UNIVERSITY DEPARTMENTS

ANNA UNIVERSITY CHENNAI : : CHENNAI 600 025

REGULATIONS - 2009

CURRICULUM I TO IV SEMESTERS (FULL TIME)

M.Sc. APPLIED MATHEMATICS

FIRST SEMESTER

Course Code	Course Title	L	T	P	C
THEORY					
MT9111	Advanced Calculus	3	0	0	3
MT9112	Modern Algebra	3	0	0	3
MT9113	Ordinary Differential Equations	3	0	0	3
MT9114	Classical Mechanics	3	0	0	3
MT9115	Object Oriented Programming	3	0	0	3
MT9116	Real Analysis	3	1	0	4
PRACTICAL					
MT9117	Object Oriented Programming Laboratory	0	0	4	2
	Total				**21**

SECOND SEMESTER

Course Code	Course Title	L	T	P	C
THEORY					
MT9121	Linear Algebra	3	0	0	3
MT9122	Probability and Random Processes	3	1	0	4
MT9123	Complex Analysis	3	1	0	4
MT9124	Partial Differential Equations	3	1	0	4
MT9125	Topology	3	0	0	3
E1	Elective I	3	0	0	3
	Total				**21**

THIRD SEMESTER

Course Code	Course Title	L	T	P	C
THEORY					
MT9131	Functional Analysis	3	0	0	3
MT9132	Numerical Analysis	3	0	0	3
MT9133	Mathematical Programming	3	0	0	3
MT9134	Continuum Mechanics	3	0	0	3
MT9135	Integral Transforms and Calculus of Variations	3	1	0	4
E2	Elective II	3	0	0	3
PRACTICAL					

MT9136	Computational Laboratory	0	0	4	2
MT9137	Seminar	0	0	2	1
	Total				**22**

FOURTH SEMESTER

Course Code	Course Title	L	T	P	C
THEORY					
E3	Elective III	3	0	0	3
E4	Elective IV	3	0	0	3
MT9141	Project	0	0	20	10
	Total				**16**

Total Credits: 80

ELECTIVES

Course Code	Course Title	L	T	P	C
MT9151	Metric Spaces and Fixed Point Theory	3	0	0	3
MT9152	Discrete Mathematics	3	0	0	3
MT9153	Number theory	3	0	0	3
MT9154	Mathematical Statistics	3	0	0	3
MT9155	Stochastic Processes	3	0	0	3
MT9156	Formal Languages and Automata Theory	3	0	0	3
MT9157	Data Structures	3	0	0	3
MT9158	Fuzzy Set Theory	3	0	0	3
MT9159	Graph Theory	3	0	0	3
MT9160	Finite Element Method	3	0	0	3
MT9161	Design and Analysis of Algorithms	3	0	0	3
MT9162	Number theory and Cryptography	3	0	0	3
MT9163	Visual Programming	3	0	0	3
MT9164	Mathematical Finance	3	0	0	3
MT9165	Approximation theory	3	0	0	3
MT9166	Fluid Mechanics	3	0	0	3
MT9167	Numerical Solution of Partial Differential Equations	3	0	0	3
MT9168	Networks, Games & Decisions	3	0	0	3
MT9169	Fixed point theory and its Applications	3	0	0	3
MT9170	Geometric Function Theory	3	0	0	3
MT9171	Wavelet Analysis	3	0	0	3
MT9172	Boundary Layer Flows	3	0	0	3
MT9173	Heat and Mass Transfer	3	0	0	3
MT9174	Mathematical aspects of Finite Element Method	3	0	0	3
MT9175	Theory of Elasticity	3	0	0	3
MT9176	Algorithmic Graph theory	3	0	0	3
MT9177	Advanced Graph Theory	3	0	0	3
MT9178	Queueing and Reliability modeling	3	0	0	3

MT 9111 ADVANCED CALCULUS

L	T	P	C
3	0	0	3

1. PARTIAL DIFFERENTIATION 9

Functions of several variables – Homogeneous functions – Total derivative - Higher order Derivatives, Equality of cross derivatives - Differentials - Directional Derivatives.

2. IMPLICIT FUNCTIONS AND INVERSE FUNCTIONS 9

Implicit functions – Higher order derivatives – Jacobians – Dependent and independent variables – The inverse of a transformation – Inverse function theorem – Change of variables – Implicit function theorem – Functional dependence – Simultaneous equations.

3. TAYLOR'S THEOREM AND APPLICATIONS 9

Taylor's theorem for functions of two variables – Maxima and Minima of functions of two and three variables – Lagrange Multipliers.

4. LINE AND SURFACE INTEGRALS 9

Definition of line integrals – Green's theorem – Applications – Surface integrals – Gauss theorem – Verification of Green's and Gauss theorems.

5. TRANSFORMATION AND LINE INTEGRALS IN SPACE 9

Change of variables in multiple integrals – Definition of line integrals in space – Stoke's theorem - Verification of Stoke's theorem.

L: 45

BOOK FOR STUDY:

1. Widder D.V. ,"Advanced Calculus", Prentice Hall of India, New Delhi, 12th Print, 2nd Edition,2002. (Unit 1: Chapter 1: Sections 3,4,8 and 11, Unit 2: Chapter 1: Sections 5,6,7,10 and 12, Unit 3: Chapter 1: Section 9 and Chapter 4: Sections 1-5, Unit 4: Chapter 7: Sections 1-4, Unit 5: Chapter 7: Sections 5 and 6 (except 6.5)).

REFERENCES:

1. Kaplan W., "Advanced Calculus", Addison Wesley (Pearson Education, Inc.), 5th Edition, 2003.
2. Malik S.C., "Mathematical Analysis", New Age International Publishers, New Delhi, 1992.
3. Burkill & Burkill, "Second course in Mathematical Analysis", Cambridge University Press.
4. Aparal T.M., "Mathematical Analysis", Narosa Publishing House, New Delhi, 1990.

MT9112 **MODERN ALGEBRA**

L	T	P	C
3	0	0	3

1. GROUPS AND SYMMETRY **10**

Isomorphism – Product of Groups - Quotient groups – Symmetry of plane figures - The groups of motions of the plane - Finite Groups of Motions - Discrete Groups of Motions - Abstract Symmetry: Group Operations - The Operation on Cosets - The Counting Formula-Permutation Representations - Finite Subgroups of the Rotation Group.

2. MORE GROUP THEORY **9**

The operations of a Group on itself - The Class Equation of the Icosahedral Group-Operations on Subsets - The Sylow theorems - The Group of Order - Computation in the Symmetric Group - The Free Group.

3. RINGS **8**

Definition of a Ring - Formal Construction of Integers and Polynomials - Homomorphism and Ideals - Quotient Rings and Relations in a Ring - Adjunction of Elements - Integral Domains and Fraction Fields - Maximal Ideals.

4. FACTORIZATION **9**

Factorization of Integers and Polynomials - Unique Factorization Domains, Principal Ideal Domains, and Euclidean Domains - Gauss's Lemma - Explicit Factorization of Polynomials - Primes in the Ring of Gauss Integers - Algebraic Integers.

5. FIELDS **9**

Examples of fields - Algebraic and Transcendental Elements - The Degree of a Field Extension - constructions with Ruler and Compass - Symbolic Adjunction of Roots - Finite Fields - Function Fields - Transcendental Extensions.

L : 45

BOOK FOR STUDY:

1. Artin M., "Algebra", Prentice - Hall, New Jersey, 1991. (Chapter 2 sections 3, 8 and 10 Chapter 5, Chapter6 first 7 sections, Chapter 10 first 7 sections, Chapter 11 first 6 and Chapter 13)

REFERENCES:

1. I.N Herstein, "Topics in Algebra", 2nd Edition, Wiley, New York, 1975.
2. N. Jacobson," Basic Algebra", Vol.1 & 2, W.H. Freeman and Company, 1985, 1980.
3. S. Lang, "Algebra" 3rd Edition, Pearson Education, 1993.
4. Fraleigh J. B., "A first course in Abstract Algebra", Narosa, 1990.

MT9113 ORDINARY DIFFERENTIAL EQUATIONS

L	T	P	C
3	0	0	3

1. LINEAR EQUATIONS **9**

Higher order equations – Linear independence – Wronskian – Variation of parameters – Systems of Linear differential equations - Existence and uniqueness theorem.

2. EXISTENCE THEOREM AND BOUNDARY VALUE PROBLEMS **9**

Successive approximations - Picard's theorem – Boundary Value problems – Sturm–Liouville problem - Green's Functions.

3. STABILITY **9**

Autonomous systems – The phase plane – Critical points and stability for linear systems – Stability by Liapunov's direct method – Simple critical points of non-linear systems.

4. LEGENDRE EQUATION **9**

Power series solutions – Second order linear equations with ordinary points – Legendre equation – Legendre polynomials – Rodrigue's formula – Recurrence relations – Orthogonality.

5. BESSEL EQUATION **9**

Second order equations with regular singular points – Series solution – Bessel Equation – Bessel functions of first kind – Recurrence relations – Orthogonality.

L : 45

TEXT BOOKS :

1. Deo S.G., Lakshmikantham V. and Raghavendra V. "Text Book of Ordinary Differential Equations", Tata McGraw-Hill Publishing Company Ltd., 2nd Edition, 2000. Sections: 2.1 to 2.8, 4.1, 4.2, 4.4, 5.1 to 5.5, 7.1 to 7.3, 3.2 to 3.4.
2. Simmons G.F. and Krantz S. G., "Differential Equations, Theory, Technique and Practice", Tata McGraw-Hill Publishing Company Ltd., 2nd Edition, 2006. Sections: 2.3, 3.3, 3.5, 4.1 to 4.5, 6.5, 10.1 to 10.4, 11.1 to 11.6.

REFERENCES:

1. Ravi P. Agarwal and Ramesh C. Gupta, "Essentials of Ordinary Differential Equations", McGraw-Hill Book Company, 1993.
2. Elsgolts, "Differential equation and the calculus of variations", MIR Publications, 1980.

MT 9114 **CLASSICAL MECHANICS**

L	T	P	C
3	0	0	3

1. KINEMATICS **9**

Kinematics of a particle and a rigid body – Moments and products of inertia – Kinetic energy – Angular momentum.

2. METHODS OF DYNAMICS IN SPACE **9**

Motion of a particle – Motion of a system – Motion of a rigid body.

3. APPLICATIONS OF DYNAMICS IN SPACE **9**

Motion of a rigid body with a fixed point under no forces – Spinning top - General motion of top.

4. EQUATIONS OF LAGRANGE AND HAMILTON **9**

Lagrange's equation for a particle – Simple dynamical system – Hamilton's equations.

5. HAMILTONIAN METHODS **9**

Natural Motions – Space of events – Action – Hamilton's principle - Phase space – Liouville's theorem.

L: 45

BOOK FOR STUDY:

1. Synge L. and Griffith B.A., "Principles of Mechanics", McGraw Hill, 1984, Chapters 11,12,14,15,16. (excluding articles : 12.3,12.5,14.3,14.4, 15.2 & 16.2).

