geometric problems using vector methods, including finding equations and distances related to lines, planes, and spheres.
5. Apply differentiation and integration techniques to vector functions and interpret physical problems involving vector fields.
6. Evaluate and apply vector calculus operators gradient, divergence, and curl and use related vector identities in solving applied mathematical problems.

Course Content

Unit 1: Partial Differentiation **(10 Hours)**

1.1 Definition of function of several variables

1.2 Definition of the partial derivative

1.3 The total differential and total derivative

1.4 Exact and inexact differentials

1.5 The chain rule

1.6 Change of variables

Unit 2: Vector Algebra **(10 Hours)**

1.1 Vector Algebra

1.2 Scalars and vectors

1.3 Addition and subtraction of vectors

1.4 Multiplication by a scalar

1.5 Magnitude of a vector

1.6 Angle between the vectors

1.7 Multiplication of vectors

1.8 Scalar Product

1.9 Vector Product

1.10 Scalar Triple Product

1.11 Vector Triple Product

Unit 3: Vector Calculus **(10 Hours)**

3.1 Differentiation of vectors

3.2 Vector operators:

i. Gradient of a scalar field;

ii. Divergence of a vector field;

iii. Curl of a vector field

3.3 Vector operator formulae

i. Vector operators acting on sums and products

ii. Combinations of grad, div and curl

Text Book:

1. Mathematical Methods for Physics and Engineering, K. F Riley, Michael Paul Hobson, and Stephen John Bence, Cambridge University Press.

   Section 5.1, 5.2, 5.3, 5.4, 5.5, 5.6, 7.1, 7.2, 7.3, 7.5, 7.6, 10.1, 10.7, 10.8

Reference Books:

1. Advanced Engineering Mathematics, Erwin Kreyszig, John Wiley & Sons.
2. Mathematics for Chemistry, Kailas S. Ahire, Rajashri Sawant, SahityaSagar Publication 2023.

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MTS-241-MN: (B) Mathematics for the Life Sciences-I

Course type: Minor **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Understand the role of mathematics in biological sciences.
2. Apply Algebra and Calculus to biological systems.
3. Extend mathematical modelling techniques to complex biological systems.
4. Use discrete mathematics and computational approaches in biological research.
5. Develop basic mathematical models for biological processes.
6. Students develop skills in identifying problems, choosing appropriate mathematical tools and communicating their findings in a clear and concise manner.

Course Content

Unit 1: Functions **(10 Hours)**

1.1 Real Number System

1.2 Sets and Their Representations

1.3 Functions

1.4 Linear Functions

1.5 Linear Inequalities

1.6 Other Sample Functions

1.7 More on Functions

1.8 Limit as x tends to infinity.

Unit 2: Exponential and Logarithm Functions **(10 Hours)**

2.1 Exponential Functions

2.2 Inverse Functions and Logarithms

2.3 Log-Log and Semi-log Plots

2.4 Natural Logarithms and Exponentials

2.5 Exponential Growth and Decay

Unit 3: Vectors and Matrices **(10 Hours)**

3.1 Vectors in Two Dimensions

3.2 The Inner Product

3.3 Relative Velocities

3.4 Forces

3.5 Matrices

3.6 Applications of Matrices

Recommended Book:

1. Jagdish C. Arya and Robin W. Lardner (1979), Mathematics for the Biological Sciences, Prentice-Hall, Inc.

Reference Books:

1. Erin N. Bodine, Suzanne Lenhart and Louis J. Gross, Mathematics for the Life Sciences, Princeton University Press, 2014.
2. Edward Batschelet, Introduction to Mathematics for Life Scientists, 3rd Edition (1979), Springer.

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MTS-241-MN : (C) Mathematics for Computer Science-I

(Numerical Techniques)

Course type: Minor **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Understand and apply numerical methods to solve algebraic and transcendental equations, including bisection, false position, and Newton-Raphson methods, with an emphasis on error analysis and convergence.
2. Develop a strong foundation in finite difference concepts, including forward, backward, central, and other difference operators, and understand their roles in numerical approximation.
3. Apply interpolation techniques for estimating intermediate values, using Newton's Gregory formulas, Lagrange's interpolation, and divided differences.
4. Utilize numerical integration methods such as the trapezoidal rule, Simpson's one-third rule, and Simpson's three-eighth rule to approximate definite integrals.
5. Solve ordinary differential equations numerically using Euler's method, Euler's modified method, and Runge-Kutta methods, understanding their accuracy and applicability.
6. Analyze the efficiency, accuracy, and limitations of various numerical methods, enabling selection of appropriate techniques for solving real-world mathematical problems.

Course Content

Unit 1: Algebraic and Transcendental Equation (06 Hours)

1.1 Errors

1.2 Bisection Mehtod

1.3 False Position Method

1.4 Newton-Raphson Method

Unit 2: Calculus of Finite Differences and Interpolation (10 Hours)

2.1 Differences

- 2.1.1 Forward Differences
- 2.1.2 Backward Differences
- 2.1.3 Central Differences
- 2.1.4 Other Differences

2.2 Relation between Operators

2.3 Newton's Gregory Formula for Forward Interpolation

2.4 Newton's Gregory Formula for Backward Interpolation

2.5 Lagrange's Interpolation Formula

2.6 Divided Difference

2.7 Newton's Divided Difference Formula

Unit 3: Numerical Integration (06 Hours)

3.1 General Quadrature Formula

3.2 Trapezoidal Rule

3.3 Simpson's one-Third Rule

3.4 Simpson's Three-Eight Rule

Unit 4: Numerical Solution of Ordinary Differential Equation (08 Hours)

4.1 Euler's Method

4.2 Euler's Modified Method

4.3 Runge-Kutta Second Order Method

4.4 Runge-Kutta Fourth Order Method (Without Proof)

Text Book:

1. A Textbook of Computer Based Numerical and Statistical Techniques, by A. K. Jaiswal and Anju Khandelwal, New Age International Publishers.

