Dr.M.G.R
Educational and Research Institute
UNIVERSITY

(Decl.U/S 3 of the UGC Act 1956)

Maduravoyal, Chennai

Department of Mathematics

M.Sc – Mathematics (Full Time)

Curriculum and Syllabus

2016 Regulation

Dr.M.G.R.
EDUCATIONAL AND RESEARCH INSTITUTE
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(Decl. U/S 3 of the UGC Act 1956)
DEPARTMENT OF MATHEMATICS

M.Sc Mathematics (Full Time)
Curriculum and Syllabus
2016 Regulation

I SEMESTER						
S.No	**Sub. Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**HMMA16001**	Real Analysis	4	0	0	4
2	**HMMA16002**	Linear Algebra	4	0	0	4
3	**HMMA16003**	Advanced Numerical Analysis	4	0	0	4
4	**HMMA16004**	Ordinary Differential Equations	4	0	0	4
		TOTAL	**16**	**0**	**0**	**16**

II SEMESTER						
S.No	**Sub. Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**HMMA16005**	Complex Analysis	4	0	0	4
2	**HMMA16006**	Partial Differential Equations	4	0	0	4
3	**HMMA16007**	Mechanics	4	0	0	4
4	**HMMA16008**	Mathematical Statistics	4	0	0	4
		TOTAL	**16**	**0**	**0**	**16**

III SEMESTER						
S.No	**Sub. Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**HMMA16009**	Functional Analysis	4	0	0	4
2	**HMMA16010**	Calculus Of Variations And Integral Equations	4	0	0	4
3		Elective I	4	0	0	4
4		Elective II	4	0	0	4
		TOTAL	**16**	**0**	**0**	**16**

IV SEMESTER						
S.No	**Sub. Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**HMMA16011**	Topology	4	0	0	4
2	**HMMA16012**	Optimization Techniques	4	0	0	4
3		Elective III	4	0	0	4
4		Project	0	0	15	15
		TOTAL	**12**	**0**	**15**	**27**

LIST OF ELECTIVES						
S.No	**Sub. Code**	**Title of Subject**	**L**	**T**	**P**	**C**
1	**HMMA16E01**	Mathematical Modeling & Applications	4	0	0	4
2	**HMMA16E02**	Fluid Dynamics	4	0	0	4
3	**HMMA16E03**	Probability Theory & Stochastic Processes	4	0	0	4
4	**HMMA16E04**	Modern Applied Algebra	4	0	0	4
5	**HMMA16E05**	Fuzzy Sets And Fuzzy Logic	4	0	0	4
6	**HMMA16E06**	Statistical Quality Control	4	0	0	4
7	**HMMA16E07**	Graph Theory	4	0	0	4
8	**HMMA16E08**	Discrete Mathematics	4	0	0	4

Total No. Of credits: 75

HMMA16001 **REAL ANALYSIS** **4 0 0 4**

UNIT I
Finite, Countable and Uncountable Sets – Metric spaces – Compact sets – Perfect sets – Connected sets. Numerical Sequences and Series: Sequences – Convergence – Subsequences - Cauchy Sequences – Upper and Lower Limits - Some Special Sequences – Tests of convergence – Power series – Absolute convergence – Addition and multiplication of series – Rearrangements. (Chapters 2 and 3) **12 Hours**

UNIT II
Limits of functions – Continuous functions – continuity and Compactness – Continuity and connectedness – Discontinuities – Monotonic functions – Infinite limits and limits at infinity. Differentiation: Derivative of a real function – Mean value Theorems - Intermediate value theorem for derivatives – L'Hospital's Rule – Taylor's Theorem – Differentiation of vector valued functions. (Chapters 4 and 5) **12 Hours**

UNIT III
Definition and Existence – Properties – Integration and Differentiation – Integration of vector valued functions. (Chapter 6) **12 Hours**

UNIT IV
Uniform Convergence and Continuity – Uniform Convergence and Differentiation – Equicontinuous families of functions – The Stone – Weierstrass Theorem. (Chapter 7) **12 Hours**

UNIT V
Linear Transformations - Differentiation – The Contraction Principle – The Inverse Function Theorem - The Implicit Function Theorem. (Chapter 9, Sections 9.1 to 9.29) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:
1. Walter Rudin (1976) *Principles of Mathematical Analysis*, Third Edition, Mcgraw Hill.

REFERENCES:
1. Apostol, T.M (1985) *Mathematical Analysis*, Narosa.
2. White, A.J (1968) *Real Analysis : An Introduction*, Addison Wesley Publishing Co.
3. Serge Lang (1969) *Analysis I & II*, Addison-Wesley Publishing Company, Inc.
4. Carothers, N.L (2013) *Real Analysis*, Cambridge University press, Indian edition.

HMMA16002 **LINEAR ALGEBRA** **4 0 0 4**

UNIT I
Vector Spaces – Subspaces – Linear Independence and Dependence – Basis and Dimension – Sum of subspaces - Coordinates.
12 Hours

UNIT II
Linear Transformations – The Algebra of Linear Transformations – Isomorphism – Representation of Transformations by Matrices – Linear Functionals. **12 Hours**

UNIT III
Characteristic Values – Annihilating Polynomials – Invariant Subspaces – Direct Sum decompositions – Invariant direct sums – Primary Decomposition Theorem. **12 Hours**

UNIT IV
Cyclic Subspaces and Annihilators – Cyclic Decomposition and the Rational Form – The Jordan Canonical form.
12 Hours

UNIT V
Inner product spaces – Orthogonal complement – Linear functionals and Adjoints – Unitary operators – Normal operators.
12 Hours

Total No. of hours: 60

TEXT BOOKS:
1. Kenneth Hoffman, Ray Kunze (1996) *Linear Algebra*, Prentice Hall India.

