M Sc – Mathematics Syllabus for 2018 Admissions Onwards
Incorporating Changes Introduced up to June, 2019

18MAT502 Advanced Algebra 3 1 0 4

Review: Groups and Rings

Unit 1

Conjugate Elements, Normalizer of an Element, Index of Normalizer, Center of a Group, Cauchy’s Theorem on Prime Order, the Number of Conjugate Classes $p(n)$ for a Permutation Group, Counting Principles, Cauchy Theorem, $p$- Sylow subgroups, Sylow’s Theorems. (Sec. 2.11 and 2.12).

Unit 2

Normal Subgroups, Isomorphic Groups, External and Internal Direct Products, Cyclic Groups, Abelian Groups, Invariants of a Group, Fundamental Theorem on Finite Abelian Groups (Sec. 2.13 and 2.14).

Unit 3

Polynomial Rings over the Rational Field, Primitive Polynomials, The Content of a Polynomial, Integer Monic Polynomial, Eisenstein Criterion, Polynomial Rings over Commutative Rings. Unique Factorisation domain (Sec. 3.10 to 3.11).

Unit 4

Euclidean Domains, Principal Ideal Domains, Unique Factorization Domains, Polynomials in Several Variables over a Field and Grobner Bases. (Sec. 8.1 to 8.3, 9.6 from Reference Book 1).

Unit 5

The Elements of Galois Theory, Group of Automorphisms and its fixed field, Galois Group, The Fundamental Theorem of Galois Theory, Solvable Groups, Solvability by Radicals, Galois Groups over the Rationals. (Sec. 5.6 to 5.8).

TEXTBOOKS:


REFERENCES


Note: The Problems are to be referred from Reference Book 1.
Unit 1
(Chapter 6: 6.1 to 6.5)

Unit 2
Sequences and Series of Functions: Sequence of functions and its point-wise limit, Discussion of main problems, Uniform convergence, Uniform convergence and continuity, Uniform convergence and Integration, Uniform convergence and Differentiation, Equicontinuous Families of Functions, The Stone-Weierstrass Theorem.
(Chapter 7: 7.1 to 7.7)

Unit 3
(Chapter 8: 8.1 to 8.4)

Unit 4
Some Special Functions and Functions of Several Variables: Fourier series, Gamma function and its properties. Linear Transformation, Differentiation.
(Chapter 8 & 9: 8.5 to 8.6. 9.1 to 9.2)

Unit 5
Functions of Several Variables: The Contraction principle, The inverse function theorem, The implicit function theorem
(Chapter 9: 9.3 to 9.5)

TEXTBOOK:

REFERENCE BOOKS:

18MAT504 ORDINARY DIFFERENTIAL EQUATIONS 3104

Prerequisite: The students must know the basic concepts on ordinary differential equation.

Unit 1
Linear differential equations: Introduction, initial value problems, the wronskian and linear independence, reduction of order of a homogeneous equation, non-homogeneous equation.
Existence - Uniqueness of Solutions to First Order Equations: Equations with variable separated, Exact equations, the method of successive approximations, Lipschitz condition, Convergence of successive approximations, Non–local existence of solutions, Approximations to, and uniqueness, of solutions.

TB2 (5.2- 5.8)(10hours)

Unit 2
Systems of first order equations, Existence and uniqueness theorem, fundamental matrix, nonhomogenous linear systems, linear systems with constant coefficients. TB3 (4.2-4.7)(10 hours)

An example – central forces and planetary motion, Some special equations.

TB2 (6.2- 6.3)(4 hours)

Unit 3
Complex n-dimensional space, Systems as vector equations, Existence and uniqueness of solutions to systems, Existence and Uniqueness of linear systems, Equations of order n.

TB2 (6.4- 6.8) (10 hours)

Unit 4

Unit 5

TEXTBOOKS:

REFERENCE:

18MAT505 Stochastic Processes 3 1 0 4
Unit – I Introduction to Probability and Stochastic Processes:

Definition of Stochastic Processes, specification of Stochastic processes, Stationary processes– Markov Chains: definition and examples, higher transition probabilities, Generalization of Independent Bernoulli trails, classification of states and chains.
(Sections: 2.1, 2.2, 2.3, 3.1, 3.2, 3.3, 3.4)

Unit – II Markov Processes with Discrete State Space:

Poisson process, Poisson process related distributions, properties of Poisson process, Generalizations of Poisson Processes, Birth and death processes, continuous time Markov Chains.
(Sections: 4.1, 4.2, 4.3, 4.4, 4.5)

Unit – III Markov processes with continuous state space:

(Sections: 5.1 to 5.6)

Unit – IV Renewal processes and theory:

(Sections: 6.1 to 6.5)

Unit – V Branching Processes:

Introduction, properties of generating functions of Branching process, Distribution of the total number of progeny, Continuous-Time Markov Branching Process, Age dependent branching process: Bellman-Harris process.
(Sections: 9.1, 9.2, 9.4, 9.7, 9.8)

Text Book:

Book for Reference:

18MAT511 ADVANCED COMPLEX ANALYSIS 3 1 0 4

Unit 1:
Schwarz Reflection: Schwarz Reflection by complex conjugation, Reflection along analytic Ares, Application of Schwarz Reflection (Chapter 9)
Unit 2
The Riemann Mapping Theorem: Compact sets in Function Spaces, Statement and Proof of the Riemann Mapping Theorem, Behaviour at the Boundary (Chapter 10).

