PSG College of Arts & Science

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M.Sc. MATHEMATICS

2015 - 2017

MSc Mathematics
Scheme of Examination
For students admitted from 2014 – 2015 & onwards

Code No.	Subject	Duration (Hrs)	Max. Marks			Credit Points
			CA	CE	Total	
14MAP01	Algebra	3	25	75	100	5
14MAP02	Real Analysis	3	25	75	100	5
14MAP03	Ordinary Differential Equations	3	25	75	100	5
14MAP04	Mathematical Programming	3	25	75	100	5
14MAP05	Complex Analysis	3	25	75	100	6
14MAP06	Partial Differential Equations	3	25	75	100	6
14MAP07	Topology	3	25	75	100	6
14MAP08	Mathematical Statistics(Allied-MA)	3	25	75	100	6
14SBP01	**Skill Based Subject** : Cyber security	-	100	-	100	2

Code No.	Subject	Duration (Hrs)	Max. Marks			Credit Points
			CA	CE	Total	
14MAP09	Functional Analysis	3	25	75	100	6
14MAP10	Mechanics	3	25	75	100	6
14MAP11	Core Elective-I	3	25	75	100	5
14MAP12A 14MAP12B 14MAP12C	***CLUSTER IDC - Theory*** Statistical Techniques (ST) OR Physics for Mathematical Sciences (PH) OR Web Designing using HTML & Java Script (CM)	3	25	75	100	2
14MAP13A 14MAP13B 14MAP13C	***CLUSTER IDC - Practical*** Statistical Practical (ST) OR Physics for Mathematical Sciences Practical (PH) OR Web Designing using HTML Java Script Practical (CM)	3	40	60	100	2
14MAP14	Operator Theory	3	25	75	100	6
14MAP15	Control theory	3	25	75	100	6
14MAP16	Fluid dynamics	3	25	75	100	6
14MAP17	Core Elective-II (Theory)	3	25	75	100	3
14MAP18	Core Elective-II (Practical)	3	40	60	100	2
					Total	**90**

Core Electives: One paper in semester III and one paper in the semester IV offered by the Department

1 Stochastic differential equation
2. Magnetohydrodynamics
3. Mat lab (Theory & Practical)
4. Programming in C++ (Theory & Practical)
5. Wavelet Analysis

CLUSTER IDC Offered by the Department

14STP16A/14PHP15A/14CMP22A: Fuzzy Logic (Theory)

14STP17A/14PHP16A/14CMP23A: Fuzzy Logic (Practical)

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14MAP01 **Algebra**

Unit I

Counting Principle: Sylow's Theorems - Conjugacy – Cauchy Theorem – Sylow Theorems - p-Sylow subgroup.

Unit II

Polynomial Rings: Ring of polynomials F[x] over F – Polynomial over the rational field – Polynomial rings over commutative rings

Unit III

Extension Fields: Finite extension fields - Algebraic Extensions – Roots of polynomials – Splitting fields .

Unit IV

Elements of Galois Theory: More about roots – Fixed field – Symmetric rational functions – Normal extensions – Fundamental theorem of Galois Theory.

Unit V

Linear Transformations : Cannonical form – Triangular forms – Trace and transpose – Hermitian , unitary and normal transformations

Text Book:

"Topics in Algebra" by **I.N. Herstein.** Second Edition, Wiley Eastern Ltd. 2002.

Unit I : Chapter 2: Sections 2.11, 2.12

Unit II : Chapter 3: Sections 3.9, 3.10, 3.11

Unit III : Chapter 5: Sections 5.1, 5.3

Unit IV : Chapter 5: Sections 5.5, 5.6

Unit V : Chapter 6: Sections 6.4, 6.8 and 6.10

14MAP02 **Real Analysis**

Unit I

The Riemann - Stieltjes Integral: Definition and Existence of the integral - Properties of the integral - Integration and Differentiation.

Unit II

Sequences and Series of Functions: Discussion of main problem - Uniform convergence- Uniform convergence and continuity - Uniform convergence and integration - Uniform convergence and differentiation - Equi-Continuous families of functions.

Unit III

Some Special Functions: Power Series - The Exponential and Logarithmic functions - The Trigonometric functions - The Algebraic completeness of the complex field - Fourier series - The Gamma function.

Unit IV

Functions of Several Variables: Linear Transformations – Differentiation - The Contraction principle - The Inverse function theorem.

Unit V

Functions of Several Variables: The Implicit function theorem - The Rank theorem- determinants - Derivative of higher order - Differentiation of integrals.