REFERENCES:
1. Finkbeiner, D.T (1978) *Introduction to Matrices and Linear Transformations*, W.H.Freeman & Co.
2. Vivek Sahai, Vikas Bhat (2002) *Linear Algebra*, Narosa.

HMMA16003 **ADVANCED NUMERICAL ANALYSIS** **4 0 0 4**

UNIT I

Rate of convergence – Secant Method, Regula Falsi Method, Newton Raphson Method, Muller Method and Chebyshev Method. Polynomial equations: Descartes' Rule of Signs - Iterative Methods: Birge-Vieta method, Bairstow's method Direct Method: Graeffe's root squaring method. (Chapter 2 § 2.5 [Pages 41-52], 2.9 [Pages 83-99]) **12 Hours**

UNIT II

Error Analysis of Direct methods – Operational count of Gauss elimination, Vector norm, Matrix norm, Error Estimate. Iteration methods - Jacobi iteration method, Gauss Seidel Iteration method, Successive Over Relaxation method - Convergence analysis of iterative methods, Optimal Relaxation parameter for the SOR method. Finding eigen values and eigen vectors – Jacobi method for symmetric matrices and Power methods only. (Chapter 3 § 3.3[Pages 134-140], 3.4[Pages 146-164], 3.5[Pages 170-173], 3.7 [Pages179-185] and 3.11 [Pages 196-198]). **12 Hours**

UNIT III

Hermite Interpolations, Piecewise and Spline Interpolation: piecewise linear interpolation, piecewise quadratic interpolation, piecewise cubic interpolation, spline interpolation-cubic Spline interpolation. Bivariate Interpolation- Lagrange Bivariate interpolation. Least square approximation. (Chapter 4 § 4.5 - 4.7 & 4.9 [Pages 284-290]) **12 Hours**

UNIT IV

Numerical Differentiation – Optimum choice of Step length – Extrapolation methods – Partial Differentiation. Numerical Integration: Methods based on undetermined coefficients - Gauss Legendre Integration method and Lobatto Integration Methods only. (Chapter 5 § 5.2 - 5.5[Pages 320-345] and 5.8[pages 361 – 365 and 380-386]) **12 Hours**

UNIT V

Local truncation error or Discretization Error, Order of a method, Taylor Series method, Runge-Kutta methods: Explicit Runge–Kutta methods– Minimization of Local Truncation Error, System of Equations, Implicit Runge-Kutta methods. Stability analysis of single step methods (RK methods only). (Chapter 6 §6.4[Pages 434-459] and 6.5[Pages 468-475]) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:

1. Jain, M.K Iyengar, S.R.K. Jain, R.K. (2012) *Numerical Methods for Scientific and Engineering Computation*, New Age International (p) Limited Publishers.

REFERENCES:

1. Kendall E. Atkinson, (1988) *An Introduction to Numerical Analysis*, II Edn., John Wiley & Sons.
2. Jain, M.K. (1983) *Numerical Solution of Differential Equations*, II Edn., New Age International Pvt Ltd.
3. Samuel. D. Conte, Carl. De Boor, (1983) *Elementary Numerical Analysis*, Mc Graw-Hill International Edn..

HMMA16004 **ORDINARY DIFFERENTIAL EQUATIONS** **4 0 0 4**

UNIT I
Linear Equations with constant coefficients – Initial value problems for second order equations – Linear Dependence and Independence – Wronskian – Non-homogeneous Equation of order two – Homogeneous Equation of order n – Initial Value Problems for n-th order Equations – Non-Homogeneous Equation of order n . **12 Hours**

UNIT II
Linear Equations with Variable Coefficients – Initial value problems and Solutions for the Homogeneous equation – Wronskian and Linear independence – Reduction of the order – Non-Homogeneous equation – Homogeneous equations with Analytic coefficients – Legendre Equation. **12 Hours**

UNIT III
Euler Equation – Second order equations with regular singular points – Convergence Proof – Bessel Equation – Regular singular points at infinity. **12 Hours**

UNIT IV
Existence and Uniqueness of Solutions to First Order Equations: Equations with Variables Separated – Exact Equations – The Method of Successive Approximations – The Lipschitz Condition – Convergence of Successive Approximations. **12 Hours**

UNIT V
Existence and Uniqueness of Solutions to Systems and n-th Order Equations: Example of Central forces and Planetary motion – Some special equations – System of Vector equations – Existence and Uniqueness of solutions to systems – Equations of Order n. **12 Hours**

Total No. of hours: 60

TEXT BOOKS:
1. Coddington, E.A (1998) *An Introduction to Ordinary Differential Equations*, Prentice Hall –India.

REFERENCES:
1. Simmons, G.F (1997) *Differential Equations with Applications and Historical Notes*, Tata McGraw Hill.