Unit 3
Analytic Continuation: Analytic Continuation along a curve, Monodromy Theorem, the Dilogrithm, Bloch-Wigner Function, Picard’s Theorem and its Application (Chapter 11).

Unit 4
Entire and Meromorphic Functions: Infinite Products, Absolute Convergence, Weierstrass Products, Functions of Finite Order, Canonical product, Minimum Modulus Theorem, Hadamard’s Theorem, Mittag-Leffler Theorem (Chapter 13).

Unit 5
Elliptic Functions: Liouville Theorem, Fundamental Parallelogram, Elliptic Function, Weierstrass Function, Addition Theorem, Sigma and Zeta Functions (Chapter 14).

TEXTBOOK

REFERENCES

18MAT512 Advanced Topology 3 1 0 4

Unit 1
Continuous Functions:
Continuous functions, homeomorphisms, Rules for Constructing continuous Functions, Pasting Lemma, the product topology, Projection, Box and Product topologies, the metric topology, Metrizable Space, Uniform metric and Uniform Topology, Sequence Lemma, Uniform Convergence, Uniform Limit Theorem.

Chapter 2: Sections 18 to 21

Unit 2 Connectedness:
Connected spaces, separation, connected subspaces of the Real line, Linear Continuum, Intermediate Value Theorem, Path and Path connectedness, Components, Path Components, locally connected, Locally Path Connected.

Chapter 3: Sections 23 to 25.

Unit 3 Compactness:
Compact spaces, Covering and Open Covering, Tube Lemma, Finite Intersection Property, Compact subspaces of the Real line, Extreme Value Theorem, Lebesgue Number Lemma, Uniform Continuity Theorem, Limit Point Compactness, Sequentially Compact, Local Compactness Compactification, One Point Compactification.

Chapter 3: Sections 26 to 29

**Unit 4 Countability and Separation Axioms**


Chapter 4: Sections 30 to 35

**Unit 5 The Tychonoff Theorem and Baire Space**

Tychonoff’s Theorem, Baire Spaces, Baire Category Theorem.

Chapter 5: Section 37 and Chapter 8: Section 48

**TEXTBOOK:**


**REFERENCE BOOKS :**

3. M. A. Armstrong “Basic Topology” Springer (India) – 2005
5. G.F.Simmons-”Introduction to Topology and Modern Analysis” McGraw Hill Education-2004

**18MAT513 PARTIAL DIFFERENTIAL EQUATIONS 4 0 0 4**

**Prerequisite:** The students must know the basic concepts on Calculus (both differential and integral), Differential Equations (ODE and PDE at UG Level), either metric space or topology to understand the words open set, closed set, compact, connected, region, continuous function, Vector Calculus in which the notion of curves, surfaces, tangent plane, normal, surface integral and volume integral and their evaluation, Fourier series and Fourier transforms.

**Unit 1**

Geometrical interpretation of a first-order pde, method of characteristics and general solutions, Monge cone, Lagrange’s equations, canonical forms of first-order linear equations, method of separation of variables.
Tb1:(2.4-2.8)  
Unit 2  
Second-order equations in two independent variables, canonical forms, equations with constant coefficients, general solutions.  
Tb1: (4.1-4.6)  

Unit 3  
The Cauchy problem, the Cauchy-Kowalewskaya theorem, homogeneous wave equations, the D’Alembert solution of wave equation, initial boundary-value problems, equations with nonhomogeneous boundary conditions, vibration of finite string with fixed ends, (review) nonhomogeneous wave equations.  
Tb1:(5.1-5.7)  

Unit 4  
Basic concepts, types of boundary-value problems, maximum and minimum principles, uniqueness and continuity theorems. Dirichlet problem for a circle, Dirichlet problem for a circular annulus, Neumann problem for a circle, Dirichlet problem for a rectangle, Dirichlet problem involving the Poisson equation, the Neumann problem for a rectangle  
Tb1:(9.1-9.10)  

Unit 5  
Derivation of the heat equation and solutions of the standard initial and boundary value problems, uniqueness and the maximum principle, time-independent boundary conditions, time-dependent boundary conditions.  

TB2: (3.1-3.4) (10 hours)  

TEXTBOOKS:  

REFERENCES:  

18MAT514  MEASURE THEORY  3 1 0 4  

Unit 1 (Sections: 2.1 to 2.5 of [1])

Unit 2 (Sections: 3.1 to 3.4 of [1])
Integration of Functions of a Real Variable: Integration of Non-Negative Functions - The General Integral - Integration of Series - Riemann and Lebesgue Integrals.

Unit 3 (Sections: 5.1 to 5.6 of [1])
Abstract Measure Spaces: Measures and Outer Measures - Extension of a Measure - Uniqueness of the Extension - Completion of a Measure - Measure Spaces - Integration with Respect to a Measure.

Unit 4 (Sections: 6.1 to 6.5 of [1])
Inequalities and the $L^p$ Spaces: The $L^p$ Spaces - Convex Functions - Jensen’s Inequality - The Inequalities of Holder and Minkowski - Completeness of $L^p(\mu)$.

