

Gujarat University
Choice Based Credit System (CBCS)
Syllabus for Semester V (Mathematics)
MAT 301: Linear Algebra – II (Theory)

Hours: 4 /week

Credits: 4

Unit I

Composition of Linear Maps, The Space $L(U,V)$, Operator Equation, Linear Functional, Dual Spaces, Dual of Dual, Dual Basis Existence Theorem, Annihilators, bilinear forms.

Unit II

Inner Product Space, Norm, Cauchy-Schwarz Inequality, Orthogonalization and orthonormalization of Basis, Gram-Schmidt Orthogonalization Process, Orthogonal complement and its properties, Orthogonal transformations.

Unit III

Determinants and their properties, Value of determinant, Basic results, Laplace expansion, Cramer's rule.

Unit IV

Eigen values and eigen vectors of linear operators and square matrices, Caley-Hamilton's Theorem and its verification, Application to reduction of Quadrics, classification of Quadrics, Diagonalization of real and symmetric Matrices, Spectral Theorem.

Text Book:

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

Reference Books:

1. Linear Algebra a Geometric Approach – S. Kumaresan, PHI.
2. Linear Algebra with Applications – Otto Bretscher– 3rd ed. –Pearson Education.
3. An Introduction to Linear Algebra – I. K. Rana, Ane Books Pvt. Ltd., New Delhi.
4. Theory and Problems of Linear Algebra – R. D. Sharma, I. K. Inter. Pub. House Pvt. Ltd.
5. Matrix and Linear Algebra by – K.B.Datta, Prentice Hall, New Delhi.
6. Linear Algebra: Theory & Applications - Ward Cheney & David Kincaid Viva Books, Jones & Bartlett.
7. Vector Calculus, Linear Algebra & Differential Forms: A unified approach - Hubbard J & Hubbard B., Prentice Hall 1999.
8. Linear Algebra with Applications -Jeanne, L. Agnew & Robert C. Knapp Brooks / Col publishing Co, California.
9. A First Course in Linear Algebra – Dr. Alok Nath Chakrabarti. ISBN: 9788182091306. Tata McGraw-Hill Edu. Pvt. Ltd.



Gujarat University
Choice Based Credit System (CBCS)
Syllabus for Semester V (Mathematics)
MAT 304: Mathematical Programming (Theory)

Hours: 4 /week

Credits: 4

Unit I Convex Set and Linear Programming Problem

Convex set, Extreme points of a convex set, convex combination, Examples of Convex sets and Theorems on convexity, Formulation techniques of LP problems (Only Examples).

Unit II Problem solving techniques for LP problems

Simplex method for solving LPP, Big-M (Penalty) method, Two-Phase method, Integer programming problem (Only Gomory's cutting plane method).

Unit III Duality and Dual simplex method

Introduction, Definition of the dual problem, General rules for converting any primal problem into its dual, How to interpret the solution of the dual from its primal and vice versa, Comparison of the solution of the primal and its dual. Find initial solution for dual simplex table, Mathematical procedure to find solution by dual simplex method.

Unit IV Transportation and Assignment Problems

Introduction, Mathematical formulation, Tabular representation, Definitions, Finding initial basic feasible solution (North West Corner Rule, Least Cost method), Optimality test (MODI method),

Gujarat University
Choice Based Credit System (CBCS)
Syllabus for Semester V (Mathematics)
MAT 306: Practical-1 (Based on MAT301, MAT302)

Hours: 6 /week

Credits: 2.5

List of Practicals:

Unit I

- 1 Examples of solving an operator equation,
- 2 Examples of finding dual bases for \mathbb{R}^2 and \mathbb{R}^3 from their given bases through the Dual-Basis-Existence-Theorem.
- 3 Examples of Inner product.
- 4 Examples of orthogonalization and orthonormalization of basis through Gram-Schmidt orthogonalization process.