REFERENCES:

1. Rana N.C. and Joag P.S., "Classical Mechanics", Tata McGraw Hill, 1991.
2. Berger V.D. and Olsson M.G., "Classical Mechanics - a modern perspective", McGraw Hill International, 1995.
3. Bhatia V.B., "Classical Mechanics with introduction to non-linear oscillations and chaos", Narosa Publishing House, 1997.
4. Sankara Rao K. "Classical Mechanics", Prentice Hall of India Pvt. Ltd., New Delhi, 2005.
5. Greenwood D. T., "Principles of Dynamics", Prentice Hall of India, 1988.

MT 9115 OBJECT ORIENTED PROGRAMMING

L	T	P	C
3	0	0	3

1. FUNCTIONS AND CLASSES IN C++ 9

Procedure Oriented Programming, characteristics of OOP – Function Prototype – Default Arguments – Inline functions – Function overloading – Template functions - Classes – This pointer – Constructors – Destructors – Friend functions – Template classes – New and delete operators – Operator overloading – Static members - Nesting of classes

2. INHERITANCE AND POLYMORPHISM IN C++ 9

Single inheritance – Multiple inheritance – Hierarchical inheritance – Hybrid inheritance – Abstract base class – Virtual functions – Dynamic binding – Polymorphism – Virtual base classes

3. INPUT/OUTPUT IN C++ 9

Input/Output operations – Overloading the insertion and extraction operators – I/O stream classes – File Input/Output – Exception handling

4. JAVA FUNDAMENTALS 9

Features of Java – Classes – Inheritance – Packages - Interfaces – Exception handling.

5. JAVA PROGRAMMING 9

Threading – Input/Output operations – Applets – Event handling – AWT controls, layout managers.

L : 45

BOOKS FOR STUDY:

1. S.B.Lipmann, “The C++ Primer”, Pearson Education, 2000.
2. Herbert Schildt, “The Complete Reference Java 2”, Tata McGraw Hill, 7th Edition, 2004.

REFERENCES:

1. Robert Lafore, “Object Oriented Programming in C++”, Galgotia Publications, 1995.
2. E. Balaguruswamy, “Object Oriented Programming with C++”, 4th Edition, Tata McGraw Hill, 2007.
3. Ivor Horton, “Beginning C++”, Wrox Press Ltd, 1998.
4. John Hubbard, “Programming with C++”, Tata McGraw-Hill, 2nd Edition, 2006.
5. Bjarne Stroustrup, “The C++ Programming Language”, Pearson Education, 2005.
6. E. Balaguruswamy, “Programming with JAVA”, Tata McGraw Hill, 3rd Edition, 2007.

MT 9116 **REAL ANALYSIS**

L	T	P	C
3	1	0	4

1. RIEMANN-STIELTGES INTEGRAL **9**

Definition and existence of the integral, Properties of the integral, Integration and Differentiation. The Four Derivatives-Continuous non differentiable functions-Functions of Bounded Variation

2. SEQUENCES AND SERIES OF FUNCTIONS **9**

Pointwise convergence, Uniform convergence, Uniform convergence and continuity, Uniform convergence and Integration, Uniform Convergence and differentiation. Equi-continuous families of functions, Stone-Weierstrass theorem

3. MEASURE AND MEASURABLE SETS **9**

Lebesgue Outer Measure-Measurable Sets-Regularity-Measurable Functions-Borel and Lebesgue Measurablity-Abstract Measure-Outer Measure-Extension of a Measure –Completion of a Measure.

4. LEBESGUE INTEGRAL **9**

Integrals of simple functions-Integrals of Non Negative Functions-The General Integral-Integratiion of Series-Riemann and Lebesgue Integrals-Legesgue Differentiation Theorem- Integration and Differentiation-The Lebesgue Set-Integration with respect to a general measure

5. LEBESGUE DECOMPOSITION AND PRODUCT MEASURE **9**

Convergence in Measure-Almost Uniform convergence-Signed measures and Hahn Decomposition - Radon-Nikodym Theorem and its applications-Measurability in a product space- The Product measure and Fubini's Theorem.

L : 45 T : 15

BOOKS FOR STUDY:

1. Rudin, W., "Principles of Mathematical Analysis", Mc Graw-Hill, 3rd Edition, 1984.
2. G. de Barra, "Measure Theory and Integration", New Age International (P) Limited, 1996.

REFERENCES:

1. Avner Friedman, "Foundations of Modern Analysis", Hold Rinehart Winston, 1970.
2. Don Hong, Jianzhong Wang and Robert Gardner, "Real Analysis with an Introduction to Wavelets and Applications", Elsevier Inc. 2005.
3. Rana I. K., "An Introduction to Measure and Integration", Narosa Publishing House Pvt. Ltd., 2nd Edition, 2007.
4. Royden H. L., "Real Analysis", Prentice Hall of India Private Ltd., 3rd Edition, 1995.

MT 9117 OBJECT ORIENTED PROGRAMMING LABORATORY

L	T	P	C
0	0	4	2

1. Function Overloading (both in C++ and Java)
2. Function Templates and Class Templates in C++
3. Classes in C++ with all possible operations/operators for encapsulating Complex Number, String, Time, Date and Matrix (Operators are to be overloaded)
4. Employee class with derived classes for specialized employees (Both in C++ and Java)
5. Interfaces and Packages in Java
6. Polymorphism (both in C++ and Java)
7. Multithreading in Java
8. Applet in Java
9. Window using AWT in Java

MT 9121 **LINEAR ALGEBRA**

L T P C
3 0 0 3

1. VECTOR SPACES AND LINEAR MAPS **9**

Vector spaces – Bases and dimension – Subspaces – Matrices and linear maps – rank nullity theorem - Inner product spaces-orthonormal basis – Gram-Schmidt Orthonormalization process.

2. DIAGONALIZATION AND THE PRIMARY DECOMPOSITION THEOREM **12**

Eigen spaces-Algebraic and Geometric multiplicities – Cayley-Hamilton theorem-Diagonalization – Direct sum decomposition – Invariant direct sums – Primary decomposition theorem.

3. UNITARY TRANSFORMATIONS **10**

Unitary matrices and their properties-rotation matrices-Schur, Diagonal and Hessenberg forms and Schur Decomposition.

4. THE JORDAN CANONICAL FORM **9**

Similarity Transformations and change of basis-Generalised eigen vectors-Canonical basis-Jordan canonical form – Applications to linear differential equations – Diagonal and the general cases.

5. APPLICATIONS **7**

An error–correcting code – The method of least squares – Particular solutions of non-homogeneous differential equations with constant coefficients – The Scrambler transformation.

L : 45

BOOKS FOR STUDY:

1. Hoffmann K. and Kunze R., “Linear Algebra”, Prentice Hall of India, 2nd Edition, 2000. (Sections: 2.1, 2.2, 2.3, 2.4, 3.1, 3.3, 3.4, 6.2, 6.4, 6.6, 6.7, 6.8, 8.2)
2. Ben Noble and James W. Daniel, “Applied Linear Algebra”, Prentice Hall International Inc, 3rd Edition, 1988. (Sections: 7.3 - 7.5, 8.2)
3. Agnew J. and Knapp R.C., “Linear Algebra with Applications”, Brooks/Cole Publishing Co., 1983. (Sections: 4.6, 5.4)

REFERENCES:

1. Gilbert Strang, “Linear Algebra and its applications”, Thomson, 3rd Edition, 1998.
2. S. Kumaresan, “Linear Algebra: A Geometric Approach”, Prentice Hall of India, 2006.

MT 9122 PROBABILITY AND RANDOM PROCESSES

L	T	P	C
3	1	0	4

1. PROBABILITY AND RANDOM VARIABLES 9

Probability Concepts - Random variables – Bernoulli, Binomial, Geometric, Poisson, Uniform, Exponential, Erlang, Weibull and Normal distributions – Function of a Random variable - Moments, Moment generating function.

2. TWO DIMENSIONAL RANDOM VARIABLES 9

Joint distributions – Transformation of random variables and their distributions – Conditional expectation – Computing probabilities and expectations by conditioning – Correlation and Regression.

3. LIMIT THEOREMS 9

Modes of convergence – Markov, Chebyshev's and Jensen's inequalities – Weak law of large numbers – Strong law of large numbers – Kolmogorov's inequality - Central limit theorem (iid case).

4. MARKOV CHAINS 9

Stochastic processes – Classification – Markov chain – Chapman Kolmogorov equations – Transition probability Matrix – Classification of states – First passage times - Stationary distribution – Mean time spent in a transient state.

5. MARKOV PROCESSES 9

Markov process – Poisson process – Pure birth process – Pure death process - Birth and death process – Limiting probabilities – Non-homogeneous Poisson process – Compound Poisson process.

L: 45 T: 15

BOOKS FOR STUDY:

1. S.M. Ross, "Introduction to Probability Models", Academic Press Inc., 9th Edition, 2007. (Chapters 1,2,3, 4, 5 and 6)
2. V.K. Rohatgi and A.K.MD. Ehsanes Saleh,"An introduction to Probability and Statistics", Wiley Eastern Ltd., 2nd Edition, 2001, (Chapter 6)

REFERENCES:

1. J. N. Kapur and H.C. Saxena, "Mathematical Statistics", S. Chand and Company Ltd., New Delhi, 2003.
2. J. Medhi, "Stochastic Processes", New Age International (P) Ltd., New Delhi,2nd Edition, 2001,.

MT 9123 COMPLEX ANALYSIS

L	T	P	C
3	1	0	4

1. COMPLEX INTEGRATION **10**

Analytic functions – Cauchy's theorem for rectangle – Cauchy's theorem for disk - Integral formula - Local properties of analytic functions – Schwartz lemma – Maximum Modulus principle.

2. CALCULUS OF RESIDUES **9**

Homology – Homologous form of Cauchy's theorem – Calculus of Residues – Contour integration through residues.

3. DOMAIN CHANGING MAPPINGS **8**

Conformality – Normal family – Riemann mapping theorem

4. HARMONIC FUNCTIONS **9**

Properties – The mean-value property - Poisson's Formula - Schwarz's theorem - Harnack's principle

5. MEROMORPHIC AND ENTIRE FUNCTIONS **9**

Meromorphic functions – Mittag Leffler's theorem – Infinite partial fraction of $\cot(\pi z)$ - Infinite product – Canonical Product – Gamma Functions – Jensen's formula- Order and Genus of an Entire function - Hadamard's theorem – Riemann Zeta function

L : 45 T : 15

BOOK FOR STUDY:

1. Lars V. Ahlfors, "Complex Analysis, McGraw Hill International , 3rd Edition ,1979.

REFERENCES:

1. Conway J.B., "Functions of one Complex variables", Springer International Student Edition, 2nd Edition, 2000.
2. Mathews J.H. and Howell R.W., "Complex Analysis for Mathematics and Engineering", Narosa Publishing House, 3rd Edition, 1998.
3. E.B. Staff, A.D.Snider, "Fundamentals of Complex Analysis with applications to Engineering and Science", Pearson Education, 3rd Edition, 2008.

