

**Carmel College of Arts, Science and Commerce for Women, Nuvem -
Goa**

Department of Mathematics

The B.Sc. Programme of Carmel College of Arts, Science and Commerce for Women, Nuvem, Goa endeavours to achieve the following outcomes:

PO1. Attribute: KNOWLEDGE. Inculcate in our learners a quest for knowledge and an understanding of fundamental concepts and scientific principles related to various phenomena in daily life.

PO2. Attribute: CRITICAL THINKING. Acquire practical skills in handling scientific instruments and other experimental analysis, observational and problem-solving skills and draw logical inferences from scientific experiments.

PO3. Attribute: RESEARCH. Encourage student engagement for research skill development.

PO4. Attribute: SUSTAINABLE DEVELOPMENT. Have an interdisciplinary approach and provide solutions for sustainable development.

PO5. Attribute: COMMUNICATION SKILLS. Have good communication skills which help in expressing ideas and views clearly and effectively.

PO6. Attribute: LIFE LONG LEARNING. Encourage a receptive mindset for lifelong learning.

PO7. Attribute: SOCIETY. To groom an eco conscious and ethical society.

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The Department of Mathematics, Carmel College of Arts, Science and Commerce for Women, Nuvem-Goa aims to achieve the following Programme Specific Outcomes.

PSO1: Attribute: Knowledge - To give a rigorous introduction of important Mathematical Concepts and help them to develop a critical eye towards Mathematical Theory.

PSO2: Attribute: Communication Skills - To inculcate the skill of communicating mathematics effectively to both lay as well as expert audiences utilizing appropriate information and communication technology.

PSO3: Attribute: Sustainable Development - To train students in setting up mathematical models of real world problems and obtain solutions in structured and analytical approaches with analytical judgement.

PSO4: Attribute: Critical Thinking and Research- To kindle curiosity among students to explore ideas and generate their own creative approach to solve problems.

SYLLABUS FOR B.Sc. MATHEMATICS DEGREE PROGRAM UNDER CBCS w.e.f. 2017-18

Discipline Specific Core (Mathematics) Papers for B.Sc.

| Sl. No. | Paper Code | Semester | Title | No. Of Credits. |
|---------|------------|----------|--|-----------------|
| 1 | DSC 1A | I | Calculus and Numerical Methods | 4+2 |
| 2. | DSC 1B | II | Matrices and Linear Algebra | 4+2 |
| 3. | DSC 1C | III | Ordinary Differential Equations and Discrete Mathematics | 4+2 |
| 4. | DSC 1D | IV | Analysis and Operations Research | 4+2 |

Skilled Enhancement Courses

| Sl. No. | Paper Code | Semester | Title | No. Of Credits. |
|---------|------------|----------|---------------------|-----------------|
| 1 | SEC 1 | III | Statistical Methods | 3+1 |
| 2. | SEC 2 | IV | Analytical Geometry | 3+1 |

Generic Elective Courses for Non Mathematics Students

| Sl. No. | Paper Code | Semester | Title | No. Of Credits. |
|---------|------------|----------|---|-----------------|
| 1. | GE-1 | I | Probability and statistics | 3+1 |
| 2. | GE-2 | II | Numerical Computations | 3+1 |
| 3. | GE-3 | III | Mathematics for Competitive Examination -I | 4 |
| 4. | GE-4 | IV | Mathematics for Competitive Examination -II | 4 |

B.Sc. Mathematics: (CBCS)

Semester I : DSC IA : Calculus and Numerical Methods

Semester II : DSC IB : Matrices and Linear Algebra

SYLLABUS

Semester I: DSC IA : Calculus and Numerical Methods. **Credits: 4+2**

Course outcome: On successfully completing the course the student will be able to:

1. Gain a thorough understanding of the real number system.
2. Have the knowledge and skills to determine if the infinite sequence is bounded, monotonic, convergent or divergent using appropriate tests.
3. Relate calculus to real-world problems.
4. Prove basic results in calculus.
5. Learn and apply various techniques from Numerical Methods

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 1 | 1 | 2 | 3 | 3 | 1 | 3 | 3 | 1 | 2 |
| CO2 | 3 | 3 | 2 | 2 | 2 | 3 | 1 | 3 | 3 | 2 | 3 |
| CO3 | 2 | 3 | 2 | 2 | 2 | 2 | 1 | 2 | 2 | 3 | 2 |
| CO4 | 3 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 3 | 2 | 2 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |

1. Real Number System: Algebra of real number system, Axioms of order structure in \mathbb{R} , Upper and Lower bounds of subsets of \mathbb{R} , lub of subsets of \mathbb{R} , Order completeness of \mathbb{R} ,

Archimedean property, Intervals and their types, Nested interval Theorem, Absolute value and their properties. **[12 hours]**

2. Real Sequences: Real Sequence (Definition and examples), Range of a sequence, Bounded sequence, Convergence of a sequence (Definition and examples), Uniqueness of limit of sequence, Algebra of sequences, Sandwich Lemma, Monotonic sequences and their convergence, Subsequence of a sequence (Definition and examples), Properties of subsequences, Bolzano Weierstrass theorem. **[12 hours]**

3. Limits and Continuity: Neighbourhood of a point, Deleted neighbourhood of a point, Limit of a function at a point (Definition and examples) Uniqueness of a limit, Algebra of

limits, Continuity of a function at a point (Definition and examples), Algebra of continuous of function, Left hand limit, Right hand limit, Types of discontinuities, Sequential continuity, Some more properties of continuous functions, Boundedness of continuous function on a closed interval, Intermediate value theorem for continuous functions, Image of the closed interval under a continuous function, Attaining maximum and minimum of a continuous function on closed interval, Fixed point of a function, Fixed point theorem for continuous function. **[12 hours]**

4. Derivatives and its Applications: Derivative of a function at a point (Definition and examples), Geometric interpretation of a derivative, Algebra of derivatives, Chain rule, Some more properties of the derivative, Darboux's theorem for differentiable functions, Intermediate value theorem for differentiable functions, Rolle's theorem and its geometric significance, Lagrange's mean value theorem and its geometric significance, Cauchy's mean value theorem and its geometric significance, Monotonic functions (Definition and examples), Monotonic functions and derivatives, Higher order derivatives, Taylor's theorem, Maclaurin's theorem, Taylor's and Maclaurin's series expansions, Leibnitz rule for higher order derivative of product of functions, Stationary points and their classification, Local maxima and Local minima, Condition for a stationary point to be local maxima and minima,

Indeterminate forms of the type $0, \infty - \infty, 0 \cdot \infty, 0^0, 1^\infty, \infty^0$. **[15**

hours].

5. Numerical Methods:

Calculus of Finite differences: Operators Δ , ∇ , & E . Difference Tables. Properties of Δ , ∇ , & E . Fundamental Theorem of Difference Calculus. Expression of any value of a function in terms of leading term and leading differences of a difference table. Method of separation of symbols.

Interpolation and Extrapolation: Newton's forward and backward interpolation formulae. Lagrange's Interpolation formula. Newton's Divided Difference formula. Examples based on the above formulae.

Numerical Differentiation and Integration: Differentiation formulae for equidistant arguments. Examples. General quadrature formula for equidistant ordinates (Newton – Cotes Formula Or Gauss Legendre quadrature formulae). Trapezoidal rule and its Geometrical interpretation. Simpson's one third rule, Simpson's three-eighth rule. Weddle's rule (Only Statements)

Solution of Algebraic and transcendental Equations: Method of Bisection, Regula-Falsi Method, Newton-Raphson Method and their Computation scheme. Special Cases of Newton Raphson Method like finding q^{th} root of a positive real number 'd' and finding reciprocal of a positive real number 'd' without using division. **[09 hours]**

List of Practical sessions: (4 hours each)

1. Basics of Programming, Programming Languages, Python syntax, If, Elif, Else and while loops, simple programs involving these loops.
2. Computing limits using $\epsilon - \delta$ definition.
3. Checking if a function is continuous & identifying discontinuity.
4. Finding Taylors and Maclaurin series expansions.
5. Identifying and classifying stationary points and finding local maxima and minima of

a function.

6. Using L'hospital's rule to compute limits.
7. Newton-Gregory Forward and Backward Interpolation Formulae.
8. Lagrange's Interpolation Formula for unequal intervals and Newton's Divided difference formula for unequal intervals
9. Numerical Differentiation: Using Differentiation formulae for equidistant arguments .
10. Numerical Integration: Trapezoidal rule, Simpson's one third rule and Weddle's rule.
11. Solution of Algebraic and transcendental equations by the Bisection method.
12. Solution of Algebraic and transcendental equations by the Regula Falsi method and the Newton-Raphson method.

Note: Practicals should be done by using free software like Python, C++, etc.

Principal Texts:

1. A Basic Course in Real Analysis, Ajit Kumar & S. Kumaresan, CRC Press.
2. Introductory Methods of *Numerical Analysis* By S.S.Sastry. PHI

References:

1. Introduction to Real Analysis, Robert G. Bartle & Donald R. Sherbert, Wiley Student Edition.
2. Mathematical Analysis, Tom Apostol, Narosa Publishing House.
3. Calculus (Vol. 1), Tom Apostol , Wiley Student Edition.
4. Shaum's outline on Advanced Calculus, Robert Wrede & Murray R. Spiegel, Tata McGraw Hill.
5. Numerical methods: Problems & Solutions. M. K. Jain, Iyengar, Jain. Wiley Eastern.
6. Calculus of Finite difference & Numerical Analysis: Gupta & Malik, Krishna Prakashan Mandir , Meerut.