HMMA16005 **COMPLEX ANALYSIS** **4 0 0 4**

UNIT I

Analytic Functions – Functions, Limits, Continuty and Differentiabllity – Power Series as an Analytic Function – Exponential and Trigonometric Functions – Complex Logarithms – Inverse Functions – Zeroes of Analytic Functions.
(pp.83 – 100, 111-136 and 145-178 of the Text) **12 Hours**

UNIT II

Complex Integration – Curves in the Complex Plane – Basic Properties of Complex Integrals – Winding Number of a Curve – Cauchy-Goursat Theorem – Homotopy Version – Morera's Theorem-Cauchy Integral Formula .
(pp.191 – 258 of the Text) **12 Hours**

UNIT III

Laurent's Series – The Maximum Modulus Principle – Schwarz Lemma – Application to Conformal Mapping - Liouville's Theorem – Gauss Theorem – Lucas Theorem. (pp. 259 – 300 of the Text) **12 Hours**

UNIT IV

Isolated and Non-isolated Singularities - Removable Singularity – Poles –Singularities at Infinity - Residue at a Finite Point - Residue at the Point at Infinity – Residue Theorem.
(pp.313 – 335, pp.347 – 375 of the Text) **12 Hours**

UNIT V

Number of Zeroes and Poles – Rouche's Theorem – Evaluation of certain Real Integrals – Singularities on the Real Axis.
(pp. 376 – 397, 407 – 445 of the Text) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:

1. Ponnusamy, S (2000) *Foundations of Complex Analysis*, Narosa Pub.

REFERENCES:

1. Ahlfors, L.V (1979) *Complex Analysis*, McGraw Hill.
2. Brown, J.W Churchill, R.V (1996) *Complex Variables And Applications*, McGraw Hill.

HMMA16006 **PARTIAL DIFFERENTIAL EQUATIONS** **4 0 0 4**

UNIT I

Introduction – Classification of Second Order PDE – Canonical Forms – Laplace Equation - Separation of Variables – Dirichlet and Neumann Problems for a Rectangle – Interior and Exterior Dirichlet Problems for a Circle – Interior Neumann Problem for a Circle – Solutions of Laplace Equation in Cylindrical and Spherical Polar Coordinates – Examples.
(pp.1-16, pp.47-98 of the Text) **12 Hours**

UNIT II

Parabolic Equations – Diffusion Equation – Boundary Conditions – Elementary Solutions –Dirac Delta Function – Separation of Variables – Solution of Diffusion Equation in Cylindrical and Spherical Coordinates – Maximum –Minimum Principle and Consequences – Examples. (pp.101-140 of the Text-Book) **12 Hours**

UNIT III

Hyperbolic Equations – Wave Equation – Solution by Canonical Reduction – De Alemberts Solution – Variables Separable Solution – Forced Vibrations – Periodic Solutions in Cylindrical and Spherical Coordinates – Boundary and Initial Value Problem for Two-Dimensional Wave Equation – Method of Eigen Functions – Vibration of a Circular Membrane – Examples.
(pp.144-169, pp.173-181 of the Text-Book) **12 Hours**

UNIT IV

Laplace Transform Methods- Introduction- Transforms of some Elementary Functions- Properties of Laplace Transform – Transforms of Periodic-, Error-, Bessel-, Unit Step- and Dirac Delta Functions – Inverse Transform – Convolution Theorem – Complex Inversion Formula – Solutions of Ordinary- and Partial differential Equations- Solutions of Diffusion Equation and Wave Equation. (pp.214-266 of the Text-Book) **12 Hours**

UNIT V

Fourier Transform Methods-Introduction – Fourier Integral Theorem – Sine and Cosine Integrals – Fourier Transform Pairs – Transforms of Elementary Functions and Dirac Delta Function – Properties of Fourier Transform- Convolution Theorem – Parseval's Relation – Finite Fourier Transforms – Finite Sine and Cosine Transforms – Solutions of Diffusion Equation, Wave Equation and Laplace Equation – Examples. (pp.278-302, 304-327 of the Text-Book) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:

1. Sankara Rao (2003) *Introduction To Partial Differential Equations*, Prentice-Hall of India.

REFERENCES:

1. Copson, E.T. (1976) *Partial Differential Equations*, S.Chand &Co.
2. Sneddon, I.N. (1986) *Elements of Partial Differential Equations*, McGraw Hill.

HMMA16007 **MECHANICS** **4 0 0 4**

UNIT I
The Mechanical system - Generalized coordinates - Constraints - Virtual work - Energy and Momentum
(Chapter 1: Sections 1.1 to 1.5) **12 Hours**

UNIT II
Derivation of Lagrange's equations - Examples - Integrals of motion.
(Chapter 2: Sections 2.1 to 2.3 [Omit Section 2.4]) **12 Hours**

UNIT III
Hamilton's Principle - Hamilton's Equation - Other variational principle.
(Chapter 4: Sections 4.1 to 4.3 [Omit section 4.4]) **12 Hours**

UNIT IV
Hamilton Principle function - Hamilton-Jacobi Equation - Separability
(Chapter 5: Sections 5.1 to 5.3) **12 Hours**

UNIT V
Differential forms and generating functions - Special Transformations - Lagrange and Poisson brackets.
(Chapter 6: Sections 6.1, 6.2 and 6.3 [omit sections 6.4, 6.5 and 6.6]) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:
1. Greenwood D.T (1995), *Classical Dynamics*, Prentice Hall of India, New Delhi.

REFERENCES:
1. H. Goldstein, *Classical Mechanics*, (2nd Edition) Narosa Publishing House, New Delhi.
2. Rane N.C, Joag P.S.C (1991), *Classical Mechanics*, Tata McGraw Hill.