MT 9124 PARTIAL DIFFERENTIAL EQUATIONS

L	T	P	C
3	1	0	4

1. FIRST ORDER EQUATIONS 9

Integral surfaces passing through a given curve – Surfaces orthogonal to a given system of surfaces – Compatible system of equations – Charpit's method.

2. SECOND ORDER EQUATIONS 9

Classification of second order Partial Differential Equations – Reduction to canonical form – Adjoint operators – Riemann's method.

3. HYPERBOLIC EQUATIONS 9

One-dimensional wave equation – Initial value problem – D'Alembert's solution – Riemann – Volterra solution – Vibrating string – Variables Separable solution – Forced vibrations – Solutions of Non-homogeneous equation – Vibration of a circular membrane.

4. PARABOLIC EQUATIONS 9

Diffusion equation – Solution of Diffusion equation in cylindrical and spherical polar coordinates by method of Separation of variables – Solution of Diffusion equation by Fourier transform.

5. ELLIPTIC EQUATIONS 9

Boundary value problems – Properties of harmonic functions – Green's Function for Laplace Equation – The Methods of Images – The Eigenfunction of Method

L : 45 T : 15

BOOK FOR STUDY:

1. Sankara Rao K., "Introduction to Partial Differential Equations" Prentice Hall of India, 2007.

REFERENCES:

1. Sneddon I.N., "Elements of Partial Differential Equations", Mc Graw Hill Book Company, 1985.
2. Dennemeyer R., "Introduction to Partial Differential Equations and Boundary Value Problems", McGraw Hill Book Company, 1968.
3. Pinsky M.A., "Partial Differential Equations and Boundary Value Problems", McGraw Hill Book Company, 3rd Edition, 1998.
4. Coleman P. M., "An Introduction to Partial Differential Equations with MAT LAB", Chapman & Hall / CRC, 2005.

MT 9125 TOPOLOGY

L	T	P	C
3	0	0	3

1. TOPOLOGICAL SPACES **9**

Topological spaces – Basis for a topology – Product topology on finite cartesian products –Subspace topology.

2. CLOSED SETS AND CONTINUOUS FUNCTIONS **9**

Closed sets and Limit points – Continuous functions – Homeomorphism – Metric Topology – Uniform limit theorem.

3. CONNECTEDNESS AND COMPACTNESS **9**

Connected spaces – Components – Path components – Compact spaces – Limit point compactness – Local compactness.

4. COUNTABILITY AND SEPARATION AXIOMS **9**

Countability axioms – T_1-spaces – Hausdorff spaces – Completely regular spaces – Normal spaces.

5. URYSOHN LEMMA AND TYCHONOFF THEOREM **9**

Urysohn lemma – Urysohn metrization theorem – Imbedding theorem – Tietze extension theorem – Tychonoff theorem.

L: 45

BOOK FOR STUDY:

1. Munkres J.R., “Topology”, Prentice-Hall of India, New Delhi, 2nd Edition, 2003. Chapter 2, sections 12, 13, 15, 16, 17, 18, 20, 21 Chapter 3 sections 23, 25, 26, 28, 29, Chapter 4, sections 30, 31, 32, 33, 34, 35, 37.

REFERENCES:

1. Simmons G.F., “Introduction to Topology and Modern Analysis”, International Student Edition, McGraw Hill Kogakusha Ltd., 1983.
2. Murdeshwar M.G., “General Topology”, 2nd Edition, Wiley Eastern, 1990.
3. Kelly J.L., “General Topology”, Van Nostrand, 1955.
4. Dugundji J., “Topology”, University Book Stall, New Delhi, 1990.
5. Joshi K. D., “Introduction to General Topology”, Willey, 1988.

MT 9131 FUNCTIONAL ANALYSIS

L	T	P	C
3	0	0	3

1. BANACH SPACES **7**

Banach Spaces - Continuous linear transformations.

2. FUNDAMENTAL THEOREMS IN NORMED LINEAR SPACES **9**

The Hahn-Banach theorem – The natural imbedding of N in N** - The open mapping theorem - Closed graph theorem – The conjugate of an operator – Uniform boundedness theorem.

3. HILBERT SPACES **10**

Hilbert Spaces – Schwarz inequality - Orthogonal complements - Orthonormal sets – Bessel's inequality – Gram–Schmidt orthogonalization process - The conjugate space H*- Riesz–Representation theorem.

4. OPERATOR ON A HILBERT SPACE **9**

The adjoint of an operator – Self-adjoint operators – Normal and unitary operators – Projections.

5. SPECTRAL AND FIXED POINT THEORIES **10**

Matrices – Determinants and the spectrum of an operator – spectral theorem – Fixed point theorems and some applications to analysis.

L : 45

BOOK FOR STUDY:

1. Simmons G.F., "Introduction to Topology and Modern Analysis", International Student Edition, Mc-Graw Hill Kogakusha Ltd., 1983. (Sections: 46-51, 52-59 and 60 – 62 in Chapters 9-11, and Appendix one.)

REFERENCES:

1. Kreyszig E.,"Introductory Functional Analysis with Applications, John Wiley & Sons, 1978.
2. Limaye B. V.,"Functional Analysis", New Age International Ltd., Publishers, 2nd Edition ,1996.
3. Coffman C. and Pedrick G., "First Course in Functional Analysis", Prentice-Hall of India, New Delhi, 1995.
4. Conway J.B., "A Course in Functional Analysis", Springer-Verlag, New York, 1985.
5. Bollobas B., "Linear Analysis", Cambridge University Press, Indian Edition, 1999.
6. Nair M.T., "Functional Analysis, A First course", Prentice Hall of India, 2002.

MT 9132 **NUMERICAL ANALYSIS**

L	T	P	C
3	0	0	3

1. SYSTEMS OF LINEAR EQUATIONS AND ALGEBRAIC EIGENVALUE PROBLEMS **9**

Direct Method: Gauss elimination method – Error Analysis– Iterative methods: Gauss-Jacobi and Gauss-Seidel – Convergence considerations - Eigenvalue Problem: Power method.

2. INTERPOLATION, DIFFERENTIATION AND INTEGRATION **9**

Interpolation: Lagrange's and Newton's interpolation -- Errors in interpolation – Optimal points for interpolation - Numerical differentiation by finite differences – Numerical Integration: Trapezoidal, Simpson's and Gaussian quadratures – Error in quadratures.

3. APPROXIMATION OF FUNCTIONS **9**

Norms of functions – Best Approximations: Least squares polynomial approximation – Approximation with Chebyshev polynomials – Piecewise Linear & Cubic Spline approximation.

4. ORDINARY DIFFERENTIAL EQUATIONS **9**

Single-Step methods: Euler's method –Taylor series method – Runge-Kutta method of fourth order – Multistep methods: Adams-Bashforth and Milne's methods – Stability considerations – Linear Two point BVPs: Finite Difference method.

5. PARTIAL DIFFERENTIAL EQUATIONS **9**

Elliptic equations: Five point finite difference formula in rectangular region – truncation error; One-dimensional Parabolic equation: Explicit and Crank-Nicholson schemes; Stability of the above schemes - One-dimensional Hyperbolic equation: Explicit scheme;

L : 45

BOOKS FOR STUDY:

1. Brian Bradie., "A Friendly Introduction to Numerical Analysis", Pearson Education, New Delhi, 1st Edition, 2007.
2. Kincaid D. and Chenney W., "Numerical Analysis: Mathematics of Scientific Computing", Brooks/Cole Pub. 2nd Edition, 2002.

REFERENCES:

1. Isaacson E. and Keller, H.B., "Analysis of Numerical Methods" Dover Publication, 1994.
2. Philips G.M and Taylor P.J., "Theory and Applications of Numerical Analysis", Elsevier, New Delhi, 2nd Edition, 2006.
3. Jain M.K., Iyenger S.R.K. and Jain R.K., "Numerical Methods for Scientific and Engineering", New Age International Pub. Co., 3rd Edition, 1993.
4. Conte S.D. and Carl de Boor, "Elementary Numerical Analysis", Tata McGraw-Hill Publishing Company, 3rd Edition,2005.
5. Atkinson K.E., "An Introduction to Numerical Analysis", Wiley, 1989.

MT 9133 MATHEMATICAL PROGRAMMING

L	T	P	C
3	0	0	3

1. LINEAR PROGRAMMING **9**

Formulation and Graphical solutions – Simplex method – Transportation and Assignment problems.

2. ADVANCED LINEAR PROGRAMMING **9**

Duality – Dual simplex method – Revised simplex method – Bounded variable technique.

3. INTEGER PROGRAMMING **9**

Cutting plane algorithm – Branch and bound technique – Applications of Integer programming.

4. NON-LINEAR PROGRAMMING **9**

Classical optimization theory : Unconstrained problems – Constrained problems – Quadratic programming.

5. DYNAMIC PROGRAMMING **9**

Principle of optimality – Forward and backward recursive equations – Deterministic dynamic programming applications.

L: 45

BOOKS FOR STUDY:

1. Sharma, J.K. “Operations Research: Theory and Applications”, Macmillan India Ltd., 3rd Edition, 2006.
2. Taha, H.A. “Operations Research: An Introduction”, Pearson Education Inc., (Prentice-Hall of India Pvt. Ltd.), New Delhi, 8th Edition, 2008.

REFERENCES:

1. Sinha S.M., “Mathematical Programming: Theory and Methods”, Elsevier India, 1st Edition, 2006.
2. Gupta P.K. and Hira , D.S., “Operations Research”, S. Chand and Co. Ltd., New Delhi, 2001.
3. Manmohan P.K. and Gupta, S.C. , “Operations Research”, Sultan Chand and Co., New Delhi, 9th Edition, 2001.
4. Ravindran A., Phillips D.T. and Solberg, J.J., “Operations Research - Principles and Practice”, Wiley India Edition, 2007.

MT 9134 CONTINUUM MECHANICS

L	T	P	C
3	0	0	3

1. TENSORS: 9

Summation Convention – Components of a tensor – Transpose of a tensor – Symmetric & anti-symmetric tensor – Principal values and directions – Scalar invariants.

2. KINEMATICS OF A CONTINUUM: 9

Material and Spatial descriptions – Material derivative – Deformation – Principal Strain – Rate of deformation – Conservation of mass – Compatibility conditions.

3. STRESS 9

Stress vector and tensor – Components of a stress tensor – Symmetry – Principal Stresses – Equations of motion – Boundary conditions.

4. LINEAR ELASTIC SOLID 9

Isotropic solid – Equations of infinitesimal theory – Examples of elastodynamics elastostatics.

5. NEWTONIAN VISCOUS FLUID 9

Equations of hydrostatics – Newtonian fluid – Boundary conditions – Stream lines – Examples of laminar flows – Vorticity vector – Irrotational flow.

