

25% REDUCED SYLLABUS ON U.G.. MATHEMATICS
FOR SEM-V OF SESSION (2020-2023)

Marks: 20 (MSE-1 Hr.)+ 80 (ESE: 3 Hrs.)= 100 Pass Marks
(MSE:8+ESE:32)=40

Instruction to Question Setter for :

Mid Semester Examination (MSE):

There will be Two group of questions. Group A is compulsory and will contain five questions of very short answer type consisting of 1 mark each Group B will contain descriptive type five questions of five marks each, out of which any three are to answer.

End Semester Examination (ESE):

There will be two group of questions. **Group A is compulsory** and will contain two **questions Question No. 1 will be very short answer type** consisting of eight questions of 1 mark each. **Question No., 2 will be short answer type** consisting two question of 4 marks. **Group B will contain descriptive type** seven questions of sixteen marks each, out of which any four are to be answer.

25 % Reduced U.G. Sem. – 5 (Session: 2020 – 23) Mathematics Core Syllabus

SEMESTER-V

MATHS-H-C-511-T	MULTIVARIATE CALCULUS	(04 Credits, 45 Lectures)
MATHS-H-C-512-T	GROUP THEORY II	(04 Credits, 45 Lectures)
MATHS-H- DSE-501A-T	LINEAR PROGRAMMING	(04 Credits, 45 Lectures)
MATHS-H- DSE-501B-T	NUMBER THEORY	(04 Credits, 45 Lectures)
MATHS-H- DSE-501C-T	ANALYTICAL GEOMETRY	(04 Credits, 45 Lectures)
MATHS-H- DSE-502A-T	INDUSTRIAL MATHEMATICS	(04 Credits, 45 Lectures)
MATHS-H- DSE-502B-T	BOOLEAN ALGEBRA AND AUTOMATA THEORY	(04 Credits, 45 Lectures)
MATHS-H- DSE-502C-T	PROBABILITY AND STATISTICS	(04 Credits, 45 Lectures)

MATHS-H-C-511-T: MULTIVARIATE CALCULUS

UNIT I

Functions of several variables, limit and continuity of functions of two variables Partial differentiation, total differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, Extrema of functions of two variables, 12 Lectures (2 question)

UNIT II

Double integration over rectangular region, double integration over non-rectangular region, Double integrals in polar co-ordinates, Triple integrals, Triple integral over a parallelepiped and solid regions. Change of variables in double integrals and triple integrals. 15 Lectures (3 question)

UNIT III

The gradient, maximal and normal property of the gradient, tangent planes Definition of vector field, divergence and curl Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, Green's theorem, surface integrals, Stoke's theorem. 18 Lectures (3 question)

Books Recommended:

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba and A. Weinstein, *Basic Multivariable Calculus*, Springer (SIE), Indian reprint, 2005.
4. James Stewart, *Multivariable Calculus, Concepts and Contexts*, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001.

MATHS-H-C-512-T: GROUP THEORY II

UNIT I

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups. 12 Lectures (2 question)

UNIT II

Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups. 11 Lectures (2 question)

UNIT III

Group actions, stabilizers and kernels, permutation representation associated with a given group action, Applications of group actions. 10 Lectures (2 question)

UNIT IV

Groups acting on themselves by conjugation, class equation and consequences, conjugacy in S_n , p -groups, Sylow's theorems. 12 Lectures (2 question)

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, 1999.

4. David S. Dummit and Richard M. Foote, *Abstract Algebra*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
5. J.R. Durbin, *Modern Algebra*, John Wiley & Sons, New York Inc., 2000.
6. D. A. R. Wallace, *Groups, Rings and Fields*, Springer Verlag London Ltd., 1998.

MATHS-H- DSE-501A-T: LINEAR PROGRAMMING

UNIT I

Introduction to linear programming problem, convex sets and their properties, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format.

15 Lectures (3 question)

UNIT II

Duality, formulation of the dual problem, primal-dual relationships.