Text Book:

"Principles of Mathematical Analysis", by **Walter Rudin.** Third Edition, McGraw Hill Book Company. 1976

Unit I : Chapter 6 : Sections 6.1 to 6.22

Unit II : Chapter 7 : Sections 7.1 to 7.25

Unit III : Chapter 8 : Sections 8.1 to 8.21

Unit IV : Chapter 9 : Sections 9.1 to 9.25

Unit V : Chapter 9 : Sections 9.26 to 9.43

14MAP03 **Ordinary Differential Equations**

Unit I

Systems of Linear Differential Equations: Introduction - Systems of First Order Equations - Model for Arms Competition Between Two Nations - Existence and Uniqueness Theorem - Fundamental Matrix.

Unit II

Systems of Linear Differential Equations: Non - Homogeneous Linear Systems - Linear Systems with Constant Coefficients - Linear Systems with Periodic Coefficients.

Unit III

Existence and Uniqueness of Solutions: Introductions - Successive Approximations - Picard's Theorem - Continuation and Dependence of Initial Conditions - Fixed-Point Method.

Unit IV

Boundary Value Problem: Introduction – Strum-Liouville Problem - Green's Function - Applications of Boundary Value Problems - Picard's Theorem.

Unit V

Equations with Deviating Arguments: Introduction - Equations with Constant Delay - Equations with Piecewise Constant Delay - A Few Other Types of Delay Equations.

Text Book:

"**Ordinary Differential Equations**" by **S.G. Deo, V. Lakshmikantham and V. Raghavendra.** Second Edition, Tata Mc Graw-Hill publishing company Ltd, New Delhi. 2004.

Unit I : Chapter 4 : Sections 4.1 to 4.5.

Unit II : Chapter 4 : Sections 4.6 to 4.8.

Unit III : Chapter 5 : Sections 5.1 to 5.6, 5.9.

Unit IV : Chapter 7 : Sections 7.1 to 7.5.

Unit V : Chapter 11: Sections 11.1 to 11.4

14MAP04 **Mathematical Programming**

Unit I

Network Models: Scope and definition of network models – Minimal Spanning tree Algorithm – Shortest Route Problem – Maximal Flow Model – CPM and PERT.

Unit II

Deterministic Programming: Dynamic – Recursive Nature of Computations in DP – Forward and Backward Recursion – Selected DP Applications – Problem of Dimensionality.

Unit III

Simulation Modeling: Definition – Monte-Carlo Simulation – Types of Simulation– Elements of Discrete Event Simulation – Generation of Random Numbers – Mechanics of Discrete Simulation – Methods for Gathering Statistical Observations.

Unit IV

Classical Optimization Theory: Introduction – Unconstrained Problems: Necessary and Sufficient Conditions. The Newton – Raphson Method – Constrained Problems: Equality Constraints, Inequality Constraints.

Unit V

Nonlinear Programming Algorithms: Unconstrained Non-Linear Algorithms: Direct Search Method, Gradient Method – Constrained Algorithms: Quadratic Programming, Chance – Constrained Programming.

Text book:

" Operations Research – An Introduction " by **Hamdy A. Taha.** Eighth edition, Prentice-Hall is an imprint of PEARSON- Delhi- 2012.

Unit 1 : Chapter 6 : Sections 6.1 to 6.7

Unit II : Chapter 10 : Sections 10.1 to 10.5

Unit III : Chapter 16 : Sections 16.1 to 16.6

Unit IV : Chapter 18 : Sections 18.1.1, 18.1.2 , 18.2.1, 18.2.2

Unit V : Chapter 19 : Sections 19.1.1, 19.1.2, 19.2.2, 19.2.3

14MAP05 **Complex Analysis**

Unit – I

Linear Transformation : The linear group –The cross ratio. **Complex Integration :** Fundamental theorem :- Line integrals – rectifiable arcs – Line integrals as functions of arcs – Cauchy's theorem for rectangle – Cauchy's theorem in a disk .**Cauchy's integral formula :** The index of a point with respect to a closed curve – the integral formula- higher derivatives.

Unit-II

The Calculus of Residues : The Residues theorem – The Argument principle - Evaluation of definite integrals. **Harmonic Function :** Definition and Basic Properties –The mean value property – Poisson's Formula – Schwarz's theorem – The reflection Principle .

Unit – III

Series and product Developments: Power series Expansions : Weierstrass's theorem –The Taylor series – The Laurent Series . **Partial fractions and Factorization :** Partial Fractions – Infinite Products – Canonical Products _ The Gamma Function. **Entire Function :** Gauss Mean – Value Theorem – Jensen's Formula – Poisson Jensen's Formula.

Unit - IV

Conformal mapping : The Riemann mapping theorem : Statement and proof – Boundary Behavior – Use of the Reflection principle – Analytical Arcs . **Conformal mapping of Polygons** : The Behavior at an angle – The Schwartz – Christoffel Formula. **A closer look at Harmonic Functions:** Functions with Mean – value property – Harnack's Principle.