L : 45

BOOK FOR STUDY:

1. Lai W.M., Rubin D. and Krempel E., “Introduction to Continuum Mechanics”, Pergamon Unified Engineering Series, 1974.
   [Chapter-2:articles 2A1 to 2B15, Chapters 3 and 4, Chapter-5:articles 5.1 to 5.7B,5.8A,5.8B, Chapter-6:articles 6.1 to 6.98B, 6.13 & 6.14]

REFERENCES:

1. Hunter S.C., “Mechanics of Continuous Media”, Ellis Harwood Series, 1983.
2. Chung T.J., “Continuum Mechanic”, Prentice Hall, 1988.
3. Chandrasekaraiah D.S. and Loknath Debnath, “Continuum Mechanics”, Prism Books Private Limited, 1994.

MT 9135 INTEGRAL EQUATIONS AND CALCULUS OF VARIATIONS

L T P C
3 1 0 4

1. VARIATIONAL PROBLEMS 9

Variation of a functional and its properties – Euler's equations – Functionals with several arguments, higher order derivatives – Functionals dependent on functions of several independent variables – Variational Problems in Parametric form.

2. VARIATIONAL PROBLEMS WITH MOVING BOUNDARIES AND WITH SUBSIDIARY CONDITIONS 9

Variation problems with a movable boundary for functionals dependent on one and two functions - One-sided variations – Constraints – Isoperimetric Problems - Applications.

3. INTEGRAL EQUATIONS WITH SEPARATE KERNELS AND NEUMANN SERIES 9

Integral equations with degenerate kernels – Solution by reduction to algebraic equations – Fredholm Alternative – Method of successive approximaion for equation of second kind – Neumann series and Resolvent kernel - Fredholm Theorems (without proof) - Applications.

4. EQUATIONS WITH SYMMETRIC KERNELS 9

Equations with Hermitian kernels – Eigen values and Eigen functions – Expansion in eigen functions – Hilbert – Schmdit theorem – Solution of equation of second kind.

5. APPROXIMATE METHODS 9

Direct Methods In Variational Problems – Rayleigh-Ritz method and Kantorovich method – Approximate methods in integral equations – Approximation of Fredholm equations by sets of algebraic equations – Approximate methods of undetermined coefficients – The method of collocation – The method of weighting functions – Approximation of the kernel - Rayleigh-Ritz method for first eigen value.

L : 45, T : 15

BOOKS FOR STUDY:

1. Gupta A.S., "Calculus of Variations with Applications" Sections 1.1-1.5, 4.2, 6.1, 6.3, 6.9, Prentice Hall of India, 1997.
2. Ram P. Kanwal, "Linear Integral Equations", Academic Press, 1971.
3. Hildebrand F. B., "Methods of Applied Mathematics", Dover Publications, 1992.

REFERENCES:

1. Elsgolts L., "Differential equations and the Calculus of Variations", MIR Publishers, 1980.
2. Moiseiwitsch B.L., "Integral Equations ", Longman, 1977.

MT 9136 COMPUTATIONAL LABORATORY

L T P C
0 0 4 2

Introduction to MATLAB Fundamentals

The MATLAB environment – Assignment statements – Mathematical operations – Use of Built-in functions – Graphics in MATLAB – M-files – Input-Output – Structured Programming – Nesting and Identation – Passing Functions to M-files

Lab Exercises on Numerical Methods:

Numerical Linear Systems
Gaussian Elimination method with pivoting
Gauss-Seidal iterative methods, Power methods
Interpolation, Approximations and Quadratures
Newton divided-difference and finite difference Interpolation,
Composite Simpson and Composite Gaussian quadratures
Cubic Spline Approximation
Numerical methods for ordinary Differential Equations
Euler's method. Fourth order Runge-Kutta Method, Adams-Bashforth Multi-Step method
Finite Difference Methods for BVP s
Two-Point BVP, Elliptic Equations, Parabolic Equations, Hyperbolic Equations.

Introduction to TORA Package

Lab exercises on Mathematical Programming:

Linear Programming Models
Simplex Method, Big M method – Bounded Variables method

Integer Programming Models
Cutting plane method, Branch and Bound method

Network Problems

REFERENCES:

1. Steven C. Chapra, "Applied Numerical Methods with MATLAB for Engineers and Scientists", Tata McGraw-Hill Publishing Company Limited, New Delhi, Second Edition, 2007.
2. John H. Mathews and Kurtis D. Fink, "Numerical Methods using MATLAB", Pearson Education, Fourth Edition, 2008.
3. Hamdy A. Taha, "Operations Research, an Introduction", 8th Edition, Pearson Education, 2004.

MT 9151 METRIC SPACES AND FIXED POINT THEORY

L	T	P	C
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1. METRIC CONTRACTION PRINCIPLES 9

Banach's Contraction principle – Further Extension of Banach's principle – The Caristis–Ekeland Principle – Equivalents of the Caristis-Ekeland Principle – Set values contractions – Generalized contractions.

2. HYPERCONVEX SPACES AND NORMAL STRUCTURES IN METRIC SPACES 10

Hyperconvexity - Properties of hyperconvex spaces - A fixed point theorem – Approximate fixed points. Normal structures in Metric spaces: A fixed point theorem – Structure of the fixed point set – Fixed point set structure – Separable case.

3. CONTINUOUS MAPPING IN BANACH SPACES 10

Brouwer's theorem – Further comments on Brouwer's theorem – Schauder's Theorem –Stability of Schauder's Theorem – Banach Algebras: Stone Weierstrass Theorem – Leray–Schauder degree – Condensing mappings – Continuous mappings in hyperconvex spaces.

4. METRIC FIXED POINT THOERY 8

Contraction mappings – Basic theorem for nonexpansive mapping – Structure of the fixed point set - Asymptotically regular mapping – Set valued mappings.

5. BANACH SPACE ULTRAPOWERS 8

Some fixed point theorem – Asympotitically nonexpansive mappings – The demiclosedness principle.

L : 45

BOOK FOR STUDY:

1. Mohamed A. Khamsi & William A. Kirk, "An Introduction of Metric Spaces and Fixed Point theory", John Wiley & sons, 2001. (Chapter 3, 4, 5, 7, 8, and 9)

REFERENCES:

1. Zeidler E., "Nonlinear Functional Analysis and its applications", Vol. I, Springer–Verlag New York, 1986.
2. Deimling K., "Nonlinear Functional Analysis", Springer–Verlag, New York, 1985.
3. Smart D.R.," Fixed Point Theory", Cambridge University Press, 1974.
4. Istratescu V. I.," Fixed Point theory", D. Reidel Publishing Company, Boston, 1979.

MT 9152 DISCRETE MATHEMATICS

L	T	P	C
3	0	0	3

1. LOGIC **9**

Propositions – Implications – Equivalences – Predicates and Quantifiers – Nested Quantifiers – Methods of Proof – Mathematical Induction.

2. NUMBER THEORY **9**

The Integers and Division – Integers and Algorithms – Applications of Number Theory.

3. COUNTING **9**

The Basis of Counting – The Pigeonhole Principle – Permutations and Combinations – Binomial Coefficients – Generalized Permutations and Combinations – Generating Permutations and Combinations – Inclusion-Exclusion – Applications of Inclusion-Exclusion.

4. RECURRENCE RELATIONS **9**

Solving Recurrence Relations – Divide-and-Conquer Algorithms and Recurrence Relations – Generating Functions.

5. BOOLEAN ALGEBRA **9**

Boolean Functions – Representing Boolean Functions – Logic Gates – Minimization of Circuits.

L: 45

BOOK FOR STUDY:

1. Rosen K.H., “Discrete Mathematics and its Applications”, Tata McGraw-Hill Publishing Company Limited, New Delhi, 5th Edition, 2003.
[Sections: 1.1 to 1.5, 3.3; 2.4 to 2.6; Chapter 4 and 6.5, 6.6; 6.1 to 6.4; Chapter 10]

REFERENCES:

1. Scheincreman E.R., “Mathematics – A Discrete Introduction”, Brooks/Cole: Thomson Asia Pte. Ltd., Singapore, 2001.
2. Grimaldi R.P., “Discrete and Combinatorial Mathematics”, Pearson Education Pte. Ltd., Singapore, 4th Edition, 2002.

MT 9153 **NUMBER THEORY**

L	T	P	C
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1. DIVISIBILITY **9**

Introduction – Divisibility – Primes – The binomial theorem.

2. CONGRUENCES **9**

Congruences – Solutions of congruences – The chinese - Remainder theorem – Techniques of numerical calculation.

3. APPLICATION OF CONGRUENCE AND QUADRATIC RECIPROCITY **9**

Public – Key cryptography – Prime power moduli – Prime modulus - Primitive roots and power residues – Quadratic residues – The Gaussian reciprocity law.

4. FUNCTIONS OF NUMBER THEORY **9**

Greatest integer function – Arithmetic functions – Mobius inversion formula – Recurrence functions – Combinational number theory

5. DIOPHAUTIN EQUATIONS AND FAREY FRACTIONS **9**

The equations ax + by = c Pythagorean triangle – Shortest examples – Farey sequences – Rational approximations.

L: 45

BOOK FOR STUDY:

1. Niven I., Zuckerman H.S., and Montgomery, H.L., “An introduction to the theory of numbers”, John Wiley & Sons (Asia) Pte. Ltd, Singapore, 5th Edition, 2004.
   Sections 1.1, 1.2, 1.3, through theorem 1.18, 1.4 through theorem1.21; 2.1, 2.2, 2.3, 2.4 thorugh example 9; 2.5, 2.6 through example12, 27through theorem 2.29, 2.8 through corollary 2.38, 3.1, 2.3; 4.1, 4.5; 5.1, 5.3, 5.4, 6.1, 6.2

REFERENCES:

1. Graham R.L., Knuth D.E., and Patachink O., “Concrete Mathematics”, Pearson education Asia, 2nd Edition, 2002.
2. Bressoud D., Wagon S., “A Course in Computational Number Theory”, Key College Publishing, 2000.

MT 9154 MATHEMATICAL STATISTICS

L	T	P	C
3	0	0	3

1. SAMPLING DISTRIBUTIONS AND ESTIMATION THEORY 9

Sampling distributions – Characteristics of good estimators – Method of Moments – Maximum Likelihood Estimation – Interval estimates for mean, variance and proportions.

2. TESTING OF HYPOTHESIS 9

Type I and Type II errors - Tests based on Normal, t, χ^2 and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

3. CORRELATION AND REGRESSION 9

Method of Least Squares - Linear Regression – Normal Regression Analysis – Normal Correlation Analysis – Partial and Multiple Correlation - Multiple Linear Regression.

4. DESIGN OF EXPERIMENTS 9

Analysis of Variance – One-way and two-way Classifications – Completely Randomized Design – Randomized Block Design – Latin Square Design.