Unit 5 (Sections: 8.1 to 8.4 of [1])

TEXTBOOK:

Reference Book:

18MAT515 NUMERICAL ANALYSIS 3 0 0 3

Prerequisites: Calculus and Algebra

Unit I:
Review of errors and error propagation theorem;
(Roots of Transcendental and Polynomial Equations, Solution of equations in one variable: Rate of convergence for fixed point iteration method and Newton-Raphson method etc.;
System of nonlinear equations: Newton's Method, Steepest-Descent Method; (B1-10.2 and 10.4)
Solution of System of Linear Algebraic Equations: Decomposition method (LU), Ill-conditioned system, Iteration methods: Gauss-Jacobi method, Gauss- Seidel method; (B2-2.2, B2-2.4, B2-2.5)
Eigenvalues and Eigenvectors: Gershgorin theorem, Inverse power method. (B1-7.2, B3-3.6)

12 Hours

Unit II:

Interpolation, Extrapolation and Approximation: Interpolating polynomials using finite differences, Hermite interpolation, Cubic-Spline interpolation, Richardson's Extrapolation. (B1-3.3, B1-3.4, B1-3.5, B1-4.2)

Numerical Differentiation: Numerical differentiation (Methods based on Interpolation, Finite difference operators, undetermined co-efficient); (B3-5.2)

Numerical integration: Trapezoidal, Simpson's 1/3rd, 3/8th rule, Gaussian Quadrature, Multiple integrals. (B1-4.3)

10 Hours

Unit III:

Solutions of Ordinary Differential Equations: System of higher order differential equations, Stability, Stiff Differential equations; (B1-5.9, B1-5.10, B1-5.11)


8 Hours

Unit IV:


10 Hours

Unit V:

Finite Elements for partial differential equations: Heat equations (Parabolic and Elliptic PDE) and Wave equations (Hyperbolic PDE) (B2- 9.3).

10 Hours

TEXTBOOKS:


Reference Books:


18MAT581 Mathematics Lab 0 0 2 1

- Introduction to a Mathematical software
- Explorations of various applications
- Implementation of Mathematical techniques.

18MAT582 Numerical Computations Lab 0 0 2 1

- Finite Element Methods using MAT LAB or Finite element tools.

18MAT601 Advanced Graph Theory 3 1 0 4

Unit 1
**Review of Graphs:** Graphs and sub graphs, isomorphism, matrices associated with graphs, degrees, walks, connected graphs, shortest path algorithm.

**Trees:** Trees, cut-edges and cut-vertices, spanning trees, minimum spanning trees, DFS, BFS algorithms.

Unit 2
**Connectivity:** Graph connectivity, k-connected graphs and blocks.

**Euler and Hamilton Graphs:** Euler graphs, Euler’s theorem. Fleury's algorithm for Eulerian trails. Necessary / sufficient conditions for the existence of Hamilton cycles, Chinese-postman problem, approximate solutions of traveling salesman problem

Unit 3
**Matching:** Matchings, maximal matchings. Coverings and minimal coverings. Berge's theorem, Hall's theorem, Tutte's perfect matching theorem, Job assignment problem. Coverings, Independent Sets and Cliques; Basic Relations.

Unit 4
**Colorings:** Vertex colorings, greedy algorithm and its consequences, Brooks’ theorem. Edge-colorings, Vizing theorem on edge-colorings.
Unit 5


**TEXTBOOKS**


**REFERENCES BOOKS**


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**18MAT602**

**FUNCTIONAL ANALYSIS**

**Unit 1** (Sections: 3.1 to 3.5 of [1])
Normed Linear Spaces: Linear Spaces – Normed Linear Spaces – The Metric on a Normed Linear Space – Linear Subspaces – Bounded Linear Transformations.

**Unit 2** (Sections: 3.7 to 3.9 and 4.1 to 4.2 of [1])
Linear Homeomorphisms – An Elementary Integral – Regulated Mappings – Integration and Differentiation - Review of Compact Metric Spaces – Basic Results on Compact Subsets of a Metric Space – Separability of Compact Metric Spaces – Conditions Equivalent to Compactness - Borel – Lebesgue Theorem.

**Unit 3** (Sections: 4.3 to 4.6 of [1])
Compactness and Continuity – Dini’s Theorem - Finite Dimensional Normed Linear Spaces – Completeness – Stone Weierstrass Theorem – Weierstrass Theorem on approximation of periodic functions by trigonometric polynomials – Extension of Stone-Weierstrass Theorem to $C_c(X)$ - Separability of $C_c(X)$ - Ascoli-Arzela Theorem – Peano’s Theorem.

**Unit 4** (Sections: 5.1 to 5.4 of [1])

**Unit 5** (Sections: 5.5 to 5.7 of [1])
A Theorem on Convex Sets – The Riesz Representation Theorem – Hergoltz’s Theorem.

**TEXTBOOKS:**


**References:**

2. Introduction to Topology and Modern Analysis by G. F. Simmons, McGraw Hill Education, 2004
Unit 1

Unit 2

Unit 3
Lagrange’s hydrodynamical equations - Bernoulli’s equation and its applications - Motion in two-dimensions and sources and sinks – irrotational motion – complex potential - Milne-Thomson circle theorem – Blasius theorem.

Unit 4

Unit 5

18MAT631 ALGEBRAIC GEOMETRY 3 0 0 3

Unit 1 AFFINE AND PROJECTIVE VARIETIES
Noetherian rings and modules; Emmy Noether's theorem and Hilbert's Basissatz; Hilbert's Nullstellensatz; Affine and Projective algebraic sets; Krull's Hauptidealsatz; topological irreducibility, Noetherian decomposition; local ring, function field, transcendence degree and dimension theory; Quasi-Compactness and Hausdorffness; Prime and maximal spectra; Example: linear varieties, hypersurfaces, curves.