Unit –V

Elliptic Functions : Simply periodic Functions: Representation by Exponentials – The Fourier Development –Functions of finite order. **Doubly Periodic Functions :** The period Module – unimodular Transformations – The Canonical Basis – General properties of Elliptic Functions. **The Weierstrass Theory :** The Weierstrass $\wp$ - Function – The Functions $\varsigma(Z)$ and $\sigma(Z)$ – The differential Equation.

Text Book :

Complex Analysis by Lars V.Ahlfors, Mcgraw – Hill Book Company, Third Edition

Unit I : Chapter 3 : Sections 3.1, 3.2

Chapter 4 : Sections 1.1to 1.5, 2.1to 2.3

Unit II : Chapter 4 : Sections 5.1 to 5.3, 6.1to 6.5

Unit III : Chapter 5 : Sections 1.1to 1.3, 2.1to 2.4, 3.1

Unit IV : Chapter 6 : Sections 1.1 to 1.4, 2.1to 2.2, 3.1to 3.2

Unit V : Chapter 7 : Sections 1.1 to1.3, 2.1to 2.4, 3.1to 3.3

14MAP06 **Partial Differential Equations**

Unit I

Equations of First Order: Origins of First order Partial Differential Equations – Cauchy's Problem for first Order Equations –Linear Equations of first order - Integral Surfaces Passing through a Given Curve - Surfaces Orthogonal to a given Systems of Surfaces - Non-linear Partial Differential Equations of First Order - Compatible Systems of First Order Equations – Charpit's Method.

Unit II

Equations of Second Order: The Origin of the Second Order Equations- Second Order Equations in Physics- Higher Order Equations in Physics- Linear Partial Differential Equations with Constant Coefficients – Equations with Variable Coefficients- Separation of Variables – The Method of Integral Transforms.

Unit III

Laplace Equations: The Occurrence of Laplace Equations in Physics- Elementary Solutions of Laplace Equations- Families of Equipotential Surfaces- Boundary Value Problems- Separation of Variables.

Unit IV

Wave Equations: The Occurrence of Wave Equations in Physics- Elementary Solutions of the One- Dimensional Wave Equations- The Riemann- Volterra Solution of the One – Dimensional Wave Equation- Vibrating Membranes- Applications of the Calculus of Variations.

Unit V

The Diffusion Equations: Occurrence of the Diffusion Equation in Physics- The Resolution of Boundary Value Problems for Diffusion Equation- Elementary Surfaces of the Diffusion Equation- Separation of Variables- The Use of Integral Transform.

Text Book:

"Elements of Partial Differential Equations" by **Ian Sneddon.** McGraw Hill Book Company. 1957.

Unit I : Chapter 2 : Sections 2.1 to 2.7, 2.9, 2.10.

Unit II : Chapter 3 : Sections 3.1 to 3.5, 3.9, to 3.10.

Unit III: Chapter 4 : Sections 4.1 to 4.5

Unit IV: Chapter 5 : Sections 5.1 to 5.4

Unit V : Chapter 6 : Sections 6.1 to 6.5.

14MAP07 **Topology**

Unit I

Topological Spaces and Continuous Functions: Topological spaces-Basis for a topology-The order topology –The product topology on X x Y-The subspace topology- Closed sets and limit points.

Unit II

Topological Spaces and Continuous Functions: Continuous functions-The product topology –The metric topology-The metric topology(continued). The quotient topology (only Theorem 22.1).

Unit III

Connectedness and Compactness: Connected spaces – Connected subspaces of the real line – Components and local connectedness- Compact spaces – Compact subspaces of the real line.

Unit IV

Connectedness and Compactness: Limit point compactness – Local compactness.
Countability and Separation Axioms: The countability axioms – The separation axioms-Normal spaces.

Unit V

Countability and Separation Axioms: The Urysohn lemma – The Urysohn metrization theorem-The Tietze Extension Theorem. **The Tychonoff Theorem:** The Tychonoff Theorem – The Stone – Cech compactification.

Text Book:

"Topology" by James R Munkres. Second Edition, Prentice-Hall of India PVT Ltd. 2002

Unit I : Chapter 2 : Sections 12, 13, 14, 15, 16, 17

Unit II : Chapter 2 : Sections 18, 19, 20, 21, 22

Unit III : Chapter 3 : Sections 23, 24, 25, 26, 27

Unit IV : Chapter 3 : Sections 28, 29

Chapter 4 : Sections 30, 31, 32

UnitV : Chapter 4 : Sections 33, 34, 35

Chapter 5 : Sections 37, 38

14MAP08 **Mathematical Statistics**

Unit I

Parameters of the Distribution of a Random Variable: Expected Values – Moments- The Chebyshev Inequality- Absolute Moments. **Characteristic Functions:** Properties of Characteristic functions – The Characteristic function and moments – Semi-invariants – The Characteristic function of the sum of independent random variables – Determination of the distribution function by the characteristic function.