HMMA16008 **MATHEMATICAL STATISTICS** **4 0 0 4**

UNIT I

Notion of a sample and a statistic - Distribution functions of X, S^2 and (X , S^2) - $\chi 2$ distribution - Student t-distribution - Fisher's Z - distribution - Snedecor's F - distribution - Distribution of sample mean from non-normal populations.
(Chapter 9: Sections 9.1 to 9.8) **12 Hours**

UNIT II

Concept of a statistical test - Parametric tests for small samples and large samples -$\chi 2$ test - Kolmogorov Theorem 10.11.1 - Smirnov Theorem 10.11.2 - Tests of Kolmogorov and Smirnov type - The Wald-Wolfovitz and Wilcoxon -Mann-Whitney tests - Independence Tests by contingency tables. (Chapter 10: Sections 10.11; Chapter 11: 12.1 to 12.7) **12 Hours**

UNIT III

Preliminary notion - Consistency estimation - Unbiased estimates - Sufficiency - Efficiency - Asymptotically most efficient estimates - methods of finding estimates - confidence Interval. (Chapter 13: Sections 13.1 to 13.8 [Omit Section 13.9]) **12 Hours**

UNIT IV

One way classification and two way classification. Hypotheses Testing: Poser functions - OC function - Most Powerful test - Uniformly most powerful test - unbiased test. **12 Hours**
(Chapter 15: Sections 15.1 and 15.2 [Omit Section 15.3]; Chapter 16: Sections 16.1 to 16.5 [Omit Section 16.6 and 16.7])

UNIT V

SPRT - Auxiliary Theorem - Wald's fundamental identity - OC function and SPRT - E(n) and Determination of A and B - Testing a hypothesis concerning p on 0-1 distribution and m in Normal distribution.
(Chapter 17: Sections 17.1 to 17.9 [Omit Section 17.10]) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:

1. Fisz, M. (1963) , *Probability Theory and Mathematical Statistics*, John Wiley and sons, New York.

REFERENCES:

1. Dudewicz, E.J. Mishra, S.N. (1988) *Modern Mathematical Statistics*, John Wiley and Sons, New York.
2. Rohatgi, V.K. (1988) *An Introduction to Probability Theory and Mathematical Statistics*, Wiley Eastern New Delhi, (3rd Edn)
3. Roussas, G.G. (1973) *A First Course in Mathematical Statistics*, Addison Wesley Publishing Company.
4. Vander Waerden, B.L. (1968) *Mathematical Statistics*, G.Allen & Unwin Ltd., London.

HMMA16009 **FUNCTIONAL ANALYSIS** **4 0 0 4**

UNIT I

Metric Space – Examples – Open Set, Closed Set, Neighbourhood – Convergence, Cauchy Sequence, Completeness – Examples – Completeness Proofs – Completion of Metric Spaces. (pp. 1 – 45 of the Text) **12 Hours**

UNIT II

Normed Space – Banach Space – Properties of Normed Spaces – Finite dimensional Normed Spaces and Subspaces – Compactness and Finite Dimension – Linear Operators – Bounded and Continuous Linear Operators – Linear Functionals – Linear Operators and Functionals on Finite Dimensional Spaces – Normed Spaces of Operators – Dual Space. (pp. 58 – 125 of the Text) **12 Hours**

UNIT III

Inner Product Space – Hilbert Space – Properties of Inner Product Spaces – Orthogonal Complements and Direct Sums – Orthonormal Sets and Sequences – Representation of Functionals on Hilbert Spaces – Hilbert Adjoint Operator – Self- Adjoint, Unitary and Normal Operators. (pp. 128 - 174, 188 - 206 of the Text) **12 Hours**

UNIT IV

Hahn - Banach Theorem – Application to Bounded Linear Functionals on C[a, b] – Adjoint Operator – Reflexive Spaces – Category Theorem – Uniform Boundedness Theorem – Strong and Weak Convergence – Convergence of Sequences of Operators and Functionals – Open Mapping Theorem – Closed Linear Operators – Closed Graph Theorem.
(pp. 213 – 268, 285 – 295 of the Text) **12 Hours**

UNIT V

Basic Concepts of Spectral Theory in Finite Dimensional Normed Spaces - Spectral Properties of Bounded Self-Adjoint Linear Operators in Hilbert Spaces – Positive Operators – Square Roots of a Positive Operator – Projection Operators – Properties of Projections – Spectral Family – Spectral Representation – Extension of Spectral Theorem to Continuous Functions .
(pp. 370 - 378, 459 – 516 of the Text) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:

1. Erwin kreyszig (2003) *Introductory Functional Analysis with Applications*, John Wiley.

REFERENCES:

1. Simmons, G.F (1963) *Introduction to Topology and Modern Analysis*, McGraw Hill.
2. Bachmann, G. Narici, L (1966) *Functional Analysis*, Academic Press.
3. Ponnusamy, S (2003) *Functional Analysis*, Narosa Pub. House.
4. Thamban Nair (2002), Functional Analysis – A First Course, PHI.

