M.Sc. Mathematics (w.e.f 2008 - 09)

S.No	Course Code	Course	Hours	Credits	CA	ESE
Semester - I						
1.	MMT–1	Algebra – I	6	4	50	50
2.	MMT–2	Real Analysis – I	6	4	50	50
3.	MMT–3	Ordinary Differential Equations	6	4	50	50
4.	MMT–4	Topology	6	5	50	50
5.	MMT–E1	Formal Languages and Automata theory	6	5	50	50
Semester – II						
6.	MMT–5	Algebra – II	6	4	50	50
7.	MMT–6	Real Analysis – II	5	4	50	50
8.	MMT–7	Partial Differential Equations	5	4	50	50
9.	MMT–8	Graph Theory	6	5	50	50
10.	MMT–E2	Programming in C++ and Numerical Methods	6	5	50	50
11.		Soft Skill Programme - 1	2	4	50	
Semester – III						
11.	MMT–9	Complex Analysis – I	6	5	50	50
12.	MMT–10	Mechanics	5	4	50	50
13.	MMT–11	Differential Geometry	5	4	50	50
14.	MMT–12	Mathematical Statistics	6	5	50	50
15.	MMT–E3	Discrete Mathematics	6	5	50	50
		Soft Skill Programme - 2	2	4	50	
Semester – IV						
16.	MMT–13	Complex Analysis – II	6	4	50	50
17.	MMT–14	Fluid Dynamics	6	4	50	50
18.	MMT–15	Functional Analysis	6	5	50	50
19.	MMT–16	Operations Research	6	5	50	50
20.	MMT–E4	Number Theory and Cryptography	6	5	50	50

Internship		2	
Total Credits		**100**	

MMT - 1: ALGEBRA – I (4 CREDITS)

UNIT I

Another counting principle – class equation for finite groups and its applications – Sylow's Theorems(for theorem 2.12.1, first proof only)

Chapter 2: section 2.11 and 2.12 (Omit Lemma 2.12.5)

UNIT II

Solvable groups – Direct Products – Finite abelian groups – Modules

Chapter 5: section 5.7(Lemma 5.7.1, Lemma 5.7.2, Theorem 5.7.1)
Chapter 2: section 2.13 and 2.14 (Theorem 2.14.1 only)
Chapter 4: section 4.5

UNIT III

Linear Transformations: Canonical forms – Triangular forms – nilpotent Transformations

Chapter 6: section 6.4 and 6.5.

UNIT IV

Jordan forms – Rational Canonical forms.

Chapter 6: section 6.6 and 6.7.

UNIT V

Trace and Transpose – Hermitian, Unitary, Normal Transformations, Real quadratic forms.

Chapter 6: section 6.8, 6.10 and 6.11

CONTENT AND TREATMENT AS IN

I. N. Herstein. Topics in Algebra (II Edition), Wiley Eastern Limited, New Delhi, 1975.

BOOKS FOR SUPPLEMENTARY READING AND REFERENCE:

1. M. Artin, Algebra, Prentice Hall of India, 1991.
2. P.B. Bhattacharya, S.K. Jain, and S.R. Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997. (Indian Editon)
3. I.S. Luther and I.B.S. Passi, Algebra, Vol. I-Groups(1996); Vol. II Rings, Narosa Publishing House, New Delhi,1999
4. D.S. Malik, J.N. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill (International Edition), New York. 1997.
5. N. Jacobson, Basic Algebra, Vol. I & II W.H. Freeman (1980); also published by Hindustan Publishing Company, New Delhi.

MMT - 2: REAL ANALYSIS – I (4 CREDITS)

UNIT I

Infinite Series and Infinite Products: Absolute and conditional convergence – Dirichlet's test and Abel's test – Rearrangement of series – Riemann's theorem on conditionally convergent series, Double sequences – Double series – Rearrangement theorem for double series – A sufficient condition for equality of iterated series – Multiplication of series – Cesaro summability – Infinite products.

Chapter 8: Sections 8.8, 8.15, 8.17, 8.18, 8.20, 8.21 to 8.26.

UNIT II

Power Series: Multiplication of power series – The Taylor's series generated by a function – Bernstein's theorem – Abel's limit theorem – Tauber's theorem.

Chapter 9: Sections 9.14, 9.15, 9.19, 9.20, 9.22, 9.23.

UNIT III

Fourier Series and Fourier Integrals: Introduction – Orthogonal system of functions – The theorem on best approximation – The Fourier series of a function relative to an orthonormal system – Properties of Fourier Coefficients – The Riesz-Fischer theorem – The convergence and representation problems for trigonometric series – The Riemann-Lebesgue lemma – The Dirichlet integrals – An integral representation for the partial sums of Fourier series – Riemann's localization theorem – Sufficient conditions for convergence of a Fourier series at a particular point – Cesaro summability of Fourier series – Consequences of Fejes's theorem – The Weierstrass approximation theorem.

Chapter 11: Sections 11.1 to 11.15

UNIT IV

Multivariable Differential Calculus: Introduction – The directional derivative – Directional derivative and continuity – The total derivative – The total derivative expressed in terms of partial derivatives – The matrix of linear function – The Jacobian matrix – The chain rule – Matrix form of chain rule – The mean value theorem for differentiable functions – A sufficient condition for differentiability – A sufficient condition for equality of mixed partial derivatives.