Unit II

Some Probability Distributions: One point and Two point distributions- The binomial distribution - The Poisson distribution – The Uniform distribution - The Normal distribution – The Gamma distribution – The Beta distribution.

Unit III

Limit Theorems: Stochastic Convergence – Bernoulli's Law of Large numbers – The Levy – Cramer Theorem – The DeMoivre Laplace Theorem - The Lindeberg – Levy Theorem.

Unit IV

Stochastic Processes: The Notion of a Stochastic process – Markov processes & processes with Independent Increments – The Poisson process – The Furry-Yule process – Stationary processes.

Unit V

Sample Moments and Their Function : The notion of a sample -The notion of a statistic - The distribution of the arithmetic mean of independent normally distributed random variables – The χ^2 distribution – The distribution of the statistic (x, s) – Student's t-distribution.

Text book:

"Probability Theory and Mathematical Statistics" by **Marek Fisz.** Third Edition, John Wiley & Sons, Inc. New York, 1963.

Unit I : Chapter 3 : Sections 3.1, 3.2, 3.3, 3.4 &

Chapter 4 : Sections 4.1, 4.2, 4.3, 4.4, 4.5

Unit II : Chapter 5 : Sections 5.1, 5.2, 5.5, 5.7 to 5.9

Unit III : Chapter 6 : Sections 6.2, 6.3, 6.6, 6.7, 6.8

Unit IV : Chapter 8 : Sections 8.1 to 8.4, 8.10

Unit V : Chapter 9 : Sections 9.1 to 9.6

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14MAP09 **Functional Analysis**

Unit I

Normed and Banach Spaces: Basic definition and properties – Examples of normed space and related concepts – Operators and functional – Properties of linear operators and dual space – Algebra of operators

Unit II

Inner product and Hilbert spaces : Basic definition and properties – Orthogonal complement and projection theorem – Orthogonal system and Fourier expansion – Duality and reflexivity – Riesz representation theorem – Reflexivity of Hilbert spaces

Unit III

Operators in Hilbert space : Adjoint of a bounded linear operator on a Hilbert space- Self ajoint, Positive, Normal and Unitary operators, Ajoint of an unbounded linear operator - Bilinear forms and lax - Milgram lemma – Projection on convex sets.

Unit IV

Fundamental theorems: Extension form of the Hahn – Banach theorem and its consequences – Geometric form of the Hahn – Banach theorem and its collaries – principle of uniform boundedness and its applications – open mapping and closed graph theorems – Examples.

Unit V

Fixed point theorem and their Applications: Banach contraction principle and its generalizations – Schauder's fixed point theorem – Application of Banach contraction principle – Spectral properties of bounded linear operators – Compact operators – Spectral properties of self ajoint and compact operators.

Text book:

" Introduction to Functional Analysis with Application " by **A.H. Siddiqi Khalil Ahmad P. Manchanda.** Anamaya Publishers New Delhi 2007.

Unit-I : Chapter 1 : Sections 1.1 to 1.3

Unit-II : Chapter 2 : Sections 2.1 to 2.4

Unit-III : Chapter 2 : Sections 2.5 to 2.7

Unit-IV : Chapter 3 : Sections 3.1 to 3.5

Unit-V : Chapter 6 : Sections 6.1 to 6.3, 7.1 to 7.3

14MAP10 **Mechanics**

Unit I

Introductory Concepts: The Mechanical System - Generalized Coordinates – Constraints- Virtual Work - Energy and Momentum.

Unit II

Lagrange's Equations: Derivation of Lagrange's Equations - Examples - Integrals of the Motion.

Unit III

Hamilton's Equations: Hamilton's Principle – Hamilton's Equations.

Unit IV

Hamilton - Jacobi Theory: Hamilton's Principal Function - The Hamilton - Jacobi Equation - Separability.

Unit V

Canonical Transformations: Differential Forms and Generating Functions - Lagrange and Poisson Brackets.

Text Book:

"Classical Dynamics" by **Donald T. Greenwood.** Prentice-Hall Private Limited, New Delhi, Third Printing, 1990.

Unit I : Sections 1.1 to 1.5

Unit II : Sections 2.1 to 2.3

Unit III : Sections 4.1 and 4.2

Unit IV : Sections 5.1 to 5.3

Unit V : Sections 6.1 and 6.3

14STP16A/ 14PHP15A / 14CMP22A Cluster IDC - Fuzzy Logic

(For MSc Statistics, MSc Physics, MSc Computer Science)

Unit I

Fuzzy Sets-Fuzzy Set Operations-Properties of Fuzzy Sets-Fuzzy Relations.