Unit 2 MORPHISMS
Morphisms in the category of commutative algebras over a commutative ring; behaviour under localization; morphisms of local rings; tensor products; Product varieties; standard embeddings like the segre- and the d-uple embedding.

Unit 3 RATIONAL MAPS
Relevance to function fields and birational classification; Example: Classification of curves; blowing-up.

Unit 4 NONSINGULAR VARIETIES
Nonsingularity; Jacobian Criterion; singular locus; Regular local rings; Normal rings; normal varieties; Normalization; concept of desingularisation and its relevance to Classification Problems; Jacobian Conjecture; relationships between a ring and its completion; nonsingular curves.

Unit 5 INTERSECTIONS IN PROJECTIVE SPACE
Notions of multiplicity and intersection with examples.

TEXTBOOKS / REFERENCES BOOKS
18MAT632   ALGEBRAIC TOPOLOGY   3 0 0  3

Unit 1
Simplicial Homology Groups: Chains, cycles, Boundaries and homology groups, Examples of homology groups; The structure of homology groups.

Unit 2
The Euler Poincare’s Theorem; Pseudomanifolds and the homology groups of Sn. [Chapter 1 Sections 1.1 to 1.4 & Chapter 2 Sections 2.1 to 2.5 from the text].

Unit 3
Simplicial Approximation: Introduction; Simplicial approximation; Induced homomorphisms on the Homology groups; The Brouwer fixed point theorem and related results;

Unit 4
The Fundamental Group: Introduction; Homotopic Paths and the Fundamental Group; The Covering Homotopy Property for S1; [Chapter 3 Sectins 3.1 to 3.4; Chapter 4 Sections 4.1 to 4.3]

Unit 5
Examples of Fundamental Groups; The Relation Between H1(K) and p1(iKi); Covering Spaces: The definition and some examples. Basic properties of covering spaces. Classification of covering spaces. Universal covering spaces. Applications. [Chapter 4: Sections 4.4, 4.5; Chapter 5 Sections 5.1 to 5.5 from the text]

TEXT BOOK

REFERENCES BOOKS:

18MAT634   CODING THEORY   3 0 0  3

Unit 1 Introduction to linear codes and error correcting codes. Encoding and decoding of a linear code,

Unit 2 Dual codes. Hamming codes and perfect codes.
**Unit 3** Cyclic codes. Codes with Latin Squares, Introduction to BCH codes.

**Unit 4** Weight ennumerators and MDS codes.

**Unit 5** Linear coding theory problems and conclusions.

**TEXT BOOKS:**

**REFERENCES**

**18MAT635 COMMUTATIVE ALGEBRA 3003**

**Unit 1** Rings and ideals, modules and operations on them (tensor product, Hom, direct sum and product).

**Unit 2** Rings and modules of Fractions, primary decomposition.

**Unit 3** Integral dependence and Valuations, Chain Conditions.

**Unit 4** Noetherian Rings and Artin Rings.

**Unit 5** Discrete valuation Rings and Dedekind Domains, Dimension theory.

**TEXT BOOKS / REFERENCES**

**18MAT636 LIE ALGEBRA 3003**

Unit 2 Descending Central Series of a Lie Algebra, Nilpotent Lie Algebras. Derived Series of a Lie Algebra, Radical of a Lie Algebra, Solvable Lie Algebras, Engel’s Theorem. (Book 1, Chapter 3).

Unit 3 Semisimple Lie Algebras - Theorems of Lie and Cartan, Jordan-Chevalley Decomposition, Cartan’s Criterion. (Book 1, Chapter 4)

Unit 4 Killing Form, Inner Derivations, Abstract Jordan Decomposition, Complete Reducibility of Lie algebras. (Book 1, Chapter 5)

Unit 5 The Weyl Group, Root Systems. (Book 1, Chapter 10)

TEXT BOOKS / REFERENCES BOOKS

18MAT637 THEORY OF MANIFOLDS 3 0 0 3

Unit 1
Definition of Manifolds, Differentiable and Analytic Manifolds, Examples of Manifolds, Product of Manifolds, Mappings between Manifolds, Submanifolds, Tangent Vectors.

Unit 2

Unit 3

Unit 4

Unit 5

TEXTBOOKS / REFERENCES:

**18MAT638 Linear Algebra and its Applications 3 0 0 3**

**Unit 1** Review: Vector Spaces.
Inner Products, Angle and Orthogonality in Inner Product Spaces, Length of a Vector, Schwarz Inequality, Orthogonal Vectors, Orthogonal Complement, Orthogonal Bases: Gram-Schmidt Process. *(Sec. 4.4)*

**Unit 2** The Algebra of Linear Transformations, Characteristic Roots, Invertible Linear transformations, Characteristic Roots, Characteristic Vector, Minimal Polynomial, Matrices, Matrix of a Linear Transformation. *(Sec. 6.1 to 6.3).*

**Unit 3** Canonical Forms: Triangular, Nilpotent Transformations, Jordan and Rational Canonical Form, invariant subspaces, cyclic subspaces. *(Sec. 6.4 to 6.6).*

**Unit 4** Trace and Transpose, Determinants, Symmetric and Skew Symmetric Matrices, Adjoint and Hermitian Adjoint of a Matrix, Hermitian, Unitary and Normal Transformations, Self Adjoint and Normal Transformations. *(Sec. 6.8 to 6.10)*

**Unit 5** Problems in Eigen Values and Eigen Vectors, Diagonalization, Orthogonal Diagonalization, Quadratic Forms, Diagonalizing Quadratic Forms, Conic Sections. *(Sec. 7.1 to 7.3 and 9.5 to 9.6 from Reference Book 2)*

**TEXT BOOK:**

**REFERENCES:**

**18MAT641 FIXED POINT THEORY 3 0 0 3**

**Unit 1** Contraction Principle, and its variants and applications;

**Unit 2** Fixed points of non-expansive maps and set valued maps, Brouwer-Schauder
fixed point theorems,

Unit 3 Ky Fan Best Approximation Theorem, Principle and Applications of KKM maps, their variants and applications.