HMMA16010 **CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS** **4 0 0 4**

UNIT I

The concept of Variation and its properties – Euler's equation – Variational problems for functional – Functionals dependent on higher order derivatives – Functions of several independent variables – Some applications to problems of mechanics.
(Chapter 1: 1.1 to 1.7) **12 Hours**

UNIT II

Movable boundary for a functional dependent on two functions – One sided variations – Reflection and Refraction of extremals – Diffraction of light rays. (Chapter 2: 2.1 to 2.5) **12 Hours**

UNIT III

Integral equations: Introduction – Definition – Regularity conditions – Special kinds of Kernals – Eigen values and eigen functions – Convolution integral – Reduction to a system of algebraic equations – Examples – Fredholm alternative – Examples – An approximation method.
(Chapter 1: 1.1 to 1.5 Chapter 2 : 2.1 to 2.5) **12 Hours**

UNIT IV

Method of successive approximations – Iterative scheme – Examples – Volterra integral equations – Examples – Some results about the resolvent kernel – The method of solution of Fredholm equation – Fredholm first theorem – Examples.
(Chapter 3: 3.1 to 3.5 Chapter 4: 4.1 to 4.3) **12 Hours**

UNIT V

Initial value problems – Boundary value problems – Examples – Singular integral equations – The Abel integral equations - Examples. (Chapter 5: 5.1 to 5.3 Chapter 8: 8.1 to 8.2) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:

1. Gupta, A.S. (2005) *Calculus of Variations with Applications*, PHI, New Delhi, 2005. (for Units I and II)
2. Ram P. Kanwal (1971) *Linear Integral Equations*, Theory and Techniques, Academic Press, New York. (for Units III, IV and V)

REFERENCES:

1. Raisinghania, M.D. (2007) *Integral Equations and Boundary Value Problems*, S. Chand & Co., New Delhi.
2. Sudir K. Pundir, Rimple Pundir (2005) *Integral Equations and Boundary Value Problems*, Pragati Prakasam, Meerut.

HMMA16011 **TOPOLOGY** **4 0 0 4**

UNIT I
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) **12 Hours**

UNITII
Continuous functions - the product topology - The metric topology.
(Chapter 2: Sections 18 to 21 [Omit Section 22]) **12 Hours**

UNIT III
Connected spaces - connected subspaces of the Real line - Components and local connectedness.
(Chapter 3: Sections 23 to 25) **12 Hours**

UNIT IV
Compact spaces - compact subspaces of the Real line - Limit Point Compactness - Local Compactness.
(Chapter 3: Sections 26 to 29) **12 Hours**

UNIT V
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) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:
1. Munkres, J.R (2002) *Topology* (2nd Edition) Pearson Education Pvt. Ltd., Delhi.

REFERENCES:

1. Dugundji, J (1975) *Topology* , Prentice Hall of India, New Delhi.
2. George F.Sinmons (1963), *Introduction to Topology and Modern Analysis*, McGraw Hill Book Co.
3. Kelly, J.L *General Topology*, Van Nostrand, Reinhold Co., New York
4. Willard, S (1970) *General Topology*, Addison - Wesley, Mass.

HMMA16012 **OPTIMIZATION TECHNIQUES** **4 0 0 4**

UNIT I
Introduction to Optimization – Classical Optimization Theory – Unconstrained Problems – Necessary and Sufficient Conditions – The Newton - Raphson Method – Constrained Problems Equality Constraints – Inequality Constraints.
(Ch.20 pp.701-730) **12 Hours**

UNIT II
Introduction to Linear Programming – Two-Variable LP Model – Graphical Solution – Solutions of Maximization and Minimization Models – Simplex Method – Computational Details of the Simplex Algorithm - M-Method –Two-phase Method- Degeneracy.
(Ch.2 pp. 11-20, Ch.3 pp. 80-83, 94-105) **12 Hours**

UNIT III
Transportation Model – Definition – Determination Of The Starting Solution – Iterative Computations of the Transportation Algorithm- Simplex Method Explanation of the Method of Multipliers – The Assignment Model – The Hungarian Method – Simplex Explanation of the Hungarian Method – The Transshipment Model . (Ch.5 pp.165- 186, 195-208) **12 Hours**

UNIT IV
Integer Linear Programming – Illustrative Applications – Branch-and-Bound Algorithm – Cutting Plane Algorithm – Traveling Salesperson Problem – B&B Solution Algorithm. (Ch.9 pp.361-378, 384-397) **12 Hours**

UNIT V
Deterministic Dynamic Programming – Recursive Nature of Computations in DP – Forward and Backward Recursion – Cargo-Loading Model – Workforce Size Model – Equipment Replacement Model – Investment and Inventory Models .
(Ch. 10 pp.401-425) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:
1. Taha, H.A (2002) *Operations Research- An Introduction*, Prentice Hall India.

REFERENCES:
1. Hillier, Lieberman (2001) *An Introduction to Operations Research*, McGrawHill,
2. Wagner, H.M (2000) *Principles of Operations Research*, Prentice-Hall India,.
3. Nocedal, Wright, (2003) *Numerical Optimization*, Springer.
4. Gupta, P.K Man Mohan (2001) *Problems in Operations Research*, Sultan Chand,

HMMA16E01 **MATHEMATICAL MODELING AND APPLICATIONS** **4 0 0 4**

UNIT I

Introduction to Mathematical Modeling- Mathematical Modeling through Ordinary Differential Equations – Linear ,Non-linear Growth and Decay- Compartment Models – Models Through Systems of Ordinary Differential Equations- Models in Population Dynamics –Modeling of Epidemics – Modeling in Economics – Modeling through Linear Differential Equations of Second Order. (Ch.1 pp.01-13, Ch.2 pp.30-43, Ch.3 pp. 53-69, Ch.4 pp. 88-93 of Book 1) **12 Hours**

UNIT II

Modeling through Difference Equations – Some Simple Models – Basic Theory of Linear Difference Equations with Constant Coefficients – Models in Economics and Finance- Models in Population Dynamics and Genetics –Models in Probability Theory . (Ch.5 pp.96 – 121 of Book 1) **12 Hours**

