PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ
।। विद्यया संपन्नता ।।
NAAC Accredited-2022
'B++' Grade (CGPA-2.96)

SYLLABUS

FOR

M.Sc. (Part-II) MATHEMATICS
(Semester III and IV)

As per NEP - 2020

WITH EFFECT FROM ACADEMIC YEAR 2024-25

(JUNE-2024).

PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

SCHOOL OF COMPUTATIONAL SCIENCES

DEPARTMENT OF MATHEMATICS

Revised Syllabi of M.Sc. II in Mathematics (NEP-2020)

1) **Title of the course:** M.Sc. in Mathematics
2) **Pattern:** Semester and Credit system.
3) **Duration of Course**: 2 years
4) **Strength of the Students:** 40
5) **Eligibility:** For M. Sc. in Mathematics following candidates are eligible.
   (i) B.Sc. with Mathematics as principal level.
   (ii) B.Sc. with any subject as principal and Mathematics at subsidiary level.

M. Sc. program in Mathematics consists of 88 credits. Credits of a course are specified against the title of the course.

M.Sc. II Mathematics Course

Sem	Course Type	Course code	No. of Credits	Course Title
III	Major Mandatory	DSC -5	4	Functional Analysis
		DSC- 6	4	Linear Algebra
		Lab-7	2	Mathematics Practical -7
		Lab-8	2	Mathematics Practical -8
	Major Elective	DSE- 3 (Any one)	4	(A)Advanced Discrete Mathematics
				(B)Differential Geometry
				(C) Relativistic Mechanics
		Lab-9	2	Mathematics Practical -9
	Research Project	RP	4	Research Project-I
IV	Major Mandatory	DSC -7	4	Partial Differential Equations
		DSC- 8	4	Integral Equations
		Lab-10	2	Mathematics Practical -10
	Major Elective	DSE- 4 (Any one)	4	(A)Measure and Integration
				(B) Graph Theory
				(C) Lattice Theory
		Lab-11	2	Mathematics Practical -11
	Research Project	RP	6	Research Project-II

M.Sc. Mathematics (NEP-2020)

Course Structure M.Sc. Part-II (Mathematics) w.e.f. June 2024

	M.Sc. MATHEMATICS SEMESTER-III											
Paper Code	**Title of the Paper**	**Credits**	**Contact hours/week**			**Distribution of Marks for Examination**					
			Th (L)	**Pr**	**Total**	**Internal**		**External**		**Total**	
						Th	**Pr**	**Th**	**Pr**	**Th**	**Pr**
DSC -5	Functional Analysis	4	4	--	4	40	--	60	--	100	--
DSC- 6	Linear Algebra	4	4	--	4	40	--	60	--	100	--
Lab-7	Mathematics Practical -7 (Operations Research –I)	2	--	4	4	--	20	--	30	--	50
Lab-8	Mathematics Practical -8 (Operations Research –II)	2	--	4	4	--	20	--	30	--	50
DSE- 3 (Any one)	(A)Advanced Discrete Mathematics (B)Differential Geometry (C) Relativistic Mechanics	4	4	--	4	40	--	60	--	100	--
Lab-9	Mathematics Practical -9 (Introduction to Scilab)	2	--	4	4	--	20	--	30	--	50
RP	Research Project-I	4	4	--	4	40	--	60	--	100	--
Total for Semester-III		**22**	**16**	**12**	**28**	**160**	**60**	**240**	**90**	**400**	**150**
	M.Sc. MATHEMATICS SEMESTER-IV											
Paper Code	**Title of the Paper**	**Credits**	**Contact hours/week**			**Distribution of Marks for Examination**					
			Th (L)	**Pr**	**Total**	**Internal**		**External**		**Total**	
						Th	**Pr**	**Th**	**Pr**	**Th**	**Pr**
DSC -7	Partial Differential Equations	4	4	--	4	40	--	60	--	100	--
DSC- 8	Integral Equations	4	4	--	4	40	--	60	--	100	--
Lab-10	Mathematics Practical -10 (Numerical Analysis)	2	--	4	4	--	20	--	30	--	50
DSE- 4 (Any one)	(A)Measure and Integration (B) Graph Theory (C) Lattice Theory	4	4	--	4	40	--	60	--	100	--
Lab-11	Mathematics Practical -11 (Advanced Scilab)	2	--	4	4	--	20	--	30	--	50
RP	Research Project-II	6	6	--	6	60	--	90	--	150	--
Total for Semester-IV		**22**	**18**	**08**	**26**	**180**	**40**	**270**	**60**	**450**	**100**