Unit 4 Fixed Point Theorems in partially ordered spaces and other abstract spaces.

Unit 5 Application of fixed point theory to Game theory and Mathematical Economics.

TEXTBOOKS / REFERENCES BOOKS

18MAT642 FRACTALS 3 0 0 3

Unit 1 Classical Fractals, Self-similarity - Metric Spaces, Equivalent Spaces.

Unit 2 The Space of Fractals, Transformation on Metric Spaces.

Unit 3 Contraction Mapping and Construction of fractals from IFS.

Unit 4 Fractal Dimension, Hausdorff measure and dimension, Fractal Interpolation Functions.

Unit 5 Hidden Variable FIF, Fractal Splines, Fractal Surfaces, Measures on Fractals.

TEXT BOOKS

REFERENCES

18MAT643 HARMONIC ANALYSIS 3 0 0 3


Unit 2 Summability – Metric theorems – Pointwise summability – Positive definite sequences – Herglotz’s theorem – The inequality of Hausdorff and Young.

Unit 3 The Fourier integral – Kernels on R. The Plancherel theorem – Another convergence theorem – Poisson summation formula – Bachner’s theorem – Continuity theorem.

Unit 4 Characters of discrete groups and compact groups – Bochner’s theorem – Minkowski’s theorem.

Unit 5 Hardy spaces - Invariant subspaces – Factoring F and M. Rieza theorem – Theorems of Szego and Beuoling.

TEXT BOOK:
Content and Treatment as in Henry Helson, Harmonic Analysis, Hindustan Book Agency, Chapters 1.1 to 1.9, 2.1 to 3.5 and 4.1 to 4.3

18MAT644 NONLINEAR PARTIAL DIFFERENTIAL EQUATIONS 3 0 0 3

Review of first order equations and characteristics.
Unit 1 Weak solutions to hyperbolic equations - discontinuous solutions, shock formation, a formal approach to weak solutions, asymptotic behaviour of shocks.

Unit 2 Diffusion Processes - Similarity methods, Fisher’s equation, Burgers’ equation, asymptotic solutions to Burgers' equations.

Unit 3 Reaction diffusion equations - traveling wave solutions, existence of solutions, maximum principles and comparison theorem, asymptotic behaviour.

Unit 4 Elliptic equations - Basic results for elliptic operators, eigenvalue problems,
stability and bifurcation.

**Unit 5** Hyperbolic system.

**TEXT BOOK**

*J David Logan, An Introduction to Nonlinear Partial Differential Equations, John Wiley and Sons, Inc., 1994*

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**18MAT645 WAVELETS ANALYSIS 3003**

**Unit 1** Basic Properties of the Discrete Fourier Transform, Translation - Invariant Linear Transformations. The Fast Fourier Transform.

**Unit 2** Construction of Wavelets on $\mathbb{Z}^N$, The First Stage Construction of Wavelets on $\mathbb{Z}^N$, The Iteration Step’s. Examples and Applications, $l_2(\mathbb{Z})$.

**Unit 3** Complete Orthonormal Sets in Hilbert Spaces, $L_2([-\pi, \pi])$, and Fourier Series, The Fourier Transform and Convolution on $l_2(\mathbb{Z})$. First-Stage Wavelets on $\mathbb{Z}$, The Iteration Step for Wavelets on $\mathbb{Z}$, Implementation and Examples.

**Unit 4** $L_2(\mathbb{R})$ and Approximate Identities, The Fourier Transform on $\mathbb{R}$, Multiresolution Analysis and Wavelets,

**Unit 5** Construction of Multiresolution Analyses, Wavelets with Compact Support and Their Computation.

**TEXT BOOK:**


**REFERENCES:**


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**18MAT646 MATHEMATICAL PHYSICS 3003**

**Objective:** This course intends to introduce applications of various mathematical techniques to problems of Theoretical Physics. Examples could be chosen from all 4 traditional divisions of Modern Fundamental Theoretical Physics – Classical Mechanics, Electrodynamics, Quantum Mechanics and Statistical Physics.

**Unit 1**

Vector calculus and applications in electromagnetic theory and fluid mechanics.
Unit 2
Introduction to tensor calculus: review of basics, index notation, tensors in physics and geometry, Levi-Civita tensor, transformations of vectors, tensors and vector fields, covariance of laws of physics.

Unit 3
Calculus of variations and extremal problems, Lagrange multipliers to treat constraints, Introduction to the Lagrangian and Hamiltonian formulations of classical mechanics with applications.

Unit 4
Gamma and Beta functions, Dirac delta function, Special functions, Review of Legendre, Bessel functions and spherical harmonics (with applications to Quantum mechanics), series solutions, generating functions, orthogonality and completeness,

Unit 5
Applied linear algebra: Dirac notation, dual vectors, projection operators, symmetric hermitian, orthogonal and unitary matrices in physics, diagonalization, orthogonality and completeness of eigenvectors, spectral decomposition and representation, simultaneous diagonalization, normal matrices, applications to coupled vibrations, Schrodinger equation in matrix form.

