Rayat Shikshan Sanstha's

SADGURU GADAGE MAHARAJ COLLEGE, KARAD.

(An Autonomous College - Affiliated to Shivaji University, Kolhapur)

Accredited By NAAC with A^{+} Grade (CGPA 3.63)

National Education Policy (NEP-2020)

Syllabus for

B.Sc. Part -III

Mathematics

Syllabus to be implemented from July 2024 onwards of Academic Year 2024-25

Rayat Shikshan Sanstha's

Sadguru Gadage Maharaj College, Karad (Autonomous)

Department of Mathematics

Course Structure & Evaluation Pattern: B.Sc. III Mathematics

(w.e.f. June 2024)

Sem.	Paper Code	Credits	Title of Paper	Evaluation Scheme (Marks) CCE	SEE	Total	Grand Total Marks
V	BMT22-501	02	Mathematical Analysis	10	40	50	200
	BMT22-502	02	Abstract Algebra	10	40	50	
	BMT22-503	02	Optimization Techniques	10	40	50	
	BMT22-504	02	Integral Transform	10	40	50	
VI	BMT22-601	02	Metric Spaces	10	40	50	400
	BMT22-602	02	Linear Algebra	10	40	50	
	BMT22-603	02	Complex Analysis	10	40	50	
	BMT22-604	02	Discrete Mathematics	10	40	50	
	BMP22-605	02	**Practical-III** Operations Research	200			
		02	**Practical-III** Numerical Methods				
		02	**Practical-III** Mathematical Computation Using Python				
		02	**Practical-III** Project, Study- Tour, Viva – Voce				
Total		24		Total			600

SEE- Semester End Examination**, CCE-** College Compressive Evaluation
Nature of question paper and evaluation scheme:

- Evaluation Scheme
- **Separate passing for Theory, Practical and internal examination is mandatory.**

- In theory examination (**SEE-** Semester End Examination) passing for each paper is at **16** marks (40% of 40 marks).
- In internal of theory examination (**CCE-** Continuous compressive Evaluation) passing for each paper is at **04** marks (40% of 10 marks).
- In practical examination (**SEE-** Semester End Examination) passing is at 20 marks (40% of 50 marks).

BMT 22-501: **Mathematical Analysis**

Theory: 45 Lectures of 48minutes (36Hours)

Marks -50 (Credits: 02)

Course Objectives: Students should **(36Hrs)**

1. The integration of bounded function on a closed and bounded interval.
2. Some of the families and properties of Riemann integrable functions.
3. The applications of the fundamental theorems of integration.
4. Extension of Riemann integral to the improper integrals when either the interval of Integration is infinite or the integrand has infinite limits at a finite number of points on the interval of integration.
5. The expansion of functions in Fourier series and half range Fourier series.

UNIT-I

1. Riemann Integration **(09)**

Definition of Riemann integration and simple examples: norm of subdivision, lower and upper sum, lower and upper integrals, oscillatory sums, Riemann Integral. Inequalities for lower and upper Darboux sums, Necessary and sufficient conditions for Riemann integrability, Existence of Riemann integral.

UNIT-II

2. Properties of Riemann Integral **(09)**

Algebra and properties of Riemann integrable functions, Primitive of a function, first and second fundamental theorems of integral calculus.

UNIT III

3. Improper Integrals **(09)**

Definition of improper integral of first kind, second kind, third kind and its examples, Comparison Test, μ – test for Convergence, Absolute and conditional convergence, Integral test for convergence of series, Definition of improper integral of second kind and some tests for their convergence, Cauchy Principal Value.

UNIT IV

4. Fourier series **(9)**

Definition of Fourier series and examples on the expansion of functions in Fourier series, Fourier series Corresponding to even and odd functions, half range Fourier series, half range sine and cosine series

Course outcomes:

Unit I: After completion, Students are able to:

1. Describe fundamental properties of the Riemann integration and existence theorems.
2. Necessary and sufficient conditions for Riemann integrability.

Unit II: After completion, Students are able to:

1. Understand the first and second theorem of Integral calculus.
2. properties of Riemann integrable functions

Unit III: After completion, Students are able to:

1. Understand the concepts of Improper integral.
2. Absolute and conditional convergence.

Unit IV: After completion, Students are able to:

1. Develop the functions in Fourier series.
2. Fourier series Corresponding to even and odd functions.

Reference Books

1. **First Course in Mathematical Analysis :**D Somasundaram and B Choudhary Narosa Publishing House New Delhi, Eighth Reprint 2013 (Chapter 8, Chapter 10, Art 10.1)
2. **Elementary Analysis The Theory of Calculus**: Kenneth. A. Ross Second Edition, Undergraduate Texts in Mathematics, Springer, 2013. (Chapter 6, Art. 32.1 to 32.11, 33.1 to 33.6 and 34.1 to 34.4)
3. **Methods of Real Analysis**: R. R. Goldberg, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. **Introduction to Real Analysis**: R.G. Bartle and D. R. Sherbert, Wiley India Pvt. Ltd., Fourth Edition 2016.

5. **Elements of Real Analysis**: Shanti Narayan and Dr. M. D. Raisinghania, S. Chand & Company Ltd. New Delhi, Fifteenth Revised Edition 2014.

6. **A Course of Mathematical Analysis:** Shanti Narayan and P. K. Mittal, S.Chand & Company Ltd. New Delhi, Reprint 2016.

7. **Real Analysis:** Hari Kishan, Pragati Prakashan, Meerut, Fourth Edition 2012.Mathematical Physics, H. K. Das, Rama Varma, S Chand Publishing,2018.