Evaluation Scheme:

Each theory paper will have 100 marks out of which 60 marks will be for Term End examination and 40 marks for Internal Assessment. The candidate has to appear for internal evaluation of 40 marks and external evaluation (University Examination) of 60 marks for each theory paper.

Each practical paper will have 50 marks out of which 30 marks will be for Term End examination and 20 marks for Internal Assessment. The candidate has to appear for internal evaluation of 20 marks and external evaluation (University Examination) of 30 marks for each practical paper.

Internal Evaluation:

- In case of theory papers internal examinations will be conducted by department / school.
- In case of practical papers 20 marks shall be for internal test, which will be conducted by the department / school.

External Evaluation (End of Term University Examination):

I) Nature of Theory question paper:

1) Each Theory paper is of 60 marks.
2) Each Theory paper will be of 2.30 hours duration
3) There shall be 05 questions each carrying 12 marks.
4) Q.No.1 contains 12 objective type sub-questions each carrying 1 mark.
5) Q.No.2 shall contains 08 short answer type sub-questions each carrying 02 marks, students have to attempt any six questions.
6) Q.No. 3 shall contains 04 short answer type sub-questions each carrying 04 marks, students have to attempt any three questions.
7) Q.No.4 and Q.No. 5 contains 03 long answer type sub-questions each carrying 06 marks , students have to attempt any two questions.

II) Nature of Practical question paper: (End of Term Examination)

For Sem-I and II: Practical examination will be conducted for 30 marks and is of two hours duration. There shall be 03 questions each of 10 marks, of which student has to attempt any 02 questions. VIVA will be for 5 marks and 5 marks shall be for day-to-day journal.

Paper Code: DSC -5

Functional Analysis

Unit - 1

Banach spaces :

Normed linear spaces, Banach spaces, Quotient norm spaces, continuous linear transformations, equivalent norms, Hahn-Banach theorem and its consequences.

(15 L)

Unit - 2

Conjugate space and separability, second conjugate space. The open mapping Theorem, The closed graph theorem, The conjugate of an operator, The uniform boundedness principle.

(15 L)

Unit - 3

Hilbert spaces :

Definition and examples and simple properties, orthogonal complements, The projection theorem, orthogonal sets, The Bessel's inequality, Fourier expansion and Perseval's equation,

(15 L)

Unit - 4

Separable Hilbert spaces, The conjugate space, Riesz's theorem, The adjoint of an operators, self adjoint operators, Normal and unitary operators, projections. Contraction mapping and Banach fixed point theorem.

(15 L)

Recommended Book :

1. G.F.Simmons **:** Topology and Modern Analysis, McGraw Hill (1963)

Reference Books :

1. D. Somsundram : A First Course in Fuctional Analysis, Narosa Publishing House
2. G.Bochman and Narici **:** Functional Analysis, Academic Press 1964
3. A.E.Taylor **:** Introduction to Functional analysis, John Wiley- and sons (1958)
4. A.L.Brown and Page **:** Elements of Functional Analysis, Van-Nastra Reinehold com (1970)
5. B.V.Limaye **:** Functioned Analysis New age international.
6. Erwie Krey Zig **:** Introduction to Functional Analysis with Applications, John Wiley and Sons.

Paper Code: DSC-6

Linear Algebra

Unit – 1

Linear Transformations

Linear transformation, Linear functional, Dual space, Dual basis, The Double dual, The Transpose of a linear transformation, Annihilator of a set, Annihilator of Annihilator. Representation of Transformation by matrix, Characteristic values of matrix, Characteristic polynomial of linear operator, Annihilating Polynomial, Invariant subspace.