Text Books:

18MAT651 Queuing Theory and Inventory Control Theory 3 0 0 3

Unit 1 Inventory concept – Components of Inventory model.

Unit 2 Deterministic Continuous Review model - Deterministic Periodic Review model.

Unit 3 The classical EOQ – Non zero lead time – EOQ with shortages allowed.

Unit 4 Deterministic Multiechelon Inventory models for supply chain management.

Unit 5 A stochastic continuous review model – A stochastic single period model for perishable products.
TEXT BOOKS

18MAT653 STATISTICAL PATTERN CLASSIFICATIONS 3 0 0 3

Unit 1 Introduction and Bayesian Decision Theory

Unit 2 Maximum-likelihood and Bayesian Parameter Estimation

Unit 3 Nonparametric Techniques and Linear Discriminant Functions

Unit 4 Nonmetric methods and Algorithm-independent Machine Learning

Unit 5 Unsupervised Learning and Clustering

TEXT AND REFERENCE BOOKS:
18MAT654  STATISTICAL QUALITY CONTROL AND SIX SIGMA QUALITY ANALYSIS  3 0 0 3

Unit 1 Introduction to Quality Management – Japanese System of Total Quality Management.

Unit 2 Quality Circles - 7 Quality Control tools - 7 New Quality Control tools.

Unit 3 ISO 9000 Quality system Standards - Project Planning, Process and measurement system capability analysis - Area properties of Normal distribution.

Unit 4 Metrics of Six sigma, The DMAIC cycle - Design for Six Sigma - Lean Sigma – Statistical tools for Six Sigma.

Unit 5 Taguchi methods. Loss functions and orthogonal arrays and experiments.

TEXT AND REFERENCE BOOKS

18MAT655  THEORY OF SAMPLING AND DESIGNS OF EXPERIMENTS  3 0 0 3

Unit 1 Stratified random sampling, estimation of the population mean, total and proportion, properties of estimators, various methods of allocation of a sample, comparison of the precisions of estimators under proportional allocation, optimum allocation and srs. Systematic sampling. Comparison of systematic sampling - srs and stratified random sampling for a population with a linear trend.

Unit 2 Unbiased ratio type estimators - Hartly-Ross estimator, regression method of estimation. Cluster sampling, single stage cluster sampling with equal and unequal cluster sizes, estimation of the population mean and its standard error. Two-stage cluster sampling with equal and unequal cluster sizes, estimation of the population mean and its standard error.
Unit 3
Unequal probability sampling, PPS sampling with and without replacement, cumulative total method, Lahiris method, Midzuno-Zen method, estimation of the population total and its estimated variance under PPS wr sampling, ordered and unordered estimators of the population total under PPS wor, Horwitz – Thomson estimator.

Unit 4
Elementary concepts (one and 2 way classified data) Review of elementary design (CRD, RBD, LSD) Missing plot technique in RBD and LSD with one and two missing values, Gauss-Markov theorem, BIBD: Elementary parametric relations, Analysis, PBIBD.

Unit 5
General factorial experiments, factorial effects, best estimates and testing the significance of factorial effects, study of $2^3$ and $2^4$ factorial experiments.

TEXT AND REFERENCE BOOKS

18MAT656 TIME SERIES ANALYSIS 3 0 0 3

Unit 1 Time series, components of time series, additive and multiplicative models, determination of trend, analysis of seasonal fluctuations.

Unit 2 Test for trend and seasonality, exponential and moving average smoothing, holt-winter smoothing, forecasting based on smoothing.

Unit 3 Time series as a discrete parameter stochastic process, auto covariance and auto correlation functions and their properties, stationary processes, test for stationarity, unit root test, stationary processes in the frequency domain, spectral analysis of time series.

Unit 4 Detailed study of the stationary processes: moving average (MA), autoregressive (AR), autoregressive moving average (ARMA) and autoregressive integrated moving average (ARIMA) models.
Unit 5 Estimation of ARMA models, maximum likelihood method (the likelihood function for a Gaussian AR(1) and a Gaussian MA(1)) and Least squares, Yule-Walker estimation for AR Processes, choice of AR and MA periods, forecasting, residual analysis and diagnostic checking.

TEXT BOOKS

18MAT657 STATISTICAL TECHNIQUES FOR DATA ANALYTICS 3-0-0-3

Data Collection, classification and analysis - Sampling methods, classification of data and representation of data - bar and pie charts – histogram frequency polygon - Data Analysis Measures of Central tendency and dispersion - Mean, median, mode, absolute, quartile and standard deviations, skewness and kurtosis for both grouped and ungrouped data. Association of attributes.

Curve fitting and interpolation - Fitting of straight lines and curves - Correlation, regression, fitting of simple linear lines, polynomials and logarithmic functions - Interpolation and extrapolation methods - Binomial expansion, Newton and Gauss methods.

Index numbers and time series analysis - Types of index numbers, construction of index numbers such as simple aggregate, weighted aggregate index numbers, chain index numbers and consumer price indices - Time series and its components and computation of trends and variations - Seasonal variations - Trend analysis methods.