Unit II

Fuzzy Tolerance and Equivalence Relations - Value Assignments - Cosine Amplitude-Max-Min Method - Other Similarity Methods.

Unit III

Membership Functions:-Features of the Membership Function-Various Forms and properties of Boundaries – Fuzzifications – Membership Value Assignments: - Intuition – Inference – Rank Ordering.

Unit IV

Fuzzy Arithmetic-Extension Principle - Functions of Fuzzy Sets - Extension Principle- Fuzzy Transforms - Practical Considerations - Fuzzy Arithmetic.

Unit V

Fuzzy Logic - Approximate Reasoning - Fuzzy Tautologies, Contradictions, Equivalence and Logical Proofs.

Text Book:

"Fuzzy Logic with Engineering Applications" by **Timothy J Ross**, University of New Maxico USA Second Edition, 2008

Unit I : Chapter 2 : Pages 34 to 40 and

Chapter 3 : Pages 58 to 66

Unit II : Chapter 3 : Pages 68 to 74

Unit III : Chapter 4 : Pages 90 to 96

Chapter 6 : Pages 179 to 182

Unit IV : Chapter 12 : Pages 445 to 457

Unit V : Chapter 5 : Pages 134 to 141 & 126 to 132

14STP17A/14PHP16A/

14CMP23A Cluster IDC - Fuzzy Logic (Practical)

(For MSc Statistics, MSc Physics, MSc Computer Science)

1. Implementation and graphical representation of membership functions in fuzzy logic.
2. Implementation of fuzzy arithmetic using MATLAB.
3. Defuzzification methods to a practical problems using MATLAB.
4. Implementation of fuzzy rules for a practical nonfuzzy problem.
5. Application of fuzzy logic to a practical problem using Rule Viewer and Surface Viewer.

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14MAP14 **Operator Theory**

Unit I

Bounded Linear Operators on a Hilbert Space: Norm of bounded linear operator-Adjoint operators-Generalized polarization identity and its applications-Several properties on projection operator-Generalized Schwarz inequality and square root of positive operator-From diagonalization of self-adjoint matrix to spectral representation of self-adjoint operator.

Unit II

Partial Isometry operator and polar decomposition of an operator – characterization of Partial isometry operator – Polar decomposition – Invariant subspace and reducing subspace - A necessary and sufficient condition for $T_1T_2=T_2T_1$ and $T_1T_2^*=T_2^*T_1$-Polar decomposition of non-normal operator - A necessary and sufficient condition for $T_1T_2=T_2T_3$ and $T_1^*T_2=T_2T_3^*$ - Hereditary Property on the Polar Decomposition of an Operator.

Unit III

Spectrum of an operator – Spectral mapping Theorem - Numerical range is a convex set - Numerical radius is equivalent to operator norm-Normaloid and Spectraloid operator.

Unit IV

Relations among several classes of non - normal operators- Paranormal Operator - Characterizations of Convexoid operators - Young Inequality and generalized operator means - Holder-McCarthy inequality - Lowner-Heinz inequality and Furuta inequality-Statement of generalized Furuta inequality (without proof)

Unit V

Aluthge Transformation on p-hyponormal operator – Aluthge Transformation on log-hyponormal operators - A subclass of paranormal operators including log- hyponormal operators -Several classes related to class A and paranormal operators - A Furuta extension of theorem 1 – An absolute K- paranormal operator is normaloid – A Characterizations of absolute k-paranormal operators- Several examples expressing inclusion relations among the classes of operators.

Text Book:

"Invitation to linear operators" by **Takayuki Furuta.** Taylor & Francis.2001

Unit I : Chapter 2 : Sections 2.1.1 to 2.1.6

Unit II : Chapter 2 : Sections 2.2.1, 2.2.2, 2.3.1 to 2.3.5

Unit III: Chapter 2 : Sections 2.4.1, 2.4.2, 2.5.1 to 2.5.4

Unit IV: Chapters 2: Sections 2.6.1, 2.6.2, 2.7.1

Chapters 3: Sections 3.1.1, 3.1.2, 3.2.1

Unit V : Chapter 3 : Sections 3.4.1, 3.4.2, 3.5.1 to 3.5.6

14MAP15 **Control Theory**

Unit I

Observability: Basic Results of Differential Equations - Fixed Point Methods - Linear Systems - Non-Linear Systems.

Unit II

Controllability: Linear Systems - Non-Linear Systems.

Unit III

Stability: Linear Systems - Perturbed Linear Systems - Non-Linear Systems.

Unit IV

Stabilizability: Stabilization via Linear Feedback Control - The Controllable Subspace - Stabilization with Restricted Feedback.

Unit V

Optimal Control: Linear Time Varying Systems - Linear Time Invariant Systems - Non-Linear Systems.