Chapter 12: Section 12.1to 12.13

UNIT V

Taylor's formula for functions from R^n to R^1.

Implicit functions and Extremum Problems: Functions with non-zero Jacobian determinants – The inverse function theorem – the implicit function theorem – Extrema of real valued functions of several variables – Extremum problems with side conditions.

Chapter 12: Sec 12.14 and Chapter 13: Sections 13.1 to 13.7

CONTENT AND TREATMENT AS IN:

Tom M. Apostal: Mathematical Analysis, 2nd Ed., Addison-Wesley Co. Inc., New York, 1974.

BOOKS FOR SUPPLEMENTARY READING AND REFERENCE:

1. Bartle R.G., Real Analysis, John Wiley and Sons Inc., 1976.
2. Rudin W., Principles of Mathematical Analysis, 3rd Edition. McGraw Hill Company, New York, 1976.
3. Malik,S.C. and Savita Arora. Mathematical Analysis, Wiley Eastern Limited, New Delhi, 1991.
4. Sanjay Arora and Bansi Lal, Introduction to Real Analysis, Satya Prakashan, New Delhi, 1991.
5. Gelbaum, B.R. and J.Olmsted, Counter Examples in Analysis, Holden day, San Francisco,1964.

MMT - 3: ORDINARY DIFFERENTIAL EQUATIONS (4 CREDITS)

UNIT I

Linear equations with constant coefficients : second order homogeneous equations – Initial value problems – Linear dependence and independence – Wronskian and a formula for Wronskian – Non-homogeneous equation of order two.

Chapter 2 : Sections 1 to 6

UNIT II

Linear Equations with constant coefficients : Homogeneous and non-homogeneous equation of order n – Initial value problems – Annihilator method to solve non-homogeneous equation – Algebra of constant coefficient operators.

Chapter 2 : Sections 7 to 12

UNIT III

Linear equations with variable coefficients : Initial value problems – Existence and uniqueness theorems – Solutions to solve a non-homogeneous equation – Wronskian and linear dependence – reduction of the order of a homogeneous equation – homogeneous equation with analytic coefficients – The Legendre equation.

Chapter 3 : Sections 1 to 8

UNIT IV

Linear equation with regular singular points : Euler equation – Second order equations with regular singular points – Exceptional cases – Bessel function.

Chapter 4 : Sections 1 to 4 and 6 to 8

UNIT V

Existence and uniqueness of solutions of first order equations : Equation with variable separated – Exact equation – Method of successive approximations – The Lipschitz condition – Convergence of the successive approximation and the existence theorem.

Chapter 5 : Sections 1 to 6

CONTENT AND TREATMENT AS IN:

E. A. Coddington : An introduction to ordinary differential equations, 3rd. Ed., Prentice-Hall of India Ltd., New Delhi, 1987.

MMT - 4: TOPOLOGY (5 CREDITS)

UNIT I: Topological Spaces:

Topological spaces – Basis for a topology – The order topology – The product topology on X x Y – The subspace topology – Closed sets and limit points

Chapter 2 : Sections 12 to 17

UNIT II: Continuous Functions

Continous functions – the product topology – The metric topology

Chapter 2 : Sections 18 to 21

UNIT III: Connectedness

Connected spaces – connected subspace of the Real line – Components and local connectedness.

Chapter 3: Sections 23 to 25

UNIT IV : Compactness

Compact spaces – compact subspaces of the Real line – Limit point compactness – Local compactness

Chapter 3 : Sections 26 to 29

UNIT V : Countability and Separation Axiom

The Countability axioms – The separation axioms – Normal spaces - The Urysohn lemma – The Urysohn metrization theorem – The Tietz extension theorem

Chapter 4 : Sections 30 to 35

CONTENTS AND TREATMENT AS IN :

James R. Munkres, Topology (2^{nd} Edition) Pearson Educative Pvt. Ltd., Delhi – 2002 (Third Indian Reprint)

BOOKS FOR SUPPLEMENTARY READING AND REFERENCE:

1. J.Dugundji, Topology, Prentice Hall of India, New Delhi, 1975.
2. George F.Sinmons, Introduction to Topology and Modern Analysis, McGraw Hill Book Co., 1963
3. J.L.Kelly, General Topology, Van Nostrand, Reinhold Co., New York
4. L.Steen and J.Seeback, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970.
5. S.Willard, General Topology, Addison - Wesley, Mass., 1970

MMT – E1

FORMAL LANGUAGES AND AUTOMATA THEORY (5 CREDITS)

UNIT I

Finite Automata, Regular Expressions and Regular Grammars: Finite state systems-Basic definitions-Non-deterministic finite automata-Finite automata with ε moves-Regular expressions-Regular grammars.

Chapter 2: Sections 2.1 – 2.5 and Chapter 9: Section 9.1

UNIT II

Properties of Regular sets: The Pumping lemma for regular sets-Closure properties of regular sets-Decision algorithms for regular sets-The Myhill-Nerode Theorem and minimization of finite automata.

Chapter 3: Sections 3.1 – 3.4

UNIT III

Context-free Grammars: Motivation and introduction-Context-free grammars-Derivation trees-Simplification of context-free grammars-Chomsky normal form-Greibach normal form.

