SHRI GOVIND GURU UNIVERSITY
Syllabus for B. Sc. Semester III (Mathematics)
BS23MJ3MT1 Major-1: Linear Algebra-I (Theory)

Hours: 4 /week **Credits: 4**

Prerequisite: Linear algebra is a fundamental branch of mathematics that deals with vector spaces and linear mappings between these spaces. To understand linear algebra effectively, it is important to have a solid understanding of some certain mathematical concepts like Basic Algebra, Geometry, Vectors, and Matrices.

Course Objectives: The objectives of a linear algebra course typically aims to empower students with a thorough understanding of fundamental concepts and techniques in linear algebra. Overall, the primary goal of this course is to provide students with the necessary mathematical tools and conceptual understanding to tackle problems involving linear relationships and structures in various contexts.

Course Learning Outcomes: The course learning outcomes collectively ensure that students acquire a comprehensive understanding of linear algebra and develop the skills necessary to apply this knowledge effectively in both theoretical and practical contexts. Overall, upon completing the course, students should be able to:

1. Demonstrate a comprehensive understanding of fundamental concepts in linear algebra, including vectors, matrices, systems of linear equations, and linear transformations.
2. Interpret linear algebra concepts geometrically.
3. Communicate mathematical ideas effectively, both orally and in writing.
4. Apply linear algebra concepts to solve a wide range of mathematical problems.
5. Develop the ability to understand and work with abstract mathematical structures.
6. Equip students with the ability to apply linear algebra techniques to real-world problems in fields such as physics, engineering, computer science, economics, and data science.

Unit I:
Vector Space: Definition, Examples, Properties, Subspaces, Necessary and Sufficient Condition to be a Subspace, Span of a Set, Examples of Subspaces, Intersection, Addition and Direct Sum of Subspaces.

Unit II:
Finite Linear Combination, Linear Dependence/Independence and their properties, Examples regarding Linear Dependence/Independence, Dimension and Basis of a vector space, Dimension Theorem.

Unit III:
Linear Transformations: Definition and Examples. Range and Kernel of a Linear Map and results regarding them. Rank and Nullity of a Linear Map, Rank – Nullity Theorem. Examples for verification of Rank – Nullity Theorem, Inverse of a Linear Map, Consequences of Rank – Nullity Theorem, Isomorphism.

Unit IV:
Matrix associated with a Linear Map, Linear Map associated with a Matrix, Linear operations in

m,n, Rank – Nullity of Matrices and verification of the Rank-Nullity Theorem for Matrices, and its examples in $\mathbb{R}^2$ and $\mathbb{R}^3$.

Reference Books:

1. An Introduction to Linear Algebra – V. Krishnamurthy & others, Affiliated East-West press, New Delhi

2. Linear Algebra a Geometric Approach - S. Kumaresan, Prentice Hall India.

3. Introduction to Linear Algebra - Serge Lang, Springer, India.

4. Introduction to Linear Algebra with Applications, DeFranza and Gagliardi, McGraw Hill

5. Linear Algebra, Hoffman and Kunze, Prentice Hall India

Teaching Plan: The teaching plan may be followed as:
Weeks 1 and 2: Vector Space, Subspace, Span of a Set, Definitions and Examples.
Weeks 3 and 4: Intersection, Addition and Direct Sum of Subspaces, Finite Linear Combination, Examples.
Weeks 5, 6 and 7: Linear Dependence/Independence and their properties, Examples regarding Linear Dependence/Independence, Dimension and Basis of a vector space.
Weeks 8 and 9: Dimension Theorem, Linear Transformations: Definition and Examples, Range and Kernel of a Linear Map and result regarding them.
Weeks 10, 11 and 12: Rank and Nullity of a Linear Map, Rank – Nullity Theorem, Examples for verification of Rank – Nullity Theorem, Inverse of a Linear Map, Consequences of Rank – Nullity Theorem, Isomorphism.
Weeks 13 and 14: Matrix associated with a Linear Map, Linear Map associated with a Matrix, Linear operations in m,n, Rank – Nullity of Matrices and verification of the Rank-Nullity Theorem for Matrices, and its examples in R2 and R3.
Week 15: Discussion about learning outcomes of the course.

SHRI GOVIND GURU UNIVERSITY
Syllabus for B. Sc. Semester III (Mathematics)
BS23MJ3MT2 Major-2: Advanced Calculus (Theory)

Hours: 4 /week **Credits: 4**

Prerequisite: Advanced calculus builds upon the concepts and techniques introduced in introductory calculus courses. Overall, a strong foundation in calculus, real analysis, and differential equations are the key prerequisites for studying advanced calculus effectively.