Text Book:

"Elements of Control Theory", by **K.Balachandran and J.P.Dauer.** Narosa

Publishing House, 2012

Unit I : Chapters 1 & 2

Unit II : Chapter 3 (Omit Sections 3 and 4)

Unit III : Chapter 4

Unit IV : Chapter 5

Unit V : Chapter 6

14MAP16 **Fluid Dynamics**

Unit I

Introduction: General Description of Fluid Mechanics - Continuum Mechanics - Fluid Properties - Regimes in the Mechanics of Fluids. **Kinematics of Fluids:** Methods of Describing Fluid Motion - Translation, Rotation and Rate of Deformation - Streamlines Path Lines and Streak Lines - The Material Derivative and Acceleration - Vorticity.

Unit II

General Theory of Stress and Rate of Strain: Nature of Stresses - Transformation of Stress - Components - Nature of Strains - Transformation of the Rates of Strain - Relation Between Stress and Rate of Strain. **Fundamental Equations of the Flow of Viscous Compressible Fluids:** The Equation of Continuity - Conservation of Mass - Equations of Motion (Navier-Stokes Equation) - Conservation of Momentum - The Energy Equation - Conservation of Energy.

Unit III

Two and Three Dimensional, Inviscid Incompressible Flow: (A) Basic Equations and Concepts of Flows: Equation of Continuity - Eulerian Equations of Motion - Circulation Theorems - Velocity Potential - Irrotational Flow - Integration of the Equations of Motion - Bernoulli's Equation - The Momentum Theorem. **(B) Simple Flows:** Laplace Equation - Stream Function in Two- Dimensional Motion - Two-Dimensional Flow Examples.

Unit IV

Laminar Flow of Viscous Incompressible Fluids: Similarity of Flows-The Reynolds Number - Flow Between Parallel Flat Plates - Steady Flow in Pipes - Flow Between Two Concentric Rotating Cylinders.

Unit V

The Laminar Boundary Layer: Properties of the Navier-Stokes Equations - Boundary Layer Concept - The Boundary Layer Equations in Two-Dimensional Flow - The Boundary Layer Along a Flat Plate - Boundary Layer on a Surface with Pressure Gradient - Momentum Integral Theorems for the Boundary Layer.

Text Book:

"Foundations of Fluid Mechanics" by **S.W.Yuan**, Prentice-Hall of India Private Limited, New Delhi, 1969.

Unit I : Sections 1.4 to 1.4 & Sections 3.1 to 3.5
Unit II : Sections 4.1 to 4.5 & Sections 5.1 to 5.3
Unit III : Sections 7.1 to 7.6, 7.8, 7.9, 7.12
Unit IV : Sections 8.1, 8.3 to 8.5
Unit V : Sections 9.1 to 9.5

Core Elective

Stochastic Differential Equations

Unit I

Introduction: Stochastic Analogs of Classical Differential Equations, Filtering Problems, Stochastic Approach to Deterministic Boundary Value Problems, Optimal Stopping, Stochastic Control and Mathematical Finance. Some mathematical preliminaries: Probability Spaces, Random Variables and Stochastic Processes and an Important Example: Brownian Motion.

Unit II

Ito Integrals: Construction of the Ito integral , Some Properties of the Ito Integral and Extensions of the Ito Integral.

Unit III

The Ito Formula and the Martingale Representation Theorem: The 1- dimentional Ito Formula, the Multi dimensional Ito Formula and the Martingale Reprsentation Theorem. Stochastic Differential Equations: Examples and Some Solution Methods, An Existence and Uniqueness Result and Weak and Strong Solutions.

Unit IV

The Filtering Problem: Introduction, The 1- dimentional Linear Filtering Problem and the Multi- dimentional Linear Filtering Problem.

Unit V

Diffusions: Basic Properties: The Markov Property, the Strong Markov Property, the Generator of an Ito Diffusion, the Dynkin Formula, the Characteristic Operator.

Text Book:

"Stochastic Differential Equations - An Introduction with Applications", by **Bernt Oksendal,** Sixth Edition, Springer- Verlag, Heidelberg. 2003

Unit I : Chapters 1 and 2

Unit II : Chapter 3

Unit III : Chapters 4 and 5

Unit IV : Chapter 6

Unit V : Chapter 7

Core Elective

Magnetohydrodynamics

Unit I

Electromagnetism-Fundamental laws-Electrostatic energy-Electrodynamics-Ampere's law-Lorentzs force on a moving charge - Magnetostatic. Energy - Faraday's law of induction - Poynting-Stresses - Electromagnetic equations with respect to moving axes - Boundary conditions of electro and magnetic fields.

Unit II

Continuum hypothesis - Kinematics of fluid motion - Equation of continuity -Stress tensor-Navier-Stoke's equation-Boundary condition - Velocity magneto fluid dynamic equations - MHD approximation - Equation of magnetic diffusion in a moving conducting medium - Magnetic Reynolds number.