Chapter 4: Sections 4.1 – 4.6

UNIT IV

Push-down Automata:Informal description-Definitions, pushdown automata and context-free languages.

Chapter 5: Sections 5.1 – 5.3

UNIT V

Properties of Context-free languages: Pumping lemma for CFL's-Closure properties for CFL's.

Chapter 6: Sections 6.1 – 6.2 (Ogden's lemma in section 6.1 is not included)

CONTENT AND TREATMENT AS IN:

John E. Hopcraft and Jeffrey D. Ullman: Introduction to Automata Theory, Languages and Computation, Narosa Publishing House, New Delhi, 1989

SEMESTER – II
MMT – 5: ALGEBRA – II (4 CREDITS)

UNIT I

Extension Fields – Transcendence of e

Chapter 5: Section 5.1 and 5.2.

UNIT II

Roots of Polynomials – More about roots.

Chapter 5: Section 5.3 and 5.5.

UNIT III

Elements of Galois theory.

Chapter 5: Section 5.6.

UNIT IV

Finite Fields – Wedderburn's theorem on finite division rings.

Chapter 7: Section 7.1 and 7.2 (theorem 7.2.1 only).

UNIT V

Solvability by Radicals – A theorem on Frobenius – integral quaternions and the four square theorem.

Chapter 5: Section 5.7(omit Lemma 5.7.1 Lemma 5.7.2 and Theorem 5.7.1).
Chapter 7: Section 7.3 and 7,4.

CONTENT AND TREATMENT AS IN

1. N. Herstein. Topics in Algebra (II Edition), Wiley Eastern Limited, New Delhi, 1975.

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. M. Artin, Algebra, Prentice Hall of India, 1991
2. P.B. Bhattacharya S.k. Jain and S.R. Nagpaul, Basic Abstract Algebra (II Edition) Cambridge University Press, 1997 (Indian Edition)
3. I.S. Luther and I.B.S. Passi, Algebra, Vol. 1 – Groups (1996); Vol. II Rings, Narosa Publishing House, New Delhi, 1999
4. D.S. Malik, J.N. Mordeson and M.K. Sen, Fundamentals of Abstract Algebra, McGraw Hill (International Edition), New York, 1997
5. N. Jacobson, Basic Algebra, Vol. I & II W.H. Freeman (1980); also published by Hindustan Publishing company, New Delhi.

MMT - 6: REAL ANALYSIS – II (4 CREDITS)

UNIT I

Lebesgue outer measure – Measurable sets – Regularity – Measurable functions – Borel and Lebesgue measurability.

Chapter 2 : Sections 2.1 to 2.5.

UNIT II

Integration of non-negative functions – The general integral – Integration of series – Riemann and Lebesgue integrals.

Chapter 3 : All sections.

UNIT III

Measures and outer measures – Extension of a measure – Uniqueness of the extension – Completion of a measure – Measure spaces – Integration with respect to a measure.

Chapter 5 : All sections.

UNIT IV

L^p spaces – Convex function – Jensen inequality – The inequalities of Holder and Minkowski – Completeness of $L^p(\mu)$

Chapter 6 : All sections

UNIT V

Signed measure and Hahn decomposition – The Jordan decomposition – The Radon-Nikodym theorem – Some application of the Radon-Nikodym theorem.

Chapter 8 : Sections 8.1 to 8.4

CONTENT AND TREATMENT AS IN

G. de Barra : Measure Theory and Integration, Wiley Eastern Ltd., New Delhi, 1987.

BOOKS FOR SUPPLIMENTRY READING AND REFERENCE

1. Bukill,J.C The Lebesgue integral, Cambridge University Press, 1951.
2. Munroe,M.E. Measure and integration. Addison Wesley Mass.1971.
3. Roydon H.L.Real Analysis,Macmillan Publishing Company, New York,1988.
4. Rudin, W.Principles of Mathematical Analysis, Wiley Eastern Limited. New Delhi, 1979.
5. Malik,S.C. and Bansi lal, Introduction to Real Analysis, Satya Prakashan, New Delhi

MMT - 7: PARTIAL DIFFERENTIAL EQUATIONS (4 CREDITS)

UNIT I

First Order P.D.E:- Curves and Surfaces, Genesis of first order p.d.e, Classification of Integrals, Linear equations of first norder, Pfaffian differential equations

Chapter 1: Sections 1.1 – 1.5

UNIT II

First Order P.D.E:- Compatible Systems, Charpit's method, Jacobi's method, Integral surfaces through a given curve

Chapter 1: Sections 1.6 – 1.9

UNIT III

Second Order P.D.E:- Genesis of second order p.d.e, Classification of second order p.d.e, One-dimensional Wave equation – vibrations of infinite, semi-infinite and finite strings.

Chapter 2: Sections 2.1 - 2.3.3

UNIT IV

Second Order P.D.E:-Laplace's equation, Boundary value problems, Maximum and minimum principle, Cauchy problem, Dirichlet problem and Neumann problem for Circle and Rectangle.

Chapter 2: Sections 2.4.1 – 2.4.9

UNIT V

Second Order P.D.E:- Heat Conduction problem, Duhamel's principle, Families of Equipotential surfaces, Kelvin's inversion theorem.