   Chapter 1: 2.1,2.4, 2.5, 2.7

   Chapter 2: 3.1, 3.2, 3.4, 3.5,4.1, 4.2, 4.3, 5.1, 5.2, 5.4, 5.5

   Chapter 3: 6.1, 6.3, 6.4, 6.5, 6.6, 6.7

   Chapter 4: 7.1, 7.4, 7.5, 7.6

Reference Books:

1. S. S. Sastry; Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India, 1999.
2. H. C. Saxena; Finite differences and Numerical Analysis, S. Chand and Company.
3. K. E. Atkinson; An Introduction to Numerical Analysis, Wiley Publications.
4. Balguruswamy; Numerical Analysis.

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MTS-242-MN:Practical on (A) Mathematics for Physical Science-I
or
MTS-242-MN:Practical on (B) Mathematics for Life Sciences-I
or
MTS-242-MN:Practical on (C) Mathematics for Computer Science-I

Course type: Minor **No. of Credits: 02(P)**

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IKS-201-MTS: Indian Knowledge System - Mathematics

Course type: IKS **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. To introduce students to the rich mathematical heritage of ancient India.
2. To explore the contributions of Indian mathematicians and their impact on modern mathematics.
3. To understand key mathematical concepts developed in ancient Indian texts.
4. To understand the proof techniques of Indian Mathematics.
5. To know the contribution to Astronomy.
6. To correlate ancient Indian mathematics to modern mathematics.v

Course Content

Unit 1: Introduction **(03 Hours)**

1.1 Overview of the Indian Knowledge System, significance, sources

1.2 *Katapayadi* and *Bhut Sankhya* number systems

Unit 2: Contributions to Geometry **(04 Hours)**

2.1 Geometry *in Sulba Sutra*: Construction of altars, Bodhayana-Pythagorean theorem

2.2 Methods of Squaring a circle, and circling a square etc.

2.3 Approximation of square roots and irrational numbers

2.4 Cyclic quadrilaterals

Unit 3: Contributions to Arithmetic and Number Theory **(07 Hours)**

3.1 Concept of zero, its history and development

3.2 Operations with negative numbers, algebraic identities

3.3 Development of Indian numeral system and its impact

3.4 Kuttaka method for solving indeterminate equations

3.5 Chakraval Method to Solve Pell's equation

Unit 4: Algebra and Calculus **(05 Hours)**

4.1 Solutions to linear and quadratic equations

4.2 Approximations of π

4.3 Some problems from the books- *Ganitasarasangraha*, *Lilavati*, *Bijaganita*

4.4 Infinite series, early concepts of calculus.

4.5 Contribution of Kerala School of Mathematics

Unit 5: Combinatorics and Astronomy-Related Mathematics (06 Hours)

5.1 Binomial coefficients and early combinatorial methods

5.2 Pingala's algorithm for binary number system

5.3 Hemachandra-Fibonacci sequence in Indian texts (prosody, Sanskrit meter)

5.4 Sine functions and tables by Aryabhata, Bhaskar I, Madhava

5.5 Use of mathematics in Indian astronomy (planetary motion, time calculations)

Unit 6: Legacy of Indian Mathematics and Vedic Techniques (05 Hours)

6.1 Jain and Buddhist mathematicians

6.2 Proof techniques by Indian mathematicians

6.3 List of books by Indian mathematicians

6.4 List of Indian concepts of mathematics

6.5 Introduction to techniques of Vedic mathematics

6.6 Conclusion: journey of mathematics from ancient to modern times

Reference Books:

1. Dr. Balachandra Rao, Indian Mathematics and Astronomy-Some Landmarks, 6th Edition, Bhavan's Gandhi Centre for Science and Human Values, Bangalore, 2017.
2. Bhaskar Kamble, The Imperishable Seed (How Hindu Mathematics Changed the World and Why this History was Erased), Garuda Prakashan, 2022.
3. B. Datta and A. N. Singh, History of Hindu Mathematics (Volumes 1 and 2), Bharatiya Kala Prakashan.
4. T. A. Saraswati Amma, Geometry in Ancient and Medieval India, Motilal Banarasidass
5. C. N. Srinivasiengar, The History of Ancient Indian Mathematics, World Press, 1967.
6. A. K. Dutta, Series of articles on "Mathematics in India," *Bhavana* (Journal of the Indian Mathematical Society).
7. K. Ramasubramanian (Editor), Studies in Indian Mathematics and Astronomy: Selected Articles of Kripa Shankar Shukla, Hindustan Book Agency, Culture and History of Mathematics Series, Volume 2, 2010.
8. NPTEL Lectures by K. Ramasubramanian, M.D. Srinivas and M. S. Sriram. https://nptel.ac.in/courses/111/101/111101080/

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MTS-221-VSC: Foundation of Mathematics

Course type: VSC **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. To understand and compute higher-order derivatives.
2. Apply standard methods to solve integrals.
3. Solve first-order ordinary differential equations.
4. Perform operations on complex numbers.
5. To use De-Moivre's theorem to find powers and roots.
6. Represent and analyze regions in the complex plane.

Course Content

Unit 1: Successive Differentiation & Methods of Integration (14 Hours)

1.1 Calculation of the nth Derivative (some standard result).

1.2 Determination of nth derivatives of rational functions.

1.3 Integration of Algebraic Rational Functions.

1.4 Integration by Parts.

1.5 Reduction formulae for $\sin^n x$, $\cos^n x$

Unit 2: Ordinary Differential Equations (10 Hours)

2.1 Linear first order equations.

2.2 Separable equations.

2.3 Exact differential equations

2.4 Determination of Integrating factor

Unit 3: Complex Numbers (06 Hours)

3.1 Sums and Products, Basic Algebraic Properties, Moduli, Complex Conjugates, Exponential form, Products and Quotients, De-Moivre's theorem.

3.2 Roots of Complex Numbers: The nth roots of unity.

Text Books:

1. Differential Calculus by Shanti Narayan, Revised Edition.
   Units 1: Chapter 5: Sec. 5.2 to 5.3.
2. Integral Calculus by Shanti Narayan, Revised Edition.
   Units 1: Chapter 3: Sec. 3.1 to 3.7, Chapter 4: Sec. 4.1 to 4.2

3. Elementary Differential equations, William F. Trench, E-book (Free download).

   Units 2: Chapter 2: Sec. 2.1 to 2.2, 2.5 to 2.6

4. Complex Variables and Applications, James Ward Brown and Ruel V. Churchill, Mc-Graw Hill, Eighth Edition.

   Unit 3: Chapter 1: Sec 1 to 10.