Unit III

Magneto hydrostatics - Force free field- Ferraro's law of isorotation - Alfven waves in incompressible MHD.

Unit IV

Incompressible viscous flows in the presence of magnetic field - Hartmann flow - Unsteady Hartmann flow - Magneto fluid dynamic pipe flow.

Unit V

Stability-Instability of linear pinch-Sausage and flute types - Method of small oscillations-Gravitational instability.

Text Book:

For Units I, II and IV:

"Magneto fluid dynamics for engineers and applied physicists" by **Cramer K.R. and Pai S.I.** McGraw Hill 1973 (Relevant sections)

For Units III and V:

"Introduction to Magneto fluid dynamics" by **Ferraro V.C.A and Plumpton.** Oxford 1966 (Relevant sections)

Core Elective
MATLAB (Theory)

Unit I

Starting with MATLAB: Starting MATLAB,MATLAB Windows – working in the command Window – Arithmetic operations with scalars – Display formats – Elementary Math Built – In Functions – Defining Scalar variables – Useful commands for managing variables. **Creating Arrays:** Creating A One – Dimensional Array(Vector) – Creating A Two – Dimensional Array (Matrix) – The Transpose Operator.

Unit II

Array Addressing – Using a Colon in Addressing Arrays – Adding Elements to Existing Variables – Deleing Elements – Built – In Functions for Handling Arrays – Strings and Stings as Variables. **Mathematical Operations with Arrays**: Addition and Subtraction – Array Multiplication – Array Divison – Element by Element Operations – Using Arrays in MATLAB Built – In Math functions – Built – In Functions for Analyzing Arrays.

Unit III

Script Files: Creating and Saving a Script File – Running A Script File – Global Variables – Input to Script File – Output Commands. **Two – Dimensional Plots:** The Plot Command – The fplot Command – Plotting Multiple Graphs in the same plot.

Unit IV

Formatting a plot – Plots with Logarithmic Axes – Plots with Special Graphics – Histograms – Polar plots – Plotting Multiple plots in the same page.

Functions and Function Files: Creating a Function file – Structure of a function file – Local and Global Variables – Saving a function file – Using a function file – Examples of Simple Function file – Inline Funcitons – The feval Command.

Unit V

Programming in MATLAB: Relational and Logical Operators – Conditional Statements – The switch – case Statement – Loops – Nested Loops and Nested Conditional Statements – The break and continue Commands.

Text Book:

1. "**MATLAB – An Introduction with Applications**" By "AMOS GILAT" Deparment of Mechanical Engineering. The Ohio State University.

Unit I : Chapter1: Sections 1.1 to 1.8
Chapter 2: Sections 2.1, 2.2, 2.4
Unit II : Chapter 2: Sections 2.5 to 2.10
Chapter 3: Sections 3.1 to 3.6
Unit III : Chapter 4: Sections 4.2 to 4.6
Chapter 5: Sections 5.1 to 5.3
Unit IV : Chapter 5: Sections 5.4 to 5.9
Chapter 6: Sections 6.1 to 6.6, 6.8, 6.9
Unit V : Chapter 7: Sections 7.1 to 7.6

Core Elective
Mat lab (Practicals)

List of Programs

1 Write a program to create a matrix with zeros, eye and ones and find their eigen and eigen vector.

2. Write a program to fit a straight line.

3. Write a program to convert the temperature from Fahrenheit to Celsius.

4. Write a program to plot $r^2 = 2 \sin 5t$, $0 \leq t \leq 2\pi$, x = r cost, y = r sint using the function polar, fill and bar.

5. Write a program to plot $Z = -5/ (1+x^2 + y^2)$ $|x| \leq 3$, $|y| \leq 3$ using the functions mesh, meshz and waterfall.

6. Write a program to find x and y values of the given function by using Euler's method.

7. Write a program to find multiplication and division of a matrix.

8. Write a program to find x and y values of the given function using Runge- kutta 2^{nd} order method.

9. Write a program to find the interval value of the given function using simpon's1/3 rd rule.

10. Write a program to find the integral value of the given function using Trapezoidal rule

Core Elective

Programming in C++ (Theory)

Unit I

Principles of Object-Oriented Programming: Object Oriented Programming Paradigm - Basic Concepts of Object Oriented Programming – Benefits of OOP- Applications of OOP. **Beginning with C ++:** What is C ++? - Applications of C ++ - A Simple C ++ Program - More C ++ Statements - An Example with class - Structure of C ++ Program - Creating the Source File - Compiling and Linking. **Token, Expressions and Control Structures:** Introduction – Tokens – Keywords – Identifier and Constants – Basic Data Types – User Defined Data Types.