Chapter 2: Sections 2.5 – 2.9

CONTENT AND TREATMENT AS IN:

An Elementary Course in Partial Differential Equations (2^{nd} Edition) – T. Amarnath, Narosa Publishing House, 2003

BOOKS FOR SUPPLIMENTRY READING AND REFERENCE

1. Partial Differential Equations for Engineers and Scientists – J.N.Sharma & Kehar Singh, Narosa Publishing House, 2000
2. Advanced Differential Equations – M.D.Raisinghania, S.Chand & Co., 1997
3. Partial Differential Equations for Science and Engineers – Tyn Miu & Loknath Debnath, North-Holland, 1987

MMT - 8: GRAPH THEORY (5 CREDITS)

UNIT I

Graphs, Sub-graphs and Trees: Graphs and simple graphs – Graph isomorphism – The incidence and adjacency matrices – subgraphs – Vertex degrees – Paths and connection – Cycles – Trees – Cut edges and bonds – Cut vertices.

Chapter 1: Sections 1.1 – 1.7 and Chapter 2: Section 2.1 – 2.3

UNIT II

Connectivity, Euler tours and Hamilton cycles: Connectivity – Blocks – Euler tours – Hamilton Cycles.

Chapter 3: Sections 3.1 – 3.2 and Chapter 4: Sections 4.1 – 4.2

UNIT III

Matchings and Edge Colourings: Matchings – Matchings and coverings in bipartite graphs – Edge chromatic number – Vizing's theorem.

Chapter 5: Sections 5.1 – 5.2 and Chapter 6: Sections 6.1 – 6.2

UNIT IV

Independent sets and Cliques, Vertex Colorings: Independent sets – Ramsey's theorem – Chromatic number – Brook's theorem – Chormatic polynomials.

Chapter 7: Sections 7.1 – 7.2 and Chapter 8: Sections 8.1 – 8.2 and 8.4

UNIT V

Planar graphs: Plane and planar graphs – Duel graphs – Euler's formula – The Five-color theorem and the four-Color conjecture.

Chapter 9: Sections 9.1 – 9.3 and 9.6

Content and treatment as in:

J.A. Bondy and U.S.R Murthy: Graph Theory and Applications, Macmillan , London, 1976.

BOOKS FOR SUPPLIMENTRY READING AND REFERENCE

1. J.Clark and D.A.Holton, A First look at Graph Theory, Allied Publishers, New Delhi, 1995.
2. R.Gould. Graph Theory, Benjamin/Cummings. Mento Park,1989.
3. A.Gibbons, Algorithmic Graph Theory, Cambridge University Press, Cambridge,1989.
4. R.J.Wilson and J.J.Watkins, Graphs : An Intorductory Approach, John Wiley and Sons, New York, 1989.
5. S.A.Choudum, A First Course in Graph Theory, MacMillan India Ltd. 1987.

MMT – E2

PROGRAMMING IN C++ AND NUMERICAL METHODS (5 CREDITS)

UNIT-I :

Tokens, Expressions and Control Structures – Functions in C++
Chapters: 3 and 4

UNIT-II :

Classes and Objects – Constructors and Destructors – Operator Overloading and Type conversions
Chapters: 5, 6 and 7

UNIT-III :

Inheritance – Pointers – Virtual Functions and Polymorphism
Chapters: 8 and 9

CONTENT AND TREATMENT AS IN:

E. Balagurusamy, *Object Oriented Programming with* C++, Tata McGraw Hill, New Delhi, 1999.

UNIT- IV:

Numerical Solution of Transcendental Equations: Definition of Root or Zero of a function – Concept of Iterative Methods – Search Method for Initial Guess – Bisection Method – False Position Method – Newton-Raphson Method – Secant Method – Method of Successive Iteration – Comparison of Different Root Method.

I**nterpolation**: Newton's Divided Difference Interpolation – Lagrange's Interpolation.

Chapter 2: Sec. 2.1 to 2.10 and Chapter 6: Sec. 6.12 to 6.13

UNIT-V :

Solution of Differential Equations: Picards Method – Taylar Series Method - Euler's Method – Heun's Method – Modified Euler's Method – Range-Kutta Method – Second Order Range-Kutta Methods, Fourth order Range-Kutta Method – Single step and Multi-step Methods – Milne-Simpson Method, Adams-Bashforth Method.

Chapter 10: Sec. 10.1 to 10.10 and 10.12 to 10.13 (Omit 10.11)

CONTENT AND TREATMENT AS IN:

P.B. Patil, U.P. Verma, *Numerical Computational Methods,* Narossa Publishing House, 2006.

BOOKS FOR SUPPLEMENTARY READING AND REFERENCE:

1. V. Rajaraman, *Computer Oriented Numerical Methods*, 3rd Edision, Prentice Hall of India, 1994
2. John H. Mathews, *Numerical Methods for Mathematics, Science and Engineering* (2nd Edn.), Prentice Hall, New Delhi, 2000
3. D. Ravichandran, *Programming with* C++, Tata McGraw Hill, New Delhi, 1996

SEMESTER – III
MMT - 9: COMPLEX ANALYSIS – I (5 CREDITS)

UNIT I

Cauchy's integral formula : The index of a point with respect to a closed curve – The integral formula – Higher derivatives – Local properties of analytical functions – Removable singularities – Taylor's theorem – Zeros and poles – The local mapping – The maximum principle