BMT22-502: Abstract Algebra

Theory: 45 Lectures of 48minutes (36Hours)

Marks -50 (Credits: 02)

Course Objectives: Students should

1. Basic concepts of group and rings with examples.
2. Identify whether the given set with the compositions form Ring, Integral domain or Field.
3. The concepts Group and Ring.

UNIT-I:

GROUPS (09)

Definition and examples of groups, group S3 and Dihedral group D4, Commutator subgroups and its properties, Conjugacy in group and class equation.

UNIT- II:

RINGS (09)

Definition and examples of Rings, commutative ring, Non-commutative ring, Ring with unity, Ring with Zero divisor, Ring without zero divisor, Integral Domain, Division Ring, Field, Boolean ring, Subring, Characteristic of a ring: Nilpotent and Idempotent elements. Ideals, Sum of two ideals, Examples, Simple Ring.

UNIT-III:

HOMOMORPHISM AND IMBEDDING OF RING (09)

Quotient Rings, Homomorphism, Kernel of Homomorphism, Isomorphism theorems, imbedding Of Ring, Maximal Ideals, Prime ideal, Semi-Prime Ideal.

UNIT-IV:

POLYNOMIAL RING AND UNIQUE FACTORIZATION DOMAIN (09)

Polynomial Rings, degree of Polynomial, addition and multiplication of Polynomials and their properties, UFD, Gauss' Lemma.

Course outcomes:

Unit I: After completion, Students are able to:

1. Perform basic computations in group theory.
2. Understand the concept of subgroups and its examples.

Unit II: After completion, Students are able to:

1. Apply fundamental theorem, Isomorphism theorems of groups to prove these theorems for Ring.
2. Understand the concept of Maximal Ideals, Prime Ideals and its examples.

Unit III: After completion, Students are able to:

1. Apply fundamental theorem, Isomorphism theorems of Ring.
2. Understand the concept of Ideals and its examples.

Unit IV: After completion, Students are able to:

1. Understand the concepts of polynomial rings, unique factorization domain.
2. Perform addition and multiplication of Polynomials.

Reference Books

1. **A Course In Abstract Algebra**, Vijay K. Khanna, S.K. Bhambri, Vikas publishing House Pvt.Ltd., New –Delhi-110014, Fifth Edition 2016.

   (Chap.3 Art. The Dihedral Group, commutator, Chap. 4 Art. Conjugate elements, Chap.7 Art. Subrings, characteristic of a ring, Ideals, Sum of Ideals, Chap. 8 Art. Quotient rings, Homomorphism, Embedding of Rings, More on Ideal, Maximal Ideal, Chap 9 Polynomial Rings, Unique Factorization Domain.)

2. **A First Course in Abstract Algebra:** Jonh B. Fraleigh, Pearson Education, Seventh Edition (2014).

3. **Topics in Algebra:** Herstein I. N, Vikas publishing House, 1979.

4. **Fundamentals of Abstract Algebra**: Malik D. S. Moderson J. N. and Sen M. K.,Mc Grew Hill, 1997.

5. **Basic Algebra:** N. Jacobson, Vol. I&II, Freeman and Company, New York 1980.

BMT22- 503: Optimization Techniques

Theory: 45 Lectures of 48 minutes (36 Hours)

Marks -50 (Credits: 02)

Course Objectives: Students should

1. develop basic knowledge of Operation Research models and techniques, which can be applied to a variety of industrial and real life applications.
2. Formulate and apply suitable methods to solve problems.
3. Identify and select procedures for various sequencing, assignment, transportation problems.
4. Identify and select suitable methods for various games.
5. To apply linear programming and find algebraic solution to games.

UNIT-I:

Linear Programming problems: (09)

Introduction, Formulation of Linear Programming Problems., Graphical methods for Linear Programming Problems. General formulation of Linear Programming problems, Slack and surplus variables, Canonical form, Standard form of Linear Programming problems.

UNIT-II:

Transportation: (10)

Transportation problem: Introduction, Mathematical formulation, Matrix form of Transportation Problem. Feasible solution, Basic feasible solution and optimal solution, Balanced and unbalanced Transportation problems. Methods of Initial basic feasible solutions: North west Corner rule [Steppingstone method], Lowest cost entry method [Matrix minima method]

UNIT-III:

Assignment Problems (08)

Assignment Models: Introduction, Mathematical formulation of assignment problem, Hungarian method for assignment problem. Unbalanced assignment problem. Travelling Salesman problem.

UNIT-IV:

Game Theory (09)

Game theory: Basic definitions, Minimax [Maximin] Criterion and optimal strategy, Saddle point, optimal strategy and value of game. Solution of games with saddle point. Fundamental theorem of game theory [Minimax theorem], Two by two (2 × 2) games without saddle point. Algebraic method of Two by two (2 × 2) games. Arithmetic method of Two by two (2 × 2) games. Graphical method for 2 x n games and m × 2 games, Principle of dominance.

Course Outcomes:

UNIT I: **After completion of the unit, Students are able to:**

1. Understand importance of optimization of industrial process management.
2. Solve Linear Programming Problems by using Graphical Method.

UNIT II: After completion of the unit, Students are able to:

1. Apply basic concepts of mathematics to formulate an optimization problem.
2. Solve Balanced and unbalanced Transportation problems.

UNIT III: After completion of the unit, Students are able to:

1. Analyze and appreciate variety of performance measures for various optimization problems.
2. Solve Travelling Salesman problem.

