Scheme of M.Sc. (Mathematics) Under Semester pattern (CBCS)

w.e.f . Session (2020-2021)

Scheme of teaching and examination under semester pattern Choice Based Credit System (CBCS) for M.Sc. Program in Mathematics

Semester I for M.Sc. Program in Mathematics												
Code	Theory / Practical	Teaching scheme (Hours / Week)		Credits			Examination Scheme					
								Max. Marks			Minimum Passing Marks	
		Th	Total	Theory	Int. Assessment	Total	Duration in hrs.	External Marks	Internal Ass	Total Marks	Th. External	Internal Ass.
Core 1	Paper 1	5	5	4	1	5	3	100	25	125	50	
Core 2	Paper 2	5	5	4	1	5	3	100	25	125	50	
Core 3	Paper 3	5	5	4	1	5	3	100	25	125	50	
Core 4	Paper 4	5	5	4	1	5	3	100	25	125	50	
Core 5	Paper 5	5	5	4	1	5	3	100	25	125	50	
	TOTAL	**25**	**25**	**20**	**5**	**25**		**500**	**125**	**625**	**250**	
Semester II for M.Sc. Program in Mathematics												
Code	Theory / Practical	Teachig scheme (Hours / Week)		Credits			Examination Scheme					
								Max. Marks			Minimum Passing Marks	
		Th	Total	Theory	Int. Assessment	Total	Duration in hrs.	External Marks	Internal Ass	Total Marks	Th. External	Internal Ass.
Core 6	Paper 6	5	5	4	1	5	3	100	25	125	50	
Core 7	Paper 7	5	5	4	1	5	3	100	25	125	50	
Core 8	Paper 8	5	5	4	1	5	3	100	25	125	50	
Core 9	Paper 9	5	5	4	1	5	3	100	25	125	50	
Core 10	Paper 10	5	5	4	1	5	3	100	25	125	50	
	TOTAL	**25**	**25**	**20**	**5**	**25**		**500**	**125**	**625**	**250**	

Semester III for M.Sc. Program in Mathematics												
Code	Theory / Practical	Teaching scheme (Hours / Week)		Credits			Examination Scheme					
								Max. Marks			Minimum Passing Marks	
		Th	Total	Theory	Int. Assessment	Total	Duration in hrs.	External Marks	Internal Ass	Total Marks	Th. External	Internal Ass.
Core 11	Paper 11	5	5	4	1	5	3	100	25	125	50	
Core 12	Paper 12	5	5	4	1	5	3	100	25	125	50	
Core 13	Paper 13	5	5	4	1	5	3	100	25	125	50	
Core Elective 1	Paper 14	5	5	4	1	5	3	100	25	125	50	
Foundation Course 1	Paper 15	5	5	4	1	5	3	100	25	125	50	
	TOTAL	**25**	**25**	**20**	**5**	**25**		**500**	**125**	**625**	**250**	

Semester IV for M.Sc. Program in Mathematics												
Code	Theory / Practical	Teaching scheme (Hours / Week)		Credits			Examination Scheme					
								Max. Marks			Minimum Passing Marks	
		Th	Total	Theory	Int. Assessment	Total	Duration in hrs.	External Marks	Internal Ass	Total Marks	Th. External	Internal Ass.
Core 14	Paper 16	5	5	4	1	5	3	100	25	125	50	
Core 15	Paper 17	5	5	4	1	5	3	100	25	125	50	
Core 16	Paper 18	5	5	4	1	5	3	100	25	125	50	
Core Elective 2	Paper 19	5	5	4	1	5	3	100	25	125	50	
Foundation Course 2	Paper 20	5	5	4	1	5	3	100	25	125	50	
	TOTAL	**25**	**25**	**20**	**5**	**25**		**500**	**125**	**625**	**250**	

*Internal Assessment: For the purpose of internal assessment the department will conduct three tests (with equal weight of marks). Best two scores of a student in these tests will be considered to obtain the internal assessment score of that student.

Foundation Course: Student can choose this paper from any other subject other than his / her main subject for post graduation.

Appendix 8

Subject wise Elective Paper:

M. Sc. Subject	Core elective paper to be opted in semester III	Core elective paper to be opted in semester IV
M. Sc. (Mathematics)	Fluid Dynamics I	Fluid Dynamics II
	General Relativity	Cosmology
	Operations Research I	Operations Research II

Appendix 9

Foundation Course:

Candidate can opt for any one foundation course paper as shown below in the semester III and IV. However, Student shall opt for this paper from any other subject other than his / her main subject for postgraduarion.