Unit II

- 5 Examples of finding value of determinant through the properties.
- 6 Examples of finding eigen values/vector of a square matrix.
- 7 Examples of the verification of Caley-Hamilton Theorem.
- 8 Examples of diagonalization of square matrices.

Unit III

- 9 Countable and Uncountable Sets
- 10 Completeness property of \mathbb{R} - problems related to infimum, supremum of sets,
- 11 Limits of sequences including inductively defined sequences, limit inferior and superior
- 12 Cauchy Sequences

Unit IV

- 13 Types of discontinuities-discussion and examples
 - 14 Uniform continuity.
 - 15 Problems based on Mean Value Theorems
 - 16 L'Hospital's Rule –Theorems+problems.
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Gujarat University
Choice Based Credit System (CBCS)
Syllabus for Semester V (Mathematics)
MAT-305 (Elective Course): Combinatorics (Theory)

Hours: 3/Week

Credits: 2

Unit I Permutations and Combinations:

Basic Counting Principles, Permutations, Circular Permutations, Combinations, The injection and Bijection Principles, Arrangements and selection with Repetitions, Distribution Problems

Unit II Binomial Coefficients and Multinomial Coefficients:

The Binomial Theorem, Combinatorial Identities, The Pascal's Triangles, Chu Shin-Chie's Identity, Shortest Routes in a Rectangular Grid, Some properties of Binomial Coefficients, Multinomial Coefficients and the Multinomial Theorem

Unit III The Pigeonhole Principle, Ramsey Numbers, The Principle of Inclusion & Exclusion:

The Pigeonhole Principle and examples, Ramsey Type Problems and Ramsey Numbers, Bounds for Ramsey Numbers, The Principle of Inclusion and Exclusion, A Generalization, Integer Solutions and Shortest Problems, Surjection Mapping and Stirling Number of the second Kind, Derangements and A Generalization, The Sieve of Eratosthenes and Euler ϕ -function.

Text Book

Principles and Techniques in Combinatorics - Chen Chuan Chong and Koh Khee Meng, World Scientific Chapters 1 to 4 (omit 4.8).

Reference Books

1. Combinatorics including concepts of Graph Theory - V. K. Balakrishnan, Schaum's Outline Series, McGraw-Hill, INC.
2. A Path to Combinatorics for Undergraduates Counting Strategies - Titu Andreescu and Zuming Feng, Birkhauser.
3. Introduction to Combinatorial Mathematics - C. L. Liu, McGraw Hill Book Company.
4. Introduction to Combinatorics - 4th Edition, Richard A. Brualdi, Pearson Education.



Gujarat University
Choice Based Credit System (CBCS)

Syllabus for Semester V (Mathematics)

MAT-305(Elective Course): Discrete Mathematics(Theory)

Hours: 3/Week

Credits: 2

Unit I Relation & Ordering:

Binary Relation, Reflexive, Irreflexive, Symmetric, Antisymmetric, Transitive, Partial Ordering (omit lexicographic ordering), Hasse Diagram, Upper bound, lower bound, lub, glb, Lattice as a poset, Properties of lattices.

Unit II Lattice & Boolean Algebra:

Lattice as an algebraic system (only definition), Sublattice, Homomorphism, Some Special Lattices, Boolean Algebra, Subalgebra, Direct Product, Homomorphism, Join Irreducible, Atoms.

Unit III Boolean Expression & Canonical forms:

Boolean Expression, Equivalent Boolean Expression, Minterm, Maxterm, Values of Boolean Expressions, Stone's Representation Theorem for finite Boolean Algebra, Sum of Products Canonical forms, Product of Sums Canonical forms, Symmetric Boolean expression.

Text Book

1. Discrete Mathematical Structures with Applications to Computer Science -J. R. Tremblay and R. Manohar, Macgraw-Hill International Editions, ISBN 0-07-065142-6.

Definitions: 2-3.3 to 2-3.7, Definition 2-3.16, 2-3.17(omit Lexicographic ordering), Article 2-3.9, Chapter 4 up to 4-3.