Chapter 4 : Sections 2.1 to 2.3, 3.1 to 3.4

UNIT II

The General form of Cauchy's theorem : Chains and cycles – Simple Connectivity – Homology – The general statement of Cauchy's theorem – Proof of Cauchy's theorem – Locally exact differentials – Multiply connected regions – Residue theorem – The argument principle

Chapter 4 : Sections 4.1 to 4.7, 5.1 and 5.2

UNIT III

Evaluation of definite integrals and harmonic functions : Evaluation of definite integrals – Definition of Harmonic function and basic properties – Mean-value property – Poisson's formula

Chapter 4 : Sections 5.3 and 6.1 to 6.3

UNIT IV

Harmonic functions and power series expansions : Schwarz theorem – The reflection principle – Weierstrass's theorem – Taylor series – Laurent series

Chapter 4 : Sections 6.4, 6.5 and Chapter 5 : Sections 1.1. to 1.3

UNIT V

Partial fractions and entire functions : Partial fractions – Infinite products – Canonical products – Gamma function – Jensen's formula – Hadamard's theorem.

Chapter 5 : Sections 2.1 to 2.4, 3.1 and 3.2

CONTENTS AND TREATMENT AS IN :

Lars V. Ahlfors, Complex Analysis, 3rd Ed., McGraw Hill Co., New Delhi, 1979.

BOOKS FOR SUPPLEMENTARY READING AND REFERENCE:

1. H.A. Prestly, introduction to complex, Clarendon Press, Oxford, 1990.
2. J.B. Conway, Functions of one complex variable, Springer – Verlag, International student Edition, Narosa Publishing Co.
3. E. Hille, Analytic function theory (2 vols), Gonm & Co,1959.
4. M. Heins, Complex function Theory, Academic Press, New York, 1968.

MMT - 10: MECHANICS (4 CREDITS)

UNIT I

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

Chapter 11 : Sections 11.1, 11.2, 11.3 (Omit existence theorem, Method of symmetry, MIA simple bodies), 11.4, 11.5 and Chapter 12 : Sections 12.1, 12.2

UNIT II

Moving frames of references – Motion of a rigid body – Impulsive motion – Simple pendulum – The spherical pendulum.

Chapter 12 : Sections 12.3, 12.4, 12.5 and Chapter 13: Sections 13.2, 13.3

UNIT III

Introduction to Lagrange's equations – Lagrange's equations continued – Hamilton's equations – Action and Hamilton's principle.

Chapter 15: 15.1, 15.2, 15.3 and Chapter 16 : Section 16.1

UNIT IV

Introduction to Relativity – Relativistic Kinematics.

Chapter 7 : 7.1, 7.2

UNIT V

Relativistic Dynamics, Accelerated Systems.

Chapter 7 : Section 7.3, 7.4

CONTENT AND TREATMENT AS IN:

UNITS I to III : John L. Synge and Byron A. Griffith : Principles of Mechanics, Hill Book Company, Inc., 3rd Edn., 1959.

UNITS IV & V : Donald T. Greenwood : Classical Mechanics, Prentice-Hall Inc., 1977.

BOOKS FOR REFERENCE :

1. H. Goldstein, Classical Mechanics, 2nd Ed., Narosa Publishing House, New Delhi.
2. N. C. Rane and P. S. C. Joag, Classical Mechanics, Tata McGraw Hill, 1991.

MMT-11: DIFFERENTIAL GEOMETRY (4 CREDITS)

UNIT I

Space Curves : Definition of a space curve – Arc length – Tangent – Normal and binormal – Curvature and torson – Contact between curves and surfaces – Tangent surface – Involutes and evolutes – Intrinsic properties.

Chapter 1: Sections 1 - 9

UNIT II

Intrinsic properties of a surface : Definition of a surface – Curves on a surface of revolution – Helicoids – Metric – Direction coefficients – Families of curves – Isometric correspondence – Intrinsic properties.

Chapter 2: Sections 1 - 9

UNIT III

Geodesics : Geodesics – Canonical geodesic equations – Normal property of geodesics – Existence theorems – Geodesic parallels – Geodesics curvature – Gauss-Bonnet theorem – Gaussian curvature – Surface of constant curvature.

Chapter 2: Sections 10 - 18

UNIT IV

Non-intrinsic properties of a surface : The second fundamental form Principle curvature – Lines of curvature – Developable – Developable associated with space curves and with curves on surface – Minimal surfaces – Rules surfaces.

Chapter 3: Sections 1 – 8

UNIT V

Differential geometry of surfaces : Compact surfaces whose points are umblics – Hilbert's lemma – Compact surface of constant curvature – Complete surface and their characterization – Hilbert's theorem – Conjugate points on geodesics.

Chapter 4: Sections 1 - 8

CONTENT AND TREATMENT AS IN:

T.J.Wilmore: An Introduction to Differential Geometry, Oxford University Press, 17th Impression, New Delhi 2002 (Indian Print)

BOOKS FOR SUPPLEMENTARY READING AND REFERENCE :

1. Struik, D.T. Lectures on Classical Differential Geometry, Addison – Wesley, Mass. 1950.
2. Kobayashi. S. and Nomizu. K. Foundations of Differential Geometry, Interscience Publishers, 1963.
3. Wilhelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer-Verlag 1078.
4. J. A. Thrope Elementary topics in Differential Geometry, Under – graduate Texts in Mathematics, Springer – Verlag 1979.