Decision analysis and Game theory - Payoffs, regrets, maximin and minimax criteria and loss and risks – Games – payoff matrix, saddle point, value of game and methods of solving – two-person-zero-sum games, dominance method, sub-game method

Text Books:

References Book
Unit 1
Introduction – limitations of ideal fluid dynamics – Importance of Prandtl’s boundary layer theory - boundary layer equations in two dimensional flows – boundary layer flow over a flat plate – Blasius solution – Boundary layer over a wedge.

Unit 2
Energy integral equation for two-dimensional laminar boundary layers in incompressible flow – application of Von Karman’s integral equations to boundary layer with pressure gradient.

Unit 3
Displacement, momentum, energy thickness – axially symmetric flows – momentum equation for laminar boundary layer by von Karman – Wall shear and drag force on a flat plate due to boundary layer – coefficient of drag. Boundary layer equations for a 2D viscous incompressible fluid over a plane wall – Similar solutions – Separation of boundary layer flow.

Unit 4

Unit 5
Polhausen’s method of exact solution for the velocity and thermal boundary layers in free convection from a heated plate – thermal energy integral equation. Boundary layer control using suction and injection.

**TEXT BOOKS / REFERENCES:**
Unit 1 Review of Conservation equations for mass, momentum and energy; coordinate systems; Eulerian and Lagrangian approach, Conservative and non-conservative forms of the equations, rotating co-ordinates.

Unit 2 Classification of system of PDEs: parabolic elliptic and hyperbolic; Boundary and initial conditions; Overview of numerical methods; Review of Finite Difference Method, Introduction to integral method, method of weighted residuals, finite elements finite volume method & least square method.


Unit 4 Advanced Finite Volume methods: FV discretization in two and three dimensions, SIMPLE algorithm and flow field calculations, variants of SIMPLE, Turbulence and turbulence modelling, illustrative flow computations.

Unit 5 Introduction to turbulence modelling, CFD methods for compressible flows.

TEXT BOOKS / REFERENCE BOOKS:

18MAT663 FINITE ELEMENT METHOD 3 0 0 3

Unit 1 Finite Element Method: Variational formulation - Rayleigh-Ritz minimization - weighted residuals - Galerkin method applied to boundary value problems.

Unit 2 Global and local finite element models in one dimension - derivation of finite element equation.

Unit 3 Finite element interpolation - polynomial elements in one dimension, two dimensional elements, natural coordinates, triangular elements, rectangular elements, Lagrangian and Hermite elements for rectangular elements - global interpolation functions.

Unit 4 Local and global forms of finite element equations - boundary conditions - methods of solution for a steady state problem - Newton-Raphson continuation.
Unit 5 One dimensional heat and wave equations.

**TEXT AND REFERENCE BOOKS**


**18MAT664 MAGNETO-HYDRO DYNAMICS 3003**

**Unit 1**

**Unit 2**
Magnetohydrostatics and steady states – Hydromagnetic equilibria and Force free magnetic fields —Chandrasekhar’s theorem – General solution of force free magnetic field when the magnetic Reynolds number is constant – Some examples of force free fields.

**Unit 3**
Steady laminar motion – Hartmann flow. Tensor electrical conductivity, Hall current and ion slip – simple flow problems with tensor electrical conductivity.

**Unit 4**

**Unit 5**

**TEXT BOOKS / REFERENCES:**


**18MAT665 MATHEMATICAL FOUNDATIONS OF INCOMPRESSIBLE FLUID FLOW 3003**
**Unit 1** Kinematics of Fluids in motion – Lagrangian and Eulerian methods – Equation of continuity – Boundary conditions – Kinematic and physical – steam line, path line and streak line – velocity potential – vorticity - rotational and irrotational motion.

**Unit 2** Equation of Motion of Compressible Viscous Fluid (Navier-Stokes Equations) - General Properties – Equation of motion of inviscid fluid – Euler’s equation – impulsive force – physical meaning of velocity potential - energy equation. 

**Unit 3** Lagrange’s hydrodynamical equations - Bernoulli’s equation and its applications - Motion in two-dimensions and sources and sinks – irrotational motion – complex potential - Milne-Thomson circle theorem – Blasius theorem.

**Unit 4** General theory of irrotational motion – flow and circulation – Stoke’s theorem – Kelvin’s Circulation theorem – Permanence of irrotational motion - Kelvin’s minimum energy theorem - Viscous Incompressible flow - Dimensional Analysis – Buckingham theorem.


**TEXT BOOKS / REFERENCES:**

**18MAT666** Introduction to FLUID DYNAMICS 3003

**Unit 1 Basic Concepts and Properties**
Fluid – definition, distinction between solid and fluid - Units and dimensions – Properties of fluids – density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension – Fluid statics: concept of fluid static pressure, absolute and gauge pressures – pressure measurements by manometers and pressure gauges.

**Unit 2 Fluid Kinematics**
Fluid Kinematics - Flow visualization - lines of flow - types of flow - velocity field and acceleration - continuity equation (one and three dimensional differential forms)- Equation of streamline - stream function - velocity potential function - circulation - flow net –

**Unit 3 Fluid Dynamics**
Fluid dynamics - equations of motion - Euler's equation along a streamline - Bernoulli’s equation – applications - Venturi meter, Orifice meter, Pitot tube -
dimensional analysis - Buckingham's theorem - applications - similarity laws and models.

**Unit 4 Incompressible Fluid Flow**
Viscous flow - Navier - Stokes equation (Statement only) - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's).