UNIT IV: After completion of the unit, Students are able to:

1. Find Saddle point of given game theory.
2. Define Fundamental theorem of game theory

Reference books

1. **"Theory Methods and Applications":** Sharma S. D. Kedarnath, Ramnath Meerut, Delhi Reprint 2015.
2. **Optimization Techniques:** Mohan, C. and Deep, Kusum, Optimization Techniques, New Age,2009.
3. **Optimization Methods in Operations, Research and Systems Analysis:** Mittal, K. V. and Mohan, C., New Age, 2003.
4. **Operations Research – An Introduction:** Taha, H.A., Prentice Hall, (7th. Edition), 2002
5. **Operations Research: Principles and Practice:** Ravindran, A. Phillips, D. T and Solberg, J. J., John Willey and Sons, 2nd Edition, 2009.

6. **Operation Research: Theory and Applications:** J. K. Sharma, Laxmi Publications, 2017.
7. **Operation Research**: Kanti Swarup, P. K. Gupta and Manmohan, S.Chand & Co.
8. **Linear programming**: G. Hadley Oxford and IBH Publishing Co.

BMT22- 504(A): Numerical Methods-I

Theory: 45Lectures (48minutes) (36 Hours)

Marks-50 (Credits: 02)

Course Objectives: Students should understand

1. Use appropriate numerical methods and determine the solutions to given non-linear equations.
2. use appropriate numerical methods and determine approximate solutions to systems of linear equations.
3. Use appropriate numerical methods and determine approximate solutions to ordinary differential equations.
4. demonstrate the use of interpolation methods to find intermediate values in given graphical and/or tabulated data.

UNIT-I:

NON-LINEAR EQUATIONS (09)

Introduction: Polynomial equations, algebraic equations and the irroots, iterative methods, Bisection method, algorithm, examples, Secant method: iterative sequence of secant method, examples, Regula-Falsi method: algorithm, graphical representation, examples. Newton's method: algorithm, examples.

UNIT-II:

SYSTEM OF LINEAR EQUATIONS: EXACT METHODS (09)

Introduction: System of linear equations as a vector equation Ax = b, Augmented matrix Direct methods: Gauss elimination method: Procedure, examples, Gauss-Jordan method: Procedure, examples. Iterative methods: General iterative rule.

UNIT-III:

SYSTEM OF LINEAR EQUATIONS: ITERATIVE METHOD 09)

Jacobi iteration scheme, examples, Gauss-Seidel method: Formula, examples.

UNIT-IV:

EIGEN VALUES AND EIGEN VECTORS (09)

Eigen values and eigenvectors of a real matrix, Power method for finding an eigenvalue of greatest modulus, the case of matrix whose "dominant eigenvalue is not repeated", examples, Method of exhaustion, examples, Method of reduction, examples. Shifting of the eigen value, examples.

Course Outcomes:

Unit I: After completion, Students are able to

1. Derive numerical methods for various mathematical operations and tasks, such as Secant method Gauss-Seidel method, Regula-Falsi method the solution of differential equations.
2. Analyze and evaluate the accuracy of common numerical methods.

Unit II: After completion, Students are able to

1. Explain procedure of Gauss elimination and Gauss Jordan method.
2. Solve system of linear equations by using Gauss elimination and Gauss Jordan method.

Unit III: After completion, Students are able to

1. Solve system of linear equations by using Jacobi Iteration method.
2. Solve system of linear equations by using Gauss-Seidel method.

Unit IV: After completion, Students are able to

1. By using Power method find eigenvalue of greatest modulus.
2. Find Eigen values and eigenvectors of a real matrix.

Reference Books

1. **An Introduction to Numerical Analysis:** Devi Prasad, Narosa Publishing House(Third Edition)
2. **Introductory Methods of Numerical Analysis:** S. S. Sastry, Prentice Hall of India.
3. **Numerical Methods for Mathematics:** J.H. Mathews, Science and Engineering, Prentice Hall of India.

4. **Numerical Methods for Scientists and Engineers:** K. Sankara Rao, Prentice Hall of India.

5. **Numerical Analysis:** Bhupendra Singh, Pragati Prakashan.

BMT22-504(B): Integral Transforms

Theory: 45 Lectures (48 minutes) (36 Hours)

Marks-50 (Credits: 02)

Course Objectives: Students should

1. Understand the concept of Laplace Transform.
2. Apply properties of Laplace Transform to solve differential equations.
3. Understand relation between Laplace and Fourier Transform.
4. Understand infinite and finite Fourier Transform.
5. Apply Fourier transform to solve real life problems.

UNIT-I:

Laplace Transform (09)

Laplace Transform**:** Definitions; Piecewise continuity, Function of exponential order, Function of class A, Existence theorem of Laplace transform. Laplace transform of standard functions. First shifting theorem and Second shifting theorem and examples, Change of scale property and examples, Laplace transform of derivatives and examples, Laplace transform of integrals and examples. Multiplication by power of t and examples. Division by t and examples. Laplace transform of periodic functions and examples. Laplace transform of Heaviside's unit Step function

Unit-II:

Inverse Laplace Transform: (09)

Inverse Laplace Transform: Definition, Standard results of inverse Laplace transform, Examples, First shifting theorem and Second shifting theorem and examples. Change of scale property and Inverse Laplace of derivatives, examples. The Convolution theorem and Multiplication by S, examples. Division by S, inverse Laplace by partial fractions, examples, Solving linear differential equations with constant coefficients by Laplace transform.

Unit-III:

Infinite Fourier Transform: (09)

The infinite Fourier transform and inverse: Definition, examples, Infinite Fourier sine and cosine transform and examples. Definition: Infinite inverse Fourier sine and cosine transform and examples. Relationship between Fourier transform and Laplace transform. Change of Scale Property and examples. Modulation theorem. The Derivative theorem. Extension theorem. Convolution theorem and examples.