5. MULTIVARIATE ANALYSIS 9

Covariance matrix – Correlation Matrix – Normal density function –Principal components – Sample variation by principal components – Principal components by graphing.

L : 45

BOOKS FOR STUDY:

1. J.E. Freund,"Mathematical Statistics", Prentice Hall of India, 5th Edition, 2001. (Chapters: 8,10,11, 12, 13, 14, 15)
2. R.A. Johnson and D.W. Wichern, "Applied Multivariate Statistical Analysis", Pearson Education Asia, 5th Edition, 2002.

REFERENCE:

1. Gupta S.C. and Kapoor V.K.,"Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 11th Edition, 2003.

MT 9155 STOCHASTIC PROCESSES

L	T	P	C
3	0	0	3

1. MARKOV AND STATIONARY PROCESSES 9

Specification of Stochastic Processes – Stationary Processes – Poisson Process – Generalizations – Birth and Death Processes – Markov Chain – Erlang Process

2. RENEWAL PROCESSES 9

Renewal processes in discrete and continuous time – Renewal equation – Stopping time – Wald's equation – Renewal theorems – Delayed and Equilibrium renewal processes – Residual and excess life times – Renewal reward process – Alternating renewal process – Regenerative stochastic process

3. MARKOV RENEWAL AND SEMI – MARKOV PROCESSES 8

Definition and preliminary results – Markov renewal equation – Limiting behaviour - First passage time.

4. BRANCHING PROCESSES 10

Generating functions of branching processes – Probability of extinction – Distribution of total number of progeny – Generalization of classical Galton – Watson process – Continuous time Markov branching process – Age dependent branching process – Bellman - Harris process

5. MARKOV PROCESSES WITH CONTINUOUS STATE SPACE 9

Brownian motion – Weiner process – Kolmogorov equations - First passage time distribution for Weiner process – Ornstein – Uhlenbeck process

L: 45

BOOK FOR STUDY:

1. J. Medhi, "Stochastic Processes", New Age International (P) Ltd., New Delhi, 2nd Edition, 2001.

REFERENCES:

1. U.N. Bhat, "Elements of Applied Stochastic Processes", John Wiley and Sons Limited, 2nd Edition, 1984.
2. D.R. Cox and H.D. Miller, "The theory of Stochastic Process", Methuen, London,1965.
3. S. M. Ross ,"Stochastic Processes", Wiley, New York, 2nd Edition,1996.
4. S. Karlin and H.M. Taylor, "A First Course in Stochastic Processes", 2nd Edition, Academic press, New York, 1975.

MT 9156 FORMAL LANGUAGES AND AUTOMATA THEORY

L	T	P	C
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1. REGULAR SETS AND FINITE STATE AUTOMATA 9

Finite state automata – Deterministic and non-deterministic model – languages accepted by Finite State Automata – Pumping Lemma for regular set.

2. CONTEXT FREE LANGUAGES 9

Grammar – Context Free Grammars – Derivation trees – Simplification of context – Free grammar (only Construction and no proof of equivalence of grammars) – Chomsky normal Form – Greibach Normal Form.

3. PUSH DOWN AUTOMATA AND PROPERTIES AND CONTEXT FREE LANGUAGES 9

Pushdown automata – Push down automata and Context free languages – Pumping lemma for context free languages.

4. TURING MACHINE AND UNDECIDEABILITY 9

Turing Machine model – Computational languages and functions – Modifications of Turing machines (only description, no proof for theorems on equivalence of the modification) –Problems – Properties of recursive and recursively enumerable languages – Universal Turing Machine and the undecidable problem.

5. THE CHOMSKY HIERARCHY 9

Regular grammar – Unrestricted grammar – Context Sensitive languages – Linear bounded automata – Relation between classes of languages.

L: 45

BOOK FOR STUDY:

1. Hopcroft J.E. and Ullman J.D. “Introduction to Automata, Languages and Computation”, Narosa Publishing House, 1987
   (Sections 2.1 to 2.5, 3.1, 4.1 to 4.6, 5.1 to 5.3, 6.1, 7.1 to 7.5, 8.1 to 8.3, 9.1 to 9.4)

REFERENCES:

1. Hopcroft, J.E., Rajeev Motwani and Ullman, J.D. “Introduction to Automata Theory, Languages, and Computation”, Pearson Education,2nd Edition , 2002.
2. Mishra K.L.P and Chandrasekaran. N, “Theory of computation”, Prentice Hall of India, 2nd Edition, 2003.
3. Peter Linz, “An Introduction to Formal Languages and Automata”, Narosa Publishing House, 3rd Edition, 2003.

MT 9157 **DATA STRUCTURES**

L	T	P	C
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1. STACKS AND RECURSION **9**

Arrays, Structures and Stacks in C – Recursion in C.

2. QUEUES AND LISTS **9**

Queue and its sequential representation, Linked lists, Lists in C, Circular linked lists.

3. TREES **9**

Binary Trees – Binary tree representation – Lists as binary trees – Application of trees.

4. SORTING **9**

General background – Exchange sorts – Selection and Tree sorting – Insertion sorts – Merge and Radix sorts.

5. SEARCHING **9**

Basic search Technique – Tree searching – Hashing.

L: 45

BOOK FOR STUDY:

1. Langsam.Y, Augenstein, M. and Tenenbam, A.M., “Data Structures using C and C++”, Prentice Hall of India, New Delhi, 1998.
(Chapter 1: Sections 1.2-1.4, Chapter 2, Chapter 3: Sections 3.1 to 3.3, Chapter 4: Sections 4.1-4.3 and 4.5, Chapter 5 : Sections 5.1, 5.2 and 5.5, Chapter 6, Chapter 7 : Sections 7.1,7.2 and 7.4).

REFERENCE:

1. Kruse, C.L., Lenny, B.P. and Tonto, C.L., “Data Structures and Program Design in C”, Prentice Hall of India, 1995.

MT 9158 **FUZZY SET THEORY**

L	T	P	C
3	0	0	3

1. BASICS **9**

Fuzzy sets-Basic types – Fuzzy sets – Basic concepts – Additional properties of α -cuts – Representations of fuzzy sets – Extension principle for fuzzy sets.

2. OPERATIONS ON FUZZY SETS **9**

Types of operations – Fuzzy complements – Fuzzy intersections: t-norms – Fuzzy unions: t-co-norms – Combinations of operations.

3. FUZZY ARITHMETIC **9**

Fuzzy numbers – Linguistic variables – Arithmetic operations on Intervals – Arithmetic operations on fuzzy numbers.

4. FUZZY RELATIONS **9**

Crisp and fuzzy relations – Binary fuzzy relations – Binary relations on a single set – Fuzzy equivalence relations – Fuzzy compatibility relations – Fuzzy ordering relations.

5. FUZZY RELATION EQUATIONS **9**

Partition – Solution method – Fuzzy relation equations based on sup-i compositions and inf-w_i compositions.

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BOOK FOR STUDY:

1. George J. Klir and Yuan B., “Fuzzy Sets and Fuzzy Logic, Theory and Applications”, Prentice Hall of India Private Limited, 1997.
   (Sections 1.3, 1.4, 2.1, 2.2, 2.3, Sections 3.1 to 3.5, Sections 4.1 to 4.4 and Sections 5.1, 5.3 to 5.7 and Sections 6.2 to 6.5).

REFERENCES:

1. Dubois D. and Prade H., “Fuzzy sets and systems, Theory and Applications”, Academic Press, 1980.
2. Kaufmann A.,” Introduction to the theory of Fuzzy Subsets”, Vol. I, Fundamental Theoretical Elements, Academic Press, 1975.

MT 9159 **GRAPH THEORY**

L	T	P	C
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1. INTRODUCTION **9**

Graphs and simple graphs – Graph isomorphism – Incidence and adjacency matrices – subgraphs – Paths and connection – cycles – Trees – Cut edges and bonds – Cut vertices.

2. CONNECTIVITIY AND TRAVERSIBILITY **9**

Connectivity – Whitney's theorems – Blocks – Applications of connectivity – Euler's tour – Hamilton Cycles – The Chinese Postman Problem – The traveling Salesman Problem (only a brief introduction on these problems.)

3. MATCHING **9**

Matching and covering bipartite graphs – perfect matchings – Independent sets.

4. COLORING **9**

Vertex chromatic number – k-critical graphs – Brook's theorem – Chromatic polynomials – Girth and Chromatic number.

5. PLANAR GRAPHS **9**

Planar graphs – Euler's formula – Kurtowski's theorem – Five color theorem.

L: 45

BOOK FOR STUDY:

1. Murthy U.S.R. and Bondy J.A., "Graph theory with Applications", Elsevier North-Holland 1976, (chapters 1-5 and 7-9 excluding 1.8, 1.9, 2.4, 3.3, 7.2-7.5, 8.3, 9.4, 9.7 and 9.8).

REFERENCES:

1. Balakrishnan R. and Ranganathan K., "A Text Book of Graph Theory", Springer-Verlag, 2000.
2. M. Bezhad G. Chartrand and L. Lesneik Foster, "Graphs and Digraphs", Wadsworth International Group, 1979.
3. Douglas B. West, "Introduction to Graph Theory", Prentice Hall of India, 2002.
4. Harary.F, "Graph Theory", Narosa Publishing House, New Delhi, 1989.

MT 9160 FINITE ELEMENT METHOD

L	T	P	C
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1. INTEGRAL FORMULATIONS AND VARIATIONAL METHODS 9

Weighted integral and weak formulations of boundary value problems – Rayleigh-Ritz method – Method of weighted residuals.

2. FINITE ELEMENT ANALYSIS OF ONE - DIMENSIONAL PROBLEMS 12

Discretization of the domain – Derivation of element equations – Connectivity of elements – Imposition of boundary conditions – Solution of equations – Applications.

3. EIGENVALUE AND TIME DEPENDENT PROBLEMS IN ONE DIMENSION 9

Formulation of eigenvalue problem – Finite element models – Applications of semi discrete finite element models for time-dependent problems – Applications to parabolic and hyperbolic equations.

4. FINITE ELEMENT ANALYSIS OF TWO- DIMENSIONAL PROBLEMS 11

Interpolation functions – Evaluation of element matrices – Assembly of element equations – Imposition of boundary conditions – Solution of equations – Applications to parabolic and hyperbolic equations.

5. FINITE ELEMENT ERROR ANALYSIS 4

Various measures of errors – Convergence of solution – Accuracy of solution.

L: 45

BOOK FOR STUDY:

1. Reddy J.N., “An Introduction to the Finite Element Method”, Tata McGraw Hill, New Delhi, 3rd Edition, 2005.

REFERENCES:

1. Buchanen G.R. and Rudhramoorthy R., “Finite Element Analysis”, Schaum’s Outline Series, Tata McGraw Hill, New Delhi, 2006.
2. Huttan D.V., “Fundamentals of Finite Element Analysis”, Tata McGraw Hill, New Delhi, 2005.

