P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF MATHEMATICS
COTTON UNIVERSITY

PAPER : MTH1001C

DISCRETE MATHEMATICS

(Credits: 4+1+0=5)

(64 lectures)

UNIT-I

Sets and classes, Relations and functions, Equivalence relations and equivalence classes, Principle of mathematics induction, Recursive definitions, Posets, Chains and well ordered sets, Axiom of choice, Cardinal and ordinal numbers, Cantor's lemma, Set theoretic paradoxes. [12Lectures]

UNIT-II

Propositional Calculus: Well-formed formulas, Tautologies, Equivalence, Normal forms, Truth of algebraic systems, Calculus of predicates. [8Lectures]

UNIT-III

Primitive roots, Indices, the order of an integer modulo n, primitives roots for primes, composite number having primitive roots, the theory of indices [7Lectures]

UNIT IV

Quadratic reciprocity law, Euler's criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruence with composite modulii [7Lectures]

UNIT V

Fibonacci numbers, Fibonacci sequence, Identities involving Fibonacci number [5Lectures]

UNIT VI

Simple continued fractions, finite and infinite continued fractions, uniqueness, representation of rational and irrational numbers as simple continued fractions, rational approximation to irrational numbers, Hurwitz theorem, basic facts of periodic continued fractions and their illustrations (without proofs); Pell's equation [9Lectures]

Books Recommended

1. I. Niven and H. S. Zuckerman, An Introduction to the Theory of Numbers (3rd edition) , Wiley Eastern Ltd., New Delhi, 1993
2. D. M. Burton, Elementary Number Theory (4th edition) , Universal Book Stall, New Delhi, 2002.
3. J.P. Tremblay and R.P. Manohar, Discrete Mathematics with Applications to Computer Science, McGraw Hill , 1989.
4. P. R. Halmos, Naive Set Theory, Springer India, 2009

Books for Reference

1. K.C.Chowdhury, A First Course In Theory Of Numbers; Asian Books Private Ltd., 2004.

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P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF MATHEMATICS
COTTON UNIVERSITY

Special Paper - 2

PAPER : MTH1002SP1

NUMBER THEORY AND CRYPTOGRAPHY

(Credits: 4+1+0=5)

(64 lectures)

Unit –I

Congruence, Linear Diophantine Equations, Chinese Remainder Theorem, Primitive Roots, Quadratic reciprocity, Legendre and Jacobi symbol. [10 Lectures]

Unit – II

Arithmetic functions Primality Testing and factorization algorithms, Pseudo-primes, Fermat's pseudo-primes, Pollard's rho method for factorization, Continued fractions, Continued fraction method

[14 Lectures]

Unit –III

Fields, Finite fields, Characteristics of fields, Generators of fields, Characterisations of finite fields.

[14Lectures]

Unit –IV

Public Key cryptography, Diffie-Hellmann key exchange, Discrete logarithm-based crypto-systems, RSA crypto-system, Signature Schemes, Digital signature standard, RSA Signature schemes, Knapsack problem. Introduction to elliptic curves, Group structure, Rational points on elliptic curves, Elliptic Curve Cryptography. Applications in cryptography and factorization, Known attacks. [26 Lectures]

Books Recommended

1. N. Koblitz, A Course in Number Theory and Cryptography, Springer, 2006.
2. I. Niven, H.S. Zuckerman, H.L. Montgomery, An Introduction to theory of numbers, Wiley, 2006.
3. L. C. Washington, Elliptic curves: number theory and cryptography, Chapman & Hall/CRC, 2003.

Books for Reference

1. J. Silverman and J. Tate, Rational Points on Elliptic Curves, Springer-Verlag, 2005.
2. D. Hankerson, A. Menezes and S. Vanstone, Guide to elliptic curve cryptography, Springer-Verlag, 2004.
3. J. Pipher, J. Hoffstein and J. H. Silverman , An Introduction to Mathematical Cryptography, Springer-Verlag, 2008.
4. G.A. Jones and J.M. Jones, Elementary Number Theory, Springer-Verlag, 1998.
5. R.A. Mollin, An Introduction to Cryptography, Chapman & Hall, 2001.