Course Objectives: The objectives of a advance calculus course aims to provide students with a comprehensive understanding of advanced calculus concepts, including limits, continuity, differentiation, integration etc. Overall, the course aims to equip students with the advanced mathematical knowledge, skills, confidence to understand, apply and communicate advanced calculus concepts effectively in various contexts, problem-solving abilities necessary for success in higher-level mathematics and its applications in various fields, and fostering their growth as mathematicians.

Course Learning Outcomes: The course learning outcomes collectively ensure that students attain a comprehensive understanding of the principles and techniques of advanced calculus. The course will prepare students for further study in mathematics and other related fields, enhance their critical thinking skills through problem-solving exercises, analyzing complex mathematical problems, providing them with a solid foundation in advanced calculus principles and techniques. Overall, upon completing the course, students should be able to:

1. Demonstrate a thorough understanding of advanced calculus concepts, including limits, continuity, differentiation, and integration.
2. Apply advanced calculus concepts to solve a wide range of mathematical problems and real-world applications in physics, engineering, and other fields.
3. Communicate mathematical ideas effectively, both orally and in writing.
4. Enhance their critical thinking skills through problem-solving exercises, analyzing and synthesizing information to solve complex mathematical problems.
5. Articulate mathematical concepts, problem-solving strategies, and logical arguments clearly and persuasively, fostering effective collaboration and dissemination of knowledge.
6. Equip students with a strong foundation in advanced calculus principles and techniques, engage in independent research, and contribute to advancements in their respective fields.

Unit I:
Introduction to function of several variables, Limit of function of several variables, Concept of iterated limits, Limit and path, Continuity of function of several variables, Directional derivatives, Introduction to partial derivatives and its problems.

Unit II:
Differentiability of function of two variables, Theorems on differentiability conditions and their converses, Schwartz's theorem and Young's theorem, Homogeneous functions, Euler's theorem for homogeneous functions of 2-variables, Taylor's Theorem for function of two variables (proof of two variables only), Problems on Taylor's and Maclaurin's theorems.

Unit III:
Introduction to double integral, Repeated or iterated integral, Double integral over a closed region,

Evaluation of double integral, Changing the order of double integral, Triple integrals, Iterated triple integrals, Introduction to Jacobian (only definition), Transformation of double and triple integrals.

Unit IV:
Definition of line integral, Green's theorem, Surface and volume integral, Gauss's divergence theorem, Verification of the two theorems and problems based on the theorems, Definition of Gradient, Divergence and Curl, Properties of theses operators.

Reference Books:

1. Calculus and Analytic Geometry - G. B. Thomas and R. L. Finney, Pearson Education, Indian Reprint, 2010.

2. Calculus - Stewart James, Cengage Learning, 2011.

3. Mathematical Analysis – S. C. Malik and Savita Arrora, Second Edition, New Age Int. (P) Ltd.

4. Integral calculus – Shanti Narayan, P.K. Mittal, S. Chand.

Teaching Plan: The teaching plan may be followed as:
Weeks 1 and 2: Introduction to function of several variables, Limit of function of several variables, Concept of iterated limits.
Weeks 3 and 4: Limit and path, Continuity of function of several variables, Directional derivatives, Introduction to partial derivatives and its problems.
Weeks 5, 6 and 7: Differentiability of function of two variables, Theorems on differentiability conditions and their converses, Schwartz's theorem and Young's theorem, Homogeneous functions, Euler's theorem for homogeneous functions of 2-variables.
Weeks 8 and 9: Taylor's Theorem for function of two variables (proof of two variables only), Problems on Taylor's and Maclaurin's theorems, Introduction to double integral, Repeated or iterated integral, Double integral over a closed region, Evaluation of double integral.
Weeks 10, 11 and 12: Changing the order of double integral, Triple integrals, Iterated triple integrals, Introduction to Jacobian (only definition), Transformation of double and triple integrals, Definition of line integral, Green's theorem, Surface and volume integral.
Weeks 13 and 14: Gauss's divergence theorem, Verification of the two theorems and problems based on the theorems, Definition of Gradient, Divergence and Curl, Properties of theses operators.
Week 15: Discussion about learning outcomes of the course.

SHRI GOVIND GURU UNIVERSITY
Syllabus for B. Sc. Semester III (Mathematics)
BS23MJ3MT3 Major-3: Linear Algebra and Advanced Calculus (Practical)
Hours: 8 /week **Credits: 4**

List of Practicals:

1. Examples on vector space.
2. Examples on subspace and intersection,addition, direct sum of subspaces.
3. Examples on linearly dependence and independence.
4. Examples on basis and dimension of a vector space.
5. Examples on linear transformation, range and kernel of L.T.
6. Examples on verify rank nullity theorem.
7. Examples on linear map associated with a matrix.
8. Examples on matrix associated with linear map
9. Examples on Limit, Continuity and Differentiation of functions of several variables using definition.
10. Examples on Euler's theorem.
11. Examples on double and triple integration.
12. Examples on change the order of integration.
13. Examples on line integrals.
14. Examples on verification of Green's theorem.
15. Examples on surface integral.
16. Examples on verification of Gauss's divergence theorem.