Semester II: UMTC 102 :Matrices and Linear Algebra. Credits: 4+2

Course outcome: On successfully completing the course the student will be able to:

1. To examine and to find the solutions of the system of linear equations using Gauss elimination and matrix methods.
2. Analyze finite and infinite dimensional vector spaces and subspaces over a field and their properties, including the basis structure of vector spaces,
3. Analyze linear transformations and its properties.
4. Compute with the characteristic polynomial, eigenvectors, eigenvalues and eigenspaces, as well as the geometric and the algebraic multiplicities of an eigenvalue and

apply the basic diagonalization result.

5. Compute inner products and determine orthogonality on vector spaces and construct an orthonormal basis for a real vector space.

6. Construct computer programs to perform matrix operations, row transformations, solve systems of linear equations and to diagonalise matrices.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 2 | 1 | 2 | 2 | 2 | 1 | 3 | 3 | 2 | 2 |
| CO2 | 3 | 3 | 2 | 1 | 3 | 3 | 2 | 3 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 3 |
| CO5 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 3 | 3 |
| CO6 | 2 | 3 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 3 | 3 |

Syllabus

System of linear equations [Nicholson, Chapter 1]: Solutions & Elementary Operations: (Linear system of equations, solutions, equivalence of 2 systems, elementary operations on equations, elementary row operations). Gaussian Elimination: (Row /Row reduced echelon forms, Gaussian algorithm, Rank). Homogeneous Equations: (Sufficient condition for the existence of non-trivial solution). **[6 hours]**

Matrix Algebra[Nicholson, Chapter 2]: Matrix Addition, Scalar multiplication, Transposition: (Definition, properties, symmetric matrix). Matrix Multiplication:(Definition, properties, block multiplication). Matrix Inverses: (Definition, uniqueness, properties, Matrix inversion algorithm (row reduction)). Elementary Matrices:(Definition, Properties, theorems). **[3 hours]**

Determinants [Nicholson, Chapter 3]:The Laplace Expansion: (Determinant, properties, upper/ lower triangular matrices). Determinant & Matrix inverses (Product theorem & other related theorems, orthogonal matrices, minors, co-factors, adjoint formula for A^{-1} , Cramer's rule) **[3 hours]**

Vector Spaces: Definition and examples, Vector subspaces, Basis and Dimension of Vector Spaces. **[6 hours]**

Lines and Quotient Spaces: Definition of a line, Affine spaces, Quotient Spaces. [6 hours]

Linear Transformations: Linear Transformation, Representation of linear maps by matrices, Kernel and Image of a Linear Transformation, Linear Isomorphism, Geometric ideas and some loose ends, Some special Linear Transformations. [9 hours]

Inner Product Spaces: Inner Product Spaces, The Euclidean plane and the dot product, General Inner Product Spaces, Orthogonality, Some geometric applications, Orthogonal projection onto a line, Orthonormal basis, Orthogonal complements and projections, Linear Functionals and Hyperplanes, Orthogonal Transformations, Coordinates associated with an Orthonormal Basis, Reflections and Orthogonal Maps of the Plane. [9 hours]

Diagonalization: Rotation of axes of conic, Eigenvalues and eigenvectors, Cayley-Hamilton theorem, Diagonalisation of symmetric matrices. [9 hours]

Review Problems: Linear equations, Linear dependence, Basis and Dimension, Linear Transformations, Euclidean Spaces, Problems in Linear Geometry, Miscellaneous problems. [9 hours]

List of Practical sessions (4 hours each)

1. For loop, List comprehensions, Entering matrices as lists within a list. Addition, Scalar multiplication, Transpose.
2. Multiplication of matrices
3. Minors of a matrix
4. Determinant of a matrix.
5. Inverse of a matrix using Adjoint
6. Cramer's Rule.
7. Defining a function to multiply a row by a scalar
Defining a function to interchange 2 rows
Defining a function to replace row (i) by row(i) + z row(j).
8. Program to perform row reduction to Reduced row-echelon form
9. Program to generate nxn identity matrix.
10. Program to find inverse of a matrix using row reduction.
Program to solve a system equations using Gaussian elimination.
11. Finding eigen vectors of a matrix (with real eigen values upto order 2x2).
12. Diagonalization of a Matrix (with distinct real eigen values upto order 2x2)

Note: Practicals should be done by using free software like Python, C++, etc.

Principal Texts:

1. Linear algebra with applications by Keith Nicholson (3rd Edition, PWS publishing company).
- 2 Linear Algebra, A Geometric Approach, S. Kumaresan, PHI Learning Private Limited. (Chapter 6 omitted.)

References:

1. An Introduction to Linear Algebra, V Krishnamurthy, V P Mainra, J L Arora, Affiliated East-West Press Pvt. Ltd.
2. Theory and Problems of Linear Algebra, Seymour Lipschitz, Schaum's Outline Series, McGraw-Hill Book Company.
3. Linear Algebra, Kenneth Hoffman and Ray Kunze, EEE Publication.
4. Linear algebra and applications by Gilbert Strang (4th Edition, Cengage Learning)

Semester – III Credits: 4+2**DSC 1C: Differential Equations and Discrete Mathematics****Course outcome:**

- 1 -Recognize ODEs and system of ODEs concepts that are encountered in the real world, understand and be able to communicate the underlying mathematics involved to help another person gain insight into the situation.
- 2 -Work with ODEs and systems of ODEs in various situations and use correct mathematical terminology, notation, and symbolic processes in order to engage in work, study, and conversation on topics involving ODEs and systems of ODEs with colleagues in the field of mathematics, science or engineering.
- 3 -Analyze real world scenarios to recognize when ordinary differential equations (ODEs) are appropriate, formulate problems about the scenarios, creatively model these scenarios in order to solve the problems using multiple approaches, judge if the results are reasonable, and then interpret and clearly communicate the results.
- 4 -To understand and apply the fundamental concepts in graph theory for solving practical problems. Demonstrate different traversal methods for trees and graphs. Model real world problems using graph theory.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 3 | 2 | 1 | 3 | 3 | 3 | 3 |
| CO2 | 3 | 1 | 1 | 1 | 3 | 1 | 1 | 3 | 3 | 1 | 1 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 2 | 1 | 3 | 3 | 1 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 3 | 2 | 3 | 2 |

Syllabus:

1. FIRST ORDER ORDINARY DIFFERENTIAL EQUATIONS:-

Review of Basic concepts such as order, degree, formation, solution and their types of differential equations. First order first degree differential equation and initial value problem. Method of separation of variables. Homogeneous and Non - homogeneous differential equation. First order linear differential equations. Bernoulli's differential equation. Exact and Non – exact differential equations. Condition for exactness. Integrating factors and rules to find integrating factors. Clairaut's differential equation and differential equations reducible to Clairaut's form. Riccati's differential equation. Applications of first order differential equations. Modeling with differential equations.

(8 Hours)

2. SECOND ORDER LINEAR DIFFERENTIAL EQUATIONS:-

General form of second order linear differential equation and its classification. Existence and Uniqueness theorem for solution of second order linear differential (Only statement). Second order homogeneous linear differential equation and its properties. Wronskian of solutions of homogeneous linear differential equation and its properties. Linear dependence and independence of solutions of homogeneous differential equation. Complementary function. Use of known solution to find second linearly independent solution of homogeneous differential equation. Homogeneous linear differential equations with constant coefficients and with variable coefficients. Method of undetermined coefficients. Method of variation of parameters. Applications of second order linear differential equations. **(10 Hours)**

3. D – OPERATORS:-

D – Operator method to solve n^{th} order homogeneous linear differential equation with constant coefficients. Properties of D – Operator. Inverse D – operator and its properties. Inverse D – operator method to solve n^{th} order Non - homogeneous linear differential equation with constant coefficients $f(D) = R(x)$, where $R(x) = e^{ax}$, $\cos ax$, $\sin ax$, polynomial in x and their products. **(8 Hours)**

4. SYSTEM OF 1ST ORDER DIFFERENTIAL EQUATIONS:-

Conversion of n^{th} order differential equation to first order system of differential equations. Existence and uniqueness of solution (statement only). “ 2×2 ” homogeneous linear first Order system of differential equations and their solution. Wronskian of “ 2×2 ” homogeneous linear first order system of differential equations and its properties. Linear dependence and independence of solutions of “ 2×2 ” homogeneous linear first order system of differential equations. Matrix method to solve “ 2×2 ” homogeneous

linear first order system of differential equations with constant coefficients. Method of solving “ 2×2 ” Non-homogeneous linear first order system of differential equations with constant coefficients. **(10 Hours)**

5. GRAPH THEORY:-

Introduction. Basic terminology. Types of Graphs. Multigraphs and Weighted graphs. Isomorphism of graphs. Paths and circuits. Shortest path in weighted graphs. Eulerian paths and circuits. Hamiltonian paths and circuits. Factors of graphs. planar graphs. **(12 Hours)**

6. TREES AND CUT-SETS:-

Trees. Rooted trees. Path lengths in rooted trees. Prefix codes. Binary search trees. Spanning trees and cut-sets. Minimum spanning tree. Kruskal’s algorithm. Prim’s algorithm. Transport network. **(12 Hours)**

List of practical sessions (4 hours each):

1. General solution of $\frac{dy}{dx} = a_1x + b_1y + c_1$.
2. General solution of $M(x, y)dx + N(x, y)dy = 0$.
3. Method of undetermined coefficients.
4. Method of variation of parameters.
5. Inverse D – operator method to solve $f(D) = R(x)$.
6. Matrix method to solve “ 2×2 ” homogeneous linear first order system of differential equations.
7. Shortest path using Dijkstra’s algorithm for weighted graphs.
8. Eulerian paths and circuits in graphs.
9. Hamiltonian paths and circuits in graphs.
10. Prefix Codes in trees.
11. Minimum Spanning tree using Kruskal’s algorithm.
12. Minimum Spanning tree using Prim’s algorithm.