MT 9161 DESIGN AND ANALYSIS OF ALGORITHMS

L	T	P	C
3	0	0	3

1. ANALYZING ALGORITHMS 7

Algorithms – Analyzing algorithms – Designing algorithms – Growth of functions – Recurrences.

2. SORTING 8

Insertion sort – Quick sort – Divide and Conquer – Mergesort – Heapsort – Lower bounds for sorting.

3. GRAPH ALGORITHMS 11

Representations of graphs – Breadth-first search – Depth-first search – Minimum spanning tree – The algorithms of Kruskal and Prim – Shortest paths – Dijkstra's algorithm – Bellman and Ford algorithm.

4. STRING MATCHING 6

The naïve string-matching algorithm – String matching with finite automata – The Knuth-Morris – Pratt algorithm.

5. POLYNOMIALS, MATRICES AND NP COMPLETENESS 13

Representation of polynomials – Fast Fourier Transform – Polynomial time – The complexity class NP – NP completeness – Reducibility – NP complete problems.

L : 45

BOOK FOR STUDY:

1. Cormen T.H., Leiserson C.E. and Rivest R.L., "Introduction to Algorithms", 2nd Edition, Prentice Hall of India, New Delhi, 2004.
   Chapters 2.3, 6.7, 23: Sections: 1.1, 4.1 to 4.3, 8.1, 22.1to 23.3, 24.1, 24.3, 32.1, 32.3, 32.4, 30.1, 30.2, 34.1, to 34.3, 34.5.1, 34.5.4.

REFERENCES:

1. Baase S., "Computer Algorithms: Introduction to Design and Analysis", 2nd Edition, Addison and Wesley, 1993.
2. Levitin A., "Introduction to the Design & Analysis of Algorithms", Pearson Education (Asia) Pvt. Ltd., New Delhi, 2003.

MT 9162 NUMBER THEORY AND CRYPTOGRAPHY

L	T	P	C
3	0	0	3

1. INTRODUCTION TO NUMBER THEORY **9**

Time estimates for doing arithmetic - Divisibility and the Euclidean algorithm – Congruences - Modular exponentiation - Some applications to factoring

2. QUADRATICS RESIDUES AND RECIPROCITY **9**

Finite Fields - Multiplicative generators – Uniqueness of fields with prime power elements - Quadratic residues and reciprocity

3. CRYPTOSYSTEMS **9**

Some simple crypto systems - Digraph transformations - Enciphering Matrices - Affine enchipering transformationsRSA - Discrete Log - Diffie-Hellman key exchange - The Massey – Omura cryptosystem - Digital Signature standard - Computation of discrete log

4. PRIMALITY AND FACTORING - I **9**

Pseudoprimes - Strong pseudo primes - Solovay-Strassen Primality test – Miller - Rabin test - Rho method - Fermat factoring and factor bases - Quadratic sieve method

5. PRIMALITY AND FACTORING - II **9**

Elliptic Curves - Elliptic curve primality test - Elliptic Curve factoring - Pollard's p - 1 method -Elliptic curve reduction modulo n - Lenstras Method.

L : 45

BOOK FOR STUDY:

1. Neal Koblitz, "A course in Number Theory and Cryptography", 2nd Edition, Springer-Verlag, 1994.

REFERENCE:

1. Menezes A, "Van Oorschot and Vanstone S.A, Hand book of Applied Cryptography", CRC Press, 1996.

MT 9163 VISUAL PROGRAMMING

L	T	P	C
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1. VB.NET FUNDAMENTALS 9

Introduction to .NET Framework - Controls – Menus and Dialog Boxes – Variables and Operators – Decision Structures –Loops and Timers - Debugging -Trapping and Handling Errors

2. VB.NET PROGRAMMING 9

Modules and Procedures – Arrays and Collections – Exploring Text Files and String Processing – Automating Microsoft Office Applications – Deployment of VB.NET Applications.

3. VB.NET UI DESIGN AND DATABASE APPLICATIONS 9

Windows Forms – Graphics and Animation - Inheriting Forms and Creating Base Classes – Working with Printers – ADO.NET – Data Grid Control

4. VC++ FUNDAMENTALS 9

Windows Programming Fundamentals - Event Driven Programming - MFC Library Application Framework – App Wizard – Class Wizard –Event Handling – Message Mapping – Device Context – Dialog Data Exchange and Validation (DDX and DDV)

5. VC++ UI DESIGN AND DATABASE APPLICATIONS 9

Dialog Based Applications - Windows Common Controls – Using ActiveX Controls - SDI and MDI applications – Document View Architecture - Splitter Windows - Serialization – Reading and Writing Documents – ODBC – MFC Database Classes

L : 45

BOOKS FOR STUDY:

1. Michael Halvorson, “Visual Basic.NET”, Prentice Hall of India, New Delhi, 2002.
2. David J. Kruglinski, “Programming VC++”, Microsoft Press, 1998.

REFERENCES:

1. Yashwant Kanetkar, “Visual C++ Programming”, BPB Publications, New Delhi, 1998.
2. Yashwant Kanetkar and Sudesh Saoji, “VC++”, COM and Beyond, BPB Publications, New Delhi, 2000.
3. MSDN Library

MT 9164 MATHEMATICAL FINANCE

L	T	P	C
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1. PROBABILITY AND RANDOM VARIABLES 9

Probability and Events – Conditional probability – Random Variables and Expected values – Covariance and Correlation – Normal Random Variables – Properties of Normal Random Variables – Central Limit theorem – Geometric Browninan Motion as a limit of simpler models – Brownian motion.

2. PRESENT VALUE ANALYSIS AND ARBITRAGE 9

Interest rates – Present value analysis – Rate of return – Continuously varying interest rates – Pricing contracts via Arbitrage – An example in options pricing.

3. ARBITRAGE THEOREM AND BLACK-SCHOLES FORMULA 9

The Arbitrage theorem – Multiperiod binomial model – Black-Scholes formula – Properties of Black – Scholes option cost – Delta Hedging Arbitrage Strategy – Pricing American put options.

4. EXPECTED UTILITY 9

Limitations of arbitrage pricing – Valuing investments by expected utility – The portfolio section problem – Capital assets pricing model – Rates of return – Single period and geometric Brownian motion.

5. EXOTIC OPTIONS 9

Barrier options – Asian and look back options – Monte Carlo Simulation – Pricing exotic option by simulation – More efficient simulation estimators – Options with non-linear pay offs – pricing approximations via multiperiod binomial models.

L: 45

BOOK FOR STUDY:

1. Ross S.M., “An elementary introduction to Mathematical Finance”, 2nd Edition, Cambridge University Press, 1999. (Chapters: 5.2, 6.1, 6.2, 7, 8.3, 9.1 – 9.3, 9.5, 9.7, 11)

REFERENCES:

1. Damien Lamberton and Bernard Lapeyre,” Introduction to Stochastic calculus applied to finance”, Chapman and Hall, 1996.
2. Marek Musiela and Marck Rutkowski,” Martingale Methods in Financial Modelling”, Springer, 2nd Edition, 2005.

MT 9165 **APPROXIMATION THEORY**

L	T	P	C
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1. APPROXIMATION IN NORMED LINEAR SPACES **9**

Existence- Uniqueness – convexity – Characterization of best uniform approximations –Uniqueness results – Haar subspaces – Approximation of real valued functions on an interval.

2. CHEBYSHEV POLYNOMIALS **9**

Properties – More on external properties of Chebyshev polynomials – Strong uniqueness and continuity of metric projection – Discretization – Discrete best approximation.

3. INTERPOLATION **9**

Introduction – Algebraic formulation of finite interpolation – Lagrange's form – extended Haar subspaces and Hermite interpolation – Hermite – Fejer interpolation.

4. BEST APPROXIMATION IN NORMED LINEAR SPACES **9**

Introduction – Approximative properties of sets – Characterization and Duality.

5. PROJECTION **9**

Continuity of metric projections – Convexity, Solarity and Cheyshevity of sets – Best simultaneous approximation.

L: 45

BOOK FOR STUDY:

1. Hrushikesh N. Mhaskar and Devidas V. Pai., "Fundamentals of approximation theory", Narosa Publishing House, New Delhi, 2000, Chapter II (Except 2.6), IV (except 4.5,4.6 & 4.7) and VIII (except8.6 & 8.7).

REFERENCES:

1. Ward Cheney and Will light, "A course in approximation theory", Brooks / Cole Publishing Company, New York, 2000.
2. Cheney E.W.,"Introduction to approximation theory", McGraw Hill, New York, 1966.
3. Singer I. ,"Best Approximation in Normed Linear Spaces by element of linear subspaces", Springer-Verlag, Berlin ,1970.

MT 9166 FLUID MECHANICS

L	T	P	C
3	0	0	3

1. KINEMATICS OF FLUIDS IN MOTION 9

Real and Ideal fluids – Velocity - Acceleration – Streamlines – Pathlines – Steady & unsteady flows – Velocity potential – Vorticity vector – Local and particle rates of change – Equation of continuity – Conditions at a rigid boundary.

2. EQUATIONS OF MOTION OF A FLUID 9

Pressure at a point in a fluid – Boundary conditions of two inviscid immiscible fluids – Euler's equations of motion – Bernoulli's equation – Some potential theorems – Flows involving axial symmetry.

3. TWO DIMENSIONAL FLOWS 9

Two-Dimensional flows – Use of cylindrical polar co-ordinates – Stream function, complex potential for two-dimensional flows, irrotational, incompressible flow – Complex potential for standard two-dimensional flows –Two dimensional image systems – Milne-Thomson circle theorem – Theorem of Blasius.

4. CONFORMAL TRANSFORMATION AND ITS APPLICATIONS 9

Use of conformal transformations – Hydrodynamical aspects of conformal mapping - Schwarz Christoffel transformation – Vortex rows.

5. VISCOUS FLOWS 9

Stress – Rate of strain – Stress analysis – Relation between stress and rate of strain – Coefficient of viscosity – Laminar flow – Navier-Stokes equations of motion – Some problems in viscous flow.

L: 45

BOOK FOR STUDY:

1. Frank Chorlton, "Textbook of Fluid Dynamics", CBS Publishers, New Delhi, 1985.(Sections: 2.1 - 2.10, 3.1 – 3.9, 5.1 – 5.12, 8.1 – 8.10, 8.15)

REFERENCES:

1. Batchelor G.K., "An Introduction to Fluid Dynamics", Cambridge University Press, 1993.
2. White F.M., "Fluid Mechanics", McGraw-Hill, 2000.
3. Milne Thomson L.M., "Theoretical Hydrodynamics", Macmillan, 1967.
4. White F.M., "Viscous Fluid Flow", McGraw-Hill, 1991.

MT 9167 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS

L T P C
3 0 0 3

1. NECESSARY BASICS 9

Iterative methods for solving large linear systems of algebraic equations: Jacobi, Gauss-seidel and S.O.R methods – Conditions for convergence of them – Methods for accelerating convergence: Lyusternite's & Aitken's methods – Optimum acceleration parameter for S.O.R method.