Unit-IV:

Finite Fourier Transform: (09)

Finite Fourier Transform and Inverse, Fourier Integrals, Finite Fourier sine and cosine transform with examples. Finite inverse Fourier sine and cosine transform with examples. Fourier integral theorem. Fourier sine and cosine integral (without proof) and examples.

Course Outcomes:

Unit I: After completion of the unit, students are able to explain

1. Recognize the different methods of finding Laplace transforms and Fourier transforms of different functions.
2. Find Laplace transform of periodic functions and examples.

Unit II: After completion of the unit, students are able to explain

1. Inverse Laplace by partial fractions
2. First shifting theorem and Second shifting theorem.

Unit III: After completion of the unit, students are able to explain

1. Infinite Fourier transform and inverse
2. Relationship between Fourier transform and Laplace transform.

Unit IV: After completion of the unit, students are able to explain

1. apply methods of solving differential equations, partial differential equations, IVP and BVP using Laplace transforms and Fourier transforms.
2. apply the knowledge of L.T, F.T, and Finite Fourier transforms in finding the solutions of differential

   equations, initial value problems and boundary value problems.

Reference Books

1. **Laplace and Fourier Transform:** J. K. Goyal, K. P. Gupta, A Pragati Edition (2016).
2. **Integral Transform:** Dr. S. Shrenadh, S. Chand Prakashan
3. **Integral Transforms and Their Applications**: B. Davies, Springer Science Business Media LLC (2002)
4. **Laplace Transforms**: Murray R. Spiegel, Schaum's outlines

BMT22- 504(C): Applications of Mathematics in Finance

Theory: 45 Lectures (48 minutes) (36 Hours)

Marks -50 (Credits: 02)

Course Objectives: Students should

1. Understand the basic concepts in linear algebra, relating to linear equations, matrices, and optimization.
2. Understand the concepts relating to functions and annuities.
3. Employ methods related to these concepts in a variety of financial applications.
4. Apply logical thinking to problem solving in context.
5. Use appropriate technology to aid problem solving.

UNIT-I:

FINANCIAL MANAGEMENT (09)

An overview, Nature and Scope of Financial Management. Goals of Financial Management and main decisions of financial management. Difference between risk, speculation and gambling.

UNIT- II:

TIME VALUE OF MONEY (09)

Interest rate and discount rate, Present value and future value, discrete case as well as continuous ompounding case, Annuities and its kinds, meaning of return, Return as Internal rate of Return (IRR), Numerical Methods like Newton Raphson Method to calculate IRR, Measurement of returns under uncertainty situations, Meaning of risk, difference between risk and uncertainty, Types of risks. Measurements of risk, Calculation of security and Portfolio Risk and Return- Markowitz Model, Sharpe's Single Index Model, Systematic Risk and Unsystematic Risk.

UNIT- III:

TAYLOR SERIES AND BOND VALUATION (09)

Calculation of Duration and Convexity of bonds.

UNIT- IV:

FINANCIAL DERIVATIVES (09)

Futures, Forward, Swaps and Options, Call and Put Option, Call and Put Parity Theorem. Pricing of contingent claims through Arbitrage and Arbitrage.

Course Outcomes:

Unit I: After completion of the unit, students are able to explain

1. Employ methods related to these concepts in a variety of financial applications.
2. Nature and Scope of Financial Management.

Unit II: After completion of the unit, students are able to explain

1. Understand the concepts relating to functions and annuities.
2. Types of risks.

Unit III: After completion of the unit, students are able to explain

1. Convexity of bonds.
2. Calculation of Duration.

Unit IV: After completion of the unit, students are able to explain

1. Swaps and Options.
2. Parity Theorem.

References:

1. **Corporate Finance -Theory and Practice:** Aswath Damodaran, John Wiley & Sons. Inc. John C. Hull, Options, Futures, and Other Derivatives, Prentice-Hall of India Private Limited.
2. **An Introduction to Mathematical Finance**: Sheldon M. Ross, Cambridge University Press
3. **Introduction to Risk Management and Insurance:** Mark S. Dorfman, Prentice Hall, Englwood Cliffs, New Jersey.

B.Sc.-III –Semester VI

BMT22-601: Metric Spaces

Theory: 45 Lectures of 48 minutes (36 Hours)

Marks – 50 (Credits: 02)

Course Objective: Students should

1. acquire the knowledge of notion of metric space, open sets and closed sets.
2. demonstrate the properties of continuous functions on metric spaces.
3. apply the notion of metric space to continuous functions on metric spaces.
4. understand the basic concepts of connectedness, completeness and compactness of metric spaces.
5. appreciate a process of abstraction of limits and continuity in metric spaces.

UNIT I

LIMITS AND METRIC SPACES (9)

Revision: Limits of a function on the real line, Metric space, Limits in Metric space.

UNIT II

CONTINUOUS FUNCTIONS ON METRIC SPACES (9)

Continuity at a point on the real line, Reformulation, Functions continuous on a metric space, Open Sets, Closed Sets, Homeomorphism, dense subset of a metric space.

UNIT III

CONNECTEDNESS, COMPLETENESS, AND COMPACTNESS (9)

More about open sets, connected sets, Bounded and totally bounded sets, dense set, Complete metric space, contraction operator, Compact metric spaces, Covering and open covering, Borel property, Finite intersection property

UNIT IV

SOME PROPERTIES OF CONTINUOUS FUNCTIONS ON (9)

Continuous functions on compact metric spaces, Bounded function, Uniform continuity,

Course Outcomes: After completion, students are able to

UNIT I : 1. understand the Euclidean distance function on R^n and appreciate its properties.

2. understand the concept and examples of metric space.

UNIT II : 1. explain the definition of continuity for functions.

2. understand the concept of open and closed sets.