Reference Books:

1. A Thomas' Calculus Maurice D. Weir, Joel Hass. Pearson.IN.
2. Differential Equations, Shepley L. Ross, Willy India Pvt.Ltd.
3. Ordinary and Partial Differential Equations, M. D. Raisingania, S. Chand and Company, 2009.
4. Calculus Volume I (Second Edition), Wiley Student Edition, T. M. Apostol, John Wiley, New Delhi.
5. Calculus Volume II (Second Edition), Wiley Student Edition, T. M. Apostol, John Wiley, New Delhi.
6. Complex Variables Theory and Application Kasana PHI.

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[Open Electives for the Students other than Faculty of Science]

OE-201-MTS: (A) Mathematics For Competitive Exams

Course type: OE **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Understand the basic concepts of quantitative ability
2. Acquire satisfactory competency in the use of Mathematical reasoning
3. Develop theoretical, applied, and computational skills
4. Solve campus placement aptitude papers covering Quantitative Ability
5. Compete in various competitive exams like Banking, CAT, CMAT, GATE, GRE, GATE, MPSC, UPSC, etc.
6. Get adequate exposure to global and local concerns that explore many aspects of Mathematical Sciences

Course Content

Unit 1: Number System and Basic Numeracy **(12 Hours)**

1.1 Number Systems: Basic Calculation (Addition, Subtraction, Multiplication, and Division) and Simplification, BODMAS, Place Value, Face Value

1.2 Test of Divisibility, LCM and HCF

1.3 Decimals and Fractions

1.4 Simplification

1.5 Powers, Square root, and Cube root

1.6 Logarithm

1.7 Surds and Indices

1.8 Percentage

1.9 Average

1.10 Problems on Ages

1.11 Series Test: Odd Man Out and Series Completion

Unit 2: Quantitative Ability (Applied Mathematics-I) **(09 Hours)**

2.1 Ratio and Proportion

2.2 Mixtures and Allegations

2.3 Partnership

2.4 Profit and Loss

2.5 Simple Interest & Compound Interest

Unit 3: Quantitative Ability (Applied Mathematics-II) (09 Hours)

3.1 Time & Work: Problems on Unitary Methods, Problems on Alternate days and wages, Problems on Chain Rule, Problems on Pipes and Cisterns

3.2 Speed, Time, and Distance: Problems on Average and Relative Speed, Problems on Trains, boats, and streams

Text Book:

1. Quantitative Aptitude for Competitive Examinations by R.S. Aggarwal

Reference Books:

1. Fast Track Objective Arithmetic by Rajesh Verma
2. Handbook for Mathematics by Arihant Experts
3. Objective Arithmetic (SSC & Railway Exam Special) by R.S Aggarwal
4. Teach Yourself Quantitative Aptitude by Arun Sharma
5. The Pearson Guide to Quantitative Aptitude for Competitive Examination by Dinesh Khattar
6. Quantitative Aptitude for all Competitive Exams by Abhijit Gupta
7. NCERT Math Books of 10th,11th, and 12th

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OE-201-MTS: (B) Mathematics for Social Science-I

Course type: OE **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Explain the role and scope of statistics in diverse fields such as social sciences, management, insurance, and information technology etc.
2. Understand various sampling methods, and data classifications
3. Construct and interpret frequency distributions and apply appropriate methods for data classification
4. Represent data using appropriate diagram for effective communication of statistical findings
5. Calculate and describe data through measures of central tendency
6. To develop student's understanding of statistical averages and their applications in data analysis

Course Content

Unit 1: Statistics, Population and Sample **(10 Hours)**

1.1 Meaning of Statistics as a Science. Importance of Statistics. Scope of Statistics: In the field of Social Sciences, Psychology, Industry, Economics, Management sciences, Agriculture, Insurance, Information technology, Education etc.

1.2 Notion of a statistical population: Finite population, infinite population, homogeneous population and heterogeneous population. Notion of a sample and a random sample

1.3 Methods of sampling (Description only): Simple random sampling with and without replacement (SRSWR and SRSWOR) stratified random sampling, systematic sampling, illustrations for each sampling method.

Unit 2: Types of characteristics **(10 Hours)**

2.1 Attributes: Nominal scale, ordinal scale,

2.2 Variables: Interval scale, ratio scale, discrete and continuous variables, difference between linear scale and circular scale

2.3 Types of data: (a) Primary data, Secondary data (b) Cross-sectional data, time series data, directional data.

2.4 Classification: Raw data and its classification, inclusive and exclusive methods of classification, open end classes, ungrouped frequency distribution, Sturges' rule, grouped frequency distribution, cumulative frequency distribution and relative frequency distribution.

2.5 Representation of data: Bar Diagrams, Pie-Diagram, Histogram, frequency polygon, frequency curve and Ogive curves

Unit 3: Statistical Averages **(10 Hours)**

3.1 Concept of central tendency of statistical data, Statistical averages, characteristics of a good statistical average.

3.2 Arithmetic Mean (A.M.): Definition, effect of change of origin and scale, combined mean of a number of groups, merits and demerits, trimmed arithmetic mean.

3.3 Mode and Median: Definition, formulae (for ungrouped and grouped data), Empirical relation between mean, median and mode (without proof).

3.4 Partition Values: Quartiles, Deciles and Percentiles (for ungrouped and grouped data), Box plot. Situations where one kind of average is preferable to others.

3.5 Case study

Recommended Books

1. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi.

2. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.

3. Ghosh, J. K. and Mitra, S. K., Parthsarthi, K. R. (1993). Glimpses of India's Statistics Heritage, Wiley publishing Co.

4. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.

5. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.

6. Neil A. Weiss, (2016). Introductory Statistics, Tenth Edition, Pearson.

7. Purohit, S. G., Gore S. D., Deshmukh S. R. (2008). Statistics Using R, Narosa Publishing House, New Delhi.

8. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentce Hall of India, New Delhi.