(15L)

Unit – 2

Elementary canonical forms

Triangulabity, simultaneous Triangulation, Diagonalizability, Simultaneous Diagonalization, Direct sum, Direct sum decompositions, Invariant direct sums, The primary decomposition theorem

(15L)

Unit – 3

Jordan and Rational Forms

Cyclic subspace and Annihilator, Cyclic decomposition and the rational form The Jordan form, computation of Invariant factors, Companion matrix.

(15L)

Unit – 4

Inner Product Spaces:

Linear functional and adjoints, unitary operators, Normal operators, Operators on Inner Product Spaces, Forms on Inner product spaces, positive forms, more on forms, spectral theory .

(15L)

Recommended Book :

1. K.Hoffman and Ray Kunze : Linear Algebra, Prentice Hall of India,Pvt Ltd. 1989.

Reference Books :

1. David M.Barton : Abstract and linear Algebra, Addison Wesley Publishing Co.
2. Sharma, Vasistha & vasistha: Linear Algebra, Krishna prakashan ltd. Meerut. 2005.
3. Friedberg H. Stephen, Insel J. Arnold, Spence E. Lawrence , Eastern Economy Edition
4. Vivek Sahai, Vikas Bist : Linear Algebra, Alpha Science International

Paper Code: Lab-7

Mathematics Practical-7

Operations Research –I

Unit-1

Convex Sets and Functions: Convex sets, supporting and separating hyperplanes, convex polyhedra and polytope, extreme points, convex functions. Linear Programming Problem (LPP): Introduction to linear programming problems, Graphical solution to LPP, Standard LPP (SLPP), basic solution and basic feasible solution to SLPP. Methods for solving LPP: Simplex Algorithm, Two-phase simplex method, Big M method .

(15 L)

Unit-2.

Duality in LPP: Concept of duality, Theorems related to duality, complementary slackness property and development of dual simplex algorithm. Integer Linear Programming Problem (ILPP): The concept of cutting plane, Gomory's method of cutting plane for all ILPP and mixed ILPP, Branch and Bound method (Algorithm only). **(15L)**

Practical Assignments 1 to 5 on Unit I and Practical Assignments 6 to 10 on Unit II.

Recommended Book:

1.Sharma S.D : Operations Research, Macmillan Publishers India Ltd.

Reference Books:

1. Hadley G. (1969): Linear Programming, Addision Wesley.
2. Taha H. A. (1971): Operations Research an Introduction, Macmillan N. Y.
3. Kanti Swaroop, Gupta and Manmohan (1985): Operations Research, Sultan Chand & Co.
4. Sharma J. K. (2003): Operations Research Theory and Applications, 2nd Ed. Macmillan India ltd.
5. Sharma J. K. (1986): Mathematical Models Operations Research, Macgraw Hill.

Paper Code: Lab-8

Mathematics Practical-8

Operations Research –II

Unit-1

Quadratic Programming Problem (QPP): Definition of QPP, Kuhn-Tucker conditions, Algorithms for solving QPP: Wolfe's and Beale's algorithm.

(15 L)

Unit-2

Theory of Games: Two person zero sum games, Minimax and Maxmin principles, Saddle point, Mixed strategies; Rules of dominance, Solution of 2 x 2 game by Algebraic method, Graphical method, Reduction of game problem as LPP, Minimax and Maxmin theorem (without proof).

(15L)

Practical Assignments 1 to 5 on Unit I and Practical Assignments 6 to 10 on Unit II.

Recommended Book:

1.Sharma S.D : Operations Research, Macmillan Publishers India Ltd.

Reference Books:

1. Hadley G. (1969): Linear Programming, Addision Wesley.
2. Taha H. A. (1971): Operations Research an Introduction, Macmillan N. Y.
3. Kanti Swaroop, Gupta and Manmohan (1985): Operations Research, Sultan Chand & Co.
4. Sharma J. K. (2003): Operations Research Theory and Applications, 2nd Ed. Macmillan India ltd.
5. Sharma J. K. (1986): Mathematical Models Operations Research, Macgraw Hill.

Paper Code: DSE-3

(A)Advanced Discrete Mathematics

Unit - 1

Lattices**:** Definition and examples of posets, Comparability, Product and Lexicographic Order, Hasse Diagrams, Special Elements in Posets, lattices, Sublattices, Complete Lattice, Modular and distributive lattices, Homomorphism's, Finite Boolean algebras and applications.