7 Lectures (1 question)

Transportation problem and its mathematical formulation, northwest-corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

12 Lectures (2 question)

UNIT III

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies.

11 Lectures (2 question)

Books Recommended

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear Programming and Network Flows*, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, *Introduction to Operations Research*, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, *Operations Research, An Introduction*, 8th Ed., Prentice-Hall India, 2006.
4. G. Hadley, *Linear Programming*, Narosa Publishing House, New Delhi, 2002.

MATHS-H- DSE-501B-T: NUMBER THEORY

UNIT I

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruence's, complete set of residues, Chinese Remainder theorem, Fermat's Little theorem.

15 Lectures (3 question)

UNIT II

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius Inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, some properties of Euler's phi-function.

15 Lectures (3 question)

UNIT III

Order of an integer modulo n , primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol and its properties,

15 Lectures (2 question)

Books Recommended

1. David M. Burton, *Elementary Number Theory*, 6th Ed., Tata McGraw-Hill, Indian reprint, 2007.
2. Neville Robinns, *Beginning Number Theory*, 2nd Ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.

MATHS-H- DSE-501C-T: ANALYTICAL GEOMETRY

UNIT I

Reflection properties of parabola, ellipse and hyperbola. Classification of quadratic equations representing lines, parabola, ellipse and hyperbola.

23 Lectures (4 question)

UNIT II

Spheres, cone, Cylindrical surfaces. Illustrations.

22 Lectures (4 question)

Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. H. Anton, I. Bivens and S. Davis, *Calculus*, John Wiley and Sons (Asia) Pvt. Ltd. 2002.
3. S.L. Loney, *The Elements of Coordinate Geometry*, McMillan and Company, London.

4. R.J.T. Bill, *Elementary Treatise on Coordinate Geometry of Three Dimensions*, McMillan India Ltd., 1994.

MATHS-H- DSE-502A-T: INDUSTRIAL MATHEMATICS

UNIT I

Medical Imaging and Inverse Problems. The content is based on Mathematics of X-ray and CT scan based on the knowledge of calculus, elementary differential equations. 6 Lectures (1 question)

Introduction to Inverse problems: Why should we teach Inverse Problems? Illustration of Inverse problems through problems taught in Pre-Calculus, Calculus, Matrices and differential equations. 12 Lectures (2 question)

UNIT II

X-ray: Introduction, X-ray behavior and Beers Law (The fundament question of image construction). 6 Lectures (1 question)

Radon Transform: Definition and Examples. 6 Lectures (1 question)

Back Projection: Definition, properties and examples. 4 Lectures (1 question)

UNIT III

CT scan: Revision of properties of Fourier and inverse Fourier transforms and applications of their properties in image reconstruction. Algorithms of CT scan machine. 11 Lectures (2 question)

Books Recommended

1. Timothy G. Feeman, *The Mathematics of Medical Imaging, A Beginners Guide*, Springer Under graduate Text in Mathematics and Technology, Springer, 2010.
2. C.W. Groetsch, *Inverse Problems, Activities for Undergraduates*, The Mathematical Association of America, 1999.
3. Andreas Kirsch, *An Introduction to the Mathematical Theory of Inverse Problems*, 2nd Ed., Springer, 2011.

MATHS-H- DSE-502B-T: BOOLEAN ALGEBRA AND AUTOMATA THEORY

UNIT I

Definition, examples and basic properties of ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sub lattices, Definition, examples and properties of modular and distributive lattices. 18 Lectures (3 question)

UNIT II

Boolean algebras, Boolean polynomials, minimal forms of Boolean polynomials, Karnaugh diagrams, switching circuits and applications of switching circuits. 12 Lectures (2 question)

UNIT III

Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages: deterministic and non-deterministic finite automata, regular expressions, regular languages and their relationship with finite automata. 5 Lectures (1 question)

Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees, ambiguities in grammars and languages, pushdown automaton (PDA) and the language accepted by PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages. 5 Lectures (1 question)

Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine. 5 Lectures (1 question)

Books Recommended

1. B A. Davey and H. A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, (2nd Ed.), Pearson Education (Singapore) P.Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Günter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
4. J. E. Hopcroft, R. Motwani and J. D. Ullman, *Introduction to Automata Theory, Languages, and Computation*, 2nd Ed., Addison-Wesley, 2001.
5. H.R. Lewis, C.H. Papadimitriou, C. Papadimitriou, *Elements of the Theory of Computation*, 2nd Ed., Prentice-Hall, NJ, 1997.
6. J.A. Anderson, *Automata Theory with Modern Applications*, Cambridge University Press, 2006.

MATHS-H- DSE-502C-T: PROBABILITY AND STATISTICS**UNIT I**

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation, moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, continuous distributions: uniform, normal and exponential distributions. 18 Lectures (3 question)

UNIT II

Joint cumulative distribution function and its properties, joint probability density functions, expectation of function of two random variables, independent random variables, bivariate normal distribution, correlation coefficient, linear regression for two variables. 17 Lectures (3 question)

UNIT III

Statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance. 10 Lectures (2 question)

Books Recommended

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, *Introduction to Mathematical Statistics*, Pearson Education, Asia, 2007.
 2. Irwin Miller and Marylees Miller, John E. Freund, *Mathematical Statistics with Applications*, 7th Ed., Pearson Education, Asia, 2006.
 3. Sheldon Ross, *Introduction to Probability Models*, 9th Ed., Academic Press, Indian Reprint, 2007.
 4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, *Introduction to the Theory of Statistics*, 3rd Ed., Tata McGraw- Hill, Reprint 2007
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25% Reduced syllabus for Bachelor of Science in Mathematics Sem-5 (Gen / Pass)
Under Choice Based Credit System

MAT-G-DSE-501A-T: Matrices

(06 Credits, 30 Lectures & 15 Tutorials)

UNIT I

R, R^2, R^3 as vector spaces over R . Standard basis for each of them. Concept of Linear Independence and examples of different bases.

(5 Lectures)

Translation, Dilation, Rotation, Reflection in a point, line and plane. Matrix form of basic geometric transformations. Interpretation of eigen values and eigen vectors for such transformations.

(5 Lectures)

UNIT II

Types of matrices. Rank of a matrix. Invariance of rank under elementary transformations. Reduction to normal form, Solutions of linear homogeneous and non-homogeneous equations with number of equations and unknowns upto four.

(10 Lectures)

UNIT III

Matrices in diagonal form. Reduction to diagonal form up to matrices of order 3. Computation of matrix inverses using elementary row operations. Rank of matrix. Solutions of a system of linear equations using matrices.

(10 Lectures)

Books Recommended

1. A.I. Kostrikin, *Introduction to Algebra*, Springer Verlag, 1984.
2. S. H. Friedberg, A. L. Insel and L. E. Spence, *Linear Algebra*, Prentice Hall of India Pvt. Ltd., New Delhi, 2004.
3. Richard Bronson, *Theory and Problems of Matrix Operations*, Tata McGraw Hill, 1989.

MAT-G-DSE-502A-T: Mechanics

(06 Credits, 30 Lectures & 15 Tutorials)

UNIT I

Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body, Laws of friction, Problems of equilibrium under forces including friction, Centre of gravity.

(15 Lectures)

UNIT II

Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve), tangential and normal components (space curve), Newton's Laws of motion, Simple harmonic motion.

(15 Lectures)

Books Recommended

1. A.S. Ramsay, *Statics*, CBS Publishers and Distributors (Indian Reprint), 1998.
2. A.P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University Press, 2003.

MAT-G-DSE-503A-T: Numerical Methods

(06 Credits, 30 Lectures & 15 Tutorials)

UNIT I

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method, LU decomposition, Gauss-Jacobi, Gauss-Siedel.

(10 Lectures)

UNIT II

Lagrange and Newton interpolation: linear and higher order, finite difference operators. Numerical differentiation: forward difference, backward difference. Integration: trapezoidal rule, Simpson's rule.