**Unit 5**
Hydraulic and energy gradient - flow through pipes - Darcy-weisback's equation - pipe roughness - friction factor - Moody's diagram - minor losses - flow through pipes in series and in parallel - power transmission - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients.

**TEXT BOOKS**

**REFERENCE:**

18MAT671       DATA STRUCTURES AND ALGORITHMS       3 0 0 3  
(Pre-requisite: Data Structures and Algorithms.

**Unit 1**

**Unit 2**

**Unit 3**

**Unit 4**
Graph algorithms: graph traversal (DFS, BFS with analysis) – biconnected components – strong connectivity; shortest path algorithms (along with analysis) – Dijkstra – Bellman Ford – Floyd Warshall. All pairs shortest path algorithm – minimum spanning tree (with analysis) – Kruskal – Prim’s – Baruvka’s.

**Unit 5**
NP problems: definition, P, NP, NP complete, NP hard & co-NP, examples – P, NP.
TEXT BOOK

REFERENCES

18MAT672 ALGORITHMS FOR ADVANCED COMPUTING 3-0-0-3

Unit I Issues regarding classification and prediction, Bayesian Classification, Classification by back propagation, Classification based on concepts from association rule mining, Other Classification Methods, Classification accuracy.

Unit II Introduction to Decision trees - Classification by decision tree induction – Various types of pruning methods – Comparison of pruning methods – Issues in decision trees – Decision Tree Inducers – Decision Tree extensions.

Unit III Introduction, Core text mining operations, Preprocessing techniques, Categorization, Clustering, Information extraction, Probabilistic models for information extraction


Text Books:

References Books:

18MAT673 COMPUTER AIDED DESIGN OF VLSI CIRCUITS  3 0 0  3

Unit 1

Unit 2

Unit 3

Unit 4
Routing and Compaction: Types of Routing Problems – Area Routing – Channel Routing – Global Routings.

Unit 5
1D and 2D Compaction. Gete level – Switch level Modeling and Simulations.

TEXT BOOK / REFERENCES:

18MAT674 CRYPTOGRAPHY  3 0 0  3
Unit 1 Classical ciphers: Cryptanalysis of classical ciphers, Probability theory, Perfect security.
Block ciphers: DES, AES, Block cipher modes of operation.

Unit 2 Private-key encryption: Chosen plaintext attacks, Randomised encryption, Pseudorandomness, Chosen cyphertext attacks.

Unit 3 Message authentication codes: Private-key authentication, CBC-MAC, Pseudorandom functions, CCA-secure private-key encryption.

Unit 4 Hash function: Integrity, Pre-image resistance, 2nd pre-image resistance, Collision freeness.
Key distribution: Key distribution centres, Modular arithmetic and group theory, Diffie-Hellman key exchange.

Unit 5 Public-key Distribution: ElGamal encryption, Cramer-Shoup encryption, Discrete logarithm problem.
Digital Signatures: RSA signatures, RSA-FDH and RSA-PSS signatures, DSA signatures.

TEXT / REFERENCE BOOKS:

18MAT675 FUZZY SETS AND ITS APPLICATIONS 3 0 0 3

Unit 1 Fuzzy Sets

Unit 2 Fuzzy Arithmetic

Unit 3 Fuzzy Relations
Binary Fuzzy relations, Fuzzy Equivalence Relations, Fuzzy Compatibility Relations.

Unit 4 Fuzzy Logic
Classical Logic, Multivalued Logic, Fuzzy Propositions, Fuzzy Quantifiers, Linguistic Hedges, Inference from Conditional Fuzzy Propositions, Conditional and Qualified Propositions and Quantified Propositions.

Unit 5 Uncertainty-based Information
Information and Uncertainty, Non Specificity of Crisp Sets – Non Specificity of Fuzzy Sets, Fuzziness of Fuzzy Sets, Uncertainty In Evidence Theory, Principles of Uncertainty.

TEXT AND REFERENCE BOOKS:

18MAT676 INTRODUCTION TO SOFT COMPUTING 3 0 0 3

Unit 1 Soft Computing
Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, applications of soft computing.

Unit 2 Artificial Intelligence
Introduction, Various types of production systems, characteristics of production systems, breadth first search, depth first search techniques, other Search Techniques like hill Climbing, Best first Search, A* algorithm, AO* Algorithms and various types of control strategies.

Unit 3 Fuzzy Logic
Crisp set and Fuzzy set, basic concepts of fuzzy sets, membership functions. Basic operations on fuzzy sets, Properties of fuzzy sets, Fuzzy relations. Propositional logic and Predicate logic, fuzzy If - Then rules, fuzzy mapping rules and fuzzy implication functions, Applications.

Unit 4 Neural Networks

Unit 5 Genetic Algorithms
Basic concepts of genetic algorithms, encoding, genetic modeling.

TEXT AND REFERENCE BOOKS
3. J. Yen and R. Langari. Fuzzy Logic, Intelligence, Control and Information, Pearson Education.

18MAT677 OBJECT-ORIENTED PROGRAMMING AND PYTHON 3 0 0 3


Unit 3 Function and class templates - Exception handling try-catch-throw paradigm – exception specification – terminate and Unexpected functions – Uncaught exception.


Unit 5 Python Programming.

TEXT BOOK

REFERENCES BOOKS
Every student is required to register for a project under a faculty member, within or outside the Department. At the completion of the Project work, the student will submit a bound volume of the project report in the prescribed format. The project work will be evaluated by a team of duly appointed examiners. The evaluation is based on contents, presentation and viva-voce.