Principal texts:

1. Differential Equations and Their Applications: Martin Braun (Springer)
2. Elements of Discrete Mathematics: C. L. Liu and D. P. Mohapatra (Tata Mcgraw Hill) **References:**

1. Differential Equations with Applications and with Historical Notes: G. F. Simmons (Tata Mcgraw Hill)
2. Ordinary Differential Equations: E. A. Coddington (PHI Learning Pvt. Ltd.)
3. Shaum’s Outline on Differential Equations: Richard Brownson (Tata McgrawHill)
4. Discrete Mathematical Structures: Kolman, Busby and Ross (PHI Learning Pvt. Ltd.)
5. Discrete Mathematics and Applications: Kenneth Rosen (TMH).
6. Shaum’s Outline on Discrete Mathematics: Seymour Lipschutz and Marc Lipson (Tata Mcgraw Hill).

Semester – IV Credits: 4+2 DSC 1D: Analysis and Operations Research

Course outcomes:

On successfully completing the course a student will be able to :

1. Apply the knowledge of convergence to determine if the infinite series is convergent or divergent by selecting the appropriate test
2. Acquire the idea about Riemann Integrability and Riemann Integration and prove various theorems associated with Riemann Integration
3. Distinguish between Pointwise convergence and Uniform Convergence of a sequence of functions.
4. Check the uniform convergence of series using various tests and illustrate the effect of uniform convergence on the limit function with respect to continuity, differentiability, and integrability
5. To provide solutions to real life or industry problems using operations research.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 2 | 1 | 3 | 1 | 1 | 3 | 3 | 1 | 3 |
| CO2 | 3 | 3 | 1 | 1 | 3 | 1 | 1 | 3 | 3 | 1 | 2 |
| CO3 | 3 | 3 | 2 | 2 | 3 | 2 | 1 | 3 | 3 | 2 | 3 |
| CO4 | 3 | 3 | 2 | 1 | 3 | 1 | 1 | 3 | 3 | 2 | 3 |
| CO5 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |

Syllabus:

1. Infinte Series [Ajit kumar, Chapter 5]:

Convergence of infnite series, absolute convergence, Conditional convergence, Geometric series, Cauchy criterion for convergence, Algebra of convergent series, Comparision test, Convergence of Harmonic P-series, D'Alembert ratio test, Cauchy nth root test, Leibniz test or alternating series test. **[10 hours]**

2. Riemann Integration [Ajit kumar, Chapter 6]:

Darboux Integrability, Criterion for integrability, Properties of integrabilities. First fundamental theorem of calculus, Second fundamental theorem of calculus, integration by parts, Mean value theorems for integrals, First mean value theorem for integrals, Second mean value theorem I, Second mean value theorem II, Riemann original definition. **[20 hours]**

3. Sequences and Series of functions[Ajit kumar, chapter 7]:

Pointwise convergence of sequence of functions and examples, Uniform convergence of sequence of functions and examples, Mn-Test, Cauchy Criterion for uniform convergence, Consequences of Uniform convergence, Continuity of limit function, Series of functions, Absolute convergence, Cauchy Criterion for uniform convergence of a series, Weierstrass M test, Weierstrass Approximation Theorem. **[10 hours]**

4. Operations Research

Fundamentals: Linear Programming problems, Convex sets, Extreme points of Convex sets, Convex Polyhedron, hyperplanes, Graphical Method, Simplex Method, Theorems on simplex method, Big-M method, Two phase method, Unrestricted variables, Duality and solution using duality, Theorems on Duality, Dual Simplex method, Post Optimal Analysis (Discrete changes in cost and requirement vector) Transportation Problems, North west corner method, Vogel's approximation method, Modi Method, Assignment Problems, Hungarian Method, Basics of Inventory control, Inventory model with No shortages and Instantaneous production, Inventory model with Shortages allowed and Instantaneous production. Basics of Queueing theory, Queueing Model (M/M/1):(1/FIFO), Queueing Model (M/M/1):(N/FIFO). [20 hours] **List of Practical sessions [4**

hours each]

1. Basics of Linear Programming problems including Formulation.
2. Graphical Method
3. Simplex Method, Unbounded solution, Alternate solution
4. Big-M method, unrestricted variables.
5. Two phase method
6. Duality and solution using duality.
7. Dual Simplex method
8. Post Optimal Analysis (Discrete changes in cost and requirement vector) 9.
9. Transportation Problems, existence of solution (North west corner method, Vogel's approximation method)
10. Transportation Problems (Modi Method, Problems to Minimize/Maximize objective function)
11. Assignment Problems (Hungarian Method)
12. Basics of inventory control, Inventory model with No shortages and Instantaneous production.
13. Inventory model with Shortages allowed and Instantaneous production.
14. Queueing Model (M/M/1):(1/FIFO)
15. Queueing Model (M/M/1):(N/FIFO)

Principal texts:

1. A Basic Course in Real Analysis, Ajit Kumar and S.Kumaresan ; CRC Press.
2. Linear Programming by G. Hadley; Addison.

References:

1. Mathematical Analysis I, R.D.Bhat, Vipul Prakashan, Mumbai.
2. Mathematical Analysis II, R.D.Bhat, Vipul Prakashan, Mumbai.
3. Introduction to Real analysis, Robert G. Bartle, Donald R. Sherbert, Third edition, Wiley Publication.
4. Methods of Real analysis, Richard R. Goldberg, Oxford and IBH publishing Co.pvt.ltd.
5. Calculus Vol-I, Tom M. Apostol, Second edition, Wiley Publication.
6. Operations Research, Kanti Swarup and Gupta, S. Chand and company, Delhi.

Semester – III Credits: 4

SEC 1 : Statistical Methods

Course outcomes:

1. Know the uses and limitations of statistics.
2. Find and apply descriptive statistics.
3. To apply the various laws of probability to concrete problems
4. To write the probability distribution and mathematical expectations of a random variable. and to study the different types of theoretical distribution.
5. Perform statistical inference tests in different situations and interpret the results in an applied context.
6. Use statistical softwares for computations with data.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| CO3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| CO4 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 |
| CO5 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| CO6 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |

1. Introduction- Meaning and Scope: Definition of Statistics, Importance and scope of Statistics, Limitations of Statistics, Distrust of Statistics. **(2 hours)**

2. Correlation and Regression Analysis: Introduction. Karl Pearson's coefficient of Correlation, Rank correlation method. Regression Analysis. **(10 hours)**

3. Theory of Probability: Introduction, Mathematical probability, Statistical probability, Axiomatic probability, Addition theorem of probability.(Proof omitted), Multiplication theorem of probability. Pair wise and mutual independence, Inverse probability – Baye's theorem. **(6 hours)**

4. Random Variables: Probability Distributions and Mathematical Expectation: Random variable, Probability distribution of a Discrete Random Variable, Probability distribution of a Continuous Random Variable, Mathematical Expectations. **(3 hours)**

5. Theoretical Distributions: Binomial distribution, Poisson Distribution, Normal Distribution. **(5 hours)**

6. Testing of Hypothesis: Interval Estimation, Testing of Hypothesis. **(3 hours)**

7. Large sample tests: Introduction, Sampling of Attributes, Sampling of Variables. **(4 hours)**

8. Parametric tests: Student's t distribution, ANOVA, Post-hoc analysis. **(10 hours)**

9. Non-Parametric tests: Chi Square test, Mann-Whitney test, Kruskal walli's test. **(7hours)**

List of Practicals (Using R or similar softwares) (10 hours)

1. Finding measures of central tendency, namely, mean, median and mode.
2. Finding measures of dispersion, namely, range, quartile deviation, mean deviation and standard deviation.
3. Testing of hypothesis for single mean and difference of means using „t- test“ and paired „t- test“.
4. Testing of hypothesis for more than two means using ANOVA.
5. Testing of hypothesis regarding independence of attributes using Chi square test.
6. Testing the hypothesis stating that the k independent samples have been drawn from the populations which have identical distributions using Kruskal Walli’s test.

References:

1. Fundamentals of Statistics, S.C Gupta, Himalaya Publishing House, Seventh Edition.
(Principal

*Reference for purpose of conducting practicals only.

1) Fundamentals of Mathematical Statistics, S.C Gupta, V.K Kapoor, S.Chand Publications. 2) Mathematical Statistics, J.N Kapur, H.C Saxena, S.Chand Publications. 3) Probability, Statistics and Random Processes, T Veerarajan, McGraw Hill Education (India) Private Limited.
 4) Probability Theory, B. R. Bhat, New Age International, 2007.

Semester – IV Credits: 4

SEC 2 : Analytical Geometry

Course outcome:

1. To review and discuss in detail various curves and surfaces in R^2 and R^3 .
2. To understand the polar coordinate system R^2 and to review the various curves in polar form.
3. To understand the polar-cylindrical and spherical coordinate system in R^3 and to be able to transform the coordinates.
4. To visualize curves and surfaces in R^2 and R^3 with the help of softwares such as Geogebra.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 3 | 2 | 1 | 2 |
| CO2 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 1 | 1 |
| CO3 | 3 | 2 | 1 | 2 | 1 | 1 | 1 | 3 | 2 | 1 | 1 |
| CO4 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 3 |

Syllabus:

1. **Metric Properties on the Plane.** (3 hours)
2. **Straight Lines in the Plane.** (3 hours)
3. **Circles in Plane.** (3 hours)
4. **Conics in the Plane and its plane sections.** (12 hours)
5. **Classification of Conics.** (5 hours)
6. **Polar Co-ordinate System.** (3hours)
7. **Co-ordinates in 3-space.** (3 hours)
8. **Plane in 3-space.** (4 hours)
9. **Lines in 3-space.** (3 hours)
10. **Transformation of Co-ordinates.** (4 hours)
11. **Sphere.** (4 hours)
12. **Cones.** (4 hours)
13. **Cylinder.** (4 hours)
14. **The Conicoid.** (5 hours)

Reference:

1. Analytic Geometry: Two and Three Dimension, D. Chatterjee, Narosa Publishing House, 2009.
2. Analytic Geometry, Shanti Narayan and P. K. Mittal, S. Chand and Company Ltd, 2007.