9. Snedecor G. W. and Cochran W. G.(1989). Statistical Methods, Eighth Ed. East- West Press.

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OE-201-MTS: (C) Commercial Mathematics I

Course type: OE **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Define and recall fundamental concepts of quadratic equations and progressions
2. Explain the relationship between roots and coefficients of a quadratic equation
3. Apply arithmetic and geometric progressions to real-world problems
4. Solve basic counting problems using fundamental principles of counting
5. Apply fundamental principles of probability to solve problems involving uncertainty, including the use of probability rules, conditional probability, and expected value, in business and real-life contexts
6. Create computational skills essential to compete in various competitive exams like CA, CAT, CMAT, GATE, GRE, GATE, UPSC, GPSC etc.

Course Content

Unit 1: Quadratic Equations and Progressions **(10 Hours)**

1.1 Quadratic equations and solutions

1.2 Polynomials and their factorizations

1.3 Number series and Progressions: Problems on Arithmetic progression, Geometric Progression and Harmonic Progressions

1.4 Problems on Number and letter series

Unit 2: Counting Principles **(08 Hours)**

2.1 Permutations: Linear and Circular, Permutations with or without repetitions

2.2 Combinations

2.3 Fundamental principles of counting: Problems on Addition and multiplication rule

2.4 Elementary problems on permutations and Combinations

2.6 Binomial theorem

Unit 3: Probability **(12 Hours)**

3.1 Introduction to Probability

3.2 Meaning of probability

3.3 Basic concepts: random experiment, sample space, event, types of events (simple, compound, mutually exclusive, exhaustive, independent, dependent)

3.4 Classical and empirical definitions of probability

3.5 Addition theorem (for mutually exclusive and non-mutually exclusive events)

3.6 Multiplication theorem (for independent and dependent events)

3.7 Complementary events

3.8 Conditional Probability

3.9 Definition and application

3.10 Use of multiplication rule in conditional probability

3.11 Bayes' Theorem: Statement and application of Bayes' theorem in solving problems

Reference Books:

1. Discrete Mathematics and its Applications, Kenneth H. Rosen, MCgraw Publications
2. Finite Mathematics for Business, Economics, Life sciences and Social Sciences, Barnett, Ziegler, Byleen, Stocker, Pearson, 14th Edition
3. Higher Algebra, Hall & Knight, Arihant Publications (Indian Edition)
4. Analytical and Logical reasoning By Sijwali B S
5. Business Mathematics by VK Kapoor,
6. CA Foundation Business Mathematics, Logical Reasoning & Statistics by P. N. Arora, S Arora, sultan Chand Publications
7. Statistics for CA Foundation by R. D Sharma

Semester -IV

MTS-251-MJ: Linear Algebra

Course type: Major **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Understand and analyze vector spaces, subspaces, and basic concepts.
2. Compute null space, column space, and verify orthogonality of vectors.
3. Define linear transformations and apply the Rank-Nullity Theorem.
4. Find eigenvalues, eigenvectors, and diagonalize matrices using Cayley-Hamilton Theorem.
5. Apply eigenvalue methods to Principal Component Analysis (PCA).
6. Use inner product space concepts and perform Gram-Schmidt orthonormalization.

Course Content

Unit 1: Vector Spaces **(10 Hours)**

1.1 Vector Spaces and Subspaces

1.2 Linear Combination, Dependence, Independence, Basis, and Dimension

1.3 Null Space and Column spaces

1.4 Orthogonally of Vectors and Subspaces

Unit 2: Linear Transformations **(06 Hours)**

2.1 Linear transformation: Definition, Properties and Examples

2.2 Matrix of a Linear transformation with respect to standard basis

2.3 Kernel and Range of Linear Transformation

2.4 Rank-Nullity Theorem (Statement and Problems only)

Unit 3: Eigen Values and Eigen Vectors **(08 Hours)**

3.1 Introduction to Eigenvalues: $Ax = \lambda x$

3.2 Eigen Vectors

3.3 Characteristic Equations, Caley-Hamilton Theorem (Statement and Problems only)

Unit 4: Inner Product Spaces **(06 Hours)**

4.1 Inner Product Spaces: Definition, Properties and Examples

4.2 Orthogonal and Orthonormal vectors

4.3 Norm of a vector

4.4 Gram - Schmidt Process of Orthonormalization

Recommended Book:

1. Gilbert Strang, Introduction to Linear Algebra, 6th Edition, Wellesley-Cambridge Press.

Reference Books:

1. S. Kumaresan, Linear Algebra: A Geometric Approach, PHI Learning Pvt. Ltd., 2000.
2. David C. Lay, Steven R. Lay, and Judi J. McDonald, Linear Algebra and Its Applications, 5th Ed. Pearson Publication, 2015.
3. Seymour Lipschutz, Schaum's Outline of Linear Algebra, 5th Ed., McGraw Hill, 2012.

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MTS- 252-MJ: Vector Calculus

Course type: Major **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Vector calculus motivates the study of vector differentiation and integration in two and three dimensional spaces.
2. This course enables students to understand vector differentiation and its applications in various fields
3. Students are well equipped to apply concepts like vector fields, derivatives, integrals, and theorems likes Greens theorems stokes and divergence theorems
4. The students receive knowledge of concepts in directional derivatives, gradients, multiple integrals, line and surface integrals, vector fields, divergence, curls
5. Students will able to learn the concepts of vector fields, Gradients fields
6. Students are aware about the gradient, divergence, curl operator and their applications.

Course Content

Unit 1: Vector Valued Functions **(08 Hours)**

1.1 Curves in Space, Limits and Continuity, Derivatives and Motion, Differentiation Rules for Vector Function, Vector Functions of Constant Length.

1.2 Integrals of Vector Functions.

1.3 Arc Length along a Space Curve, Speed on a Smooth Curve, Unit Tangent Vector.

1.4 Curvature of a Plane Curve, Circle of Curvature for Plane Curves, Curvature and Normal Vectors for a Space Curve.

Unit 2: Integrals **(14 Hours)**

2.1 Line Integral of Scalar Functions, Additivity, Line integral in the Plane.

2.2 Vector Fields, Gradient of a scalar field, Line Integral of Vector Fields, Line Integrals.

2.3 Work done by a Force over a Curve in Space, Flow Integrals and Circulation for Velocity Fields, Flux across the Simple Closed Plane Curve.