Reference Books

1. Boolean Algebra and its Application – J. E. Whitesitt, Addison-Wesley Publishing Co. Inc.
2. Foundation of Discrete Mathematics – K. D. Joshi, New Age International Limite Publishers, ISBN 81-224-0120-1.
3. Logic and Boolean Algebra – B. H. Arnold, P H Inc LCCN 62-19100.
4. Introduction to Lattice Theory – D. E. Rutherford, University Mathematical Oliver and Boyed Ltd.
5. Modern Applied Algebra - Garret Birkhoff and Thomas C Barteel, CBS Publishers and Distributors.
6. Sets Lattices and Boolean Algebras - James C Abbott.



Unit I

Sum and product of complex numbers with properties, moduli and conjugate, triangle inequality, polar coordinates, product and quotients in exponential form, roots of complex numbers, de Moivre's theorem and application, the exponential function, trigonometric functions, hyperbolic functions, convergence of sequence and series.

Unit II

Functions of complex variables, theorems on limits, continuity, derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient condition for differentiability, polar coordinates, analytic functions and harmonic functions.

Unit III

Linear transformations, the transformation $w = \frac{1}{z}$, linear fractional transformations, an implicit form, preservation of angles, further properties.

Unit IV

Fourier series, Bessel's inequality, Riemann-Lebesgue theorem.

Text Books:

1. Complex variables and applications - Ruel V. Churchill, Mcgraw-hill inter. 6th edition, Articles 1 to 7, 23 to 25 and 43. Chapter 2 (omit art. 13). Articles. 68, 69, 70, 71, 79, 80.
2. A first course in Mathematical analysis – D. Somasundaram, Chapter-10.1 and 10.2 (only first two theorems).

Reference books:

1. Fundamentals of Mathematical Analysis- G. Das & S Pattanayak, Tata Mcgraw Hill Pub. Co. Ltd.
2. Analytical Geometry & Real and Complex analysis – T. Veerarajan, Mcgraw Hill.
3. Complex Analysis - V. Karunakaran, Narosa publishers.
4. Higher Engineering Mathematics – B. S. Grewal, Khanna Publishers.
5. Advance engineering Mathematics – H. K. Dass, S. Chand.
6. A First Course in Complex Analysis with Applications - Dennis G. Zill & Patrick S. Shanahan Jones & Bartlett India Pvt Ltd.
7. Complex Analysis - T. W. Gamelin, Springer (India) Ltd.
8. Theory of Complex functions - Marden & Hoffman W. H. Freeman, N.Y.
9. Functions of One Complex Variable – Conway.
10. An Introduction to Complex Analysis - A. R. Shastri, Macmilan India.
11. Fourier Analysis: An Introduction - E. M. Stein & R. Shakarchi, Princeton Uni. Press.
12. Fourier Series - R. Bhatia, Hindustan Book Agency-2010 corrected edition.



Gujarat University
Choice Based Credit System (CBCS)
Syllabus for Semester V (Mathematics)

MAT-305 (Elective Course): C Programming for Mathematical Problems (Practical)

Hours: 3/Week

Credits: 2

Instructions:

1. The programming language "C" should be used **only** for syntax and semantics. Detailed non-mathematical examples, which divert the attention, should be discarded from the discussion.
2. Each student should have to perform one practical for each week.
3. Each practical is of three lecture hours

Syllabus: Importance of C, Basic Structure of C programs, Programming style, Executing a C program, Constants, Variables and Data types, Operators and Expressions, Managing Input Output Operations, Decision making and Branching, Decision making and Looping, Arrays.

Programs for Practical

Design an algorithm and write a program for each of the following:

Unit I

1. To generate the first n terms of the Fibonacci sequence, where $n \geq 1$.
2. To find the greatest common divisor and the least common multiple factorial of given two non-zero integer.
3. To find all the prime numbers in the first n positive integers.
4. To find (i) all the prime divisors (ii) all the divisors (iii) the prime power factorization of a given positive integer.