Remark:

1. Tracing of general second degree conics/conicoids using the mathematical software GEOGEBRA, SAGE, MATH and PYTHON.
2. Properties of pair of lines, circles, parabola, Ellipse etc., may be verified using mathematical softwares lime GEOGEBRA/SAGEMATH.

Semester I

GE-01

COURSE: Probability and statistics

Course outcomes:

1. Know the uses and limitations of statistics.
2. Find and apply descriptive statistics.
3. To apply the various laws of probability to concrete problems
4. To write the probability distribution and mathematical expectations of a random variable. and to study the different types of theoretical distribution.
5. Perform statistical inference tests in different situations and interpret the results in an applied context.
6. Use statistical softwares for computations with data.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |
| CO2 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| CO3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| CO4 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 |
| CO5 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 |
| CO6 | 3 | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 3 | 3 | 3 |

1. Introduction- Meaning and Scope: Definition of Statistics, Importance and scope of Statistics, Limitations of Statistics, Distrust of Statistics. **(2 hours)**

2. Correlation and Regression Analysis: Introduction. Karl Pearson's coefficient of Correlation, Rank correlation method. Regression Analysis. **(10 hours)**

3. Theory of Probability: Introduction, Mathematical probability, Statistical probability, Axiomatic probability, Addition theorem of probability.(Proof omitted), Multiplication theorem of probability. Pair wise and mutual independence, Inverse probability – Baye's theorem. **(6 hours)**

4. Random Variables: Probability Distributions and Mathematical Expectation: Random variable, Probability distribution of a Discrete Random Variable, Probability distribution of a Continuous Random Variable, Mathematical Expectations. **(3 hours)**

5. Theoretical Distributions: Binomial distribution, Poisson Distribution, Normal Distribution. **(5 hours)**

6. Testing of Hypothesis: Interval Estimation, Testing of Hypothesis. **(3 hours)**

7. Large sample tests: Introduction, Sampling of Attributes, Sampling of Variables. **(4 hours)**

8. Parametric tests: Student's t distribution, ANOVA, Post-hoc analysis. **(10 hours)**

9. Non-Parametric tests: Chi Square test, Mann-Whitney test, Kruskal walli's test. **(7hours)**

List of Practicals (Using R or similar softwares) (10 hours)

1. Finding measures of central tendency, namely, mean, median and mode.
2. Finding measures of dispersion, namely, range, quartile deviation, mean deviation and standard deviation.
3. Testing of hypothesis for single mean and difference of means using „t- test“ and paired „t- test“.
4. Testing of hypothesis for more than two means using ANOVA.
5. Testing of hypothesis regarding independence of attributes using Chi square test.
6. Testing the hypothesis stating that the k independent samples have been drawn from the populations which have identical distributions using Kruskal Walli’s test.

References:

1. Fundamentals of Statistics, S.C Gupta, Himalaya Publishing House, Seventh Edition. (Principal)

*Reference for purpose of conducting practicals only.

- 1) Fundamentals of Mathematical Statistics, S.C Gupta, V.K Kapoor, S.Chand Publications.
- 2) Mathematical Statistics, J.N Kapur, H.C Saxena, S.Chand Publications.
- 3) Probability, Statistics and Random Processes, T Veerarajan, McGraw Hill Education (India) Private Limited.
- 4) Probability Theory, B. R. Bhat, New Age International, 2007.

Semester II

GE-02

Course outcomes:

1. To find the roots of algebraic and transcendental equations using numerical techniques.
2. To understand the difference operators and the use of interpolation.
3. To compute differentiation and integration using simple numerical algorithms.
4. To find the polynomial approximations using the method of least squares.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 | 3 | 2 |
| CO2 | 3 | 3 | 2 | 3 | 3 | 2 | 1 | 3 | 3 | 3 | 2 |
| CO3 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 2 | 3 |
| CO4 | 3 | 3 | 2 | 3 | 3 | 3 | 1 | 3 | 3 | 2 | 3 |

COURSE: NUMERICAL COMPUTATIONS

1. **Elementary Error Analysis:** Introduction. Numbers: Exact and Approximate, Significant digit. Errors: Absolute, Relative and Percentage errors. Examples.
2. **Calculus of Finite Differences:** Operators Δ , ∇ & E . Difference tables. Properties of Δ , ∇ & E . Fundamental Theorem of Difference Calculus. Expression of any value of a function in terms of the leading term and leading differences of a difference table. Method of separation of symbols.

3. **Interpolation:** Newton's forward and backward interpolation formulae. Lagrange's Interpolation formula. Newton's Divided Difference formula, Examples based on the above formulae.
4. **Numerical Differentiation and Integration:** Difference formulae for equidistant arguments. Examples. General quadrature formula for equidistant ordinates (Newton-Cotes Formula Or Gauss Legendre quadrature formulae) Trapezoidal rule and its Geometrical interpretation. Simpson's one third rule, Simpson's three-eighth rule. Weddle's rule (only Statements)
5. **Solution of Algebraic and Transcendental Equations:** Introduction. Method of Bisection, Regula-Falsi Method, Newton-Raphson Method and their computation scheme. Special Cases of Newton-Raphson Method like finding qth root of a positive real number 'd' and finding reciprocal of a positive real number 'd' without using division.
6. **Approximations:** the least square polynomial approximation method (Linear, quadratic, Exponential)

Practicals :

- 1 Newton-Gregory Forward and Backward Interpolation Formulae.
- 2 Lagrange's Interpolation Formula for unequal intervals and Newton's Divided difference formula for unequal intervals
- 3 Numerical Differentiation: Using Differentiation formulae for equidistant arguments .
- 4 Numerical Integration: Trapezoidal rule, Simpson's one third rule and Weddle's rule.
- 5 Solution of Algebraic and transcendental equations by the Bisection method.
- 6 Solution of Algebraic and transcendental equations by the Regula Falsi method and the Newton-Raphson method.
- 7 The least square polynomial approximation (Linear, quadratic)
- 8 The least square polynomial approximation(Exponential)

Semester – III Credits: 4

GE-3: Mathematics for Competitive Examination –I

Course outcome:

Will be able to attempt the mathematical and logical questions confidently in competitive examination.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 1 | 2 | 1 | 3 | 2 | 2 | 3 |

Syllabus

Ratio and proportion; Indices; Logarithms; Linear, Quadratic and cubic equations; Inequalities; Simple & compound interest, annuity & loans

Problem sets on

Time & distance; Time & work; Percentages; Profit & Loss; Boats & Streams; Testing directional sense; Problems on age calculation; Pattern analysis; Data

interpretation

Short cut techniques for

Multiplication; Finding squares, square roots; Cubes, cube roots; Magic squares; Digit sum method; Subtraction; solving Linear, Quadratic and cubic equations;

References:

1. Quantitative Aptitude for Common Admission Test by Arun Sharma , Mc Graw Hill (6th edition)
2. Common Proficiency test Quantitative Aptitude, published by The institute of chartered accountants of India

Semester – IV Credits: 4

GE-4: Mathematics for Competitive Examination –II

Course outcome:

Will be able to attempt the mathematical and logical questions confidently in competitive examination.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 1 | 2 | 1 | 3 | 2 | 2 | 3 |

Syllabus:

Permutation and combinations; Sequences & Series (Arithmetic progression/Geometric progression); Number systems; Sets, relations and functions

Problem sets on

Partnerships; Age; LCM/GCD; simplification of decimal fractions; unitary method; Mensuration (2D/3D); conics; trigonometry; alphabet & number series; Coding & Decoding; Number ranking; stocks & shares; blood relations; surds

Short cut techniques for

Analytical conics; Division; Factorization; Partial fractions

References:

1. Quantitative Aptitude for Common Admission Test by Arun Sharma , Mc Graw Hill (6th edition)
2. Common Proficiency test Quantitative Aptitude, published by The institute of chartered accountants of India.

Credits: 06

Effective from: June, 2019.

Course outcomes:

CO1 - Students will learn concepts of Group and Ring and apply to solve problems.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 3 |

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| Prerequisites | Knowledge of Set theory, Number system, algebraic operations and their properties. | |
| Objectives | This course helps in understanding basic concepts of Groups and Rings. | |
| Contents | 1. Groups definition and elementary properties; Finite group and subgroups; Examples; Cyclic groups; Properties of cyclic groups; Classification of subgroups of cyclic groups. | 18 hours |
| | 2. Permutation groups; Cycle notation; Properties of permutations. Isomorphisms: Definitions and examples; Cayley's Theorem; Properties of isomorphisms; Automorphism. | 20 hours |
| | 3. Cosets; Properties of cosets; Lagrange's Theorem and consequences; An application of cosets to permutation group. | 05 hours |
| | 4. Definition and examples of external direct product; Properties of external direct product; The group of units modulo n as an external direct product. | 04 hours |
| | 5. Normal subgroups and factor groups; Application of factor groups; Internal direct product. Definition and examples of group homomorphisms; Properties of homomorphisms; First Isomorphism Theorem. | 12 hours |

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| | 6. Fundamental Theorem of Finite Abelian Groups; Isomorphism classes of Abelian groups; Proof of Fundamental Theorem. | 08 hours |
| | 7. Rings; Properties of rings; Subrings; Integral domains; Examples of integral domains; Fields; Characteristic of a ring. | 08 hours |
| | 8. Ideals and Factor rings; Prime ideals; maximal ideals; Ring homomorphisms; Properties of ring homomorphisms; Field of quotients. | 12 hours |
| | 9. Polynomial rings; The Division Algorithm and consequences. | 03 hours |

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| Pedagogy | Lectures/ tutorials/assignments/self-study |
| References | <p>PRINCIPAL TEXT: Joseph A. Gallian, <i>Contemporary Abstract Algebra</i>, (8th ed), Cengage Learning.</p> <p>References (1) John B. Fraleigh, <i>A First Course in Abstract Algebra</i>, (7th ed), Pearson Education Inc. (2) I. N. Herstein, <i>Topics in Algebra</i>, Second Edition, Wiley Student Edition, 2006. (3) G. Birkhoff and S. Mac Lane : <i>A survey of Modern Algebra</i> . Routledge; [Recommended for Teachers. Teachers Manual is available.] (4) E.B. Vinberg <i>A graduate course in Algebra</i> American Mathematical society Publications.</p> |

Programme: B.Sc. Mathematics Sem V

Course Code: MTC 106 Title of the Course: Analysis II Number of Credits: 06

Effective from: June, 2019.