2.4 Path Independence, Conservative and Potential Functions.

2.5 Divergence, Two forms for Green's Theorem, Green's Theorem in the Plane (1 - form only)

Unit 3: Surface Integrals **(08 Hours)**

3.1 Parameterizations of Surfaces, Implicit surfaces, surface area, surface integrals.

3.2 The Curl of Vector Field, Conservative Fields and Stokes' Theorem (without proof).

3.3 Divergence in three Dimensions, Divergence Theorem (without proof).

Text Book:

1. Thomas' Calculus (14th Edition) by Hass, Heil, Weir, Pearson.

   Unit 1: Chapter 13: Sec- 13.1, 13.2, 13.3, 13.4

   Unit 2: Chapter 16: Sec-16.1, 16.2, 16.3, 16.4

   Unit 3: Chapter 16: Sec- 16.5, 16.6 , 16.7, 16.8

Reference Book:

1. Basic Multivariable Calculus by J. E. Mardson, A. J. Tromba, A. Weinstein, Springer Verlag (Indian Edition)
2. Advanced Calculus by M.R. Spiegel, Schaum Series.
3. Advanced Calculus (IInd Edition) by D.V. Widder, Prentice Hall of India, New Delhi (1944).
4. Advanced Calculus by John M. H. Olmsted, Eurasia Publishing House, New Delhi (1970)
5. Calculus Vol. II (2nd Edition) by T. M. Apostol, John Wiley, New York (1967).

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MTS-253-MJP: Practical on Linear Algebra and Vector Calculus

Course type: Major **No. of Credits: 02(P)**

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[Skill Enhancement Course]

SEC-251-MTS: LaTex

Course type: SEC **No. of Credits: 02(P)**

Course Outcomes: Students will able to

1. Students will be able to create well-structured, professional documents using LaTeX.
2. Learners will gain the ability to typeset mathematical equations, scientific content, and complex layouts effectively.
3. Students will demonstrate proficiency in incorporating graphics, tables, and multimedia elements into their documents.
4. Students will be able to troubleshoot common issues and extend LaTeX capabilities using custom packages and configurations.
5. Learners will be prepared to use LaTeX for academic writing, publishing, and professional documentation tasks.
6. Students will be able to create well-structured, professional documents using LaTeX

Course Content

Unit 1: LaTeX Basics **(04 Hours)**

1.1 What is Latex?

1.2 How LaTeX works

1.3 The LaTeX input files

1.4 Installation of MikTex

1.5 Introduction of Console

1.6 Overleaf-online LaTeX Editor

Unit 2: Creating LaTex Document **(06 Hours)**

2.1 Document Classes

2.2 Packages

2.3 Making a Title page

2.4 Making a Table of contents

2.5 Page styles

2.6 Margins

Unit 3: Within the Text **(06 Hours)**

3.1 Changing Type Style and Size

3.2 Spaces

3.3 Drawing Rules

3.4 Centering

3.5 Making Lists

Unit 4: Tabular Environment in Latex **(08 Hours)**

4.1 Changing Type Style and Size

4.2 Spaces

4.3 Drawing Rules

4.4 Centering

4.5 Multicolumn and multirow

Unit 5: Typesetting Mathematics **(20 Hours)**

5.1 In-line Math

5.2 Display Math

5.3 AMS packages

5.4 Simple Mathematical formulas

5.5 Equation Environment (numbered and unnumbered)

5.6 Creating Matrices

5.7 Building Mathematical Expressions

Unit 6: Including Graphics **(04 Hours)**

6.1 Graphics environment

6.2 Importing Graphic into LaTeX document

6.3 Captions and Sub-captions

6.4 Images through TexCAD

6.5 Tikz LaTex

Unit 7: Beamer presentation **(12 Hours)**

7.1 Documentclass

7.2 Beamerthemes

7.3 Beamercolors

7.4 Creating frames

7.5 Animations

7.6 LaTeX for quizes

Reference Books:

1. More Math into Latex, by George Gratzer, 4th Edition, Springer-Verlag, New Yark.
2. A Guide to LaTeX by Helmut Kopka and Patrick W. Daly, 4th Edition, Addison-Wesley.

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[Minor Subjects]

MTS-291-MN: (A) Mathematics for Physical Science-II

Course type: Minor **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Understand and classify different types of first-order differential equations and solve them using appropriate analytical techniques such as separable, linear, exact, and homogeneous methods.
2. Apply integrating factors and solve real-world problems modeled by first-order differential equations, including applications in electrical circuits and population dynamics.
3. Analyze and solve second-order linear differential equations with constant coefficients, and determine their general solutions.
4. Interpret and model physical systems such as undamped and damped harmonic oscillators using second-order differential equations.
5. Solve initial value problems numerically using Euler's method, Modified Euler's method, and Runge-Kutta methods.
6. Demonstrate the ability to choose and apply suitable analytical or numerical methods for solving differential equations in applied contexts.

Course Content

Unit 1: Differential Equations **(15 Hours)**

1.1 Introduction

1.2 Nature of Solutions

1.3 Separable Equations

1.4 First Order Linear Equations

1.5 Exact Equations

1.6 Homogeneous Equations

1.7 Integrating Factors

1.8 Real life applications of First Order Differential Equations

i. Bacterial growth

ii. Half-Life decay of radioactive materials

iii. Age of fossil

iv. Newton's law of cooling

v. Population dynamics (Logistic Model)

Unit 2: Second Order Differential Equations **(08 Hours)**

2.1 Introduction

2.2 Second-order linear equations

2.3 General solutions to homogeneous differential equations with constant coefficients

2.4 Real life applications of Second Order Differential Equations:-

i. Vibrations and oscillations

ii. Undamped Simple Harmonic Motion

iii. Damped Vibrations (without external force).

Unit 3: Numerical Solutions to Differential Equations **(07 Hours)**

3.1 Introduction to the Initial value problems

3.2 Euler's method

3.3 Improved / Modified Euler's method

3.4 Second Order Runge-Kutta Method

3.5 Fourth Order Runge-Kutta Method (Without Derivation)

Recommended Book:

1. Differential Equations: Theory, Technique, and Practice, George F. Simmons and Steven G. Krantz, Tata McGraw-Hill Edition.