(15 L)

Unit - 2

Graph Theory:

Definition of a graph, vertex degrees, simple and multigraph, graph isomorphism, regular, complete and bipartite graphs, subgraphs, paths and cycles in a graph, connected graphs, eccentricity, radius and diameter of graph, The matrix representation of a graph, Fusion.

(15 L)

Unit - 3

Trees: Definition and simple properties of a tree, bridges, spanning trees, cut vertices, vertex connectivity.

(15 L)

Unit - 4

Combinatorics : The fundamental principles**,** Permutation and combination, principle of Inclusion-Exclusion, Pigeonhole principle, recurrence relations and generating functions.

(15 L)

Recommended Books :

1. Gorrett Birkhaff and T.C.Bartee,Modern Applied Algebra, CBS Pub. and Distributors.
2. John Clark and Derek Holton A first book at Graph Theory Applied Publishers Ltd.
3. C.T.Liu **:** Discrete Mathematics.

Reference Books:

1. Rudolf Lidl and Gunter Pils : Applied Abstract Algebra, Springer Verlag.
2. J.E. Hopcroft and Jeffery D. Ullman. Introduction to Automata theory, languages and computation Narosa publishing House, 1993
3. K.L.P.Mishra and M Chandrasekaran Theory of Computer Science, Prentice Hall of India Ltd.
4. John C. Martin : Introduction to languages and the theory of computation Tata McGraw Hill Publishing Co, Ltd, New Delhi
5. Swapan Kumar: A text book of Discrete Mathematics
6. Rich and Brualdi **:** Combinatories

Paper Code: DSE-3

(B)Differential Geometry

Unit -1

Tangent vectors and tangent vector fields, frame fields, Reparametrization of curves, standard curves, Directional derivative, Differential forms, Speed of curve

(15 L)

Unit- 2

Frenet formulas for unit speed and for arbitrary speed curves, Isometries in E^3, Translation, Rotation, Orthogonal Transformation, Frenet approximation of curves, Covariant derivatives.

(15 L)

Unit -3

Calculus on Surface, Co-ordinate patches, Surface, Surface of revolution, Patch Computation Parametrization of a region X(D) in M .

(15 L)

Unit- 4

Differentiable functions and Tangent vectors, Shape Operator, Normal curvature, Gaussian and mean curvature .

(15 L)

Recommended Books:

1. O'Neill, B.: Elementary Differential geometry, Academic Press, London 1966

Reference Books:

1. Millman, R. and Parker, G.D. : Elements of differential geometry: Prentice-Hall of India Pvt. Ltd. 1977

2. Hicks, N. : Notes of differential geometry, Princeton University Press (1968)

3. Nirmala Prakash : Differential Geometry, Tata McGraw-Hill 1981

Paper Code: DSE-3

(C) Relativistic Mechanics

Unit-1:Relativistic Kinematics : (15 lectures)

Galilean transformations, Newtonian Relativity, Electromagnetism and Newtonian Relativity, Inertial frames, postulates of special relativity, Derivation of the Lorentz Transformation equations, Consequences of the Lorentz Transformation equations, viz. Lorentz contraction, time dilation, simultaneity and co-locality of events. Invariance of electromagnetic wave equation. The relativistic addition of velocities (Einstein's formula) Lorentz velocity and acceleration transformation equations, relativistic aberration formula and Doppler effect [1]

Unit-2:.Relativistic Dynamics : (15 lectures)

Variation of mass of a moving particle, relativistic momentum, force, work and energy, The equivalence of mass and energy. The transformation properties of momentum, energy, mass and force Minkowski space-time, four velocity vector, four momentum, Relativistic Lagrangian and Hamiltonian. [1]

Unit-3:Electromagnetism : (15 lectures)

The interdependence of electric and magnetic fields, The transformation for electric and magnetic fields, the field of a uniformly moving point charge, The invariance of Maxwells equations [1]

Unit-4: Tensor Analysis : (15 lectures)

Transformation of co-ordinates, Laws of transformation of contravariant, covariant and mixed tensors of different ranks. Cartesian tensor, metric tensor.