Course outcomes:

CO1 - Students will learn to evaluate improper integrals, compute beta , gamma functions and Fourier series.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 3 |

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|---------------|---|----------|--|
| Prerequisites | Knowledge of basic course in Analysis and Calculus of one variable. | | |
| Objectives | This course helps in understanding advance concepts of applied analysis. | | |
| Contents | <p>1. Improper Integrals: Improper Integrals of type I; Cauchy’s general principle of convergence for Improper integrals of type I; Comparison test for improper integrals of type I; Comparison test in limit form for improper integrals of type I; p - test for improper integrals of type I; Improper Integrals of type II; Cauchy’s general principle of convergence for Improper integrals of type II; Comparison test for improper integrals of type II; Comparison test in limit form for improper integrals of type II; p - test for improper integrals of type II; Improper Integrals of type III.</p> | 20 hours | |
| | <p>2. Beta and Gamma Functions: Definitions of Beta and Gamma Functions and their convergence. Properties of Beta and Gamma functions. Relation between beta and Gamma functions. Legendre’s duplication formula.</p> | 15 hours | |
| | <p>3. Power series in IR: Definition and examples. Radius and interval of convergence, Uniform convergence and absolute convergence, Term by term differentiation and integration of power series in IR. Power series definitions of Exponential, Logarithmic and trigonometric functions, their properties. Weierstrass’ polynomial approximation theorem. [Statement only and explanation]</p> | 15 hours | |
| | <p>4. Inner product spaces: Square integrable functions. Usual integral inner product on $C[a, b]$ and its properties. Norm induced by usual integral inner product. Orthogonal and orthonormal sequences of functions in $C[a, b]$ with usual integral inner product. Complete orthogonal and orthonormal set in $C[a, b]$ with respect to usual integral inner product. Bessel’s inequality and Parseval’s identity set in $C[a, b]$ with respect to usual integral inner product.</p> | 20 hours | |

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| | <p>5. Fourier series: Fourier series of real functions on $(-\pi, \pi)$ and $(0, \pi)$. Fourier coefficients; properties of Fourier coefficients; the Fourier series of a function relative to an orthonormalsystem. Bessel's inequality. Trigonometric Fourier series, Fourier series of odd & even function. Integration & differentiation of Fourier series at a point. Fourier theorem. Fourier Series of real functions on $(c, c+2l)$. Riemann-Lebesgue Lemma. Parseval's identity.</p> | 20 hours |
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| Pedagogy | Lectures/ tutorials/assignments/self-study |
| References | <p>Principal Texts :</p> <ol style="list-style-type: none"> 1. S. C. Malik : Principles of Mathematical Analysis 2. R.D.Bhat : Mathematical analysis II 3. B.S.Grewal: Higher Engineering Mathematics <p>References:</p> <ol style="list-style-type: none"> 1. Tom Apostol , Calculus Vol. I , Second Edition, Wiley Students Edition ,India, 2012 2. R. Goldberg : Methods of Real analysis, Oxford and IBH Publishers. 3. E. Kreyszig: Advanced Engineering Mathematics |

Programme: B.Sc. Mathematics Sem V

Course Code: MTC107 Title of the Course: Calculus of 2 and 3 variables Number of Credits: 06

Effective from: June, 2019.

Course Outcomes:

CO1 - Students will learn to find extreme values of functions of several variables, evaluate multiple integrals and apply the concepts to solve some problems of Physics.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 3 |

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| Prerequisites | Knowledge of Real Analysis, Linear Algebra, Vector Algebra and Calculus of one variable. |
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| Objectives | This course helps in understanding basic concepts multivariable calculus. | | |
| Contents | <p><u>Differential Calculus.</u></p> <p>Review of vectors in Plane and space. Vector products and their properties. n- dimensional Euclidean space. Curves in the plane and space.</p> | 05 hours | |
| | <p>Functions from \mathbb{R}^n to \mathbb{R} (scalar fields) and functions from \mathbb{R}^2 to \mathbb{R}^3 (vector fields), limits and continuity of functions, basic results on limits and continuity of sum, difference, scalar multiples of vector fields, continuity and components of a vector field. Partial derivatives and continuity. Differentiability. Derivative Matrix and tangent planes. The Chain rule. Gradients and directional derivatives. Implicit differentiation.</p> | 15 hours | |
| | <p>Higher order partial derivatives. Equality of mixed derivatives. Taylor's theorem. Critical points and extrema. . Second derivative test. Constrained extrema and Lagrange's multipliers.</p> | 15 hours | |
| | <p>Applications. Acceleration. Arc length. Vector fields. Divergence and Curl .</p> | 10 hours | |
| | <p><u>Integral Calculus</u></p> <p>Volume and Cavalier's Principle. Double integral over a Rectangle, over a region. Triple integrals. Change of variables. Cylindrical and spherical coordinates. Applications. Average value. Center of mass. Moments of inertia.</p> | 20 hours | |
| | <p>Integrals over curves and surfaces. Line integrals. parameterized surfaces. Area of a surface. Surface integrals. Green's theorem. Stokes' Theorem, Gauss' theorem. Path independence. Fundamental theorem of Calculus.</p> | 25 hours | |
| Pedagogy | Lectures/ tutorials/assignments/self-study | | |
| References | <p><u>Principle Text:</u></p> <p>Basic multivariable Calculus by J.E. Marsden, A.J. Tromba and A. Weinstein, Springer Verlag. Indian print. II edition 2005. [Teacher's manual available]</p> | | |

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| | <p><u>References:</u></p> <ol style="list-style-type: none"> 1. T. Apostol: Calculus, Vol. 2, John Wiley & Sons. 2. J. Stewart, Calculus, Brooke/Cole Publishing Co. 3. D. Zill & W.S. Wright: Multivariable Calculus |
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Programme: B.Sc. Mathematics Sem V

Course Code: MTE101 Title of the Course: Foundations of Mathematics Number of Credits: 04

Effective from: June, 2019.

Course outcome: Students will learn to present mathematics logically.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 3 |

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|---------------|--|----------|--|
| Prerequisites | Knowledge of Set theory, Number system, algebraic operations and their properties. | | |
| Objectives | This course helps in developing basic Logic required for study of Mathematics. | | |
| Contents | 1. Statements and Logic: Statements; Statements with quantifiers; Compound statements; Implications; Proofs in Mathematics. | 05 hours | |
| | 2. Sets: Sets; Operations on sets; Family of sets; Power sets; Cartesian product of sets. | 05 hours | |
| | 3. Functions: Basic definitions; one-one, onto functions and bijections; Composition of functions; Inverse of a function; Image of subsets under functions; Inverse image of subsets under functions. | 15 hours | |

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| | <p>4. Relations: Relation on sets; Types of relations; Equivalence relations; Equivalence classes and partitions of sets.</p> | 08 hours |
| | <p>5. Induction Principles: The induction Principle; The Strong Induction Principle; The Well-Ordering Principle; Equivalence of the three principles.</p> | 10 hours |
| | <p>6. Countability of sets: Sets with same cardinality; Finite sets; Countable sets; Comparing cardinality.</p> | 10 hours |
| | <p>7. Order Relation: Partial and total orders; Chains, bounds and maximal elements; Axiom of choice and its equivalents.</p> | 07 hours |
| Pedagogy | Lectures/ tutorials/assignments/self-study | |
| References | <p>PRINCIPAL TEXT:</p> <p>1. Kumar, S. Kumaresan and B.K. Sarma, <i>A Foundation Course in Mathematics</i>, Narosa Publisher, 2018</p> <p><u>References:</u></p> <p>1. Paul Halmos : Set Theory, SpringerVerlag, 1960.</p> <p>2. Set Theory: Read it, Absorb it and Forget it by Vipul Kakkar</p> | |

Programme: B.Sc. Mathematics Sem V

Course Code: MTE102 Title of the Course: Combinatorics Number of Credits: 04

Effective from: June, 2019.