   Section: 1.1, 1.2, 1.3, 1.4, 1.5, 1.7, 1.8, 2.1, 2.5.1, 2.5.2

Reference Books:

1. First Course in Differential Equations with Modeling Applications, Ninth Edition, Dennis G. Zill, CengagePublications.Section: 3.1

2. Differential Equations Theory, Technique, and Practice with Boundary Value Problems, Steven G. Krantz, CRC Press. Section: 4.1, 4.2, 4.4, 4.5

3. Introductory Methods of Numerical Analysis, S. S. Sastry, PHI publications.

4. Mathematics for Chemistry, Kailas S. Ahire, Rajashri Sawant, Sahitya Sagar Publication 2023.

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MTS-291-MN: (B) Mathematics for the Life Sciences-II

Course type: Minor **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Understand the role of mathematics in biological sciences.
2. Apply Algebra and Calculus to biological systems.
3. Extend mathematical modelling techniques to complex biological systems.
4. Use discrete mathematics and computational approaches in biological research.
5. Develop basic mathematical models for biological processes.
6. Students develop skills in identifying problems, choosing appropriate mathematical tools and communicating their findings in a clear and concise manner.

Course Content

Unit 1: The Derivative **(10 Hours)**

1.1 Increments and Rates

1.2 Limits

1.3 More on Limits

1.4 Continuous Functions

1.5 The Derivative

1.6 Derivatives of Power Functions

1.7 Derivatives of Products and Quotients

1.8 Derivatives of Composite Functions

1.9 Higher Derivatives

Unit 2: Applications of Derivative **(10 Hours)**

2.1 Analysis of Curves

2.2 Maxima and Minima

2.3 Applications of Maxima and Minima

2.4 Newton's Method

2.5 The Differentials dx and dy.

2.6 Implicit Differentiation

2.7 Parametric Equations

Unit 3: Integration **(10 Hours)**

3.1 Antiderivatives

3.2 Method of Substitution

3.3 Tables of Integrals

3.4 Method of Partial Fractions

3.5 Trigonometric Substitutions

3.6 Integration by Parts

Recommended Book:

1. Jagdish C. Arya and Robin W. Lardner (1979), Mathematics for the Biological Sciences, Prentice-Hall, Inc.

Reference Book:

1. Erin N. Bodine, Suzanne Lenhart and Louis J. Gross, Mathematics for the Life Sciences, Princeton University Press, 2014.

2. Edward Batschelet, Introduction to Mathematics for Life Scientists, 3rd Edition (1979), Springer.

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MTS-291- MN: (C) Mathematics for Computer Science-II (Computational Geometry)

Course type: Minor **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Understand the fundamental concepts and mathematical representations of two-dimensional transformations, including translation, rotation, scaling, reflection, and shearing.

2. Apply transformation matrices to perform and combine 2D geometric transformations on points, lines, and simple shapes using homogeneous coordinates.

3. Analyze three-dimensional transformations such as scaling, shearing, reflection, and rotation about coordinate axes and planes, and their application in object manipulation.

4. Construct and interpret different types of projections, including orthographic, axonometric, and oblique projections, for visualizing 3D objects on 2D planes.

5. Develop parametric representations of common plane curves such as circles and hyperbolas, and generate these curves through mathematical methods.

6. Demonstrate the ability to integrate multiple transformation techniques and projections to solve basic computer graphics problems involving geometric modeling.

Course Content

Unit 1: Two dimensional transformations **(10 Hours)**

1.1 Introduction

1.2 Representation of points

1.3 Transformations and matrices.

1.4 Transformation of points.

1.5 Transformation of straight lines

1.6 Midpoint Transformation

1.7 Transformation of parallel lines

1.8 Transformation of intersecting lines

1.5 Transformation: rotations, reflections, scaling, shearing

1.6 Combined transformations

1.7 Transformation of a unit square.

1.8 Solid body transformations

1.9 Translations and homogeneous coordinates

Unit 2: Three dimensional transformations **(07 Hours)**

2.1 Introduction

2.2 Three dimensional Scaling, shearing, rotation, reflection, translation

2.3 Multiple transformations

2.4 Rotation about an axis parallel to coordinate axes,

2.5 Reflection through coordinate planes

Unit 3: Projection **(07 Hours)**

3.1 Orthographic projections.

3.2 Axonometric projections.

3.3 Oblique projections.

3.4 Application of projection

Unit 4: Plane Curves **(06 Hours)**

4.1 Introduction

4.2 Curve representation

4.3 Parametric curves

4.4 Parametric representation of a circle and generation of circle

4.5 Parametric representation of an hyperbola and generation of hyperbola

Text Book:

1. D. F. Rogers, J. A. Adams, Mathematical elements for Computer graphics, Mc Graw Hill Intnl Edition.

   Chapter 1: 2-1 to 2.14

   Chapter 2: 3.1 to 3.7,

   Chapter 3: 3.12 to 3.12

   Chapter 4: 4.1, 4.2, 4.6

Reference books:

1. Schaum Series, Computer Graphics. .
2. M. E. Mortenson, Computer Graphics Handbook, Industrial Pres Inc

MTS-292-MN:Practical on (A) Mathematics for Physical Science-II
or
MTS-292-MN:Practical on (B) Mathematics for Life Sciences-II
or
MTS-292-MN:Practical on (C) Mathematics for Computer Science-II

Course type: Minor **No. of Credits: 02(P)**

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[Open Electives for the Students other than Faculty of Science]

OE-251-MTS: (A) Mathematics for Competitive Exams-II

Course type: OE **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Understand the basic concepts of quantitative ability.
2. Acquire satisfactory competency in use of Mathematical reasoning.
3. Develops theoretical, applied and computational skills.
4. Develop strong analytical and mathematical skill for the competitive exams.
5. Solve campus placements aptitude papers covering Quantitative Ability.
6. Compete in various competitive exams like Banking, CAT, CMAT, GATE, GRE, GATE, MPSC, UPSC etc.