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P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF MATHEMATICS
COTTON UNIVERSITY

PAPER : MTH1002SP2

FLUID DYNAMICS

(Credits: 4+1+0=5)

(64 lectures)

Unit -I

Theory of stress and rate of strain: Newton's law of viscosity, body and surface forces, Stress vector and components of stress tensor, state of a stress tensor. Transformation of stress components. Plane stress, principle stress and principle directions, Relation between stress and rates of strain components. Stokes's law of viscosity. Translation, rotation and rate of deformation. [16 Lectures]

Unit -II

Viscous fluid motion: Navier-Stokes equation of motion, rate of change of vorticity and circulation, rate of dissipation of energy, diffusion of a viscous filament. [14Lectures]

Unit -III

Exact solution of Navier-Stokes equation: Flow between plates, Flow through a pipe (circular, elliptic), Suddenly accelerated plane wall, Flow near an Oscillating flat plate, Circular motion through cylinders.

[14Lectures]

Unit -IV

Laminar boundary layer theory: General outline of Boundary layer flow, Boundary layer thickness, Displacement thickness, Energy thickness, Flow along a flat plate at zero incidence, Similarity solution and Blasius solution for flow about a flat plate.

Karman's momentum integral equation, Energy integral equation, Pohlhausen solution of momentum integral equation. Two-dimensional Boundary layer equations for flow over a curved surface, Blasius solution for flow past a cylindrical surface, phenomenon of separation. [20 Lectures]

Books Recommended

1. H. Lamb, Hydrodynamics , Dover Publications, 1945

2. L.M.Milne-Thomson: Theoretical Hydrodynamics(5th ed. edition), Dover Publications, 2013

3. H. Schlichting (translated by J. Kertin), Boundary Layer Theory: ,McGraw Hill, New York,2014

Books for Reference

1. S. Goldstein, Modern Development of Fluid Dynamics, Vol –I ,Dover Publication, New York,1938

2. G.K. Batchelor,An Introduction to Fluid Dynamics , Cambridge University Press, 2012

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P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF MATHEMATICS
COTTON UNIVERSITY

PAPER : MTH1002SP3

FINITE ELEMENT METHOD

(Credits: 4+1+0=5)

(64 lectures)

Unit-I

Introduction: Basic concepts of process of discretization, subdivision, continuity, convergence, bounds, error.

[8 Lectures]

Unit-II

Finite Element Methods: Introduction, general idea of element configuration, approximation models or functions. Energy methods, methods of weighted residuals. Introduction to variational calculus.

[14Lectures]

Unit-III

One-dimensional Stress Deformation: Element configuration, local and global coordinates, interpolation functions, stress-strain relationship, element equations and assembling, direct stiffness method, formulation by Galerkin method. [16Lectures]

Unit-IV

One-dimensional flow: Theory and formulation, finite element formulation, variational approach, Galerkin method, boundary conditions. [12Lectures]

Unit-V

Two and Three-dimensonal formulations: Introduction, two-dimensional formulation, triangular and quadrilateral elements, three-dimensional formulation, tetrahedron element, brick element.

[14 Lectures]

Books Recommended

1. C. S Desai and T. Kundu, Introductory Finite element method ,CRC Press, 2001

2. D. Braess and L. L. Schumaker, Finite elements: theory, fast solvers and applications in solid mechanics ,Cambridge University Press, 2001

3. S. C. Brenner and L. R. Scott, The mathematical theory of finite element methods, Springer, 2008

Books for Reference

1. P. G. Ciarlet,The finite element method for elliptic problems ,North Holland, 1978

2. V. Thomee, Galerkin finite element methods for parabolic problems ,Springer, 1997

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P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF MATHEMATICS
COTTON UNIVERSITY

PAPER : MTH1002SP4

ALGEBRAIC NUMBER THEORY

(Credits: 4+1+0=5)

(64 lectures)

Unit-I

Algebraic numbers, number fields, Discriminants, Norms and Traces. [10 Lectures]

Unit-II

Algebraic Integers, rings of integers, Integral Bases, Problems for quadratic and cubic cases.

[10 Lectures]

Unit-III

Arithmetic of Number Fields: Quadratic Fields, Cyclotomic polynomials and fields. [10 Lectures]

Unit-IV

Units in Number Rings, Dirichlet's Unit Theorem. [10 Lectures]

Unit-V

Ideal Theory: norms of ideals, fractional ideals. [12 Lectures]

Unit-VI

Ideal Classes-The Class Group, Class Numbers of Quadratic Fields and Cyclotomic fields.