Unit II

5. To evaluate x^n for a given positive integer n and a given real number x .
6. To find the n th Fibonacci number without finding all the preceding Fibonacci numbers.
7. To remove all duplicates from an ordered array and contract the array accordingly.
8. To partition the elements of a given randomly ordered array of n elements and a given an element x into two subsets such that the elements $\leq x$ are in one subset and the elements $> x$ are in the other subset.

Unit III

9. To merge two monotonically increasing arrays into a single monotonically increasing array.
10. To sort a given randomly ordered array of n elements into non-descending order using (i) the selection sort method (ii) the exchange method (iii) Shell's diminishing increment insertion method.

Text Books:

1. For "C" programming language "Programming in ANSI C" covers the course -second edition E. BALAGURUSAMY, Tata McGraw-Hill Publishing Company Limited ISBN 0-07460401-5. Chapter 1-7, 9,11,13 (omit case studies, 7.8, 9.20, 11.16, 13.14)
2. Algorithms and Practicals are covered by "How to Solve It by Computer"-R. G. Dromey (second edition) Prentice Hall of India.

Reference book:

1. Algorithms + Data Structures = Programs Niklaus Wirth-Prentice-Hall of India ISBN-81-203-05698.
2. Numerical Methods with C++ programming – Nita H Shah. PHI Learning.



Gujarat University
Choice Based Credit System (CBCS)
Syllabus for Semester V (Mathematics)
MAT 302: Analysis – I (Theory)

Hours: 4 /week

Credits: 4

Unit I The Real Numbers

- 1.1 Sets and Functions
 - 1.2 Finite and Infinite Sets
 - 1.3 Algebraic and Order properties of \mathbb{R}
 - 1.4 Absolute Value and Real Line
 - 1.5 The completeness Property of \mathbb{R}
 - 1.6 The Applications of Supremum Property
- Articles 1.1, 1.3, 2.1 to 2.5 of Text Book (2)

Unit II Sequences

- 2.1 Sequences and limits
 - 2.2 Limit Theorems
 - 2.3 Monotonic sequences
 - 2.4 Sequences defined inductively
 - 2.5 Subsequences (includes \limsup and \liminf)
 - 2.6 Cauchy Sequences
 - 2.7 Infinite limits
- Articles 4.2 to 4.7 of Text Book (3); 2.4 of Text book (1).

Unit III Functions and continuity

- 3.1 Limit of a function
 - 3.2 Limit theorems
 - 3.3 Other limits
 - 3.4 Continuity. Intermediate values, extreme values
 - 3.5 Uniform continuity
 - 3.6 Monotone and Inverse functions
- Articles 3.1-3.6 of Text Book (1), Article 5.6 of Text Book (2)

Unit IV The derivative

- 4.1 Definition
- 4.2 Rules for differentiation
- 4.3 Mean value theorems
- 4.4 Inverse functions
- 4.5 Intermediate value Property of Derivatives
- 4.6 L'Hospital's Rules

Articles 4.1 to 4.4 of Text Book (1), Sections 6.2.11 and 6.2.12, Article 6.3 of Text Book (2)

Text Books:

1. An Introduction to Analysis - Gerald G. Bilodeau, Paul R. Thie and G. E. Keough. Second Edition
2. Introduction to Real Analysis - Robert G. Bartle and Donald R. Sherbert, Wiley Student Edition, 2010.
3. Fundamentals of mathematical analysis- G. Das & S Pattanayak, Tata Mcgraw Hill Pub. Co. Ltd

Reference Books:

1. A First course in Mathematical Analysis, D. Somasundaram & B. Choudhary, (Corrected Edition) Narosa Publication.
2. Elementary Analysis: the theory of calculus - K. Ross, Springer, India.
3. Numbers to Analysis - I. K. Rana, world scientific.
4. Calculus - Michael Spivak.
5. Principles of Mathematical Analysis- W. Rudin, McGraw-Hill
6. A Course In Calculus & Real Analysis – S. R. Ghorpade & B. V. Limaye