Course Content

Unit 1: Calendar and Clocks **(05 Hours)**

1.1 Calendar Problems

1.2 Clock Problems

Unit 2: Geometry and Mensuration **(10 Hours)**

2.1 Lines and Angles

2.2 Triangles

2.3 Quadrilaterals

2.4 Circles

2.5 Polygons

2.6 Areas and Volumes

Unit 3: Permutation and Combination **(08 Hours)**

3.1 Problems on linear arrangement

3.2 Problems on circular arrangement

3.3 Problems when repetitions are allowed

3.4 Problems on selections

Unit 4: Probability **(07 Hours)**

4.1 Problems on coins, dice, leap year and non-leap year

4.2 Problems on deck of cards, balls

4.3 Problems on addition and multiplication theorems

Recommended Books:

1. Fast Track Objective Arithmetic by Rajesh Verma
2. Handbook for Mathematics by Arihant Experts.
3. Quantitative Aptitude for Competitive Examinations by R S Aggarwal .
4. Objective Arithmetic (SSC and Railway Exam Special) by R.S Aggarwal.
5. Teach Yourself Quantitative Aptitude by Arun Sharma.
6. The Pearson Guide To Quantitative Aptitude For Competitive Examination by Dinesh Khattar.
7. Quantitative Aptitude for all Competitive Exam by Abhijit Gupta.
8. NCERT Math Books for 10th,11th and 12th.

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OE-251-MTS: (B) Mathematics for Social Science-II

Course type: OE **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Explain the various measures of dispersion and their applications in social sciences.
2. Assess the symmetry of frequency distributions using skewness measures such as Bowley's and Karl Pearson's coefficients.
3. Evaluate frequency distribution's peakedness and shape using kurtosis measures.
4. Apply statistical techniques learned to real-world problems in social sciences and related fields.
5. Calculate and describe data through measures of central dispersion.
6. To enhance applications of statistical techniques in social sciences

Course Content

Unit 1: Measures of Dispersion **(15 Hours)**

1.1 Concept of dispersion, characteristics of good measure of dispersion.

1.2 Range, Semi-interquartile range (Quartile deviation): Definition. Mean deviation: Definition, statement of minimal property (without proof). Mean squared deviation: Definition, minimal property of mean squared deviation (without proof).

1.3 Variance and standard deviation: Definition, effect of change of origin and scale (without proof).

1.4 Measures of dispersion for comparison: coefficient of range, coefficient of quartile deviation and coefficient of mean deviation, coefficient of variation (C.V.)

Unit 2: Moments, Skewness and Kurtosis **(15 Hours)**

2.1 Moments: Raw moments and Central moments for ungrouped and grouped data, Effect of change of origin and scale on central moments (without proof). Relations between central moments and raw moments, upto 4-th order (only formulae)

2.2 Skewness: Concept of skewness of frequency distribution, positive skewness, negative skewness, symmetric frequency distribution.

2.3 Bowley's coefficient of skewness: Bowley's coefficient of skewness lies between -1 and 1(without proof), Karl Pearson's coefficient of skewness.

2.4 Kurtosis: Concepts of kurtosis, leptokurtic, mesokurtic and platykurtic frequency distributions. Measures of kurtosis based on moments. Comment on type of skewness.

Recommended Books:

1. Gupta, S. C. and Kapoor, V. K. (1997). Fundamentals of Applied Statistics, Third Edition, Sultan Chand and Sons Publishers, New Delhi.

2. Agarwal, B. L. (2003). Programmed Statistics, Second Edition, New Age International Publishers, New Delhi.

3. Ghosh, J. K. and Mitra, S. K., Parthsarthi, K. R. (1993). Glimpses of I ndia's Statistics Heritage, Wiley publishing Co.

4. Goon, A. M., Gupta, M. K. and Dasgupta, B. (1983). Fundamentals of Statistics, Vol. 1, Sixth Revised Edition, The World Press Pvt. Ltd., Calcutta.

5. Gupta, S. C. and Kapoor, V. K. (1983). Fundamentals of Mathematical Statistics, Eighth Edition, Sultan Chand and Sons Publishers, New Delhi.

6. Neil A. Weiss, (2016). Introductory Statistics, Tenth Edition, Pearson.

7. Purohit, S. G., Gore S. D., Deshmukh S. R. (2008). Statistics Using R, Narosa Publishing House, New Delhi.

8. Sarma, K. V. S. (2001). Statistics Made it Simple: Do it yourself on PC. Prentce Hall of India, New Delhi.

OE-251-MTS: (C) Commercial Mathematics II

Course type: OE **No. of Credits: 02(T)**

Course Outcomes: Students will able to

1. Recall and explain fundamental financial mathematics concepts
2. Compute interest, accumulated and discounted values in various financial scenarios
3. Analyze and interpret financial outcomes using the equation of value
4. Evaluate different financial instruments and repayment methods
5. Understand the basic concepts related the finance and become financially literate.
6. Design amortization schedules and annuity plans for practical scenarios

Course Contents

Unit 1: : Simple Interest and Compound Interest (15 Hours)

1.1 Simple Interest

- The time between dates
- Equation of value
- Partial payments
- Simple discount

1.2 Compound interest

- Accumulated value
- Equivalent rates
- Discounted value
- Accumulated and discounted values for fractional periods
- Finding the rate
- Finding the time
- Equation of value
- Compound discount a ta discount rate

Unit 2: : Annuities and Loans (15 Hours)

2.1 Annuities

Definition and notation

- Accumulated value of an ordinary simple annuity
- Discounted value of an ordinary simple annuity
- Other simple annuities
- Finding the term of an annuity
- Finding the interest rate
- General annuities
- Perpetuities
- Annuities whose payments vary

2.2 Loans and sinking funds

- EMI using flat interest rate method
- EMI using floating interest rate methods
- Amortization of a debt
- Outstanding principal
- Mortgages
- Refinancing a loan
- Sinking funds
- Comparison of amortizations and sinking fund methods

Reference Books:

1. Mathematics of Finance, Petr Zima, Robert L. Brown, Schaum's Outline Series, McGraw Hill (2nd edition)
2. Math in Society, David Lippman, Open Education Resource (OER) Libre Texts Project
3. Financial Mathematics, A. Lenin Jothi, Himalaya Publishing House.