UNIT III :1. explain the geometric meaning of each of the metric space properties (M1) – (M3) and be able to verify whether a given distance function is a metric.

2. identify the dense set, Complete metric space, Compact metric spaces.

UNIT IV : 1. distinguish between open and closed balls in a metric space and be able to determine them for given metric spaces.

2. check the continuity and uniform continuity on compact metric space.

References :

1. **Methods of Real Analysis,** R.R.Goldberg, Oxford and IBH Publishing House, 2017.

2. **Mathematical Analysis**, T. M. Apostol, Narosa Publishing House,2002.

3.**Mathematical Analysis**, Satish Shirali, H.L.Vasudeva, Narosa Publishing House, 2013

4.**First Course in Mathematical Analysis**, D. Somasundaram, B. Choudhary, Narosa Publishing House, 2018.

5. **Principles of Mathematical Analysis**, W. Rudin, McGraw Hill Book Company, 1976.

6.**A Course of Mathematical Analysis**, Shanti narayan, Mittal, S.Chand and Company, 2013.

1. **Mathematical Analysis-I**, J.N. Sharma, Krishna Prakashan Mandir, Meerut, 2014.

2. **Mathematical Analysis-** S.C.Malik, Savita Arrora, New age international ltd,2005.

BMT22-602: Linear Algebra

Theory: 45 Lectures of 48 minutes (36 Hours)

Marks – 50 (Credits: 02)

Course Objectives: Students should

1. understand the notion of vector space.
2. work out algebra of linear transformations.
3. appreciate connection between linear transformation and matrices.
4. work out Eigen values, Eigen vectors and its connection with real life situation.

UNIT I

Vector Spaces **(9)**

Vector space, Subspace, Sum of subspaces, direct sum, Quotient space, Homomorphism or Linear transformation, Kernel and Range of homomorphism, Fundamental Theorem of homomorphism, Isomorphism theorems, Linear Span, Finite dimensional vector space, Linear dependence and independence, basis, dimension of vector space and subspaces.

UNIT II

Linear Transformations **(9)**

Linear Transformation, Rank and nullity of a linear transformation, Sylvester's Law, Algebra of Linear Transformations, Sum and scalar multiple of Linear Transformations. The vector space of homomorphism, Product (composition) of Linear Transformations, Linear operator, Linear functional, Invertible and non-singular Linear Transformation, Definition of Dual Space.

UNIT III

Inner Product Spaces **(9)**

Inner product spaces: Norm of a vector, Cauchy- Schwarz inequality, Orthogonality, Pythagoras Theorem, orthonormal set, Gram-Schmidt orthogonalization process, Bessel's inequality

UNIT IV

Eigen values and Eigen vectors **(9)**

Eigen values and Eigen vectors: Eigen space, Characteristic Polynomial of a matrix and remarks on it, similar matrices, Characteristic Polynomial of a Linear operator, Examples on eigenvalues and eigenvectors.

Course Outcomes: After completion, students are able to

UNIT I : 1. explain the concepts of basis and dimension of a vector space.

2. explain the concept of kernel and range of homomorphism.

UNIT II : 1. explain the properties of vectors.

2.check invertible and non-singular Linear Transformation.

UNIT III : 1. explain the Inner product spaces and check whether the set is orthonormal or not.

2.explain Gram-Schmidt orthogonalization process.

UNIT IV : 1. understands eigenvalues, eigenfunctions, Characteristic Polynomial of a matrix.

2. find the eigenvalues and eigenvectors.

References:

1.**A Course in Abstract Algebra**, Khanna V. K. and Bhambri S. K.,Vikas Publishing House PVT Ltd., New Delhi , 5th edition ,2016.

2.**Elementary Linear Algebra (with Supplemental Applications)**, H. Anton & C.Rorres, Wiley India Pvt. Ltd (Wiley Student Edition), New Delhi, 11th Edition 2016.

3.**Linear Algebra**, S. Friedberg, A. Insel, L. Spence, Prentice Hall of India, 4th Edition, 2014.

4**. Linear Algebra**, Holfman K. and Kunze R**,** Prentice Hall of India, 1978.

5.**Linear Algebra**, Schaum's Outline Series, Lipschutz S**,** McGraw Hill, Singapore, 1981.

6.**Linear Algebra and its Applications**, David Lay, Steven Lay, Judi McDonald, Pearson ducation Asia, Indian Reprint, 5th Edition, 2016.

BMT22-603: Complex Analysis

Theory: 45 Lectures of 48 minutes (36 Hours)

Marks – 50 (Credits: 02)

Course Objective: Students should

1. learn basic concepts of functions of complex variable.
2. introduce the concept of analytic functions.
3. learn concept of complex integration.
4. introduce the concepts of sequence and series of complex variable.
5. learn and apply concept of residues to evaluate certain real integrals.

UNIT I

Analytic functions **(9)**

Limit and continuity of a function of a complex variable, complex valued function. Differentiability and continuity and elementary rules of Differentiation. Analytic function and Analytic function in domain. Necessary and sufficient condition for F(z) = u+iv to be Analytic and examples, Limit of a sequence of complex numbers, Polar form of Cauchy-Riemann Equation, harmonic function, conjugate harmonic function, construction of Analytic function, Solved problems related to the test of analyticity of functions and construction of analytic function.