(20 Lectures)

Recommended Books

1. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation*, 5th Ed., New age International Publisher, India, 2007.

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RING THEORY AND LINEAR ALGEBRA – I

UNIT – I

Definition and examples of ring, Elementary properties of ring, Subring, Integral Domain, Field and subfield. Theorems on Ring, Integral Domain and Field. Characteristic of a ring, Ideal, Ideal generated by a subset of a ring, Operation on ideals, (03 questions)

UNIT – II

Homomorphism of rings and its properties, Kernel of a ring homomorphism, Isomorphism theorem – I, II and III, (01 question)

Definition and general properties of Vector space, Vector Subspace, Linear sum of subspaces, Quotient space, Linear combination of vectors, Linear span, Linear dependence and linear independence of vectors, Basis of Vector space, Dimension of finitely generated vector space, and theorems thereon. (02 questions)

UNIT – III

Homomorphism of vector spaces or Linear transformations, Isomorphism, Null space, range, Rank and Nullity of a linear transformation, Algebra of linear transformations. (01 questions)

Text Books:

1. A. R. Vasishtha: Modern Algebra, Krishna Publication.
2. Goyal & Gupta: Advanced Course in Modern Algebra, Pragati Publication.
3. K. P. Gupta: Linear Algebra, Krishna Publication.
4. Bhupendra Singh: Linear Algebra, Pragati Publication.
5. Joseph A. : Contemporary Abstract Algebra, Narosa Publication.

Reference Books:

1. John B. : A first course in Abstract Algebra, Pearson Publication.
2. Gilbert S. : Linear Algebra and its applications, Thomson Publ.

Reduced Part:

1. Factor rings. Prime ideals and Maximal ideals.
2. Field of quotients.
3. Matrix representation of a linear transformation, Isomorphism theorem, Invertibility and Isomorphism, change of coordinate matrix.

**25% REDUCED SYLLABUS ON MATHEMATICS GENERIC & GENERAL PAPERS FOR
SEM – 4 EXAMINATION 2022**

GE 4.1 Applications of Algebra

FULL MARKS: 80

TIME: 3 hours (06 Credits, 45 Lectures)

UNIT I

Balanced incomplete block designs (BIBD): definitions and results, incidence matrix of a BIBD, construction of BIBD from difference sets, construction of BIBD using quadratic residues, difference set families. 12 Lectures (2 question)

UNIT II

Coding Theory: introduction to error correcting codes, linear codes, generator and parity check matrices. 6 Lectures (1 question)

Symmetry groups and color patterns: review of permutation groups, groups of symmetry and action of a group on a set. 6 Lectures (1 question)

UNIT III

Special types of matrices: idempotent, nilpotent, involution, and projection tri diagonal matrices, circulant matrices, Vandermonde matrices, Hadamard matrices, permutation and doubly stochastic matrices, Frobenius- König theorem, Birkhoff theorem. Positive Semi-definite matrices: positive semi-definite matrices, square root of a positive semi-definite matrix, a pair of positive semi-definite matrices, and their simultaneous diagonalization. Symmetric matrices and quadratic forms: diagonalization of symmetric matrices, quadratic forms, constrained optimization. 12 Lectures (2 question)

UNIT IV

Applications of linear transformations: Fibonacci numbers, incidence models, and differential equations. Least squares methods: Approximate solutions of system of linear equations, approximate inverse of an $m \times n$ matrix, solving a matrix equation using its normal equation, finding functions that approximate data. Linear algorithms: LDU factorization, the row reduction algorithm and its inverse. 9 Lectures (2 question)

Books Recommended:-

1. I. N. Herstein and D. J. Winter, *Primer on Linear Algebra*, Macmillan Publishing Company, New York, 1990.
2. S. R. Nagpaul and S. K. Jain, *Topics in Applied Abstract Algebra*, Thomson Brooks and Cole, Belmont, 2005.
3. Richard E. Klima, Neil Sigmon, Ernest Stitzinger, *Applications of Abstract Algebra with Maple*, CRC Press LLC, Boca Raton, 2000.
4. David C. Lay, *Linear Algebra and its Applications*. 3rd Ed., Pearson Education Asia, Indian Reprint, 2007.
5. Fuzhen Zhang, *Matrix theory*, Springer-Verlag New York, Inc., New York, 1999.