Recommended Books :

1. Introduction to special Relativity by R.Resnick [1968]
2. A text book of Matrix and Tensor by Paria G. Scholan's Publication, Indore.

Reference Books :

1 Relativity and Gravitation by Philippe Tourrence (1972) Cambridge University Press.

2 Relativistic Mechanics by Satyaprakash Pragati Prakashan.

Paper Code: Lab-9

Mathematics Practical-9

Introduction to SCILAB

Unit-1

Download and install SCILAB, General Environment and console, Simple numeric calculations, menu bar, editor, graphic window, windows management and workspace customization.

(15 L)

Unit-2

Variables , assignment and display, loops, test, 2D-3D plots, supplemnets on matrices and vectors, calculation accuracy, solving differential equations.
Scilab function in analysis, probability and statistics, display and plot, utilities.

(15 L)

Practical Hands on session should be conducted on SCILAB software.

Practical Assignments 1 to 5 on Unit I and Practical Assignments 6 to 10 on Unit II.

Reference Books:

1. Scilab for very beginners co-written by Scilab Enterprises and Christine Gomez, mathematics teacher at Lycée Descartes (Descartes High School) in Antony, Hauts-de-Seine (France).
2. https://www.scilab.org/tutorials/getting-started/first-steps

RP

Research Project-I

- Project should be based on current research areas of Mathematics or new Concept which is not covered in Syllabus and focus on Problem, definition, Data collection, Data analysis, Interpretation, Major findings and Report writing. Student should work under a teacher to complete the project. Project report should be typed in Latex typesetting.

M.Sc.Part II Sem IV

Paper Code: DSC-7

Partial Differential Equations

Unit - 1

First order Partial Differential Equations:

Curves and surfaces, classification of integrals, linear equations of first order, Pfaffians, compatible systems, Charpits method, Jacobi method.

(15 L)

Unit -2

Integral surfaces through a given curve, quasi linear equations, nonlinear first order partial differential equations.

(15 L)

Unit - 3

Second order Partial Differential Equations:

Genesis of Second order Partial Differential Equations, Classification, one dimensional wave equations, vibrations, of a string, families of equipotential surface.

(15 L)

Unit -4

Maximum and minimum principles, Dirichlets and Neumann problems. Dirichlet problem for circle, Harnacks theorem. Greens theorem (Statement only), Classification in case of n variables.

(15 L)

Recommended Book:

1. T. Amarnath: An elementary course in Partial differential equations, Narosa publication, 1987.

Reference Books:

1. Ordinary and Partial Differential Equations: M. D. Raisinghania, S Chand Publications

2. Frite John**:** Partial Differential Equations.

3. R.McOwen **:** Partial differential equations, Prentice Hall 1995

4. G.Folland : Partial Differential Equations Prentice Hall India 1995

Paper Code: DSC-8
Integral Equations

Unit - 1

Preliminary concepts :Introduction, Some problems which give rise to integral equations, Classification of linear integral equations, Integro -differential equations, conversions of initial value problems to Volterra type integral equations and boundary value problems Fredholm type integral equations,

(15 L)

Unit - 2

Fredholm Equations :Integral equations with separable (Degenerate), Hermitian and symmetric Kernel, The operator method in the theory of integral equations, Determination of Iterated Kernels and Resolvent Kernels, Solution of Fredholm's integral equations by successive approximations problems.

(15L)

Unit - 3

Volterra Equations :Types of Volterra equations, Resolvent kernel of Volterra equations, Methods of successive approximations, Convolution type kernels. Conversion of Sturm Liouville problems to integral equations, Solution of Sturm Liouville

(15L)

Unit - 4

Hilbert-Schmidt theorem. Construction of Green function and its use in solving Boundary Value Problems,Application of Fourier and Laplace transforms to the solution of Volterra integral equations.