Course outcome:

CO1 - Students will learn various counting techniques and apply them to the problems.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 3 |

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|---------------|---|
| Prerequisites | Knowledge of Set theory, Number system, algebraic operations and their properties |
| Objectives | This course will help student to learn various enumeration techniques. |

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| Contents | 1. <u>Basic Methods:</u> Basic Pigeon-hole principle, generalized Pigeon-hole principle, methods of mathematical induction – weak induction and strong induction.. | 08 hours |
| | 2. <u>Elementary Counting Problems:</u> Permutations, Strings over finite alphabet, Choice problems. | 08 hours |
| | 3. <u>The Binomial Theorem:</u> Binomial theorem, Multinomial theorem(,When exponent is a positive integer.) | 08 hours |
| | 4. <u>Partitions:</u> Compositions, Set partitions, Integer partitions. | 08 hours |
| | 5. <u>Cycles in Permutations:</u> Cycles in permutations, Permutations with restricted cycle structure. | 08 hours |
| | 6. <u>The Sieve:</u> Enumerating the elements of intersecting sets, applications of the sieve formula. | 08 hours |
| | 7. <u>Generating Functions:</u> Ordinary generating functions – Recurrence relations and generating functions, Products of generating functions, Compositions of generating functions. Exponential generating functions – Recurrence relations and exponential generating functions, Products of exponential generating functions, Compositions of exponential generating functions. | 12 hours |
| Pedagogy | Lectures/ tutorials/assignments/self-study. | |
| References | <u>PRINCIPAL TEXT:</u> A Walk Through Combinatorics – An Introduction to Enumeration and Graph Theory by Miklos Bona, Second Edition, World Scientific Publications. | |

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| | <p><u>References:</u></p> <p>1. Applied Combinatorics by Alan Tucker, Third Edition, John Wiley and sons, New York.</p> <p>2. Combinatorial Theory and Applications by V. Krishnamurthy, East-West Press, New Delhi.</p> |
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Programme: B.Sc. Mathematics Sem VI

Course Code: MTC108 Title of the Course: Differential Equations-II Number of Credits: 06

Effective from: June, 2019.

Course outcome: Students will learn to solve differential equations by different methods.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 3 |

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|---------------|--|----------|--|
| Prerequisites | Knowledge of Real Analysis, Linear Algebra, Differential equations, Several variable calculus. | | |
| Objectives | This course helps in understanding basic concepts of Differential Equations. It develops the ability to solve differential equations by standard methods. | | |
| Contents | <p><u>1. Review of First and Second order ordinary differential equations:</u></p> <p>Basic concepts. First order ordinary differential equations with constant coefficients. Homogeneous and non homogeneous equations. Exact and non exact differential equations. Integrating factors. Second order differential equations with constant coefficients. Complementary function and particular solution. Use of known solution to find linearly independent second solution. Method of variation of parameters. Equations with variable coefficients. Method of undetermined coefficients.</p> | 20 hours | |

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| | <p>2. <u>Power Series Solutions of Some Linear Equations:</u></p> <p>Homogeneous equations with analytic coefficients. Legendre equation, Justification of power series method, Introduction to linear equations with Regular singular points, Euler equation, example and general case of second order equations with regular singular points, A convergence proof, Exceptional cases, Bessel equation, Regular singular points at infinity. Properties of Legendre Polynomials and Bessel's function. Generating function.</p> | 35 hours |
| | <p>3. <u>Laplace Transforms:</u></p> <p>Laplace transforms of various functions, General properties of Laplace transforms, Inverse Laplace transforms, Convolution theorem, Application of Laplace transforms to solve differential equations.</p> | 15 hours |
| | <p>4. <u>Numerical Methods of Solving Differential Equations:</u></p> <p>Picard's method, Euler's method, Modified Euler's method, Runge-Kutta method, Milne's method, Adams-Bashforth-Moulton method.</p> | 20 hours |
| Pedagogy | Lectures/ tutorials/assignments/self-study. | |
| References | <p><u>PRINCIPAL TEXTS:</u></p> <p>1) An Introduction to Ordinary Differential Equations by Earl A.</p> | |

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| | <p>Coddington, Prentice-Hall of India Private Limited, New Delhi.</p> <p>2) A text book of Differential Equations by S.G.Deo, V Raghavendra and V. Lakshmikantham. TMH edition.</p> <p>3) Numerical methods by M.KJain, S.R.K.Iyenger, R. K..Jain</p> <p><u>Refrences:</u></p> <p>1. Differential Equations with historical notes by G. Simmons , TMH.</p> <p>2. Mathematical Methods by Iyengar, Gandhi and others, S. Chand Publication.</p> <p>3. Ordinary Differential Equations by G. Birkoff and G.C. Rota .</p> |
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Programme: B.Sc. Mathematics Sem VI

Course Code: MTC109 Title of the Course: Complex Analysis Number of Credits: 06

Effective from: June, 2019.

Course Outcomes:

CO1 - Students will learn basic concepts of complex analysis and apply them.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 3 |

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|---------------|--|----------|--|
| Prerequisites | Knowledge of Real Analysis and Calculus of one and two variables. | | |
| Objectives | This course helps in understanding basic concepts of Complex analysis. . | | |
| Contents | 1. <u>Complex Numbers:</u> Sums and products, Algebraic properties, Vectors and moduli, Complex conjugates, Exponential form, Arguments of products and quotients, Roots of complex numbers, Regions in the complex plane. | 08 hours | |
| | 2. <u>Analytic Functions:</u> Functions of complex variable, Limits, Theorems on limits, Continuity, Derivatives, Differentiation formulas, Cauchy-Riemann equations, Sufficient condition for Differentiability, Polar coordinates, Analytic functions, Harmonic functions. | 12 hours | |
| | 3. <u>Elementary Functions:</u> Exponential function, Logarithmic function, Branches and Derivatives of Logarithms, Identities involving logarithms, Complex exponents, Trigonometric functions, Hyperbolic functions, Inverse trigonometric and hyperbolic functions. | 10 hours | |

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| | <p>4. <u>Integrals:</u></p> <p>Derivatives of functions, Definite integrals of functions, Contours, Contour integrals, Contour integrals of functions with branch cuts, Upper bounds for moduli of contour integrals, Antiderivatives, Cauchy-Goursat theorem (without proof), Simply and Multiply connected domains, Cauchy integral formula and extension of Cauchy integral formula, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus principle.</p> | 18 hours |
| | <p>5. <u>Series:</u></p> <p>Convergence of sequences and series, Taylor series, Taylor's theorem, Laurent series, Laurent's theorem.[statements only and applications]</p> | 12 hours |
| | <p>6. <u>Residues and Poles:</u></p> <p>Isolated singular points, Residues, Cauchy Residue theorem, Residue at infinity, The three types of Isolated singular points, Residues at poles, Zeros of analytic functions, Zeros and Poles.</p> | 18 hours |

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| | <p>7. <u>Mappings by Elementary functions:</u></p> <p>Fractional Linear transformations, Transformation $w=1/z$, Mappings by $1/z$, Mobius transformation.</p> | 12 hours |
| Pedagogy | Lectures/ tutorials/assignments/self-study | |

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| References | <p><u>PRINCIPAL TEXT:</u></p> <p>Complex Variables and Applications by James Brown and Ruel Churchill, Eighth Edition, McGraw-Hill International Edition. (With omission of sections 13, 14,27,28,47,63,64,65,66,67,80,81,82,83,84,85,88,89 of the principal text.)</p> <p><u>References:</u></p> <p>1) Foundations of Complex Analysis by S. Ponnusamy, Second Edition, Narosa Publishing House.</p> <p>2) Functions of One Complex Variable by John B. Conway, Second Edition, Springer International Student Edition.</p> <p>3) Basic Complex analysis by J.E.Marsden and M.J.Hoffman W H Freeman & Co.</p> |
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Programme: B.Sc. Mathematics Sem VI

Course Code: MTC110 Title of the Course: Metric Spaces Number of Credits: 06

Effective from: June, 2019.

Course Outcome:

CO1 - Students will learn basic concepts of metric spaces.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 3 |

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|---------------|---|
| Prerequisites | Course on Foundations of Mathematics and basic Analysis. |
| Objectives | This course helps in understanding basic concepts of Metric spaces. |

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| Contents | <p>1. INTRODUCTORY CONCEPTS IN METRIC SPACES:- Definition and Examples of Metric Spaces, Open Balls and Closed Balls, Hausdorff Property, Interior Point and Interior of a Set, Open Sets and their properties, Closed Sets and their properties, Limit Points and Isolated Points, Derived Set and its properties, Closure of a Set and its properties, Boundary Points, Distance between Sets, Diameter of a Set, Subspace of Metric Space and its properties, Boundedness in a Metric Space.</p> | 20 hours |
| | <p>2. COMPLETENESS IN METRIC SPACES:- Sequence in a metric Space, Convergence of a Sequence in a Metric Space, Cauchy Sequence in a Metric Space, Complete Metric Spaces, Cantor's Intersection Theorem, Dense Sets.</p> | 10 hours |
| | <p>3. CONTINUOUS FUNCTIONS ON METRIC SPACES:- Sequential Continuity, Continuity of Functions using Open Sets and Closed Sets, Continuity of Functions using Closure of a Set, Contraction map and its properties, Fixed Points, Picard's Fixed Point Theorem, Picard's Existence and Uniqueness Theorem for First Order Initial Value Problem.</p> | 20 hours |
| | <p>4. COMPACTNESS IN METRIC SPACES:- Compact Metric Spaces and Compact Sets, Examples of Compact Metric Spaces and Compact Sets, Properties of Compact Metric Spaces and Compact Sets, Sequential Compactness, Bolzano – Weierstrass Property, Heine – Borel Theorem, Totally Boundedness, Equivalence of Compactness and Sequential Compactness, Lebesgue Covering Lemma, Compactness and Finite Intersection Property, Continuous Functions and Compactness.</p> | 20 hours |
| | <p>5. CONNECTEDNESS IN METRIC SPACES:- Separated Sets, Connected Metric Spaces and Connected Sets, Properties of Connected Metric Spaces and Connected Sets, Connected Subsets of IR, Connectedness and Continuous Functions, Intermediate value Theorem.</p> | 20 hours |
| Pedagogy | Lectures/ tutorials/assignments/self-study. | |
| References | <u>Principal text:</u> | |

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| | <p>Mathematical Analysis-I (Metric Spaces) : J.N.Sharma</p> <p><u>References:</u></p> <p>1. Metric Spaces: E. T. Copson (Cambridge University Press). 2. Topology of Metric Spaces: S. Kumaresan (Narosa Publishing House). 3. A First Course in Metric Spaces: B. K. Tyagi (Foundation Books). 4. Metric Spaces : P. K. Jain and Khalil Ahmed (Narosa Publishing House).</p> |
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Programme: B.Sc. Mathematics Sem VI

Course Code: MTE103 Title of the Course: Number Theory Number of Credits: 04

Effective from: June, 2019.