Reference Books:

1. An Introduction to Linear Algebra – V. Krishnamurthy & others. (Affiliated East-West press, New Delhi)
2. Introduction to Linear Algebra with Applications, DeFranza and Gagliardi, McGraw Hill
3. Linear Algebra, Hoffman and Kunze, Prentice Hall India
4. Calculus and Analytic Geometry - G. B. Thomas and R. L. Finney, Pearson Education, Indian Reprint, 2010.
5. Calculus - Stewart James, Cengage Learning, 2011.
6. Mathematical Analysis – S. C. Malik and Savita Arrora, Second Edition, New Age Int. (P) Ltd.
7. Integral calculus – Shanti Narayan, P.K. Mittal, S. Chand.

SHRI GOVIND GURU UNIVERSITY
Syllabus for B. Sc. Semester III (Mathematics)
BSC23SE306 Skill Enhancement Course: Discrete Mathematics-II

Hours: 2 /week **Credits: 2**

Prerequisite: Discrete Mathematics-I

Course Objectives: The common objectives for a discrete mathematics course aim to provide students with a foundation in the fundamental concepts of discrete mathematics and prepare them for applications in computer science, information technology, and other fields where discrete structures and objects rather than continuous ones play a crucial role. The objectives outlined here aim to develop and strengthen students' abilities in mathematical reasoning and logical thinking in terms of deep understanding about logic gates, design logic circuits using gates, discuss and understand ethical considerations related to the application of discrete mathematics.
Course Learning Outcomes: The learning outcomes of a discrete mathematics course are designed to equip students with a solid understanding of fundamental concepts and the ability to apply discrete structures and methods to solve problems. Upon completing the course, students should be able to:

1. Demonstrate a thorough understanding of set theory concepts.
2. Work with propositional and predicate logic, construct truth tables, and utilize quantifiers for logical reasoning.
3. Recognize the relevance of discrete mathematics in algorithm design and optimization.
4. Develop strong problem-solving skills by applying discrete mathematics techniques to a variety of problems.
5. Consider ethical implications when solving problems and applying Discrete Mathematics in real-world contexts.
6. Understand basic algorithms and analyze their complexity and apply algorithmic thinking to problem-solving.

Unit I: Ordered Sets, Partially ordered sets, Hasse Diagram, Consistent enumeration, Supremum and infimum, Isomorphic ordered sets, Well-ordered sets, Lattices, Bounded Lattices, Distributive Lattices, Complements and complemented lattices.
(14.1 to 14.11 of [1])

Unit II: Logic Gates and Circuits, Truth Tables, Boolean Functions, Karnaugh Maps, Recurrence Relations, Linear recurrence relations with constant coefficients, Second order homogeneous linear recurrence relations.
(6.6 to 6.8, 15.10 to 15.12 of [1])

Reference Books:

1. Theory and Problems of Discrete Mathematics, S. Lipschutz and M. L. Lipson, Schaum's Outline Series, Third Edition, McGraw-Hill, New Delhi, 2007.
2. Discrete Mathematics and its Applications, Kenneth H. Rosen, Eighth Edition, McGraw-Hill, New York, 2019.

3. Discrete Mathematics, B. S. Vatssa, Third Edition, Wishwa Prakashan, New Delhi, 2002.

Teaching Plan: The teaching plan may be followed as:
Weeks 1 and 2: Ordered Sets, Partially ordered sets, Hasse Diagram.
Weeks 3 and 4: Consistent enumeration, Supremum and infimum, Isomorphic ordered sets, Well-ordered sets.
Weeks 5, 6 and 7: Lattices, Bounded Lattices, Distributive Lattices, Complements and complemented lattices.
Weeks 8 and 9: Logic Gates and Circuits, Truth Tables, Boolean Functions.
Weeks 10, 11 and 12: Karnaugh Maps, Recurrence Relations, Linear recurrence relations with constant coefficients.
Weeks 13 and 14: Second order homogeneous linear recurrence relations.
Week 15: Discussion about learning outcomes of the course.

SHRI GOVIND GURU UNIVERSITY
Syllabus for B. Sc. Semester III (Mathematics)
BS23MD3MT1 Multidisciplinary : Multivariate Calculus-I (Theory)

Hours: 2 /week **Credits: 2**

Prerequisite: Multivariate calculus builds upon foundational knowledge in calculus. Common prerequisites for a course in multivariate calculus include single variable calculus, algebra and trigonometry, analytical geometry, linear algebra, coordinate systems, and vector calculus.