(15L)

Recommended Book :

1. Kanwal, R.P. :Linear Integral Equations, Theory and Techniques, Academic Press (1971)

Reference Books :

2. Chambers, L.G. :Integral Equations : A Short Course, International Text Book Co., (1976)
3. C.D.Green: Integral Equation Methods, Thomas Nelson and Sons(1969)
4. J.A. Cochran :The Analysis of linear Integral Equations, Mc-Graw Hill (1972)
5. Krasnow M.A.: Kislov and G. Hakaronke : Problems and exerciscs in integral equations Mir Publications(1971)
6. Pundir and Pundir : IntegralEquations
7. M.D.Raisinghania: Linear Integral Equations,Kedar Nath Ram Nath ,MEERUT DELHI.

Paper Code: Lab-10

Mathematics Practical-10

Numerical Analysis.

Unit–1

The iteration method: Bisection method, Method of false position, Secant method Newton Raphson method, Numerical solutions of system of linear equations & Eigen Values: Gaussian elimination method, Method of factorization (LU decomposition), Iterative Method, Gauss Seidal Method, Eigen value problem, Householder's method, Eigen value of symmetric tridiagonal matrix, Power method for largest Eigenvalue.

(15 L)

Unit –2

Numerical Differentiation: Solution of differential equation by Taylor's series, Euler's method and Euler's modified method, Picard's method of successive approximations, Runge- Kutta Methods**,** Numerical Solution of Partial differential Equation, Finite difference approximation to derivative, Laplace's equation, Jacobi's method.

(15 L)

Recommended Book :

1. M. K. Jain, S.R.K. Iyengar, S.R. Iyenger, R. K. Jain, Numerical Methods for scientific and Engineering computation, 3rd edition, wiley Eastern Ltd.,1992

Reference Book :

1. S.S.Sastry, Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India, 2001
2. Atkinson K. E., An Introduction to Numerical Analysis, John Wiley and Sons, N. Y., 1978.
3. Froberg C. E., Introduction to Numerical Analysis, Johns Hopkins University Press, Baltimore,1950.

Paper Code: DSE-4
(A)Measure and Integration.

Unit - 1

Measure and Integration: Measure space, Complete Measure, Locally measurable Set, Saturated Measure, Measurable function, Fatous lemma (statement only), Monotone Convergence Theorem, Integrable Function, Lebesgue Convergence Theorem, Generalized Fatous Lemma (Statement Only), Generalized Lebesque convergence theorem.

(15 L)

Unit - 2

Signed Measure : Definition of Signed Measure, Positive Set , Negative Set and Null Set, Hahn Decomposition Theorem, Mutually Singular Measure, Jordan Decomposition Theorem, Absolutely Continuous Measure, Radon-Nikodym theorem, Lebesque Decomposition Theorem.

(15 L)

Unit - 3

Product Measure and Outer Measure: Semi algebra, Measurable Rectangle, Product measures, x-cross Section and y-cross Section, Fubini's and Tonelli's theorem, Outer Measure and measurability, The Extension theorem.

(15L)

Unit - 4

Inner measure and its properties, Baire Borel sets and positive linear functional and Borel measures.

(15 L)

Recommend Book :

1.Royden H.L: Real Analysis (Third Edition Practice Hall ,2002).

Reference Books :

1. Berberian, S.K. : Measure and Intergration McMillan, N.Y. 1965
2. Friedman A. : Foundations of Modern Analysis, Helf Rinehart and Winston, 1970
3. Wheeden R.L. and Zygmund A. : Measure and integral, Marcel Dakker, 1977
4. Halmos, P.R. : Measure Theory : Van Nostrand 1950
5. A Murkherjee and K.Pethoven : Real and Functional Analysis, Plenum Press 1978.
6. Rana J.K. : Measure and integration Narosa (1997)
7. P . K. Jain and V.P. Gupta :- Lebesgue measure and Integration , Anushan Publication

Paper Code: DSE-4

(B) Graph Theory

Unit - 1

Trees and connectivity: Definitions and simple properties, Bridges, spanning trees, cut vertices and connectivity, Euler Tours and Hamiltonian Cycles:Eulertours, the chinese postman problem, Hamiltonian graphs, The travelling salesman problem. **(15L)**

Unit – 2

Matchings and Augmenting paths, The marriage problem, The Personal Assignment problem, The Optimal Assignment problem, Plane and Planar graphs, Eulers formula, Kurotowskis theorem (st. only), Non Hamiltonian plane graphs. The dual of a plane graph. **(15L)**

Unit – 3

Vertex coloring, vertex coloring algorithms, critical graphs, cliques, Edge coloring, map coloring.