UNIT II

Complex Integration (9)

Elementary Definitions, complex line integral, Integral along oriented curve and examples, Cauchy's integral theorem and its consequences, Cauchy's integral formula for multiply connected domain and its examples, Jordan curve, orientation of Jordan curve, simple connected and multiply connected domain, rectifiable curve and their properties. Higher order derivative of an analytic function,

UNIT III

SINGULARITIES AND RESIDUES (9)

Development of an analytic function as a power series, Taylor's theorem for complex function, Examples on Taylor's and Laurent series, Zeros of an analytic function, singular point, different types of singularity, poles and zeros, limiting point of zeros and poles. Residue theorem, residue at a pole and residue at infinity. Cauchy's residue theorem, computation of residue at a finite pole. Integration round unit circle, Jordan's lemma, Evaluation of Integrals $\int_{-\infty}^{\infty} f(z)dz$ when $f(z)$has no poles on the real line and when poles on the real line.

UNIT IV

ENTIRE MEROMORPHIC FUNCTIONS (9)

Definition of entire and meromorphic functions. Characterization of polynomials as entire functions, Characterization of rational functions as meromorphic functions, Mittag-Leffler's expansion, Rouche's theorem and solved problems. Some theorems on poles and singularities.

Course Outcomes: After completion, students are able to

UNIT I : 1. define the concept of derivation of analytic functions.
2. solved problems related to the test of analyticity of functions.

UNIT II : 1. calculate the analytic functions.
2.understands the concept of Jordan curve, orientation of Jordan curve, rectifiable curve and it's properties.

UNIT III : 1. express the power series expansion of analytic functions.
2. evaluate the integrals $\int_{-\infty}^{\infty} f(z)dz$ when $f(z)$ has no poles on the real line and when poles on the real line.

UNIT IV : 1. define the concept of Cauchy-Goursat Integral Theorem.

2.understands the Rouche's theorem and problems on it.

References :

1.**Complex Variables and Applications**, James Ward Brown and Ruel V.Churchill, McGraw – Hill Education (India) Edition, 8th Ed.2014 , Eleventh reprint 2018.

2.**Foundations of Complex Analysis**, S.Ponnusamy, Narosa Publishing House, Second Edition, 2005, Ninth reprint 2013.

3.**Complex Analysis**, Lars V Ahlfors, McGraw-Hill Education,3 edition, January 1, 1979.

BMT22-604(A): Numerical Methods-II

Theory: 45 Lectures of 48 minutes (36 Hours)

Marks – 50 (Credits: 02)

Course Objective: Students should

1.analize the errors obtained in the numerical solution of problems.

2. understand the common numerical methods and how they are used to obtain approximate solutions.

3. derive numerical methods for various mathematical operations and tasks, such as interpolation,

differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.

UNIT I

INTERPOLATION: EQUAL INTERVALS (9)

Forward interpolation: Newton's forward differences, forward difference table Newton's forward form of interpolating polynomial (formula only), examples Backward interpolation: Newton's backward differences, backward difference table, Newton's backward form of interpolating polynomial (formula only), examples

UNIT II

INTERPOLATION:UNEQUAL INTERVALS (9)

Introduction, Lagrangian interpolating polynomial (formula only), examples,

Divided difference interpolation, Newton's divided differences, divided difference table, examples (finding divided differences of given data),Newton's divided difference form of interpolating polynomial, examples.

UNIT III

NUMERICAL DIFFERENTIATION AND INTEGRATION (9)

Numerical differentiation based on interpolation polynomial. Numerical integration: Newton-Cotes formula (statement only), Basic Trapezoidal rule (excluding the computation of error term), composite Trapezoidal rule, examples, Basic Simpson's 1/3rd rule (excluding the computation of error term), composite Simpson's 1/3rd rule, examples. Basic Simpson's 3/8th rule (excluding the computation of error term), composite Simpson's 3/8th rule, examples.

UNIT IV

ORDINARY DIFFERENTIAL EQUATIONS (9)

Euler’s Method, Examples, Second order Runge-Kutta method (formula only), examples Fourth order Runge-Kutta method (formula only), examples

Course Outcomes: After completion, students are able to

UNIT I : 1.apply numerical methods to find the solution of algebraic equations using different methods under different conditions.

2.find the numerical solution of system of algebraic equations.

UNIT II : 1. apply various interpolation methods.

2.find numerical solutions.

UNIT III : 1. work out numerical differentiation and integration whenever and wherever routine methods are not applicable.

2. apply basic Trapezoidal rule, basic Simpson's 1/3rd rule, basic Simpson's $3/8^{th}$ rule.

UNIT IV : 1.apply Euler’s Method and find numerical solutions.

2.apply Second order Runge-Kutta method, Fourth order Runge-Kutta method and find numerical solutions.

References:

1.**An Introduction to Numerical Analysis**, Devi Prasad, Narosa Publishing House, Third Edition.

2.**Introductory Methods of Numerical Analysis**, S. S. Sastry, Prentice Hall of India.

3.**Numerical Methods for Mathematics, Science and Engineering**, J.H. Mathews, Prentice Hall of India.

4.**Numerical Methods for Scientists and Engineers,** K. Sankara Rao, Prentice Hall of India.

5.**Numerical Analysis**, Bhupendra Singh, Pragati Prakashan.

BMT22-604(B): Discrete Mathematics

Theory: 45 Lectures of 48 minutes (36 Hours)

Marks – 50 (Credits: 02)

Course Objective: Students should

1. use classical notions of logic: implications, equivalence, negation, proof by contradiction, proof by induction, and quantifiers.
2. apply notions in logic in other branches of Mathematics.
3. know elementary algorithms: searching algorithms, sorting, greedy algorithms, and their complexity.
4. apply concepts of graph and trees to tackle real situations.
5. appreciate applications of shortest path algorithms in computer science.

UNIT I

Mathematical Logic (9)

The logic of compound statements: Statements, compound statements, truth values, logical equivalence, tautologies and contradictions. Conditional statements: Logical equivalences involving implication, negation. The contra positive of a conditional statement, converse, inverse of conditional statements, biconditional statements.