MMT - 12: MATHEMATICAL STATISTICS (5 CREDITS)

Unit – I

Probability – I and II; Random Variables and Distribution functions

Chapters: 3, 4 and 5

Unit – II

Mathematical Expectation; Generating Functions and Law of Large Numbers

Chapters: 6 and 7 (Sections: 7.1 to 7.8)

Unit – III

Special Discrete Probability Distribution; Special Continuous Probability Distribution

Chapters: 8 (Sections: 8.1 to 8.9) and 9 (Sections: 9.1 to 9.3, 9.5 to 9.8, 9.12 and 9.13)

Unit – IV

Large Sample Theory ; Exact Sampling Distribution – I (χ^2 – Distribution) and Exact Sampling Distribution – II (t, F and Z – Distributions)

Chapters: 14, 15 (Sections: 15.1 to 15.4 and 15.6) and
16 (Sections: 16.1 to 16.3 and 16.5 to 16.10)

Unit – V

Statistical Inference – I (Theory of Estimation);
Statistical Inference – II (Tests of Hypothesis)

Chapters: 17 (Sections: 17.1 to 17.3, 17.6 and 17.7) and 18 (Sections: 18.1 to 18.6)

CONTENT AND TREATMENT AS IN:

S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, New Delhi, 2002.

BOOKS FOR SUPPLEMENTARY READING AND REFERENCE :

1. K. L.Chung, A course in Probability, Academic Press, New Tork, 1974.
2. Y.S. Chow and H. Teicher, Probability theory, Springer Verlag. Berlin, 2005 (3^{rd} Edition).
3. R. Durrett, Probability : Theory and Examples, (2^{nd} Edition) Duxbury Press, New York, 1996.
4. M. Fisz, Probability theory and mathematical statistics, John Wiley and Sons,New York.1963.
5. V. K. Rohatgi, An Introduction to Probability theory and Mathematical Statistics, Wilsey Eastern Ltd, New Delhi, 1988 (3^{rd} Print).
6. S. I. Resnick, A Probability Path, Birhauser, Berlin, 1999.

MMT – E3

DISCRETE MATHEMATICS (5 CREDITS)

UNIT I

Mathematical Logic: Statements and Notations – Connectives: Negation, Conjunction, Disjunction – Statement Formulas and Truth Tables – Conditional and Bi-conditional – Well-formed Formulas – Tautologies – Equivalence of Formulas – Duality Law – Normal Forms: Disjunctive Normal Form – Conjunctive Normal Form – Principal Disjunctive and Conjunctive Normal Forms.

Chapter 1: Sections 1.1 to 1.2.10, 1.3.1 to 1.3.4. (Omit *1.2.5*)

Content and treatment as in (For Unit I)

J.P. Tremblay and R. Manohar: Discrete Mathematical Structures with Applications to Computer Science, Mc-Graw Hill Book Co., 2nd Ed., 1984.

UNIT II

Boolean algebra: Introduction – Order – Boolean Polynomials – Block Diagrams for Gating Networks – Connections with Logic – Boolean Sub-algebras.

Chapter 5: Sections 5.1 to 5.5, 5.8.

UNIT III

Lattices: Lattices and Posets – Lattices as Poset – Lattices and Semi lattices – Sub-lattices – Direct Products – Distributive Lattices – Modular and Geometric Lattices – Boolean Lattices.

Chapter 9: Sections 9.1 to 9.7.

Content and treatment as in (For Units II and III)

Garrett Birkoff and Thomas C. Barte: Modern Applied Algebra, CBS Publications and Distributors, 1987.

UNIT IV

Turing Machines: Introduction – The Turing Machine Model – Computable Languages and Functions – Technique of Turing Machine Construction – Modifications of Turing Machines – Church's Hypothesis.

Chapter 7: Sections 7.1 to 7.6.

Content and treatment as in (For Units IV)

John E. Hopcroft and Jeffrey D. Ullman: Introduction to Automata Theory, Languages and Computation, Narosa Publishing House, 1993.

UNIT V

Coding Theory: Error-Correcting Codes – Linear Codes – Variable-Length and Huffman Codes

Chapter 11: Sections 11.1 to 11.3

CONTENT AND TREATMENT AS IN (FOR UNIT V)

John Truss: Discrete Mathematics for Computer Scientists, Addison-Wesley, 2000.

BOOKS FOR SUPPLEMENTARY READING AND REFERENCE

1. Rudolf Lidl Gunder Pilz, Applied Algebra, Springer Verlag, New York, 1984.
2. A. Gill, Applied Algebra for Computer Science, Prentice Hall Inc., New Jersey.

SEMESTER – IV
MMT - 13: COMPLEX ANALYSIS – II (5 CREDITS)

UNIT I

Riemann zeta function and normal families: Product development – Extension of $\varsigma(s)$ to the whole plane – The zeros of zeta function – Equicontinuity – Normality and compactness – Arzela's theorem – Families of analytic functions – The classical definition.

Chapter 4: Sections 4.1 to 4.4, Chapter 5: Sections 5.1 to 5.5.

UNIT II

Riemann mapping theorem: Statement and Proof – Boundary behaviour – Use of the reflection principle.