[12Lectures]

Books Recommended

1.R. A. Mollin, *Algebraic Number Theory* ,CRC Press, 1999

2. I. N. Stewart & D. Tall, *Algebraic Number Theory and Fermat's Last Theorem(*3rd ed),AK Peters Ltd, 2008

Books for Reference

1. J. Esmonde & M. Ram Murty, *Problems in Algebraic Number Theory*, GTM Vol. 190,Springer-Verlag, 2006

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P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF MATHEMATICS
COTTON UNIVERSITY

PAPER : MTH1002SP5

FUZZY SETS AND APPLICATIONS

(Credits: 4+1+0=5)

(64 lectures)

Unit -I

Fuzzy sets: Basic definitions, d-level sets, convex fuzzy sets, basic operations on fuzzy sets, types of fuzzy sets, Cartesian products, algebraic products, bounded sum and difference.

Extension principle: The Zadeh extension principle, image and inverse image of fuzzy sets, fuzzy numbers, elements of fuzzy arithmetic. [10 Lectures]

Unit -II

Fuzzy relations and fuzzy graphs: Fuzzy relations and fuzzy sets, composition of fuzzy relations, min-max composition and its properties, fuzzy equivalence relations, fuzzy compatibility relations, fuzzy relations equations, fuzzy graphs, similarity relation. [14 Lectures]

Unit -III

Fuzzy logic: An overview of classical logic, multivalued logic, fuzzy propositions, fuzzy quantifiers, linguistic variable and hedges, inference from conditional fuzzy propositions, the compositional rule of inference.

Approximate reasoning: An overview of fuzzy expert system, fuzzy implications and their selection, multiconditional approximate reasoning. [14 Lectures]

Unit -IV

Introduction to fuzzy control Fuzzy controllers, fuzzy rule base, fuzzy inference engine, fuzzification,defuzzification and the various defuzzification methods (the centre of area, the centre of maxima and the mean of maxima methods). [14 Lectures]

Unit -V

Decision making in fuzzy environment: Individual decision making, mult-person decision making, multicriteria decision making, multi stage decision making, fuzzy ranking methods, fuzzy linear programming. [12 Lectures]

Books Recommended

1. G.J. Klir and B.Yuan: Fuzzy Sets and Fuzzy Logic- Theory and Applications, Prentice Hall of India, 1995.

2. H.J. Zimmermann: Fuzzy Theory and its Application, Allied Publishers Ltd., 1991

Books for Reference

1.G. Bojadziev, M. Bojadziev, Fuzzy Sets, Fuzzy Logic, Applications, World Scientific,1995

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P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF MATHEMATICS
COTTON UNIVERSITY

PAPER : MTH1002SP6

DYNAMICAL SYSTEMS

(Credits: 4+1+0=5)

(64 lectures)

Unit-I

Dynamical systems and Vector fields, the fundamental theorem, existence and Uniqueness, continuity of solution in initial condition, orbit of a map, fixed point, equilibrium point, periodic point, circular map, configuration space and phase space. [6 Lectures]

Unit-II

Stability of a fixed point, equilibrium point, concept of limit cycle and torus, hyperbolicity. Quadratic Map, Period doubling phenomenon, Feigenbaum's universal constant. [8 Lectures]

Unit-III

Nonlinear oscillators – conservative system. Hamiltonian system. Various types of Oscillators in nonlinear system. Solutions of nonlinear differential equations. [10 Lectures]

Unit-IV

Phenomenon of losing stability, Quasiperiodic motion. Topological study of nonlinear differential equations. Poincare map. [10 Lectures]

Unit-V

Randomness of orbits of a dynamical system. Chaos. Strange attractors. Various routes to chaos. Onset mechanism of turbulence. [10 Lectures]

Unit –VI

Basic idea of Fractal geometry, construction of the middle third Cantor set, Von Koch curve, Sierpinski gasket, self similar fractals with different similarity ratio, Julia set, measure and mass distribution, Housdorff measure, Housdorff dimension and its properties. [10 Lectures]

Unit – VII

Measurement of asset at scale box dimension, its equivalent versions, properties of box dimension, box dimension of middle third Cantor set and other simple sets, upper estimate of box dimension, generalized Cantor set and its dimension. [10 Lectures]

Books Recommended

1. R. L. Devany: An Introduction to Chaotic Dynamical Systems, Addison-Wesley Publishing Co. Inc, 1989.

2. M. W. Hirsch, S. Smale: Differential Equation, Dynamical System and an introduction to chaos, Academic Press,2012

3. K. Falconer, Fractal Geometry: Mathematical Foundations and applications, Wiley-Blackwell, 2014

Reference books:

1. V.I. Arnold, Dynamical systems, Bifurcation Theory and Catastrophy Theory, Springler Verlag, 1992.
2. D.K. Arrowsmith & C.M. Place, Introduction to Dynamical Systems, Cambridge University Press,1990
3. K.J. Falconer, The Geometry of Fractals Sets, Cambridge University Press, 1985.
4. M.F. Barnsley,Fractals everywhere, Academic Press., 1988.