UNIT II

Valid and Invalid Arguments (9)

Modus Ponens and modus Tollens, Additional valid argument forms, rules of inferences, contradictions and valid arguments, Number system: Addition and subtraction of Binary, decimal, quintal, octal, hexadecimal number systems and their conversions.

UNIT III

Graphs (9)

Graphs: Definitions, basic properties, examples, special graphs, directed and undirected graphs, concept of degree, Trails, Paths and Circuits: connectedness, Euler circuits, Hamiltonian circuits, Matrix representation of graphs, Isomorphism of graphs, isomorphic invariants, graph isomorphism for simple graphs.

UNIT IV

Trees **(9)**

Definitions and examples of trees, rooted trees, binary trees and their properties. spanning trees , Minimal spanning trees, Kruskal's algorithm, Prim's algorithm, Dijkstra's shortest path algorithm.

Course Outcomes: After completion, students are able to

UNIT I :1. understand the notion of mathematical thinking, mathematical proofs and algorithmic thinking.

2.apply mathematical thinking, mathematical proofs and algorithmic thinking. in problem solving.

UNIT II : 1. understand the basics of discrete probability.

2.understand Addition and subtraction of Binary, decimal, quintal, octal, hexadecimal number systems and their conversions.

UNIT III : 1. understand the definition of graph and it's basic properties.

2.understand Matrix representation of graphs, Isomorphism of graphs, isomorphic invariants, graph isomorphism for simple graphs.

UNIT IV : 1. understand the concept of trees, spanning trees.

2.apply Kruskal's algorithm, Prim's algorithm, Dijkstra's shortest path algorithm.

References:

1.**Discrete Mathematics with Applications,** Susanna S. Epp, PWS Publishing Company, 1995. (Brooks/Cole, Cengage learning, 2011)

2.**Discrete Mathematics and its Applications**, Kenneth H. Rosen, McGraw Hill, 2002.

3.**Discrete Mathematical Structure with Applications**, J.P.Tremblay and R.Manohar, McGraw– Hill.

4.**Combinatorics: Theory and Applications**, V. Krishnamurthy, East-West Press.

5.**Discrete Mathematical Structures**, Kolman, Busby Ross, Prentice Hall International.

6.**Discrete Mathematical Structures**, R M Somasundaram, (PHI) EEE Edition 7.

7.**A Graduate Text in Computer Mathematics**, A.B.P.Rao and R.V.Inamdar, SUMS 1991.

8.**Discrete Mathematics**, Seymour Lipschutz and Marc Lipson, Schaum's Outlines Series, Tata McGraw - Hill.

BMT-604(C): Applications of Mathematics in Insurance

Theory: 45 Lectures of 48 minutes (36 Hours)

Marks – 50 (Credits: 02)

Course Objective: Students should

1. statistics and probability theory together with mathematical analysis.
2. modeling in the various applications.
3. the different risks that challenge our everyday lives.

UNIT I

INSURANCEFUNDAMENTALS (9)

Insurance, Meaning of loss, Chances of loss, peril, hazard and proximate cause in insurance. Costs and benefits of insurance to the society and branches of insurance. Life insurance and various types of general insurance.

UNIT II

LIFE INSURANCE AND MATHEMATICS (9)

Insurable loss, exposures features of a loss that is ideal for insurance, Construction of Mortality Tables, Computation of Premium of Life Insurance for a fixed duration and for the whole life.

UNIT III

DETERMINATION OF CLAIMS FOR GENERAL INSURANCE (9)

Determination of claims for general insurance using Poisson distribution.
Determination of claims for general insurance using Negative Binomial Distribution. The Polya Case

UNIT IV

DETERMINATION OF THE AMOUNT OF CLAIMS IN GENERAL INSURANCE (9)

Compound Aggregate claim model and its properties, claims of reinsurance, Calculation of a compound claim density function, F-recursive and approximate formulae.

Course Outcomes: After completion, students are able to

UNIT I : 1. understand the meaning of insurance.

2. understand Costs and benefits of insurance to the society and branches of insurance.

UNIT II : 1. illustrate the life insurance products.

2.construct Mortality Tables and compute Premium of Life Insurance for a fixed duration and for the whole life.

UNIT III : 1. determine the claims for general insurance using Poisson distribution.

2.determine the claims for general insurance using Negative Binomial Distribution.

UNIT IV : 1. understands the claims of reinsurance , F-recursive and approximate formulae.

2.calculate compound claim density function.

References:

1.**Corporate Finance -Theory and Practice**, Aswath Damodaran, John Wiley & Sons.Inc.

2.**Options, Futures, and Other Derivatives**, John C. Hull, Prentice - Hall of India Private Limited

3.**An Introduction to Mathematical Finance**, Sheldon M.Ross, Cambridge University Press.

4.**Introduction to Risk Management and Insurance**, Mark S. Dorfman, Prentice Hall, Englewood Cliffs, New Jersey

BMP22- 605: Practical Paper-III (A)

Operations Research

Course Objectives: The aim of this course is to

1. develop basic knowledge of Operations Research models and techniques, which can be applied to a variety of industrial and real life applications.
2. formulate and apply suitable methods to solve problems.
3. identify and select procedures for various sequencing, assignment, transportation problems.
4. identify and select suitable methods for various games.
5. to apply linear programming and find algebraic solution to games.