Gujarat University
Choice Based Credit System (CBCS)
Syllabus for Semester V (Mathematics)
MAT 306: Practical-2 (Based on MAT303, MAT304)

Hours: 6 /week

Credits: 2.5

List of Practicals:**Unit I**

1. Application of De-Moivre's theorem (to find the roots of an equation and simplify common statements)
2. Verification of Cauchy-Riemann equations (Cartesian & polar form).
3. Find the harmonic conjugate of a function and hence find corresponding analytic function.
4. If $f(z) = u + iv$ is an analytic function then find $f(z)$ when $u, v, u - v$ or $u + v$ is given.

Unit II

5. Problems on transformation under function $w = \frac{1}{z}$.
6. Problems on verification of conformality.
7. Find the Fourier series of functions - I.
8. Find the Fourier of functions-II.

Unit III

9. Solve Linear programming problem by graphical method for two variable problem (3 problems)
10. Solve Linear Programming Problem by simplex method-I (3 problems)
11. Solve Linear Programming Problem by big-M method (3 problems)
12. Solve Linear Programming Problem by Two-Phase method (3 problems)

Unit IV

13. Using duality solve Linear Programming Problem (3 problems)
14. Using Modi method to solve Transportation problem (Balanced) (3 problems)
15. Using Modi method to solve Transportation problem (Unbalanced) (3 problems)
16. Using "Hungarian method" to solve Assignment problem (Balanced and Unbalanced) (3 Problems)



Gujarat University
Choice Based Credit System (CBCS)

Syllabus for Semester V (Mathematics)

MAT 305 (Elective Course): Mathematical Statistics (Theory)

Hours: 3 /week

Credits: 2

Unit I Theory of probability

Introduction, Basic terminology, Mathematical and statistical probability, Subjective probability, Mathematical tools (Sets and elements of sets, Operation on sets, Algebra on sets, Limit of sequence of sets, classes of sets), Random experiment, Sample space, Elementary events, Event, Addition theorem of probability, Boole's inequality, Conditional probability, Multiplication theorem of probability, Independent events, Multiplication theorem of probability for independent events, mutually independent events, Bayes' theorem.

Unit II Random variable and some basic idea of distribution

Introduction, distribution function, Discrete random variable (probability mass function, discrete distribution function), Continuous random variable (probability mass function, continuous distribution function), Mathematical expectation, Expected value of function of random variable, properties of expectation, properties of variance, covariance, moment generating function(M.G.F), Cumulate generating function (C.G.F).

Unit III Discrete and Continuous Probabilities distributions

Introduction, Bernoulli distribution, Binomial distribution (Moments, recurrence relation for the moments, recurrence relation for the probabilities, Moment generating function (M.G.F), Cumulate generating function (C.G.F), Characteristic), Poisson distribution (Moments, recurrence relation for the moments, recurrence relation for the probabilities, Moment generating function (M.G.F), Cumulate generating function (C.G.F), Characteristic), Negative binomial distribution, Normal distribution (Mode, Median, Moments, Moment generating function (M.G.F), Cumulate generating function (C.G.F), Characteristic), Exponential distribution (Moment generating function (M.G.F)), Beta distribution of first kind, Beta distribution of second kind.

Text Book

Fundamentals of Mathematical Statistics - S. C. Gupta and V. K. Kappor, Sultan Chand and Sons, Educational Publishers, New Delhi.

Reference books

- 1 An introduction to Probability Theory and Mathematical Statistics - V. K. Rohatgi, Wiley Eastern limited, New Delhi.
- 2 Elementary Mathematical Statistics - S. C. Gupta and V. K. Kappor, Sultan Chand and Sons, Educational Publishers, New Delhi.
- 3 Mathematical Statistics - Parimal Mukhopadhyay.
- 4 Modern Probability Theory - B. R. Bhatt.