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PAPER : MTH1002SP7

COMMUTATIVE ALGEBRA

(Credits: 4+1+0=5)

(64 lectures)

Unit – I

Extension and Contraction of ideals, Prime spectrum of Rings, Jacobson radical of a ring, Prime avoidance lemma, Rings of formal power series, Restriction and extension of scalars. [14 Lectures]

Unit –II

Localisation, Local properties, Extended & contracted ideals in rings of fractions, Primary decomposition, First and second uniqueness theorem of primary decomposition, Noetherian rings, Primary decomposition in Noetherian rings, Artin rings, Structure theorem for Artin rings. [28 Lectures]

Unit – III

Integral dependence, Going up theorem, Going down theorem, Integrally closed domains, Valuation rings, Hilbert's Nullstellensatz theorem, Discrete valuation rings, Dedekind domains, Fractional ideals.

[22 Lectures]

Books Recommended

1. M.F. Athiyah & I.G. Macdonald, Introduction to Commutative Algebra, Addison Wesley, 1969.

Books for Reference

1. B. Singh, Basic Commutative Algebra, World Scientific Publishing Co., 2011.
2. D. Eisenbud, Commutative Algebra with a view towards algebraic geometry, Springer Verlag, 1995.
3. O. Zariski & P. Samuel, Commutative Algebra, Vol. 1 & 2, SpringerVerlag, 1975.
4. R.Y. Sharp, Steps in Commutative Algebra, Cambridge University Press, 1990

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P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF MATHEMATICS
COTTON UNIVERSITY

Open Elective -2

PAPER : MTH1003OP1

COMBINATORICS

(Credits: 4+1+0=5)

(64 lectures)

Unit- I

Counting principles, multinomial theorem, set partitions and Striling numbers of the second kind, permutations and Stirling numbers of the first kind, number partitions, Lattice paths, Gaussian coefficients, Aztec diamonds. [10Lectures]

Unit - II

Formal series, infinite sums and products, infinite matrices, inversion of sequences, probability generating functions. [8Lectures]

Unit - III

Generating functions, evaluating sums, the exponential formula, more on number partitions and infinite products, Ramanujan's formula. [8Lectures]

Unit - IV

Hypergeometric sums, summation by elimination, infinite sums and closed forms, recurrence for hypergeometric sums, hypergeometric series. [8Lectures]

Unit - V

Sieve methods, inclusion-exclusion, Mobius inversion, involution principle, Gessel-Viennot lemma, Tutte matrixtree theorem [7Lectures]

Unit - VI

Enumeration and patterns, Polya-Redfield theorem, cycle index, symmetries on N and R, polyominoes [7Lectures]

Books Recommended

1. M. Aigner. A Course in Enumeration. Springer,2012.

Books for Reference

1. C. Berge. Principles of Combinatorics. Academic Press, 1971.

2. J. Riordan. Introduction to Combinatorial Analysis. Dover, 2002.

3. M. Bona. Introduction to Enumerative Combinatorics. Tata McGraw Hill, 2007.

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P.G. 4th SEMESTER SYLLABUS
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COTTON UNIVERSITY

PAPER : MTH1003OP2

DIFFERENTIAL GEOMETRY

(Credits: 4+1+0=5)

(64 lectures)

Unit-I

Theory of space curves: Space curves, plane curves, curvature, torsion and Serret-Frenet formulae. Osculating planes, osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves. [8Lectures]

Unit-II

Theory of surfaces: Parametric curves on surfaces. Direction coefficients. First and second fundamental forms. Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigue's formula, conjugate and asymptotic lines.

Developables: Developable associated with space curves and curves on surfaces, minimal surfaces.

[10Lectures]

Unit-III

Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution. Clairaut's theorem. Normal property of geodesics. Torsion of a geodesic. Geodesic curvature. Gauss-Bonnet theorem. Surfaces of constant curvature. Conformal mapping. Geodesicmapping. Tissot's theorem.