2. ONE DIMENSIONAL PARABOLIC EQUATIONS 9

Explicit and Crank-Nicolson Schemes for $u_t = u_{xx}$ – Weighted average approximation - Derivative boundary conditions – Truncation errors – Consistency, Stability and convergence- Lax Equivalence theorem.

3. MATRIX NORMS & TWO DIMENSIONAL PARABOLIC EQUATION 9

Vector and matrix norms – Eigenvalues of a common tridiagonal matrix - Gerischgorin's theorems – stability by matrix and Fourier-series methods – L.O.D and A.D.I. methods.

4. HYPERBOLIC EQUATIONS 9

First order quasi-linear equations and characteristics – Numerical integration along a characteristic - Lax-Wendroff explicit method - Second order quasi-linear hyperbolic equation – Characteristics – Solution by the method of characteristics.

5. ELLIPTIC EQUATIONS 9

Solution of Laplace and Poisson equations in a rectangular region – Finite difference in Polar coordinate Formulas for derivatives near a curved boundary when using a square mesh – Discretisation error – Mixed Boundary value problems.

L: 45

BOOK FOR STUDY:

1. Smith G.D., "Numerical Solution of P.D.E.", Oxford University Press, New York, 1995. (Pages 1-71, 175-213, 239-297).

REFERENCES:

1. Mitchel A.R. and Griffiths S.D.F., "The Finite Difference Methods in Partial Differential Equations", John Wiley and sons, New York, 1980.
2. Morton K.W., Mayers, D.F., "Numerical Solutions of Partial Differential Equations", Cambridge University Press, Cambridge, 2002.

MT 9168 NETWORKS, GAMES AND DECISIONS

L	T	P	C
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1. NETWORK MODELS **9**

Scope and definition of network models - Minimal spanning tree algorithm – Shortest-route problem – Maximal-flow Model.

2. CPM AND PERT **9**

Network representation – Critical path (**CPM**) computations – Construction of the time schedule – Linear programming formulation of **CPM** – **PERT** calculations.

3. GAME THEORY **9**

Optimal solution of two-person zero-sum games – Mixed strategies – Graphical solution of (2 x n) and (m x 2) games – Solution of m x n games by linear programming.

4. DECISION ANALYSIS **9**

Decision making under certainty: analytic hierarchy process (**AHP**) – Decision making under risk – Decision under uncertainty.

5. MARKOVIAN DECISION PROCESS **9**

Scope of the Markovian decision problem – Finite stage dynamic programming model – Infinite stage model – Linear programming solution.

L: 45

BOOK FOR STUDY:

1. Taha H.A., “Operations Research: An introduction”, Pearson Education, 8th Edition, 2007. [Chapters: 6, 13 & 23]

REFERENCES:

1. Hillier F.S., and Lieberman G.J., “Introduction to Operations Research”, Tata Mc-Graw Hill, 8th Edition, 2005.
2. Winston W.L., “Operations Research”, Thomson – Brooks/Cole, 4th Edition, 2003.

MT 9169 FIXED POINT THEORY AND ITS APPLICATIONS

L	T	P	C
3	0	0	3

1. THE BANACH FIXED POINT THEOREM AND ITERATIVE METHODS 9

The Banach fixed point theorem – The significance of Banach fixed point theorem – Applications to nonlinear equations – The Picard – Lindelof theorem – The Main theorem for iterative methods for linear operator equation – Applications to systems of linear equations and to linear integral equations.

2. THE SCHAUDER FIXED POINT THEOREM AND COMPACTNESS 9

Extension theorem – Retracts – The Brouwer fixed point theorem – Existence principle for systems of equations – Compact operators – Schauder fixed – point theorem – Peano's theorem – Systems of Integral equations and semi linear differential equations.

3. FIXED POINTS OF MULTIVALUED MAPS 8

Generalized Banach fixed point theorem – Upper and lower semi continuity of multi-valued maps – Generalized Schauder fixed point theorem – Variational inequalities and Brouwer fixed point theorem.

4. NONEXPANSIVE OPERATORS AND ITERATIVE METHODS 9

Uniformly convex Banach spaces – Demiclosed operators – The fixed point theorem of Brouwer, Gohde and Kirk – Demicompact operators – Convergence principles in Banach spaces – Modified successive approximations – Applications to periodic solutions.

5. CONDENSING MAPS 10

A noncompactness measure – Condensing maps – Operators with closed range and an approximation technique for constructing fixed points – Sadovskii's fixed point theorem for condensing maps – Fixed point theorem for perturbed operators – Application to differential equations in Banach spaces.

L: 45

BOOK FOR STUDY:

1. Zeidler E., "Nonlinear Functional Analysis and its applications", Vol. 1, Springer-Verlag, New York, 1986. (Chapter 1, 2, 9, 10 and 11)

REFERENCES:

1. Deimling K., "Nonlinear Functional Analysis", Springer-Verlag, New York, 1985.
2. Smart D.R., "Fixed Point Theory," Cambridge University Press, 1974.
3. Istratescu V.L., "Fixed Point Theory", D. Reidel Publishing Company, Boston, 1979.

MT 9170 GEOMETRIC FUNCTION THEORY

L	T	P	C
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1. ELEMENTARY THEORY OF UNIVALENT FUNCTIONS 9

The Area theorem - Growth and Distortion Theorems - Coefficient Estimates - Convex and Starlike functions - Close to Convex functions - Spirallike functions - Typically Real functions**.**

2. VARIATIONAL METHODS 9

A Primitive Variational Method - Growth of Integral Means - Odd Univalent functions - Asymptotic Bieberbach Conjecture**.**

3. SUBORDINATION 9

Basic Principles - Coefficient Inequalities - Sharpened Forms of the Schwartz Lemma – Majorization - Univalent Subordinate Functions.

4. GENERAL EXTREMAL PROBLEMS 9

Functionals of Linear Spaces - Representation of Linear Functionals - Extreme Points and Support Points- Properties of Extremal Functions - Extreme Points of S, Extreme Points of $\sum$.

5. COEFFICIENT CONJECTURE 9

Preliminaries – Proof of the Coefficient Conjecture

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BOOKS FOR STUDY:

1. Peter L. Duren, “Univalent Functions”, Springer Verlag, May 1983.
2. A.W. Goodman, “Univalent Functions”, Vol. 1, 11, Polygonal Publishing House, 1983.

REFERENCE:

1. Lui de Branches, “On the Bieberbach Conjecture, Acta Mathematica, 1984.

MT 9171 **WAVELET ANALYSIS**

L	T	P	C
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1. FOURIER ANALYSIS **9**

Fourier and inverse Fourier transforms – Continuous time convolution and the delta function – Fourier transform of square integrable functions – Poisson's summation formula.

2. WAVELET TRANSFORMS AND TIME - FREQUENCY ANALYSIS **9**

The Gabor transform – Short time Fourier transforms and the uncertainty principle – The integral wavelet transform – Diadic Wavelets and inversions – Frames.

3. MULTI RESOLUTION ANALYSIS AND WAVELETS **11**

The Haar wavelet construction – Multi resolution analysis – Riesz basis to orthonormal basis – Sealing function and scaling identity – Construction of wavelet basis.

4. COMPACTLY SUPPORTED WAVELETS **10**

Vanishing moments property – Meyer's wavelets – Construction of a compactly supported wavelet – Smooth wavelets.

5. APPLICATIONS **6**

Digital Filters – Discrete wavelet transforms and Multi resolution analysis – Filters for perfect reconstruction – Para unitary filters and orthonormal wavelets – Filter design for orthonormal wavelets – Biorthogonal filters.

L: 45

BOOKS FOR STUDY:

1. C.K. Chui, "An introduction to Wavelets", Academic Press, San Diego, CA, 1992. (Sections:2.1 - 2.3, 2.5, 3.1-3.5)
2. P. Wojtaszczyk, "A mathematical introduction to Wavelets", London Mathematical Society Student Texts 37, Cambridge University Press, 1997. (Sections 1.1, 2.1-2.4, 3.1, 3.2, 4.1, 4.2).
3. Y.T. Chan, "Wavelet Basics", Kluwer Academic Publishers, 1995. (Sections 3.1-3.7)

MT 9172 BOUNDARY LAYER FLOWS

L T P C
3 0 0 3

1. DERIVATION AND PROPERTIES OF NAVIER-STOKES EQUATIONS 10

Equation of motion and continuity – Stress system – Rate relation between stress and strain – Stokes hypothesis – Navier-Stokes equations – Derivation – Interpretation – Limiting case.

2. EXACT SOLUTIONS 8

Exact solutions of the Navier-Stokes equations – Parallel flow – Other exact solutions.

3. BOUNDARY LAYER EQUATIONS AND THEIR PROPERTIES 9

Derivation of boundary layer equations – Separation – Skin friction – Boundary layer along a flat plate – Similar solutions – Transformation of the boundary layer equations – Momentum and integral equations.

4. EXACT AND APPROXIMATE METHODS 9

Exact solutions of boundary layer equations – Flow past a wedge – Approximate methods – Application of the momentum equation – Von Karman and Pohlhausen method – Comparison – Methods of boundary layer control.

5. TURBULENT BOUNDARY LAYERS 9

Turbulent flow – Introduction – Mean motion and fluctuations – Apparent stresses – Derivation of the stress tensor – Assumptions for turbulent flows – Prandtl's mixing theory.

L: 45

BOOK FOR STUDY:

1. Schlichting H. ,"Boundary Layer Theory", Mc Graw Hill , 7th Edition,1979.
   Chapter 3(a,b,c,d,e,g), Chapter 4(a,c,d,e), Chapter 5 a(1,2,3,4,7), b(9,9a,10), Chapter 7(a,b,d,e), Chapter 8(b,c,d), Chapter 9(a), Chapter 10(a,b,c), Chapter 14 a(1,2,3,4,5,6), b(1.1,1.2), Chapter 18(a,b,c,d) and Chapter 19(a,b).

REFERENCES:

1. Batchelor G.K., "An Introduction to Fluid Dynamics", Cambridge University Press, 1979.
2. Yuan S.W., "Foundations of Fluid Mechanics", Prentice-Hall, 1988.

MT 9173 HEAT AND MASS TRANSFER

L	T	P	C
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1. FLOW ALONG SURFACES AND IN CHANNELS 9

Boundary layer and turbulence – Momentum equation – Laminar flow boundary layer equation –Plane plate in longitudinal flow – Pressure gradients along a surface – Exact solutions for a flat plate.

2. FORCED CONVECTION IN LAMINAR FLOW 9

Heat flow equation – Energy equation – Plane plate in laminar longitudinal flow – Arbitrarily varying wall temperature – Exact solutions of energy equation.

3. FORCED CONVECTION IN TURBULENT FLOW 9

Analogy between momentum and heat transfer - Flow in a tube – Plane plate in turbulent longitudinal flow – Recent developments in the theory of turbulent heat transfer.