Unit II

Token, Expressions and Control Structures: Derived Data Types - Symbolic Constants - Type Compatibility - Declaration of Variables – Reference Variables - Operators in C ++ - Scope Resolution Operators - Manipulators - Control Structures. **Functions in C ++:** Introduction - The Main Function - Function Prototyping - Return by Reference - Inline Functions - Default Arguments – const Arguments - Function Overloading – Friend and Virtual Functions.

Unit III

Classes and Objects: Introduction- C Structure Revisited - Specifying a Class - Defining Member Functions - A C ++ Program with Class - Making an Outside Function Inline - Nesting of Member Functions - Private Member Functions – Arrays Within a class – Memory allocation for Objects – Static data Members – Static Member Functions – Array of Objects – Objects as Function Arguments – Friendly Functions – Returning Objects.

Unit IV

Constructors and Destructors: Introduction - Constructors - Parameterized Constructors - Multiple Constructors in a Class - Constructors with Default Arguments – Copy Constructors - Destructors. **Operator Overloading and Type Conversions:** Introduction- Defining Operator Overloading- Overloading Unary Operators - Overloading Binary Operators - Manipulation of Strings Using Operators - Rules for Overloading Operators - Type Conversions.

Unit V

Inheritance: Introduction - Defining Derived Classes – Single Inheritance - Making a Private Member Inheritable - Multilevel Inheritance- Multiple Inheritance - Hierarchical Inheritance- Hybrid Inheritance-Virtual Base Classes.

Text Book:

"Object Oriented Programming with C ++" by **E. Balagurusamy**, Second Edition, Tata McGraw Hill Publishing Company. (2006)

Unit I : Chapter 1 to 3 : Sections 1.4 to1.6, 1.8, Sections 2.1 to 2.8 & Sections 3.1 to 3.6

Unit II : Chapter 3&4 : Sections 3.8 to 3.15 (omit 3.12), 3.18, 3.25, & Sections 4.1 to 4.8(omit 4.4) 4.10,4.11.

Unit III : Chapter 5 : Sections 5.1 to 5.16

Unit IV : Chapter 6 & 7 : Sections 6.1 to 6.5, 6.7, 6.11 & Sections 7.1 to 7.9(omit 7.5,7.7)

Unit V : Chapter 8 : Sections 8.1 to 8.9

Core Elective

Programming in C++ (Practical)

List of Programs

1. Program to print all the prime numbers up to 5000.
2. Program to perform matrix addition, subtraction, multiplication and transpose.
3. Program to find the mean and standard deviation of the given set of numbers.
4. Program to perform the following operations in the given strings.
    i) Find the length
    ii) Reverse the string and check for palindrome
    iii) Concatenate the given strings
    iv) Convert the upper case character to lower case character and vice-versa.
5. Program to verify whether a given number is an Armstrong number.
6. Program for solving non linear equations by Newton – Raphson Method.
7. Program for numerical integration by Simpson's rule.
8. Program to arrange the set of strings in alphabetical order.
9. Program to solve fourth order differential equations by Runge Kutta Method (4^{th} Order).
10. Program to do arithmetic operations on complex numbers.
11. Program to overload the operators to perform string manipulations.
12. Program to implement the concept of inheritance.

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Core Elective
Wavelet Analysis

Unit I

Linear Algebra and Dual Bases: Inner Products, Star Notation, and Reciprocal Bases - Function Spaces and Hilbert Spaces - Fourier Series, Fourier Integrals, and Signal Processing - Measures and Integrals.

Unit II

Windowed Fourier Transforms: Motivation and Definition of the WFT – Time - Frequency Localization - The Reconstruction Formula - Signal Processing in the Time - Frequency Domain.

Unit III

Continuous Wavelet Transforms: Motivation and Definition of the Wavelet Transform - The Reconstruction Formula - Frequency Localization and Analytic Signals - Wavelets, Probability Distribution, and Detail.

Unit IV

Analysis and Synthesis: From Resolutions of Unity to Frames - Reconstruction Formula and Consistency Condition - Discussion: Frames versus Bases - Recursive Reconstruction- Discrete Frames - Roots of Unity: A Finite - Dimensional Example.

Unit V

Discrete Time - Frequency Analysis and Sampling: The Shannon Sampling Theorem - Sampling in the Time - Frequency Domain - Time Sampling versus Time - Frequency Sampling - Other Discrete Time - Frequency Sub frames - The Question of Orthogonality.

Text Book:

"A Friendly Guide to Wavelets" by **Gerald Kaiser**, Springer International Edition, 2005.

Unit I : Chapter1: Sections 1.1 to 1.5
Unit II : Chapter2: Sections 2.1 to 2.4
Unit III : Chapter3: Sections 3.1 to 3.4
Unit IV : Chapter4: Sections 4.1 to 4.6
Unit V : Chapter5: Sections 5.1 to 5.5