Course Objectives: The specific objectives of this course are to enrich the students with a comprehensive understanding of advanced multivariable calculus concepts and their diverse applications in science, engineering, and mathematics. Overall, the course equips students with the knowledge and skills necessary for further study and research in mathematics, and related disciplines. More precisely, through practical applications in engineering, science, and other disciplines, students are expected to gain thorough understanding and better insights into the relevance and importance of multivariate calculus techniques in real-world scenarios. The multivariate calculus course aims to extend the foundational concepts of single-variable calculus to functions of multiple variables. The course also fosters to develop critical thinking and problem-solving abilities among the students.
Course Learning Outcomes: The learning outcomes, expected to acquire after completing this course, typically aim to equips students with a comprehensive understanding of multivariate calculus and its applications in various disciplines. Upon completing the course, students should be able to:

1. Understand and manipulate functions of multiple variables, including concepts such as limit, continuity, and differentiability.
2. Compute partial derivatives of functions of several variables, understanding their geometric interpretation and applications.
3. Effectively communicate mathematical ideas in written and oral forms, interpreting results contextually.
4. Apply multivariable calculus concepts in fields like physics, engineering, economics, and computer science.
5. Understand theorems like Eulers's theorem for homogeneous functions of two variables, Taylors' theorem, Schwartz's theorem, Young's theorem and their applications.
6. Enhance critical thinking skills through solving challenging multivariable calculus problems, including real-world applications and modeling.

Unit I:
Introduction to function of several variables, Limit of function of several variables, concept of iterated limits, limit and path, continuity of function of several variables, directional derivatives, Introduction to partial derivatives and its problems.

Unit II:
Differentiability of function of two variables, theorems on differentiability conditions and their converses, Schwartz's theorem and Young's theorem, Homogeneous functions, Euler's theorem for homogeneous functions of 2-variables, Taylor's Theorem for function of two variables (proof of two variables only), problems on Taylor and Maclaurin theorems.

Reference Books:

1. Calculus and Analytic Geometry - G. B. Thomas and R. L. Finney, Pearson Education, Indian Reprint, 2010.

2. Calculus - Stewart James, Cengage Learning, 2011.

3. Mathematical Analysis – S. C. Malik and Savita Arrora, Second Edition, New Age Int. (P) Ltd.

4. Integral calculus – Shanti Narayan, P.K. Mittal, S. Chand.

5. Advanced Calculus (Third Edition) Robert Wrede, Murray Spiegel, (Schaums Outline Series), McGraw Hill.

Teaching Plan: The teaching plan may be followed as:
Weeks 1 and 2: Introduction to function of several variables, Limit of function of several variables.
Weeks 3 and 4: Concept of iterated limits, limit and path, continuity of function of several variables, directional derivatives.
Weeks 5, 6 and 7: Introduction to partial derivatives and its problems, Differentiability of function of two variables.
Weeks 8 and 9: Theorems on differentiability conditions and their converses, Schwartz's theorem and Young's theorem.
Weeks 10, 11 and 12: Homogeneous functions, Euler's theorem for homogeneous functions of 2-variables.
Weeks 13 and 14: Taylor's Theorem for function of two variables (proof of two variables only), problems on Taylor and Maclaurin theorems.
Week 15: Discussion about learning outcomes of the course.

Syllabus for B. Sc. Semester III (Mathematics)
Multidisciplinary : Multivariate Calculus-I (Practical)

Hours: 4 /week **Credits: 2**

List of Practicals:

1. Examples on limit of a function of two variables using definition.
2. Examples on iterated limits.
3. Examples on continuity.
4. Examples on directional derivatives.
5. Examples on partial derivatives using definition.
6. Examples on differentiability of function of two variables
7. Examples on Euler's theorem for Homogeneous function of two variables.
8. Examples on Taylor's and Maclaurin's theorem for function of two variables.

Reference Books:

1. Calculus and Analytic Geometry - G. B. Thomas and R. L. Finney, Pearson Education, Indian Reprint, 2010.
2. Calculus - Stewart James, Cengage Learning, 2011.
3. Mathematical Analysis – S. C. Malik and Savita Arrora, Second Edition, New Age Int. (P) Ltd.
4. Integral calculus – Shanti Narayan, P.K. Mittal, S. Chand.
5. Advanced Calculus (Third Edition) Robert Wrede, Murray Spiegel, (Schaums Outline Series), McGraw Hill.