UNIT III

Partial Differential Equations – Initial and Boundary Conditions - Modeling through Partial Differential Equations – Mass Balance Equations – Momentum Balance Equations – Variational Principles – Probability Generating Function – Model for Traffic Flow. (Ch. 6 pp.124 – 150 of Book 1) **12 Hours**

UNIT IV

Review of Basic Graph Theory - Modeling through Graphs , Directed Graphs , Signed Graphs and Weighted Digraphs and Unoriented Graphs – Modeling through Functional Equations .(Ch.7 pp.151-176, Ch.8 pp.177-183 of Book 1) **12 Hours**

UNIT V

Introduction to Calculus of Variations – Euler's Equations – Functionals dependent on First and Second Derivatives – Brachistochrone Problem – Isoperimetric Problems – Variational Methods of Solving Partial Differential Equations – Mathematical Modeling of Geometrical Problems and problems in Mechanics using Calculus of Variations. (Ch.9 pp.205 – 212 of Book) **12 Hours**

Total No. of hours: 60.

TEXT BOOKS:

1. Kapur J.N (2003) *Mathematical Modeling*, New Age International Publishers.
2. Elsgolts l. (1971) *Differential Equations and Calculus of Variations*, Mir Pub.

REFERENCES:

1. Thomas, Saaty, Joyce, M.A, *Thinking With Models*, Pergamon Press.
2. Murthy, D.P.N , Page, N.W, Rudin, E.V (1990) *Mathematical Modeling*, Pergamon Press.
3. Mayer, W.J (1992), *Concepts of Mathematical Modeling*, McGraw Hill.

HMMA16E02 **FLUID DYNAMICS** **4 0 0 4**

UNIT I

Scalar and Vector Fields – Gradient and Direction Differentiator – Normal Flux - Divergence – Line Integrals – Relations between Surface and Volume Integrals –Relations between Line and Surface Integrals – Conservative Vector Fields – General Orthogonal Curvilinear Coordinates – Some Cartesian Tensor Notation . (pp.14-62 of the Text) **12 Hours**

UNIT II

Real Fluids and Ideal Fluids – Velocity of a Fluid at a Point – Streamlines and pathlines-Velocity Potential – Vorticity Vector – Local and Particle Rates of Change – The Equation of Continuity – Acceleration – Conditions at a Rigid Boundary – General Analysis of Fluid Motion – Pressure at a Point in a Fluid at Rest and in a Moving Fluid – Euler's Equations of Motion – Bernoulli's Equation – The Case of Steady Motion Under Conservative Body Forces.
(pp.70 – 110 of the Text) **12 Hours**

UNIT III

Flows involving Axial Symmetry – Special Two Dimensional Flows – Impulsive Motion – Aspects of Vortex Motion – Sources, Sinks and Doublets – Images in a Rigid Infinite Plane – Images in Solid Spheres – Axi - Symmetric Flows – Stokes Stream Function – Stream Function for Axi - symmetric Irrotational Motions . (pp.110 – 159 of the Text) **12 Hours**

UNIT IV

Two-Dimensional Flow – Use of Cylindrical Coordinates – The Stream Function – Complex Potential for Two - Dimensional Irrotational Incompressible Flow – Complex Velocity Potentials for Standard Two-Dimensional Flows – Two- Dimensional Image Systems – Milne -Thomson Circle Theorem – Theorem of Blasius – The Use of Conformal Transformations.
(pp.160 – 201 of the Text) **12 Hours**

UNIT V

Viscous Flow : Stress Components in a Real Fluid – Relations between Cartesian Components of Stress –Translational Motion of a Fluid Element – The Rate of Strain Quadric and Principal Stresses – Properties – Stress Analysis in Fluid Motion – Relations between Stress and Rate of Strain – Coefficient of Viscosity and Laminar Flow – The Navier - Stokes Equations of Motion – Problems - Steady Viscous Flow in Tubes of Uniform Circular Cross-Section – Diffusion of Vorticity – Energy Dissipation due to Viscosity – Steady Flow past a Fixed Sphere – Dimensional Analysis: Reynolds Number.
(pp.310 – 345 of the Text) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:

1. Frank Chorlton (2003) *Textbook of Fluid Dynamics*, CBS Pub., New Delhi.

REFERENCES:

1. Batchelor, G.K. (2000) *An Introduction To Fluid Dynamics*, Camb. Univ. Press.
2. Chorin, A.J. Marsden, J.E (1993) *A Mathematical Introduction to Fluid Mechanics*, Springer.
3. Acheson, D.J. (1990) *Elementary Fluid Dynamics*, Clarendon Press, Oxford.

HMMA16E03 **PROBABILITY THEORY & STOCHASTIC PROCESSES** **4 0 0 4**

UNIT I

Probability Theory-Introduction- Sample space and events – Conditional probabilities – Independent Events – Baye's formula – simple problems. (Sections 1.1- 1.6 of the Text) **12 Hours**

UNIT II

Random variables- Discrete Random variables- Continuous random variables – Expectation of a random variable- Joint distributed random variables – Moments and Moment generating functions-Limit theorems –Conditional expectations - simple problems. (Sections 2.1 - 2.7., 3.4., 3.5 of the Text) **12 Hours**

UNIT III

Stochastic Processes: Introduction – Classification of stochastic processes- Chapman-Kolmogrov equation – Limiting probabilities- Markov Decision processes- Poisson processes – Properties of Poisson processes- Generalizations of Poisson Processes - simple applications of Poisson processes. (Sections 2.8., 4.1- 4.4, 4.10, 5.3, 5.4 of the Text) **12 Hours**