[10Lectures]

Unit-IV

Tensors: Summation convention and indicial notation, coordinate transformation and Jacobian, contra-variant and covariant vectors, tensors of different types, algebra of tensors and contraction, metric tensor and 3-index Christoffel symbols [10Lectures]

Unit-V

Parallelism of vectors, angle between two vectors, covariant and intrinsic derivatives, curvature tensor and its properties, curl, divergence and Laplacian operators in tensor form, physical components.

[10Lectures]

Books Recommended:

1. T.J.Willmore, An Introduction to Differential Geometry, Dover Publications, 2012.

Books for Reference:

1. B. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.

2. C.E.Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003.

3. D.J. Struik, Lectures on Classical Differential Geometry, Dover Publications, 1988.

4. S. Lang, Fundamentals of Differential Geometry, Springer, 1999.

5. B. Spain, Tensor Calculus: A Concise Course, Dover Publications, 2003.

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PAPER : MTH1003OP3

SCIENTIFIC COMPUTING

(Credits: 4+1+0=5)

(64 lectures)

Unit-I

Errors; Iterative methods for nonlinear equations; Polynomial interpolation, spline interpolations; Numerical integration based on interpolation, quadrature methods, Gaussian quadrature. [12Lectures]

Unit-II

Initial value problems for ordinary differential equations - Euler method, Runge- Kutta methods, multi-step methods, predictor-corrector method, stability and convergence analysis. [12Lectures]

Unit-III

Finite difference schemes for partial differential equations - Explicit and implicit schemes; Consistency, stability and convergence; Stability analysis (matrix method and von Neumann method), Lax equivalence theorem. [12Lectures]

Unit-IV

Finite difference schemes for initial and boundary value problems (FTCS, Backward Euler and Crank-Nicolson schemes, ADI methods, Lax Wendroff method, upwind scheme). [12Lectures]

Books Recommended

1. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing(3rd Ed.), AMS, 2002.

2. G. D. Smith, Numerical Solutions of Partial Differential Equations(3rd Ed.), Calrendorn Press, 1985.

Books for Reference

1. K. E. Atkinson, An Introduction to Numerical Analysis, Wiley, 1989.

2. S. D. Conte and C. de Boor, Elementary Numerical Analysis - An Algorithmic Approach, McGraw-Hill, 1981.

3. R. Mitchell and S. D. F. Griffiths, The Finite Difference Methods in Partial Differential Equations, Wiley, 1980.

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P.G. 4th SEMESTER SYLLABUS
DEPARTMENT OF MATHEMATICS
COTTON UNIVERSITY

PAPER : MTH1003OP4

INDUSTRIAL MATHEMATICS

(Credits: 4+1+0=5)

(64 lectures)

Unit -I

An introduction to Financial Derivatives, types of financial derivatives – Forward and Futures; Options and its kinds and SWAPS. [12Lectures]

Unit -II

The arbitrage theorem and introduction to Portfolio Selection and Capital Market Theory, Static and Continuous- Time model. [12Lectures]

Unit -III

A single period option pricing model, multi period option pricing model, Cox-Ross-Rubistein model, bounds on option price. [12Lectures]

Unit -IV

The Ito's Lemma and the Ito's integral. [12Lectures]

Books Recommended

1. J. C. Hull and S. Basu , Options, Futures, and Other Derivatives, Pearson, 2016

Books for Reference

1. S. M. Ross, An Introduction to Mathematical Finance, Cambridge University Press, 2011

2. S. N. Neftci, An Introduction to the Mathematics of Financial Derivatives, Academic Press,1996

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PAPER : MTH1003OP5

BIOMECHANICS

(Credits: 4+1+0=5)

(64 lectures)

Pre-requisite : Fluid Mechanics (See MM 503. MM 504, MM 5'05-8)

Newton's equations of motion. Mathematical modeling. Continuum approach.

Segmental Movement and Vibrations.

External Flow: Fluid Dynamic Forces Acting on Moving Bodies.

Flying and Swimming.

Blood Flow in Heart, Lung, Arteries, and Veins.

Micro-and Macrocirculation.

Books Recommended

1. Y.C. Fung, Biomechanics, Springer-Verlag, New York lnc., 1990.

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MTH1004DPW

Dissertation & Project Work