SHRI GOVIND GURU UNIVERSITY
Syllabus for B. Sc. Semester IV (Mathematics)
BS23MJ4MT1 Major-1: Abstract Algebra-I (Theory)

Hours: 4 /week **Credits: 4**

Prerequisite: The study of abstract algebra typically builds upon foundational mathematical knowledge. Understanding the basic concepts of linear algebra, number theory, some knowledge of advanced calculus and discrete mathematics can greatly facilitate the understanding of abstract algebraic concepts and techniques.

Course Objectives: The specific objectives of this course are to enrich the students with a comprehensive understanding of the fundamental algebraic concepts of groups, subgroups, quotient groups, homomorphism, isomorphism, definitions, properties etc. More precisely, students are expected to develop a rigorous understanding of the properties of groups, enhancing problem-solving skills, rigorous mathematical reasoning abilities, abstract thinking skills, and equipping them for further study and research in mathematics or related disciplines.

Course Learning Outcomes: The learning outcomes aim to equip students with the knowledge, skills, confidence to understand the mathematical problems, communicate abstract algebraic concepts effectively in various contexts, and fostering their growth as mathematicians and researchers. Upon completing the course, students should be able to:

1. Demonstrate a thorough understanding of fundamental algebraic concepts, including groups, subgroups, quotient groups, homomorphism, isomorphism, and their properties.

2. Develop proficiency in analyzing and manipulating algebraic concepts to solve problems and prove theorems.

3. Apply abstract algebraic concepts to various mathematical problems and real-world applications, including cryptography, coding theory, and geometric constructions.

4. Enhance their problem-solving skills, utilizing abstract algebraic techniques to recognize patterns, generalize concepts, and tackle challenging mathematical problems.

5. Understand the practical significance of abstract algebra in various applications including cryptography and coding theory, and highlighting the relevance of abstract algebraic concepts in real-world scenarios.

6. Develop rigorous mathematical reasoning abilities by constructing and understanding formal proofs of theorems and propositions in abstract algebra.

Syllabus:

Unit I:

Equivalence Relations, Congruence and congruence classes, Definition of Group, Examples of Groups, Elementary properties of Group, Finite Group and their tables.
(2.2 to 2.4, 6.5, 7.3 to 7.5 of [1])

Unit II:

Subgroups, Cyclic Subgroups, Lagrange's theorem and it's implications, Permutation, Transposition and cycles, Normal Subgroups.
(8.1 to 8.3, 9.1 to 9.3, 10.1 of [1])

Unit III:
Quotient groups, Isomorphism, Property of Cyclic groups, Isomorphism of Cyclic groups, Subgroups of Cyclic Groups, Generators of Cyclic Groups.
(10.2,10.3,11.1,11.2, 12.1 to 12.5 of [1])

Unit IV:
Homomorphism: Definition and examples, Kernel of Homomorphism, First Fundamental Theorem of Homomorphism, Cayley's theorem.
(13.1 to 13.3, 13.6 of [1])

Reference Books:

1. Abstract Algebra (Second Edition) - I. H. Sheth, PHI Learning Pvt. Ltd.
2. Abstract Algebra (Third Edition) - I. N. Herstein, Prentice-Hall.
3. A First Course in Abstract Algebra (Third Edition) - Joseph J. Rotman, Prentice-Hall
4. Contemporary Abstract Algebra (Nineth Edition) - Joseph A. Gallian, Cengage India Private Limited.

Teaching Plan: The teaching plan may be followed as:
Weeks 1 and 2: Equivalence Relations, Congruence and congruence classes, Definition of Group, Examples of Groups.
Weeks 3 and 4: Elementary properties of Group, Finite Group and their tables, Subgroups.
Weeks 5, 6 and 7: Cyclic Subgroups, Lagrange's theorem and it's implications, Permutation, Transposition and cycles.
Weeks 8 and 9: Normal Subgroups, Quotient groups, Isomorphism, Property of Cyclic groups.
Weeks 10, 11 and 12: Isomorphism of Cyclic groups, Subgroups of Cyclic Groups, Generators of Cyclic Groups, Homomorphism: Definition and examples.
Weeks 13 and 14: Kernel of Homomorphism, First Fundamental Theorem of Homomorphism, Cayley's theorem.
Week 15: Discussion about learning outcomes of the course.

SHRI GOVIND GURU UNIVERSITY
Syllabus for B. Sc. Semester IV (Mathematics)
BS23MJ4MT2 Major-2: Numerical Analysis (Theory)
Hours: 4 /week **Credits: 4**

Prerequisite: Numerical analysis requires a strong foundation in mathematics and computer science. Common prerequisites for a course in numerical analysis include proficiency in calculus, linear algebra, differential equations, probability and statistics, and discrete mathematics.