UNIT IV

Introduction to renewal theory- Limit theorems and its applications- Regenerative processes- Computing the renewal function. Reliability theory: Introduction –Reliability of systems of independent components- Expected life time – Systems with repair- simple applications (Sections 7.1., 7.3., 7.5., 7.8., 9.1., 9.3., 9.6., 9.7 of the Text) 1**2Hours**

UNIT V

Introduction to Brownian motion- Gambler's ruin problem –Variations on Brownian motion - Pricing stock options- White Noise- Gaussian processes – Simple Applications (Sections 10.1., 10.3- 10.6 of the Text) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:

1. Ross (2003) *Introduction to Probability Models, 8^h edition*, Elsevier..

REFERENCES:

1. Taylor, H.W. Karlin, S (1984) *An Introduction to Stochastic Modelling*, Academic press.
2. Ross, S.M (1996) *Stochastic processes, 2nd Edition*, John Wiley.
3. Wentzel, W. Ovcharov, L. (1983) *Applied problems in probability theory*, Mir Publishers, Moscow.

HMMA16E04 **MODERN APPLIED ALGEBRA** **4 0 0 4**

UNIT I
Rings and Ideals: Introduction – Integral Domain and Field – Field of Quotients – Subrings – Morphisms of Rings – Direct Sums – Ideals and Quotient Rings – Divisibility – Euclidean Domains – Unique Factorization Theorem – Prime and Maximal Ideals .
(pp.281 – 309 of Book 1) **12 Hours**

UNIT II
Polynomial Rings and Polynomial Codes: The Ring R[x] - Polynomial Rings over Fields – Polynomial Codes – Advantageous Properties - Shift Registers – Unique Factorization Theorem for Polynomials – Polynomial Functions and Formal Derivatives .
(pp.315 – 339 of Book 1) **12 Hours**

UNIT III
Fields – Quotient Field – Prime Field – Examples and Definitions – Simple Extensions – Finite Extensions - Finite Fields – Cyclotomic Polynomials – Factorization of Polynomials over finite fields- Berlekamp's Algorithm.
(pp.124 – 175 of Book 2) **12 Hours**

UNIT IV
Coding Theory: Introduction to Coding – Hamming distance –Hamming Bounds – Linear Codes – Generator Matrix – Decoding Algorithm – Hamming Code – Cyclic Codes – Special Cyclic Codes – BCH Code – Decoding BCH Codes.
(pp. 183 – 236 of Book 2) **12 Hours**

UNIT V
Cryptology: Classical Cryptosystems – Modular Enciphering – Caesar Cipher, Affine Cipher, Periodic Substitution Cipher – Hill Cipher – Examples – Public Key Cryptosystems - RSA Cryptosystem – Discrete Logarithms and Other Ciphers.
(pp.239 – 279 of Book 2) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:
1. Garrett Birkhoff, Thomas, C. B (1987*) Modern Applied Algebra*, CBS Publishers, New Delhi.
2. Rudolf lidl, Gunter pilz (2004) *Applied Abstract Algebra, 2nd Edition*, Springer.

REFERENCES:
1. Berlekamp, E.R. (1968) *Algebraic Coding Theory*, McGraw Hill.
2. Peterson, W.W. (1961) *Error-Correcting Codes*, M.I.T Press.

HMMA16E05 **FUZZY SETS AND FUZZY LOGIC** **4 0 0 4**

UNIT I
Fuzzy Sets: Introduction - Basic Concepts – α-cuts – Properties – Representations of Fuzzy Sets – Extension Principle . (pp.1 – 30, 35-48 of the Text) **12 Hours**

UNIT II
Operations on Fuzzy Sets: Types – Fuzzy Complements – Fuzzy Intersections –Fuzzy Unions – Combinations of Operations – Aggregation Operations. (pp.50 – 94 of the Text) **12 Hours**

UNIT III
Fuzzy Arithmetic: Fuzzy Numbers – Linguistic Variables – Arithmetic Operations on Intervals – Arithmetic Operations on Fuzzy Numbers - Lattice of Fuzzy Numbers – Fuzzy Equations . (pp.97 – 117 of the Text) **12 Hours**

UNIT IV
Fuzzy Relations: Crisp versus Fuzzy Relations – Projections and Cylindric Extensions – Binary Fuzzy Relations – Binary Relations on a Single Set – Fuzzy Equivalence Relations – Fuzzy Compatibility Relations – Fuzzy Ordering Relations – Fuzzy Morphisms. (pp. 119 – 144 of the Text) **12 Hours**

UNIT V
Fuzzy Logic: An Overview of Classical Logic – Multi-valued Logics – Fuzzy Propositions – Fuzzy Quantifiers – Linguistic Hedges – Inference from Conditional Fuzzy Propositions - Inference from Conditional and Qualified Propositions – Inference From Quantified Propositions . (pp. 212 – 242 of the Text) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:
1. George Klir, Bo Yuan (2000) *Fuzzy Sets and Fuzzy Logic – Theory & Applications*, Prentice Hall India.

REFERENCES:
1. Zimmermann, H.J. (1985) *Fuzzy set Theory and Its Applications*, Kluwer.