Gujarat University
Choice Based Credit System (CBCS)
Syllabus for Semester V (Mathematics)
MAT 305 (Elective Course): Number Theory (Theory)

Hours: 3 /week

Credits: 2

Unit I

- (a) **Some Preliminary Consideration:** Well-Ordering Principle, Mathematical Induction, the Binomial Theorem & binomial coefficients.
- (b) **Divisibility Theory:** the division algorithm, divisor, remainder, prime, relatively prime, the greatest common divisor, the Euclidean algorithm (Without proof), the least common multiple, the linear Diophantine equation & its solution.

Unit II

- (a) **Prime Numbers:** Prime and composite number, the Fundamental Theorem of Arithmetic (without proof), canonical form of a number, the Sieve of Eratosthenes.
- (b) **Theory of Congruence:** Definition and basic properties of congruence, Residue class & complete system of residues, special divisibility test, linear congruence, Chinese Remainder Theorem. (without proof)

Unit III

- (a) **Fermat's Theorem:** Fermat's Factorization method, Fermat's little theorem, Wilson theorem,
- (b) **Euler's theorem:** Euler's Phi-function ϕ and formula for ϕ , Euler's theorem (without proof) and only problems on Euler's theorem.

Text Book

Elementary Number Theory - David M. Burton, Sixth Edition, Universal Book stall, New Delhi.

Chapter 1: 1.1 - 1.2	Chapter 4: 4.1 - 4.3
Chapter 2: 2.1 - 2.4	Chapter 5: 5.2 - 5.3
Chapter 3: 3.1 - 3.2	Chapter 7: 7.2 - 7.3

Reference Books:

- 1 An introduction to the Theory of numbers - Niven and Zuckerman, Wiley Eastern Ltd.
- 2 Number Theory - S. G. Telang, Tata Mc Graw-Hill Publishing Company Limited, New Delhi
- 3 Elementary Theory of Numbers - C. Y. Hsiung, Allied Publishers Ltd.-India, ISBN 81-7023-464-6.
- 4 Number Theory - George E. Andrews, Hindustan Publishing Corporation- Delhi.
- 5 Elementary Number Theory - Gareth A. Jones & J. Mary Jones, Springer Verlag, ISBN 81-8128-278-7.
- 6 Number Theory - J. Hunter, Oliver and Boyd-London.
- 7 Beginning Number Theory - Neville Robbins, Narosa Pub. House -New Delhi ISBN 978-81-7319-836
- 8 Introduction to the theory of Numbers - G. H. Hardy & E. M. Wright, Oxford Uni. Press
- 9 Higher Algebra - S. Barnard & J. M. Child, Macmillan India Ltd
- 10 Elements of Number Theory - I. M. Vinogradov, Dover Pub INC
- 11 Elementary Number Theory in Nine chapters - James J. Tattersall, Cambridge Uni Press
- 12 A first course in Theory of Numbers - K. C. Chowdhary, Asian Books Pvt Ltd New Delhi
- 13 1001 problems in Classical Number Theory - Jean Marie De Konick Armed Mercier, AMS



Gujarat University
Choice Based Credit System (CBCS)

Syllabus for Semester V (Mathematics)

MAT 305 (Elective Course): Financial Mathematics (Theory)

Hours: 3 /week

Credits: 2

Unit I

Basic Concepts: Arbitrage, Return and Interest, Time Value of Money, Bonds, Shares and Indices, Models and Assumptions.

Unit II

Deterministic Cash Flows: Net Present Value (NPV), Internal Rate of Return (IRR), Comparison of IRR and NPV, Bonds price and yield, Clean and Dirty Price, Price – Yield Curves, Duration, Term structure of Interest rates, Immunisation, Convexity.

Unit III

Random Cash Flows: Random Returns, Portfolio Diagrams and Efficiency, Feasible Set, Markowitz Model.

Text Book

The Calculus of Finance - Amber Habib, University Press, Chapters 1, 2, 3 (upto 3.4).