Course Objectives: The specific objectives of this course are to enrich the students with a comprehensive understanding of fundamental numerical methods used for solving mathematical problems that are difficult or impossible to solve analytically. More precisely, through practical applications in engineering, science, and other disciplines, students are expected to gain insight into the relevance and importance of numerical analysis in real-world scenarios. The course also fosters critical thinking, problem-solving abilities, and ethical considerations related to numerical computations.
Course Learning Outcomes: The learning outcomes, expected to acquire after completing this course, typically aim to equips students with a comprehensive understanding of fundamental numerical methods and their applications in solving mathematical problems encountered across various disciplines. Upon completing the course, students should be able to:

1. Develop a deep understanding of fundamental numerical methods used for solving mathematical problems that cannot be solved analytically.

2. Delve into detailed discussions on different types of errors encountered in numerical computations.

3. Develop the ability to solve ordinary and partial differential equations numerically.

4. Apply numerical methods to solve practical problems encountered in engineering, physics, chemistry, biology, economics, and other fields, demonstrating the relevance and applicability of numerical analysis.

5. Learn interpolation techniques to approximate functions from a set of discrete data points.

6. Enhance critical thinking skills through the analysis and evaluation of numerical methods, their applicability to different problems.

Unit I:
Approximation, Errors and their computation, General Error Formula, Solution of Algebraic and Transcendental Equations: Bisection Method, Method of False Position, Iterative Method, Newton-Raphson Method. (1.3,1.4, 2.2 to 2.5 of [1])

Unit II:
Interpolation, Finite Differences, Difference Table, Newton's Formulae for Interpolation, Central Difference Interpolation Formulae (Gauss', Stirling's, Bessel's, Everett's Formula).
(3.1,3.3 to 3.7 of [1])

Unit III:
Lagrange's Interpolation Formula, Divided differences, Newton's General Interpolation Formula, Numerical Integration: Trapezoidal Rule, Simpson's $1/3$-Rule, Simpson's $3/8$-Rule. (3.9, 3.10, 6.4.1 to 6.4.3 of [1])

Unit IV:
Numerical Solution of ODE: Solution by Taylor's Series, Picard's Method of Successive Approximations, Euler's Method, Runge-Kutta Method.
(8.1 to 8.5 of [1])

Reference Books:

1. Introductory Methods of Numerical Analysis (Fifth Edition) - S. S. Sastry, PHI Learning Pvt. Ltd.

2. A Friendly Introduction to Numerical Analysis - Brian Bradie, Pearson Education.

3. An Introduction to Numerical Analysis - Süli and Mayers, Cambridge University Press.

4. Introduction to Numerical Analysis (Second Edition) - F.B. Hildebrand, Dover Publications.

Teaching Plan: The teaching plan may be followed as:
Weeks 1 and 2: Approximation, Errors and their computation, General Error Formula, Solution of Algebraic and Transcendental Equations: Bisection Method.
Weeks 3 and 4: Method of False Position, Iterative Method, Newton-Raphson Method, Interpolation, Finite Differences, Difference Table.
Weeks 5, 6 and 7: Newton's Formulae for Interpolation, Central Difference Interpolation Formulae (Gauss', Stirling's, Bessel's, Everett's Formula).
Weeks 8 and 9: Lagrange's Interpolation Formula, Divided differences, Newton's General Interpolation Formula, Numerical Integration: Trapezoidal Rule.
Weeks 10, 11 and 12: Simpson's $1/3$-Rule, Simpson's $3/8$-Rule, Numerical Solution of ODE: Solution by Taylor's Series.
Weeks 13 and 14: Picard's Method of Successive Approximations, Euler's Method, Runge-Kutta Method.
Week 15: Discussion about learning outcomes of the course.

SHRI GOVIND GURU UNIVERSITY
Syllabus for B. Sc. Semester IV (Mathematics)
BS23MJ4MT3 Major-3: Abstract Algebra and Numerical Analysis (Practical)
Hours: 8 /week **Credits: 4**

List of Practicals:

1. Examples on group.
2. Examples on finite groups and their tables.
3. Examples on subgroups and cyclic subgroups.
4. Examples based on permutations, Examples on normal Subgroups.
5. Examples on quotient groups.
6. Examples on cyclic groups and their generators.
7. Examples on homomorphism and kernel of a homomorphism.
8. Problems based on First Fundamental Theorem of Homomorphism and Cayley's theorem.
9. Examples on Bisection Method and Method of False Position.
10. Examples on Iterative Method and Newton-Raphson Method.
11. Examples on Newton's Formulae for Interpolation and Gauss' Formula.
12. Examples on Stirling's and Bessel's Formulas for Interpolation.
13. Examples on Lagrange's Interpolation Formula and Newton's General Interpolation Formula.
14. Examples on Trapezoidal Rule, Simpson's $1/3$-Rule, Simpson's $3/8$-Rule.
15. Examples on Solution of ODE by Taylor's Series, Picard's Method of Successive Approximations.
16. Examples on Solution of ODE by Euler's Method, Runge-Kutta Method.