Conformal mapping of polygons : Behaviour at an angle – Schwarz-Christoffel formula – Maping on a rectangle.

Harmonic Functions : Functions with mean value property – Harnack's principle.

Chapter 6: Sections 1.1 and 1.3, 2.1 to 2.3, 3.1 and 3.2.

UNIT III

Elliptic Functions : Simply periodic functions – Doubly periodic functions.

Chapter 7: Sections 1.1 to 1.3 and 2.1 to 2.4.

UNIT IV

Weiertrass Theory : The Weierstrass $\wp$-function – The functions $\varsigma(z)$ and $\sigma(z)$ – The differential equation – The modular function $\lambda(\tau)$ – The Conformal mapping by $\lambda(\tau)$.

Chapter 7: Sections 3.1 to 3.5.

UNIT V

Analytic Continuation : The Weirstrass theory – Germs and sheaves – Sections and Riemann surfaces-Analytic continuation along arcs – Homotopic curves – The Monodromy theorem – Branch points.

Chapter 8: Sections 1.1 to 1.7.

CONTENTS AND TREATEMENT AS IN:

Lars F. Ahlfors, Complex analysis, 3rd Ed.,McGraw Hill book company, New York, 1979.

BOOKS FOR SUPLEMENTARY READING AND REFERENCE

1. H.A .Prestly, Introduction to complex Analysis, Clarendon Press, Oxford, 1990.
2. J.B.Conway, Functions of one complex variable, Springer, - Verlag. International student Edition, Narosa Publishing Co.
3. E.Hille, Analytic function Theory (2 vols.), Gonm & Co, 1959.
4. M.Heins, Complex function Theory, Academic Press, New York, 1968.

MMT-14: FLUID DYNAMICS (4 CREDITS)

UNIT I

Kinematics Of Fluids In Motion: Real Fluids and Ideal Fluids – Velocity of a Fluid at a point – Streamlines and Pathlines; Steady and Unsteady Flows – The Velocity Potential – The Velocity Vector – Local and Particle Rates of Changes – The Equation of Continuity – Worked Examples – Acceleration of a Fluid – Condition at a Rigid Boundary

Chapter 2: Sections 2.1 to 2.10.

UNIT II

Equations Of Motion Of A Fluid: Pressure at a Point in a Fluid at Rest - Pressure at a Point in a Moving Fluid – Conditions at a Boundary of two Inviscid Immiscible Fluids – Euler's Equations of Motions – Bernoulli's Equation – worked Examples – Discussion of the Case Steady Motion under Conservative Body Force – Some flows involving axial symmetry – Kelvin's Theorem

Chapter 3: Sections 3.1 to 3.7, 3.9, 3.12

UNIT III

Some Three Dimensional Flows: Introduction – Sources, Sinks, and Doublets – Images in a Rigid Infinite Plane – Axi-Symmetric Flows; Stroke's Stream Function

Chapter 4: Sections 4.1 to 4.3 and 4.5

UNIT IV

Some Two Dimensional Flows: Meaning of Two-Dimensional Flow – Use of Cylindrical Polar Coordinates – The Stream Function – The Complex Potential for Two - Dimensional irrotational, Incompressible Flow – Complex Velocity Potential for Standard Two-Dimensional Flows – Some Worked Examples – The Milne-Thomson Circle Theorem – The Theorem of Blasius

Chapter 5: section 5.1 to 5.6, 5.8, 5.9

UNIT V

Viscous Flows: Stress Components in a Real Fluid – Relations between Cartesian Components of Stress – Translational Motion of Fluid Element – The Rate of Strain Quadric and Principal Stresses – Some Further Properties of the Rate of Strain Quadric – Stress analysis in Fluid Motion – Relations between Stress and Rate of Strain Quadric – The Coefficient of Viscosity and Laminar Flow – The Navier –Stokes Equations of Motion of a Viscous Fluid – Some Solvable Problems in Viscous Flow.

Chapter 8: section 8.1 to 8.10

CONTENTS AND TREATEMENT AS IN

F. Charlton, Text book of Fluid Dynamics, CBS Publications, New Delhi,1985.

MMT - 15: FUNCTINAL ANALYSIS (5 CREDITS)

UNIT I

Banach Spaces: Definition – Some examples – Continuous linear transformations – The Hahn-Banach theorem – natural embedding of N in N**

Chapter 9: Sections 46 to 49.

UNIT II

Banach Spaces and Hilbert Spaces: open mapping theorem – Conjugate of an Operator – Definition and simple properties – Orthogonal complements – Orthogonal sets

Chapter 9: Sections 50 and 51 and Chapter 10: Section 52 to 54.

UNIT III

Hilbert Spaces: Conjugate space H* - Adjoint of an operator – Self-adjoint operators – Normal and Unitary Operators - Projections

Chapter 10: Sections 55 to 59.

UNIT IV

Preliminaries on Banach Algebras: Definition and Some examples – Regular and single elements – Topological divisors of zero – Spectrum – The formula for the spectral radius – The radical and semi-simplicity

Chapter 12**:** Sections 64 to 69.

UNIT V

Structure of Commutative Banach algebras: Gelfand mapping – Applications of the formula $r(X) = lim \, || \, x \, ||^{1/n}$ Involutions in Banach algebras –Gelfand_Neumark theorem.

Chapter 13: Sections 70 to 73.