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MTS-271-VSC: R Programming

Course type: VSC **No. of Credits: 02(P)**

Course Outcomes: Students will able to

1. Demonstrate how to install R software.
2. Explain the use of data structures and conduct arithmetic operations.
3. Using R, solve complicated differentiation and integration problems.
4. Perform different operations on matrices and test their characteristics.
5. Visualize the data using a diagrammatic form.
6. Import datasets in R and export outputs from R.

Course Content

Unit 1: Introduction to R (20 Hours)

1.1 Getting Started with R Programming

R is a free, Open Source Programming Language, so students can download from R Programming project Website and install on their own machine (Linux, Windows or MacOS). They do have RStudio, which is an integrated development environment (IDE) that provides a user-friendly interface. The section covers the following topics.

- Installation of R
- Use of R console
- R script/ editor file, R Prompt, Menu Ribbon, Saving R editor/script file
- Clearing R console,
- Comments (single line, multiple line)
- Packages,
- Taking help in R
- Closing R session.

1.2 R Operators:

Assignment Operators: =, $<-$, $->$, $<<-$, $->>$, assign()

Arithmetic Operators: addition (+), subtraction (-), multiplication (*), division(/), exponent (ˆ or **), remainder operator (%%), Integer division (%/%)

Comparison Operators: equal to (==), less than (<), greater than (>), less than or equal to (<=), greater than or equal to (>=), not equal to (! =)

Logical Operators: element wise logical AND (&), logical AND (&&), element wise logical OR (|), logical OR (| |), logical NOT (!), xor(), isTRUE(), isFALSE().

1.3 Data Structures and R Objects: Constants, Variables, Vectors, Matrices, Data Frame, Factors, Lists, Arrays

Vectors: creating vectors using scan(), combine (c()), seq(), sequence operator (:), rep(). numeric vector, character vector, factors, converting numeric vectors into character vectors, converting character vectors into factors, checking variable types using class(), typeof(), is.numeric(), is.character(), is.factor(), arithmetic operations on vectors, printing vectors using print(), cat() functions.

Matrices: creating matrix using matrix(), creating identity matrix using diag(), creating null matrix using diag(), converting matrices into data frames using as.data.frame(), checking the dimensions of the matrix using dim(), nrow(), ncol(), extracting rows, columns or elements of matrix.

Data frames: creating dataframes using data.frame(), converting data frames into matrices using as.matrix(), view data frames in a new window using View(), extracting variables from a dataframe using $ and [ ], subsetting of data frames using subset() and [ ].

Lists: Creating lists, storing and extracting elements of lists, applying functions on list using lapply().

1.4 R as a calculator:

BODMAS rule. Basic Mathematical functions: sqrt(), exp(), abs(), round() ceiling(), floor(), log(), log10(), sum(), prod(), cumsum(), cumprod(), min(), max(), diff(), sign(), pi, sort(), order(), etc.

Complex Numbers: complex(), is.complex(), as.complex(), Re(), Im(), Mod(), Arg(), Conj() etc.

Special Functions: beta(), gamma(), choose() and factorial() in base R, combn() and permn() available in R package combinat.

Trigonometric functions: sin(), cos(), tan() etc.

Set operations: union(), intersect(), setdiff(), setequal(), is.element(), %in%, all(), cross product of two sets.

Unit 2: Matrix Operations in R **(15 Hours)**

2.1 Matrix Manipulation: dim(), colnames(), rownames(), cbind() , rbind(), colSums(), rowSums(), colMeans(), rowMeans(), apply().

2.2 Arithmetic Operations on matrix: Addition, subtraction, multiplication of matrices, row sums and column sums of matrix, power of a matrix.

2.3 Matrix Product: matrix multiplication (%*%), crossprod(), Outer product (%o%).

2.4 Rank of matrix using rankMatrix(), transpose of a matrix using t(), Finding determinant of matrix using det(), finding inverse of matrix using solve(), trace of a matrix.

2.5 Verifying properties of trace of matrix and transpose of matrix, solving system of linear equations using solve().

Unit 3: Differentiation and Integration in R **(10 Hours)**

3.1 Defining mathematical functions in R, expression(), D(), deriv, eval(), numericDeriv(),

3.2 integrate(), uniroot(), ysym(), Sym(), lim(), Limit().

3.3 Examples on differentiation and integration.

3.4 Solving polynomial equations using polyroot()

Unit 4: Data Visualization in R **(15 Hours)**

4.1 Importing data available in .csv and .txt files into R,

4.2 Exporting outputs and base R datasets in .csv and .txt files from R.

4.3 Pie diagram for raw data and frequency table, Venn diagrams.

4.4 Barplot: simple barplot, subdivided barplot, multiple barplot.

4.5 line plot for time series data, spike plot for discrete frequency distribution,

4.6 Histogram for raw data and continuous frequency distribution with equal and unequal class width.

4.7 Exporting plots and diagrams from R in MS-word.

Recommended Books:

1. Long, J.D. Teetor P.(2019). R Cookbook (2nd Edition). O'Reilly Media, Inc.
2. Pfaff, T. (2019). R For College Mathematics and Statistics (first edition.). Chapman and Hall/CRC., New York.
3. Purohit, S.G.; Gore, S.D. and Deshmukh, S.R. (2015). Statistics using R (second edition). Narosa Publishing House, New Delhi.
4. Tilman M. Davies (2015). The Book of R: A First Course in Programming and Statistics (first edition). No Starch Press, USA.

List of Practicals

1. Using R as a calculator (Unit I)
2. Mathematical Computations using R functions (Unit I)
3. Vectors and arithmetic operations on vectors (Unit I)
4. Dealing with data frames and lists in R (Unit I)
5. Set Operations (Unit I)
6. Creating matrices and performing arithmetic operations (Unit II)
7. Computation of determinant, trace, inverse, power of matrix and verifying matrix properties (Unit II)
8. Solving system of linear equations (Unit II)
9. Solving differentiation problems using R (Unit III)
10. Solving integration problems using R (Unit III)
11. Visualization of the Data in R (Unit IV)
12. Graphical representation of the Data In R (Unit IV)

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