GE 4.2 Combinatorial Mathematics

FULL MARKS: 80

TIME: 3 hours (06 Credits, 45 Lectures)

UNIT I

Basic counting principles, Permutations and Combinations (with and without repetitions), Binomial theorem, Multinomial theorem, Counting subsets, Set-partitions. 5 Lectures (1 question)

Principle of Inclusion and Exclusion, Inversion formulae. 5 Lectures (1 question)

Generating functions: Algebra of formal power series, Generating function models, Calculating generating functions. 5 Lectures (1 question)

UNIT II

Recurrence relations: Recurrence relation models, Solution of recurrence relations, Solutions by generating functions. 12 Lectures (2 question)

Integer partitions, Systems of distinct representatives, Polya theory of counting: Necklace problem and Burnside's lemma, Cyclic index of a permutation group. 6 Lectures (1 question)

UNIT III

Latin squares, Hadamard matrices, Combinatorial designs: t designs. 12 Lectures (2 question)

Books Recommended:-

1. J.H. van Lint and R.M. Wilson, *A Course in Combinatorics*, 2nd Ed., Cambridge University Press, 2001.
2. V. Krishnamurthy, *Combinatorics, Theory and Application*, Affiliated East-West Press 1985.
3. P.J. Cameron, *Combinatorics, Topics, Techniques, Algorithms*, Cambridge University Press, 1995.
4. M. Jr. Hall, *Combinatorial Theory*, 2nd Ed., John Wiley & Sons, 1986.
5. S.S. Sane, *Combinatorial Techniques*, Hindustan Book Agency, 2013.
6. R.A. Brualdi, *Introductory Combinatorics*, 5th Ed., Pearson Education Inc., 2009.

GE 4.3 Algebra (except mathematics Hons.)

FULL MARKS: 80

TIME: 3 hours (06 Credits, 45 Lectures)

UNIT I

Definition and examples of groups, examples of abelian and non-abelian groups, the group Z_n of integers under addition modulo n and the group $U(n)$ of units under multiplication modulo n .

Cyclic groups from number systems, complex roots of unity. 12 Lectures (2 question)

UNIT II

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets,

Index of subgroup, Lagrange's theorem, order of an element and its properties. 17 Lectures (3 question)

UNIT III

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Z_n the ring of integers modulo n , ring of real quaternions, rings of matrices, Subrings and ideals, Integral domains and fields and their properties with examples.

16 Lectures (3 question)

Books Recommended:-

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.
4. George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.

MATHS. GENERAL

MAT-G-DSC-401D-T: Algebra;

(Credits 06: Lectures-45)

Marks: 20 (MSE: 1Hr) + 80 (ESE: 3Hrs) = 100 Pass Marks (MSE: 8 + ESE: 32) = 40

UNIT I

Definition and examples of groups, examples of abelian and non-abelian groups, the group Z_n of integers under addition modulo n and the group $U(n)$ of units under multiplication modulo n .

Cyclic groups from number systems, complex roots of unity, circle group, the general linear group $GL_n(n, R)$, groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle. (3 Questions)

UNIT II

Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange's theorem, order of an element. (2 Questions)

UNIT III

Definition and examples of rings, examples of commutative and non-commutative rings: rings from number systems, Z_n the ring of integers modulo n , ring of real quaternions, rings of matrices. Definition, examples and properties of Subrings, ideals, Integral domains and fields. (3 Questions)

Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.

Joseph A Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa, 1999.

George E Andrews, *Number Theory*, Hindustan Publishing Corporation, 1984.