CONTENTS AND TREATEMENT AS IN:

G.F. Simmons, Introduction to topology and Modern Analysis, McGraw Hill International book company, New York, 1963.

BOOKS FOR SUPPLEMENTARY READING AND REFERENCES:

1. W. Rudin , Functional Analysis, Tata McGraw-Hill Publishing Company, New Delhi, 1973
2. G. Bachman and L. Narici, Functional Analysis, Academic Press, New york, 1966.
3. H. C. Goffman and G. Fedrick, Firrst Course in Functional Analysis, Printice Hall of India, New Delhi, 1987
4. E. Keryszig, Introductory Functional Analysis with Applications, John Wiley & Sons, New York, 1978.

MMT – 16: OPERATIONS RESEARCH (5 CREDITS)

UNIT - I

Revised Simplex Method: Introduction - Standard forms for Revised Simplex Method – Computational Procedure for Standard Form I – Comparison of Simplex Method and Revised Simplex Method.

Dual Simplex Method: Introduction – Dual – Simplex Method

Chapters: 26 and 27

UNIT – II

Integer Linear Programming: Introduction **–** Types of Integer Linear Programming Problems – Enumeration and Cutting Plane Solution Concept – Gomory's All Integer Cutting Plane Method – Gomory's mixed Integer Cutting Plane method – Branch and Bound Method

Dynamic Programming: Introduction –Dynamic Programming Terminology – Developing Optimal Decision Policy – Dynamic Programming Under Certainty – Dynamic Programming Approach for Solving Linear Programming Problem.

Chapters: 7 (Sections: 7.1 to 7.6) and 22.

UNIT – III

Classical Optimization Methods: Introduction – Unconstrained Optimization – Constrained Multi-variable Optimization with Equality Constraints - Constrained Multi-variable Optimization with inequality Constraints

Non-linear Programming Methods: Introduction – General Non-Linear Programming Problem – Quadratic Programming: Kuhn-Tucker Conditions - Wolf's Modified Simplex Method – Beale's Method

Chapters: 23 and 24 (Sections: 24.1, 24.2 and 24.4)

UNIT – IV

Deterministic Inventory Control Models: Introduction – The Meaning of Inventory Control – Functional Role of Inventory – Reasons of Carrying Inventory – Factors Involved in Inventory Problem Analysis – Inventory Model building - Inventory Control Models without Shortage – Inventory Control Models with Shortages

Chapter: 14 (Sections: 14.1 to 14.8)

UNIT – V:

Queuing Theory: Introduction - Essential Features of Queuing System – Performance Measures of a Queuing System – Probabilistic Distribution in Queuing Systems – Classification of Queuing Models and their Solutions – Single Server Queuing Models – Multi Server Queuing Models – Finite Calling Population Queuing Models – Multi-Phase Service Queuing Model.

Chapter: 16 (Sections: 16.1 to 16.9)

CONTENT AND TREATMENT AS IN:

J.K. Sharma, *Operations Research Theory and Applications*, Second Edition, Macmillan (India) New Delhi 2005

BOOKS FOR SUPPLEMENTARY READING AND REFERENCE:

1 Kanti Swarup, Manmohan, P.K. Gupta, Operation Research, Sultan & Chand Publications

2 Manmohan, Gupta, Problems in Operation Research, Sultan & Chand Publications

3 Hamdy A. Taha, *Operations Research*, (seventh edition), Prentice - Hall of India Private Limited, New Delhi, 1997.

4 F.S. Hiller & J.Lieberman *Introduction to Operation Research* (7^{th} Edition) Tata-McGraw Hill Company, New Delhi, 2001.

MMT – E4

NUMBER THEORY AND CRYPTOGRAPHY (5 CREDITS)

UNIT I

Some Topics in Elementary Number Theory: Time Estimates for doing arithmetic – Divisibility and Euclidean algorithm – Congruences – Application to Factoring.

Chapter I: Sections 1 – 4.

UNIT II

Finite Fields and Quadratic Residues: Finite Fields – Quadratic Residues and Reciprocity

Chapter II**:** Sections 1, 2

UNIT III

Cryptography: Some simple Cryptosystems – Enciphering Matrices

Chapter III: Sections 1, 2

UNIT IV

Public Key: The Idea of Public Key Cryptography – RSA – Discrete log – Knapsack.

Chapter IV: Sections 1 – 4 (Index calculus algorithm is not included)

UNIT V

Primality and Factoring: Pseudoprimes - The rho Method,
Elliptic Curves: Basic facts – Elliptic Curve Cryptosystems.

Chapter V: Sections 1 (Up to Proposition V.1.5) , 2 and Chapter VI: Sections 1, 2.

CONTENTS AND TREATEMENT AS IN:

Neal Koblitz, A course in Number Theory and Cryptography, Springer Verlag, New York, 1987.

BOOKS FOR REFERENCE:

1. Niven and Zuckermann, An Introduction to Theory of numbers (Edn. 3), Wiley Eastern Ltd., New Delhi, 1976
2. David M. Button, Elementary Number Theory, Wm C. Brown Publishers, Dubuque, lowa, 1989
3. K. Ireland and M. Rosen, A Classical Introduction to modern Number Theory, Springer Verlag, 1972
4. G.Alexander Raymand , A special book in number theory. 2005