Reference Books:

1. Abstract Algebra (Second Edition) - I. H. Sheth, PHI Learning Pvt. Ltd.
2. Abstract Algebra (Third Edition) - I. N. Herstein, Prentice-Hall.
3. Contemporary Abstract Algebra (Nineth Edition) - Joseph A. Gallian, Cengage India Private Limited.
4. Introductory Methods of Numerical Analysis (Fifth Edition) - S. S. Sastry, PHI Learning Pvt. Ltd.
5. A Friendly Introduction to Numerical Analysis - Brian Bradie, Pearson Education.
6. Introduction to Numerical Analysis (Second Edition) - F.B. Hildebrand, Dover Publications.

SHRI GOVIND GURU UNIVERSITY
Choice Based Credit System (CBCS)
Syllabus for B. Sc. Semester IV (Mathematics)
BS23MN4MT1 Minor : Multivariate Calculus-II (Theory)

Hours: 2 /week **Credits: 2**

Prerequisite: Multivariate calculus builds upon foundational knowledge in calculus, and typically include a solid foundation in single-variable calculus, proficiency in algebra and trigonometry. Common prerequisites for a course in multivariate calculus include single variable calculus, algebra and trigonometry, analytical geometry, linear algebra, coordinate systems, vector calculus and Multivariate Calculus-I.

Course Objectives: The specific objectives of this course encompass a comprehensive understanding of functions with multiple variables, including their properties and graphical representations. Overall, the course equips students with the knowledge and skills necessary for further study and research in mathematics, and apply multiple integration techniques in various coordinate systems. More precisely, through practical applications in engineering, science, and other disciplines, students are expected to gain thorough understanding and better insights into the relevance and importance of multivariate calculus techniques in real-world scenarios. The multivariate calculus course aims to extend the foundational concepts of single-variable calculus to functions of multiple variables. The course also fosters to develop critical thinking and problem-solving abilities among the students.

Course Learning Outcomes: The learning outcomes, expected to acquire after completing this course, collectively aim to provide students with a comprehensive understanding of multivariate calculus and its applications in various disciplines as well as the skills necessary for further study. Upon completing the course, students should be able to:

1. Understand and manipulate functions of multiple variables, including concepts such as multiple integral, beta and gamma functions.
2. Compute double integral, changing the order of double integral and triple integrals, understanding their geometric interpretation and applications.
3. Effectively communicate mathematical ideas in written and oral forms, interpreting results contextually.
4. Apply multivariable calculus concepts in fields like physics, engineering, economics, and computer science.
5. Understand theorems related to beta and gamma functions and their applications.
6. Enhance critical thinking skills through solving challenging multivariable calculus problems, including real-world applications and modeling.

Unit I: Multiple Integral
Introduction to double integral, Repeated or iterated integral, Double integral over a closed region, Evaluation of double integral, Changing the order of double integral, triple integrals, Iterated triple integrals, Introduction to Jacobian (only definition), Transformation of double and triple integrals.

Unit II: Beta and Gamma Functions
Definition of beta and gamma functions, Properties of beta and gamma functions, Relation between beta and gamma functions, Duplication formulas, Evaluation of definite integrals using beta-gamma functions and its examples.

Reference Books:

1. Calculus and Analytic Geometry - G. B. Thomas and R. L. Finney, Pearson Education, Indian Reprint, 2010.

2. Calculus - Stewart James, Cengage Learning, 2011.

3. Mathematical Analysis – S. C. Malik and Savita Arrora, Second Edition, New Age Int. (P) Ltd.

4. Integral calculus – Shanti Narayan, P.K. Mittal, S. Chand.

5. Advanced Calculus (Third Edition) Robert Wrede, Murray Spiegel, (Schaums Outline Series), McGraw Hill.

Teaching Plan: The teaching plan may be followed as:
Weeks 1 and 2: Introduction to double integral, Repeated or iterated integral.
Weeks 3 and 4: Double integral over a closed region, Evaluation of double integral, Changing the order of double integral, triple integrals.
Weeks 5, 6 and 7: Iterated triple integrals, Introduction to Jacobian (only definition), Transformation of double and triple integrals.
Weeks 8 and 9: Definition of beta and gamma functions, Properties of beta and gamma functions.
Weeks 10, 11 and 12: Relation between beta and gamma functions, Duplication formulas.
Weeks 13 and 14: Evaluation of definite integrals using beta-gamma functions and its examples.
Week 15: Discussion about learning outcomes of the course.