HMMA16E06 **STATISTICAL QUALITY CONTROL** **4 0 0 4**

UNIT I

Quality Assurance in Business and Industries – Meaning of Quality – Quality Assurance – Quality Cost – Methods of Quality Assurance – Responsibility for Quality – Statistical Process Control – Chance and Assignable Causes of Quality Variation - Statistical Basis of Control Charts. (Ch..1.1 – 1.5, Ch.4.1 – 4.2 of the Text) **12 Hours**

UNIT II

Control Charts for Attributes: Control Chart for Fraction Non-conforming – p, np Charts - Variable Sample Size – O.C.Functions – Control Charts for Non-conformities (Defects) – C Chart – Procedures with Constant Sample Size – O.C.Functions. (Ch.5.1 – 5.3.1 & 5.3.4 of the Text) **12 Hours**

UNIT III

Control Charts for Variables: Introduction – Control Charts for X and R – Development and Use of X and R Charts – Control Limits – Specification limits and Natural Tolerance Limits – Probability Limits on the X and R Charts – Interpretation O.C.Functions. (Ch.6.1 – 6.2.2 upto pp.183, pp.187-192 & Ch.6.2.6 of the Text) **12 Hours**

UNIT IV

Acceptance Sampling : Lot-by Lot Acceptance Sampling for Attributes – Acceptance Sampling Problem – Advantages and Disadvantages – Single Sampling Plan for Attributes – OC Curve – Effects of n and c on OC Curve – Type A and Type B – OC Curves – Designing SSP with a specified OC Curve - AOQ & ATI. (Ch.10.1 – 10.1.1, Ch.10.2 of the Text) **12 Hours**

UNIT V

Acceptance Sampling by Variables: Types of Sampling Plans Available – Caution and use of Variables Sampling – Designing a Variables Sampling Plan with a Specified OC Curve – MIL-STD-105D and MIL-STD –414 - Dodge-Romig Sampling Plans & Uses. (Ch. 11.1 – 11.2, 10.5.1-10.5.2, 10.6, 11.3.1-11.3.2 of the Text) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:

1. Douglas Montgomery (2009) *Introduction to Statistical Quality Control*, John Wileyv & Sons.

HMMA16E07 **GRAPH THEORY** **4 0 0 4**

UNIT I
Graphs - Graph Isomorphism - The Incidence and Adjacency Matrices – Sub graphs - Vertex Degrees - Paths and Connection - Cycles - Trees - Cut Edges and Bonds - Cut Vertices.
(Chapter 1 Section 1.1 - 1.7; Chapter 2 Section 2.1 - 2.3) **12 Hours**

UNIT II
Connectivity - Blocks - Euler tours - Hamilton Cycles. (Chapter 3 Section 3.1 - 3.2; Chapter 4 Section 4.1 - 4.2) **12 Hours**

UNIT III
Matchings - Matchings and Coverings in Bipartite Graphs - Edge Chromatic Number - Vizing's Theorem.
(Chapter 5 Section 5.1 - 5.2; Chapter 6 Section 6.1 - 6.2) **12 Hours**

UNIT IV
Independent sets - Ramsey's Theorem - Chromatic Number - Brooks' Theorem - Chromatic Polynomials.
(Chapter 7 Section 7.1 – 7.2; Chapter 8 Section 8.1 – 8.2, 8.4) **12 Hours**

UNIT V
Plane and planar Graphs - Dual graphs - Euler's Formula - The Five-Colour Theorem and the Four-Colour Conjecture.
(Chapter 9 Section 9.1 - 9.3, 9.6) **12 Hours**

Total No. of hours: 60

TEXT BOOKS:
1. Bondy, J.A Murthy, U.S.R (1976) *Graph Theory and Applications*, Macmillan, London.

REFERENCES:
1. J.Clark, J Holton , D.A (1995) *A First look at Graph Theory*, Allied Publishers, New Delhi.
2. Gould, R (1989) *Graph Theory*, Benjamin/Cummings, Menlo Park.
3. Gibbons, A (1989) *Algorithmic Graph Theory*, Cambridge University Press, Cambridge.
4. Wilson, R.J. Watkins, J.J (1989) *Graphs: An Introductory Approach*, John Wiley and Sons, New York.
5. Wilson, R.J (2004) *Introduction to Graph Theory*, Pearson Education, 4th Edition.
6. Choudum, S.A (1987) *A First Course in Graph Theory*, MacMillan India Ltd..

HMMA16E08 **DISCRETE MATHEMATICS** **4 0 0 4**

UNIT I
Statements – Connectives – Tautologies – Equivalence – Duality – Tautological Implications- Normal forms – Theory of Inference for the statement calculus – Predicate calculus – Inference theory of the predicate calculus. **12 Hours**

UNIT II
Basic Concepts – Operations on Sets – Relations and Ordering – Equivalence relations – Partial ordering – Functions – Composition of functions – Inverse functions. **12 Hours**

UNIT III
Semi-groups and Monoids – Groups – Subgroups – Homomorphisms – Cosets – Lagrange's theorem – Normal subgroups – Algebraic Systems with two binary Operations. **12 Hours**

UNIT IV
Lattices as partially ordered sets – Properties of Lattices – Sub lattices – Direct Product – Homomorphism in lattices. Boolean Algebra – Sub algebra – Direct product and Homomorphism in Boolean Algebra. **12 Hours**

UNIT V
Graph theory: Basic Concepts –Digraphs - Isomorphism - Paths – Reachability and Connectedness – Trees – Matrix Representations of Graphs. **12 Hours**

Total No. of hours: 60

TEXT BOOKS:
1. Tremblay, J.P, Manohar, R (1975) *Discrete Mathematical Structures with Applications to Computer Science*, McGraw Hill.

REFERENCES:
1. Kolman, Busby, Ross *Discrete Mathematical Structures*, Pearson Education Series.
2. Liu, J.T *Elements of Discrete Mathematics*, McGraw Hill.