Experiments

1. Simplex Method: Maximization Case
2. Simplex Method: Minimization Case
3. Two-Phase Method
4. Big-M-Method
5. North- West Corner Method
6. Least Cost Method
7. Vogel's Approximation Method
8. Optimization of T.P. by Modi Method
9. Hungarian Method
10. Maximization Case in Assignment Problem
11. Unbalanced Assignment Problems
12. Travelling Salesman Problem
13. Games with saddle point
14. Games without saddle point: (Algebraic method)
15. Games without saddle point: a) Arithmetic Method b) Matrix Method
16. Games without saddle point: Graphical method

Course Outcomes: After completion, students are able to

1. understand importance of optimization of industrial process management.
2. apply basic concepts of mathematics to formulate an optimization problem.
3. analyze and appreciate variety of performance measures for various optimization problems

Reference Books:

1. **Operations Research [Theory and Applications],** By J.K.Sharma Second edition, 2003, Macmillan India Ltd., New Delhi
2. **Operations Research**: S. D. Sharma.

BMP22- 605: Practical Paper-III (B)

Numerical Methods

Course Objectives: The aim of this course is to

1. use appropriate numerical methods and determine the solutions to given non-linear equations.
2. use appropriate numerical methods and determine approximate solutions to systems of linear equations.
3. use appropriate numerical methods and determine approximate solutions to ordinary differential equations.
4. demonstrate the use of interpolation methods to find intermediate values in given graphical and/or tabulated data.

Experiments

1. Bisection method
2. Secant method
3. Newton's method
4. Gauss elimination method Two-Phase Method
5. Gauss-Jordan method.
6. Jacobi iteration scheme
7. Gauss-Seidel method
8. Power method
9. Newton's forward interpolation
10. Newton's backward interpolation
11. Lagrangian interpolation
12. Divided difference interpolation
13. Trapezoidal rule
14. Simpson's 1/3rd rule
15. Second order Runge-Kutta method
16. Fourth order Runge-Kutta method

Course Outcomes: After completion, students are able to

1. apply numerical methods to find the solution of algebraic equations using different methods under different conditions.
2. numerical solution of system of algebraic equations.
3. apply various interpolation methods and finite difference concepts.
4. work out numerical differentiation and integration whenever and wherever routine methods are not applicable.

Reference books

3. **An Introduction to Numerical Analysis:** Devi Prasad, Narosa Publishing House(Third Edition)
4. **Introductory Methods of Numerical Analysis:** S. S. Sastry, Prentice Hall of India.
5. **Numerical Methods for Mathematics:** J. H. Mathews, Science and Engineering, Prentice Hall of India.
6. **Numerical Methods for Scientists and Engineers:** K. Sankara Rao, Prentice Hall of India.
7. **Numerical Analysis:** Bhupendra Singh, Pragati Prakashan.

BMP22- 605: Practical Paper-III (C)

Mathematical Computation Using Python

Course Objective: Students should

1. learn the fundamentals of writing Python scripts.
2. write Python functions to facilitate code reuse.
3. use Python to read and write files.
4. work with Python standard library.

Experiment

1. **Introduction to Python:** Python, Anaconda, Spyder IDE, Python Identifiers and Keywords , data types, simple mathematical operation, Indentation and Comments., Input and Output, First Python program.

2. **Expression and operators:** Expression, Boolean expression, logical operations: comparison operator, membership operator, identity operator, bitwise operator. Order of evaluation. File Handling: open, read, write, append modes of file.

3. **Conditional Statements:** if-else, nested if-else, if-elif-else, try-except block.

4. **Looping Statements, Control statements:** Looping Statements: for loop, while loop , Nested loops Control Statements: break, continue and pass.

5. **Functions :**Built-in functions, User-defined functions, Arguments, recursive function, Python

Anonymous/Lambda Function, Global, Local and Nonlocal variables and return statement.

6.**Modules and packages in Python:** Modules, import, import with renaming, from-import statement, math module, cmath module, random module, packages.

7.Python Data structure: Strings, list, tulpes, dictionary, set and array.

8.**Operations on set and array:** Set operations, Intersection, union, difference, symmetric difference, searching and sorting.

9.**Systems of linear algebraic equations:** Gauss Elimination Method, LU Decomposition Methods

10.**Roots of Equations:** Bisection, Newton-Raphson Method

11. **Initial Value Problems:** Euler's Method, Runge-Kutta Methods.

12. Magic square and Area calculation without measurement.

13.**Graph Theory: Network** Graph, nodes, edges, directed graph, multigraph, drawing graph, Google page rank by random walk method

14.**Collatz conjecture and Monte Hall problem**

15.**Data compression using Numpy**

16. **Data visualization in Python:**2D and 3D plot in python: line plot, bar plot, histogram plot, scatter plot, pie plot, area plot, Mandelbrot fractal set visualization.

Course Outcomes: After completion, students are able to

1. learn data types, simple mathematical operation, Indentation and Comments.
2. use if-else, nested if-else statement to write programs.
3. to solve system of linear algebraic equations.
4. to plot 2D and 3D plots, histogram plot, pie plot, area plot.

References:

1.**Numerical Methods in Engineering with Python3**, Jaan Kiusalaas, Cambridge University Press

2.**Doing Math with Python**, Amit Saha, No Starch Press, 2015

3.**Let Us Python**, Yashwant Kanetkar and Aditya Kanetkar**,** BPB Publication, 2019.

BMP22- 605: Practical Paper-III (C)

Project, Study- Tour, Viva – Voce

A **Project**

Each student of B.Sc. III is expected to read, collect, understand the culture of Mathematics, its historic development. He is expected to get adequate Mathematical concepts, innovations and relevance of Mathematics. Report of the project work should be submitted to the Department of Mathematics. Evaluation of the project report will be done by the external examiners at the time of annual examination.

B **Study Tour**

It is expected that the tour should be arranged to visit the well-known academic institutions so that the students will be inspired to go for higher studies in Mathematics

C **SEMINARS**

D **VIVA-VOCE (on the project report)**