SHRI GOVIND GURU UNIVERSITY
Choice Based Credit System (CBCS)
Syllabus for B. Sc. Semester IV (Mathematics)
BS23MN4MT2 Minor : Multivariate Calculus-II (Practical)

Hours: 4 /week **Credits: 2**

Number of Practicals: 08

1. Examples on double integration over a closed region.
2. Examples on evaluation of double integration.
3. Examples on change of order of double integration.
4. Examples on triple integration.
5. Problems on properties of beta and gamma functions.
6. Problems on relation between beta and gamma functions.
7. Problems on duplication formulas.
8. examples of Evaluation of definite integrals using beta-gamma functions.

Reference Books:

1. Calculus and Analytic Geometry - G. B. Thomas and R. L. Finney, Pearson Education, Indian Reprint, 2010.
2. Calculus - Stewart James, Cengage Learning, 2011.
3. Mathematical Analysis – S. C. Malik and Savita Arrora, Second Edition, New Age Int. (P) Ltd.
4. Integral calculus – Shanti Narayan, P.K. Mittal, S. Chand.
5. Advanced Calculus (Third Edition) Robert Wrede, Murray Spiegel, (Schaums Outline Series), McGraw Hill

SHRI GOVIND GURU UNIVERSITY
Syllabus for B. Sc. Semester IV (Mathematics)
BSC23SE406 Skill Enhancement Course: Introduction to Combinatorics
Hours: 2 /week **Credits: 2**

Prerequisite: Introduction to combinatorics course typically include a solid foundation in foundational mathematics, including arithmetic, algebra, probability, and elementary number theory. These prerequisites ensure that students have the necessary mathematical background and problem-solving abilities to engage effectively with the concepts presented in the course.

Course Objectives: In an introductory course on combinatorics, students emerge equipped with a robust foundation in combinatorial concepts and techniques, prepared to apply their knowledge in mathematics and computer science. Throughout the course, students are exposed to proof techniques like induction and contradiction, equipping them with the ability to construct and validate combinatorial arguments. Depending on the course level, students delve into key concepts such as permutations, combinations, and the pigeonhole principle, laying the groundwork for advanced exploration. Further, students may also delve into advanced topics such as generating functions and Ramsey theory, fostering a deeper understanding of combinatorial theory and its applications. Ultimately, the course aims to empower students with the analytical skills and theoretical knowledge necessary to excel in combinatorial problem-solving across diverse fields.
Course Learning Outcomes: The learning outcomes, expected to acquire after completing this course, typically aim to equips students with the knowledge and skills necessary to excel in solving complex combinatorial problems, to enrich their understanding of combinatorial theory and to communicate their solutions effectively. Upon completing the course, students should be able to:

1. Demonstrate a solid understanding of fundamental combinatorial concepts, including permutations, combinations, and the pigeonhole principle.
2. Recognize and apply combinatorial principles in various real-world applications, including computer science, cryptography, and optimization problems.
3. Effectively communicate mathematical ideas in written and oral forms, demonstrating clarity and precision in their explanations.
4. Effectively utilize counting techniques such as the multiplication principle, addition principle etc., to solve combinatorial problems of varying complexity.
5. Develop proficiency in constructing and validating combinatorial arguments.
6. Synthesize their understanding of combinatorial concepts and problem-solving techniques to tackle novel and multi-faceted combinatorial problems, demonstrating critical thinking and analytical skills.

Unit I:
Basic of counting, sum rule and product rule, Pigeonhole principal, Generalized pigeonhole principal, Applications of pigeonhole principal, Permutations, Combinations.
(6.1 to 6.3 of [1])

Unit II: The Binomial Theorem (without proof), Pascal's triangle, Permutations and combination with repetition, Distribution of objects into boxes.
(6.4, 6.5 of [1])

Reference Books:

1. Discrete Mathematics and its Applications, Kenneth H. Rosen, Eighth Edition, McGraw-Hill, New York, 2019.

2. Introductory Combinatorics, Richard A. Brualdi, Pearson Education.

3. A Walk Through Combinatorics (Fourth Edition), Miklòs Bòna, World Scientific.

4. Discrete Mathematics, B. S. Vatssa, Third Edition, Wishwa Prakashan, New Delhi, 2002.

Teaching Plan: The teaching plan may be followed as:
Weeks 1 and 2: Basic of counting, sum rule and product rule.
Weeks 3 and 4: Pigeonhole principal, Generalized pigeonhole principal.
Weeks 5, 6 and 7: Applications of pigeonhole principal, Permutations, Combinations.
Weeks 8 and 9: The Binomial Theorem (without proof), Pascal's triangle.
Weeks 10, 11 and 12: Permutations and combination with repetition.
Weeks 13 and 14: Distribution of objects into boxes.
Week 15: Discussion about learning outcomes of the course.