Course Outcomes:

CO1 - Students will learn basic concepts of Number theory and will be ready for advanced course on Number theory

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 3 |

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|---------------|---|----------|--|
| Prerequisites | Course on Foundations of Mathematics and Basic Algebra. | | |
| Objectives | This course helps in understanding basic concepts of Number theory. | | |
| Contents | <p>1. DIVISIBILITY THEORY IN INTEGERS:- Divisibility in \mathbf{Z} and its properties, Proper and Improper Divisors, Division Algorithm, Greatest Common Divisor(gcd) and its properties, Least Common Multiple(lcm) and its properties, Euclidean Algorithm to find gcd of two integers, Prime integers, Composite integers and Relatively Prime or Co-prime integers, Euclid's Lemma, The Linear Diophantine equation $\mathbf{ax + by = c}$, The Fundamental Theorem of Arithmetic, The Sieve of Eratosthenes.</p> | 20 hours | |

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| | <p>2. THE THEORY OF CONGRUENCES:- Congruence Modulo 'n' Relation and its properties, Linear Congruence in one variable and its solution in \mathbf{Z}, Congruent and Incongruent solutions of Linear Congruence. System of Linear Congruence in one variable and Chinese Remainder Theorem, System of Linear Congruence in two variables, Fermat's Theorem and Wilson's Theorem.</p> | 15 hours |
| | <p>3. NUMBER – THEORETIC FUNCTIONS:- The Functions τ and σ and their properties, Multiplicative Functions. The M O bius Function μ and its Properties, Multiplicative property of M O bius Function, μ. The M O bius Inversion Formula, The Greatest Integer Function and its properties, Euler's Phi – Function and its properties. Euler's Theorem.</p> | 15 hours |
| | <p>4. SOME NON-LINEAR DIOPHANTINE EQUATIONS:- Pythagorean triple, Primitive Pythagorean triple, Non- Linear Diophantine Equation $x^2 + y^2 = z^2$, Fermat's Last Theorem.</p> | 10 hours |
| Pedagogy | Lectures/ tutorials/assignments/self-study | |
| References | <p><u>Principal text:</u> 1. Elementary Number Theory: David M. Burton (Tata Mcgrow Hill).</p> | |

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| | <p><u>References:</u> 1. An Introduction to the Theory of Numbers: I. Niven, H. S. Zuckerman and H. L. Montgomery (Wiley – India). 2. Elementary Number Theory with Applications: Thomas Koshy. (Elsevier India Pvt. Ltd.).</p> |
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Programme: B.Sc. Mathematics Sem VI

Course Code: MTE104 : Title of the Course: Operations Research II Number of Credits: 04

Effective from: June, 2019.

Course Outcomes:

CO1 - Students will learn basic concepts in decision making.

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| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PSO1 | PSO2 | PSO3 | PSO4 |
| CO1 | 3 | 3 | 1 | 2 | 2 | 1 | 1 | 3 | 2 | 2 | 3 |

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|---------------|---|----------|
| Prerequisites | Knowledge of basics of operations research, probability theory and Linear algebra. | |
| Objectives | This course helps in understanding basic concepts of operations research in decision making. | |
| Contents | 1. Project Management Planning, Scheduling and controlling of a project. Techniques of analysing. Methods of planning and programming. Development of bar charts. Shortcomings and remedial measures. Milestone Charts. | 10 hours |
| | 2. Elements of Network Event, activity, dummy. Rules of Network, Numbering of events, Cycles. Planning for network construction. Work breakdown structures. | 6 hours |
| | 3. Project Evaluation & Review Technique (PERT) PERT time estimates T^E , T^L . Network analysis. Probability of meeting schedule time. | 6 hours |
| | 4. Critical Path Method (CPM) CPM process and network. Time estimates, Float. Critical activities and path. Project crashing | 6 hours |

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| | <p>5. Dynamic Programming</p> <p>Dynamic Programming: Recursive nature of dynamic programming Forward and Backward Recursion</p> | 12 hours |
| | <p>6. Integer Linear Programming (ILP)</p> <p>Algorithms: Branch and Bound; Cutting Plane; Heuristic. Examples. Computational considerations in ILP. Travelling salesman problem.</p> | 10 hours |

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| | <p>7. Game theory</p> <p>Some basic terminologies, Optimal solution of two person zero sum game, Solution of mixed strategy games, graphical solution of games, linear programming solution of games. Two person Zero sum games. Solving simple games.</p> | 10 hours |
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| Pedagogy | Lectures/ tutorials/assignments/self-study |
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| References | <p>PRINCIPAL TEXTS:</p> <ol style="list-style-type: none"> 1. Kanti Swarup, Man Mohan and Gupta, <i>Operations Research</i>, S. Chand and company, New Delhi. 2. H.A.Taha, <i>Operations Research, An Introduction</i>, Pearson, India. <p>References</p> <ol style="list-style-type: none"> (1) S.C. Gupta, <i>Operations Research</i>, S. Chand and Co. New Delhi. (2) Richard Bronson, <i>Theory and Problems of Operations Research</i>, TMH. (3) A. M. Natarajan, P. Balasubramani and A. Tamilarasi <i>Operations Research</i>; Pearsons India (4) P. RamaMurthy <i>Operations Research II edition</i> New age International (P) Ltd |
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**CARMEL COLLEGE OF ARTS, SCIENCE AND COMMERCE FOR
WOMEN, NUVEM GOA**

Department of Mathematics

PROGRAMME OUTCOMES- B.Com

PO1: Knowledge: Acquire in-depth knowledge in commerce discipline including new knowledge relating to market and industry and integrating the same to enhance knowledge.

PO2: Critical Thinking: Develop the ability to critically evaluate and analyze information for decision-making and problem-solving.

PO3: Communication Skills: Develop the ability to communicate information in the form of oral/written reports.

PO4: Teamwork: Inculcate the ability to work in diverse teams in a cohesive manner.

PO5: Holistic Education: Create a spirit of social and ethical responsibility towards business and society.

PO6: Life-Long Learning: Generate interest in exploring an individual's core competencies and using the same for employment and entrepreneurship.

The Department of Commerce, Carmel College of Arts, Science and Commerce for Women, Nuvem-Goa aims to achieve the following Programme Specific Outcomes.

PSO1: Knowledge: Develop an understanding of the principles and practices of financial accounting for corporate, non- corporate, and governmental organizations, cost accounting, business finance, direct and indirect tax, auditing, financial reporting, business finance, investment, and tax planning.

PSO2: Critical Thinking: Demonstrate problem-solving skills by critically evaluating and analyzing information by applying the accountancy concepts learned to numerical illustrations, practical assignments, and case studies.

PSO3: Teamwork, Holistic Education, and Communication Skills: Prepare a project report based on accountancy and finance with the help of primary and secondary data giving recommendations based on the data analyzed.

PSO4: Life-Long Learning: Demonstrate accountancy-related transferable skills relevant to higher education, entrepreneurship, and employment.

B.COM. SEMESTER I
Commercial Arithmetics – I (CC 4) (100 marks - 60 Lectures)

Course Outcomes:

- CO1** - To understand Mathematical Logic and use it to analyze complex statements.
- CO2** - To use Set Theory results in counting problems in real life situations.
- CO3** - To solve combinatorial problems using permutations, combinations and progressions
- CO4** - To use results involving matrices and determinants to solve problems.
- CO5** - To learn mathematics involved in some problems in finance.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 2 |
| CO2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| CO3 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 1 | 1 | 1 |
| CO4 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 |
| CO5 | 2 | 3 | 2 | 2 | 1 | 1 | 1 | 2 | 2 | 1 |

Unit I Mathematical Logic and Set Theory

(a) Mathematical Logic (10 marks - 7 Lectures)

Logical Statement, Truth value. Compound Statement, Negation, Conjunction, Disjunction Conditional and Bi-conditional statement Truth tables Logical equivalence Tautology and Contradiction Argument, Validity of an argument (using truth table for 2 statements only)

(b) Set Theory (10 marks - 6 Lectures)

Quadratic equation, Solution of general quadratic equation $ax^2 + bx + c = 0$ Sets: Definition, Representation of sets Types of sets: Finite and infinite sets, null sets, singleton set, examples Venn diagrams Subset, Complement of a set, Union, Intersection and Difference of sets, Power sets De Morgan's Law, Verification by examples and Venn diagrams Number of elements of a set, Results involving number of sets (upto three sets) and problems based on these results

Unit II Permutations and Combinations (20 marks - 15 Lectures) Fundamental Principle – examples Factorial notation Definition of Permutation Number of permutations of n different things taken r at a time Permutations with repetition Definition of Combination Number of combinations of n different things taken r at a time (no proof for results)

Unit III Progressions and Mathematics of Finance

(a) Progressions (20 marks - 10 Lectures) Arithmetic Progression (A.P.) Definition of A.P. Formula for nth term of an A.P. Sum of the first n terms of an A.P. Business applications of

A.P. Geometric Progression (G.P.) Definition of G.P. Formula for nth term of a G.P. Sum of the first n terms of a G.P. Business applications of G.P.