4. FREE CONVECTION 9

Laminar heat transfer on a vertical plate and horizontal tube – Turbulent heat transfer on a vertical plate – Free convection in a fluid enclosed between two plane walls – Mixed free and forced convection.

5. MASS TRANSFER 9

Diffusion – Flat plate with heat and mass transfer – Integrated boundary layer equations of mass transfer – Similarity relations for mass transfer - Evaporation of water into air.

L: 45

BOOK FOR STUDY:

1. E.R. G. Eckert and R.M. Drake, “Heat and Mass Transfer”, Tata McGraw Hill Publishing Co., 2nd Edition, 1979.

REFERENCES:

1. Gebhart B., “Heat Transfer”, Mc Graw Hill Publishing Co., New York, 1971.
2. Schlichting H.,”Boundary Layer Theory”, Mc Graw Hill Publishing Co., 7th Edition, 1979.

MT 9174 MATHEMATICAL ASPECTS OF FINITE ELEMENT METHOD

L T P C
3 0 0 3

1. BASIC CONCEPTS **9**

Weak formulation of Boundary Value Problems, Ritz-Galerkin approximation, Error Estimates, Piecewise polynomial spaces, Finite Element Method, Relationship to Difference Methods, Local Estimates.

2. SOBOLEV SPACES **9**

Review of Lebesgue integration theory, Weak derivatives, Sobolev norms and associated spaces, Inclusion relations and Sobolev's inequality, Trace Theorems, Negative norms and duality.

3. VARIATIONAL FORMULATIONS **9**

Review of Hilbert spaces, projections onto subspaces and Riesz representation theorem, Symmetric and nonsymmetric variational formulation of elliptic and parabolic boundary value problems, Lax-Milgram Theorem, Error estimates for General Finite Approximation, Higher-dimensional examples

4. CONSTRUCTION OF FINITE ELEMENT SPACE AND APPROXIMATION THEORY IN SOBOLEV SPACES **9**

The Finite Element, Triangular finite elements, Lagrange element, Hermite element, Rectangular elements, Interpolant, Averaged Taylor polynomials, Error representation, Bounds for the Interpolation error, Inverse estimates

5. HIGHER DIMENSIONAL VARIATIONAL PROBLEMS **9**

Variational formulation and approximation of Poisson's and Neumann equations, Coercivity of the variational problem, Elliptic regularity estimates, Variational approximations of general Elliptic and Parabolic problems, Negative – Norm estimates.

L : 45

BOOKS FOR STUDY:

1. Brenner.S and Scott.R., "The Mathematical Theory of Finite Element Methods", Springer-Verlag, New York 1994.
2. Claes Johnson, "Numerical Solutions of Partial Differential Equations by the Finite Element Method", Cambridge University Press, Cambridge, 1987.

REFERENCES:

1. Ciarlet P.G., "The Finite Element Methods for Elliptic Problems", North Holland, Amsterdam, 1978.
2. Thomee V., "Galerkin Finite Element Methods for Parabolic Problems", Lecture Notes in Mathematics, Vol.1054, Springer-Verlag, Berlin, 1984.

MT 9175 THEORY OF ELASTICITY

L	T	P	C
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1. ANALYSIS OF STRAIN 9

Deformation, strain tensor in rectangular Cartesian coordinates, Geometric interpretation of infinitesimal strain, rotation, compatibility of strain components, properties of strain tensor, strain in spherical and cylindrical polar coordinates.

2. ANALYSIS OF STRESS 9

Stresses, laws of motion, Cauchy's formula, equations of equilibrium, transformation of coordinates, Plane state of stresses, Cauchy's stress quadric, shearing stress, Mohr's circle, stress deviation, stress tensor in general coordinates, physical components of a stress tensor in general coordinates, equation of equilibrium in curvilinear coordinates.

3. LINEAR THEORY OF ELASTICITY 8

Generalized Hooke's law, Stress-Strain relationship for an isotropic elastic material, Basic equation of elasticity for homogeneous isotropic bodies, boundary value problems, the problem of equilibrium and the uniqueness of solution of elasticity, Saint-Venant's principle.

4. TORSION 7

Torsion of prismatic bars, torsion of circular, elliptic and rectangular bars, membrane analogy, torsion of rectangular section and hollow thin walled sections.

5. SOLUTION OF TWO AND THREE DIMENSIONAL PROBLEMS IN ELASTICITY 12

Bending of a cantilever beam, simply supported beam with simple loadings. Semi-infinite medium subjected to simple loadings. Plane elastic waves, Rayleigh surface waves, Love waves, Vibration of an infinite isotropic solid cylinder.

L: 45

BOOKS FOR STUDY:

1. Hetnarski R.B. and Ignaczak J. "Mathematical Theory of Elasticity", Taylor & Francis, London, 2004.
2. Sokolnikoff I.S. "Mathematical Theory of Elasticity", Tata-McGraw Hill, New Delhi, 1974.
3. Achenbach J.D. "Wave Propagation in Elastic Solids", North-Holland Pub. Co., Amsterdam, 1973.

REFERENCES:

1. Srinath L.S., "Advanced Mechanics of Solids", Tata McGraw Hill, New Delhi, 3rd Edition, 2008.
2. Fung Y.C., "Foundations of Solid Mechanics", Prentice Hall Inc., New Jercy, 1965.

MT 9176 ALGORITHMIC GRAPH THEORY

L	T	P	C
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1. INTRODUCTION TO GRAPHS AND ALGORITHMIC COMPLEXITY 9

Introduction to graphs – Introduction to algorithmic complexity – Introduction to data structures and depth - First searching – Adjacency matrices and Adjacency lists – Depth first searching – Spanning trees and branching – Optimum weight spanning trees – Optimum branching – Enumeration of spanning-trees. Circuits, Cut-sets, and Connectivity – Fundamental of circuits of graphs – Fundamental cut – Sets of a graph – Connectivity

2. PLANAR GRAPHS AND NETWORK FLOW 9

Basic properties of planar graphs – Genus, crossing-number and thickness – Characterizations of planarity - Dual Graphs – Planarity testing algorithm – Networks and flows – Maximizing the flow in a network – Menger's theorems and connectivity – Minimum cost flow algorithm.

3. GRAPH TRAVERSALS AND MATCHINGS 9

Matching – Maximum matching - Perfect Matching – Maximum – Weight matching - Eulerian paths and circuits – Eulerian graphs – Finding Eulerian circuits. Postman problems – Counting Eulerian circuits – Chinese postman problem for undirected graphs – Chinese postman problem for digraphs – Hamiltonian tours – some elementary existence theorems – Finding all Hamiltonian tours by martial products – Traveling salesman problem - 2- Factors of a graph.

4. GRAPH COLOURING 9

Dominating sets, independence cliques – Coloring graphs – Edge – Coloring – Vertex – Coloring – Chromatic polynomials – Face coloring of embedded graphs – Five colour theorem – Four colour theorem.

5. GRAPH PROBLEMS AND INTRACTABILITY 9

Introduction to NP - Completeness – Classes P and NP – NP - Completeness and Cook's theorem. NP - Complete graph problems – Problems of vertex cover, independent set and clique – Problems of Hamiltonian paths and circuits and the traveling salesman problem – Problems concerning the coloring of graphs.

L : 45

BOOK FOR STUDY:

1. Gibbon. A., "Algorithmic Graph Theory", Cambridge University Press, 1985.

REFERENCE:

1. Douglas B. West, "Introduction to Graph Theory", Prentice Hall of India, 2002.

MT 9177 ADVANCED GRAPH THEORY

L	T	P	C
3	0	0	3

1. PERFECT GRAPHS **9**

The Perfect graph theorem – Chordal graphs – Other class of Perfect graphs – Imperfect Graphs – The Strong Perfect Graph Conjecture.

2. RAMSEY THEORY **9**

Ramsey's Theorem – Ramsey Numbers – Graph Ramsey Theory – Sperner's Lemma and Bandwidth.

3. EXTREMAL GRAPHS **9**

Encodings of Graphs – Branchings and Gossip – List Coloring and Choosability – Partitions Using Paths and Cycles.

4. CONNECTEDNESS IN DIGRAPHS **9**

Digraphs – Connected and Disconnected graphs – Strong digraphs – Digraphs and matrices.

5. TOURNAMENTS **9**

Properties of tournaments – Hamiltonian tournaments – Score Sequences.

L : 45

BOOKS FOR STUDY:

1. M. Bezhad G. Chartrand, L. Lesneik Foster, "Graphs and Digraphs", Wadsworth International Group, 1995.
2. Douglas B. West, "Introduction to Graph Theory", Prentice Hall of India, 2002.

REFERENCES:

1. Martin Charles Golumbic, "Algorithmic Graph Theory and Perfect Graphs", Academic Press, 1980.
2. Bela Bollabas, "Extremal Graph Theory", Dover Publications, 2004.
3. Jorgen Bang-Jensen and Gregory Gutin, "Digraphs – Theory, Algorithms and Applications", Springer-Verlag London, 2001.

MT 9178 QUEUEING AND RELIABILITY MODELLING

L	T	P	C
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1. MARKOVIAN QUEUES: 9

Arrival and Departure processes, single and multiple channel queues, Queues with finite waiting room, Little's formula, waiting time distributions, busy period analysis, Erlang's loss formula (Transient solutions for M/M/1 model) and Self-serving queues.

2. QUEUES WITH SPECIAL CHARACTERISTICS 9

Finite source queue, State-dependent queues, Balking and reneging, Bulk input and bulk service models, Erlangian Models, Priority queues.

3. NON-MARKOVIAN QUEUES 9

M/G/1 queueing model, Pollaczek-Khintchine formula, steady-state system size probabilities, waiting time distributions, Generalization of Little's formula, Busy period analysis.

4. RELIABILITY CHARACTERISTICS 9

Reliability and hazard functions – exponential, normal, log-normal, weibull and Gamma failure distributions – Time-dependent hazard models, Reliability of series, stand by and parallel systems, k-out-of-m systems.

5. SYSTEM RELIABILITY 9

Redundancy techniques in system design, Optimal Design – Availability and maintainability concepts, Markovian models for reliability and availability of repairable two-unit systems, Preventive maintenance.

L: 45

BOOKS FOR STUDY:

1. Gross D. and Harris C.M., "Fundamentals of Queueing Theory", John Wiley and Sons, New York, 1998. (Chapters 1-5)
2. Balagurusamy E., "Reliability Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi, 1984. (Chapters 4-7)

REFERENCES:

1. Govil A.K., "Reliability Engineering", Tata-McGraw Hill Publishing Company Ltd., New Delhi, 1983.
2. Charless E. Ebeling, "Reliability and Maintainability Engineering", Tata McGraw Hill, New Delhi, 2000.
3. A. Bivolioni, "Quality and Reliability of Technical Systems", Spring, Belgin, 2nd Edition, 1997.
4. J. Medhi," Stochastic models of Queueing Theory", Academic Press, Elsevier, Amsterdam, 2003.