(15L)

Unit-4

Directed graphs: Definition, Indegree and outdegree, Tournaments, traffic flow.

Networks : Flows and Cuts, The Ford and Fulkerson Algorithm, Separating sets**(15L)**

Recommended books :

1. John Clark and Derec Haltan : A first look at graph theory,
   Allied publishers Ltd. Bombay.

Reference Books :

1. Douglas B.West : Introduction to Graph Theory Pearson Education Asia.
2. F. Harary - Graph Theory, Narosa Publishing House (1989)
3. K.R.Parthsorthy : Basic Graph Theory, Tata McGraw Hill publishing Co.Ltd.New Delhi

Paper Code: DSE-4

(C)Lattice Theory

Unit-1: Two definitions of lattices, Hasse diagrams,homomorphism, isotone maps, ideals,Congruence relations, congruence lattices, the homorphism theorem, product of lattices,Complete lattice, ideal lattice, distributive –modular inequalities and identifies, complements, pseudocomplements, Boolean lattice of pseudo complements, join and meet irreducible elements

Unit-2: Characterization theorems and representation theorems-Dedekind`s modularity criterion, Birkhoff`s distributivity criterion,Hereditary subsets, rings of sets, Stone theorems, Nachbin theorem, statements of Hashimoto's theorem.

Unit-3: Modular lattices ,Isomorphism theorem,Upper and lower covering conditions, Kuros-Ore theorem, independent sets.

Unit-4: Semi modular lattices, Jordan-Holder chain condition, Modular pair, M-sysmmetric lattices

Recommended books :

1. G. Gratzer- Birkhauser, General Lattice Theory, IInd Edition 199.

Scope: Chapter- 1 (Section 1,2, 3,4,6), Chapter – 2(Section -1), Chapter-3(Section –1, 2)

Reference Books:

1. Vijay K. Garg, Introduction to lattice theory with computer science applications, John Wiley and Sons.

Paper Code: Lab-11

Mathematics Practical-11

Advanced SCILAB

Unit 1: Scilab programming : Branching statements, if-else statement, select statement, looping statement, while statement, functions, calling a function.

Unit 2: Plotting: 2-dimensional plotting, contour plot, 3-dimensional plot, solving ordinary differential equations, polynomials in scilab, matrices of polynomials, operations on polynomials, Evaluation on polynomials.

Recommended books :

1. Advanced SCILAB, Karaial .

Reference Books:

1. Scilab for very beginners co-written by Scilab Enterprises and Christine Gomez, mathematics teacher at Lycée Descartes (Descartes High School) in Antony, Hauts-de-Seine (France).
2. https://www.scilab.org/tutorials/getting-started/first-steps

RP

Research Project-II

- Project should be based on current research areas of Mathematics or new Concept which is not covered in Syllabus and focus on Problem, definition, Data collection, Data analysis, Interpretation, Major findings and Report writing. Student should work under a teacher to complete the project. Project report should be typed in Latex typesetting.

- **Equivalence of Papers of M.Sc. II SEM III**

Paper Code	Old Paper	Paper Code	Equivalent paper
HCT 3.1	Functional Analysis	DSC-5	Functional Analysis
HCT 3.2	Advanced Discrete Mathematics	DSE-3(A)	Advanced Discrete Mathematics
HCT 3.3	Linear Algebra	DSC-6	Linear Algebra
SCT 3.1	Differential Geometry	DSE-3(B)	Differential Geometry
SCT 3.2	Fuzzy Mathematics		No Equivalence
OET 3.1	Numerical Techniques		No Equivalence

- **Equivalence of Papers of M.Sc.II SEM IV**

Paper Code	Old Paper	Paper Code	Equivalent paper
HCT 4.1	Measure & Integration	DSE-4(A)	Measure & Integration
HCT 4.2	Partial Differential Equations		No Equivalence
HCT 4.3	Integral Equations	DSC-8	Integral Equations
HCT 4.4	Operations Research		No Equivalence
SCT 4.1	Numerical Analysis		No Equivalence