(b) Mathematics of Finance (25 marks - 12 Lectures) Simple Interest Compound Interest – compounded annually, six monthly, quarterly, monthly and daily Nominal and Effective rate of interest Present and future value Ordinary annuity, Present value of ordinary annuity EMI using Interest on reducing balance and Flat Interest rate

Unit IV Determinants and Matrices (15 marks - 10 Lectures)

Determinant - Meaning , Order Minor , Co-factor, Expansion (Order 2 and 3) Cramer's Rule Matrices - Definition, Notation, Types of matrices Algebra of Matrices – Negative, Transpose, Equality, Addition and Subtraction, Scalar multiplication, Matrix multiplication. Applications to Business Problems

References

1. Joshi N. and Chitale S.G., A New Approach To Mathematical Techniques , Sheth Publishers
2. Vaidya M.L., Deshpande A.V., Kumtha A.P., Elementary Business Mathematics, Vipul Prakashan
3. DikshitAmarnath, Jain Jinendra Kumar, Business Mathematics, Himalaya Publishing House
4. GoelAjayand GoelAlka, Mathematics and Statistics, Taxmann Allied Services
5. Vaidya M.V., Kumtha A. P., Business Mathematics, Vipul Prakashan
6. ShahS., Business Mathematics(for ICWAI International Course), New Central Book Agency.
7. Abranches, M.E, Mathematical Techniques, Gracias Print Arts.

B.COM. SEMESTER II
Commercial Arithmetic – II (CC 8) (100 marks - 60 Lectures)

Course Outcomes:

CO1 To solve linear programming problems by graphical method.

CO2 To know integral and differential Calculus and will see their applications in day-to-day problems.

CO3 To know ratios and proportions and apply this knowledge to real life problems.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 2 | 3 | 2 | 1 | 1 | 1 | 1 | 2 | 1 | 2 |
| CO2 | 2 | 3 | 1 | 2 | 1 | 1 | 1 | 1 | 2 | 1 |
| CO3 | 2 | 3 | 1 | 1 | 1 | 2 | 1 | 2 | 1 | 1 |

Unit I The Straight Line (25marks - 12 hours) Rectangular Cartesian Co-ordinate System Distance formula, Section formula (Simple problems only) Slope and intercepts of a straight line Equations of lines parallel to the axes. Equations of lines in slope point form, two point form, slope intercept form, two intercept form General equation of a line, Parallel and perpendicular lines Intersection of lines Graphs of linear equations and inequalities Graphical solution of Linear Programming Problems with two variables only

Unit 2 Calculus I (a) Relations and Functions (5marks - 4 Lectures) Ordered pair Cartesian product Relation, Function – Domain, Co-domain, Range. (b) Limits and Continuity (5marks - 4 Lectures) Definition Operations of finding limits Algebra of limits Concept of continuity and examples (c) Derivatives and their Applications (25 marks - 12 Lectures) Concept of derivatives Standard forms Algebra of derivatives Derivatives of composite functions Higher order derivatives Applications – Total revenue function, Total cost function, Elasticity of demand and supply Increasing and decreasing function/sign of derivative (economic applications) Maxima and Minima (economic applications)

Unit III Calculus II (a) Integration and its Applications (15marks - 12 Lectures) Definition Standard forms x^n , e^x , ax , $1/x$ 45 Goa University, Taleigao Plateau, Goa Integral of $f(x) + g(x)$ and $kf(x)$ Integral of $(ax+b)^n$, e^{ax+b} , $kax+b$, $1/ax+b$ Applications – Total revenue function, Total cost function Definite integration Area under a curve (formula only) Consumer's Surplus and Producer's Surplus (b) Partial Derivatives (5marks - 4 Lectures) Definition Partial derivatives of first and second order Economic applications: Demand function, Utility function, Production function

Unit IV Commercial Mathematics (20marks - 12 Lectures) Ratio Proportion Percentage Discount – Trade Discount, Cash discount, Discount and profit.

References

1. Joshi N. and Chitale S.G., A New Approach To Mathematical Techniques , Sheth Publishers
2. Vaidya M.L., Deshpande A.V., Kumtha A.P., Elementary Business Mathematics, Vipul Prakashan
3. DikshitAmarnath, Jain Jinendra Kumar, Business Mathematics, Himalaya Publishing House
4. GoelAjayand GoelAlka, Mathematics and Statistics, Taxmann Allied Services
5. Vaidya M.V., KumthaA. P., Business Mathematics, Vipul Prakashan
6. ShahS., Business Mathematics(for ICWAI International Course), New Central Book Agency.
7. Abranches, M.E, Mathematical Techniques, Gracias Print Arts.

B.COM. SEMESTER III
Business Statistics– I (GE 3) (100 Marks - 60 Lectures)

Course Outcomes:

CO1- To know the uses and limitations of statistics, concept related to Collection of statistical data, Organize, present statistical data, both numerically and graphically,

CO2- Finding various measures that describe the inherent characteristics of the data. *i.e.* measure of central tendencies, measures of dispersion, measures of skewness and kurtosis.

CO3- To Analyze Chronological data using concepts time series analysis and Index numbers

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 2 | 2 | 1 | 2 | 2 | 3 | 1 | 2 | 2 | 3 |
| CO2 | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 1 | 3 | 2 | 3 | 2 | 3 |

Unit I Data Analysis (15 Lectures -24 marks)

Introduction: Meaning and definition of Statistics, function, scope and limitation of Statistics, Basic Statistical concepts: Population, sample, variate, attribute, parameter and Statistic. Types of data-Primary and secondary data, Sources and methods of collecting data, classification-univariate frequency distribution and questionnaire design. Graphs and diagrams-Frequency polygon, frequency curve and ogives, Simple, multiple, subdivided bar diagram, pie chart.

Unit II Summarisation Measures (24 Lectures -40 marks)

Measures of Central Tendency: Meaning, objectives and requirement of a good measure of central tendency, Arithmetic Mean, Mode and Median (with & without grouping), Harmonic Mean (ungrouped data), Quartiles, deciles and percentiles. Measures of Dispersion: Meaning, objectives and requirement of a good measure of dispersion, absolute and relative measure, Range, quartile deviation, mean deviation, standard deviation, Coefficient of range, Coefficient of quartile deviation, Coefficient of mean deviation, Coefficient of variation, Skewness- Karl Pearson's and Bowley's measure and coefficient of Skewness.

Unit III Index Numbers (13 Lectures -18 marks)

Meaning, types, uses and limitations of index numbers, Methods of constructing price and quantity Index numbers by weighted and unweighted methods, Weighted aggregative Laspeyre's, Paasche's, Fishers and Value index numbers, Weighted average of price relatives, fixed base, chain base, shifting of base, deflating and splicing of Index numbers, cost of living Index numbers.

Unit IV Analysis of Time series (8 Lectures -18 marks)

Components and models of Time series, Measurement of trend-semi averages, moving averages, freehand and least square method(linear and non linear).

References:

1. Gupta S.P., Statistical Methods, Sultan Chand & sons.
2. Gupta C.B., Fundamentals of Statistics, Himalaya Publishing House.
3. Shah, R.J., Statistical Methods.
4. Mazumdar Neeta, Statistical Techniques, Rajhauns Vitaran.

B.COM. SEMESTER IV
Business Statistics – II (GE 5) (100 Marks - 60 Lectures)

Course Outcomes:

CO1-Apply the concept of two-dimensional random variables to correlation, regression. To compute and interpret coefficients of correlation and perform regression analysis.

CO2- Use various methods to compute the probabilities of events, Analyse and interpret statistical data using appropriate probability distributions.

CO3- Identify and demonstrate appropriate sampling and data collection processes. Apply central limit theorem to describe inferences, Construct and interpret confidence intervals to estimate means and proportions for populations and Testing of hypothesis (Large sample tests for mean and proportion)

CO4- Perform past projection, future forecasting and prediction using interpolation and extrapolation techniques.

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PSO1 | PSO2 | PSO3 | PSO4 |
|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| CO1 | 2 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 3 |
| CO2 | 2 | 3 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 3 |
| CO3 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 3 | 3 |
| CO4 | 3 | 3 | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 3 |

Unit I Correlation and Regression Analysis (14 Lectures -30marks) Meaning, Types and Methods of studying Correlation, Scatter Diagram, Karl Pearson's Coefficient of Correlation, Spearman's Rank Coefficient of Correlation, Properties of Coefficient of correlation, Linear Regression, Lines of regression and regression coefficients.

Unit II Probability Theory (21 Lectures -36 marks) Elements of Probability-Random Experiments, events, definition of probability, conditional probability, addition and multiplication theorem, Mathematical expectation. Theoretical Distribution - Random variable, Binomial, Poisson and Normal Distribution.

Unit III Sampling Theory (14 Lectures -16 marks) Methods of sampling- Census and Sample enumeration, Methods of Sampling: Simple Random Sampling, Systematic Sampling, Stratified Sampling, Cluster Sampling, Purposive Sampling, Quota and multi stage sampling (with

examples). Test of Hypothesis and Estimation- Sampling distribution, Standard error, Sample mean and Sample proportion, confidence limits, population mean and population proportion, Procedure for testing of hypothesis, Type I and Type II error, critical region, level of significance, test of significance for large samples.

Unit IV Interpolation and Extrapolation (11 Lectures -18marks) Finite differences, Forward and Backward differences, Forward and Backward difference table, Newton-Gregory forward and backward difference formula for equidistant values of the argument (only applications), Lagrange's Interpolation formula for unequally spaced points (only applications), Shift Operator, Binomial Expansion method to find missing values (maximum 2 missing values).

References:

1. Gupta S.P., Statistical Methods, Sultan Chand & sons.
2. Gupta C.B., Fundamentals of Statistics, Himalaya Publishing House.
3. Shah R.J., Statistical Methods.
4. Mazumdar Neeta, Statistical Techniques, RajhaunsVitaran.
5. Sastry S.S., Introductory Methods of Numerical Analysis