List of foundation course available:

M. Sc. Subject	Foundation Course I in semester III (Sem V in case of M. Sc. (Tech) Applied Geology)	Foundation Course II in Semester IV (Sem VI in case of M. Sc. (Tech) Applied Geology)
M. Sc. (Mathematics)	Elementary Mathematics –I	Elementary Mathematics –II

Appendix-10

General Rules and Regulations regarding pattern of question paper, absorption scheme and choice based credit system:

A) Pattern of Question Paper

1. There will be four units in each paper.
2. Maximum marks of each theory paper will be 100
3. Question paper will consist of five questions, each of 20 marks.
4. Four questions will be on four units with internal choice (One question on each unit).
5. Fifth question will be compulsory with questions from each of the four units having equal weightage and there will be no internal choice.

B) Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA)

M. Sc. (Mathematics) Program shall consist of four semesters, wherein the student has to complete certain number of credits as indicated in Table 1. Each subject (or course) has fixed number of credits. The types of subject subheads are: Core, Core Elective, , Foundation Course.

Among the 100 credits the candidate needs to complete and clear for M. Sc. (Mathematics) in any concerned subjects, at least 90 credits must be taken from the parent department where he / she is registered for M. Sc. (Mathematics) Course. The remaining 10 credits (Maths) can be taken from any other department of university or affiliated colleges offering foundation courses of PG programs.

Table 1: Credit Requirements for Post Graduate Studies									
PG	Semester	Core	Pract Core	Core Elective	Pract Core Elective	Foundation Course	Project / Review Writing	Seminar	Total Credits
M. Sc. Maths	I	25							100
	II	25							
	III	15		5		5			
	IV	15		5		5			
Total		**80**		**10**		**10**			**100**

SYLLABUS for M. Sc. MATHEMATICS Choice Based Credit System (Semester Pattern) Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Course Study and Scheme of Examination with paper code

Semester I									
Sr. No.	Paper Core/Elective	Paper	Code	Title of the paper	Hrs. in week	Credit	Maximum Marks		
							Int. Ass	Ext. Mar	Total
1	Core -1	Paper -I	1T1	Algebra I	5	5	25	100	125
2	Core -2	Paper -II	1T2	Real Analysis I	5	5	25	100	125
3	Core -3	Paper -III	1T3	Topology I	5	5	25	100	125
4	Core-4	Paper -IV	1T4	Ordinary Differential Equations	5	5	25	100	125
5	Core-5	Paper -V	1T5	Integral Equations	5	5	25	100	125
Semester II									
Sr. No.	Paper Core/Elective	Paper	Code	Title of the paper	Hrs. in week	Credit	Maximum Marks		
							Int. Ass	Ext. Mar	Total
1	Core -1	Paper -VI	2T1	Algebra II	5	5	25	100	125
2	Core -2	Paper -VII	2T2	Real Analysis II	5	5	25	100	125
3	Core -3	Paper -VIII	2T3	Topology II	5	5	25	100	125
4	Core-4	Paper -IX	2T4	Differential geometry	5	5	25	100	125
5	Core-5	Paper -X	2T5	Classical Mechanics	5	5	25	100	125

M.Sc. (Mathematics) Under CBCS
Course Study and Scheme of Examination with paper code

Semester III									
Sr. No.	Paper Core/Elective	Paper	Code	Title of the paper	Hrs. in week	Credit	Maximum Marks		
							Int. Ass	Ext. Mar	Total
1	Core -1 (Compulsory paper)	Paper -XI	3T1	Complex Analysis	5	5	25	100	125
2	Core -2 (Compulsory paper)	Paper -XII	3T2	Functional Analysis	5	5	25	100	125
3	Core -3 (Compulsory paper)	Paper - XIII	3T3	Mathematical Method	5	5	25	100	125
4	Core Elective (Opt any one)	Paper – XIV (Opt any one)	3T4	(i) Fluid Dynamics-I (ii) General Relativity (iii) Measure and Integration Theory (New) (iv) Number Theory (v) Algebraic Topology- I	5	5	25	100	125
5	Foundation Paper	Paper - XV	3T5	Elementary Mathematics -I	5	5	25	100	125
OR	Subject Centric	Paper - XV	3T5	Operation Research -I	5	5	25	100	125

M.Sc. (Mathematics) Under CBCS
Course Study and Scheme of Examination with paper code

Semester IV									
Sr. No.	Paper Core/Elective	Paper	Code	Title of the paper	Hrs. in week	Credit	Maximum Marks		
							Int. Ass	Ext. Mar	Total
1	Core -1 (Compulsory paper)	Paper - XVI	4T1	Dynamical Systems	5	5	25	100	125
2	Core -2 (Compulsory paper)	Paper - XVII	4T2	Partial Differential Equations	5	5	25	100	125
3	Core -3 (Compulsory paper)	Paper - XVIII	4T3	Advance Numerical Methods	5	5	25	100	125
4	Core Elective (Opt any one)	Paper – XIX (Opt any one)	4T4	(i) Fluid Dynamics II (ii) Cosmology (iii) Cryptography (iv)Operator theory (v)Algebraic Topology-II	5	5	25	100	125
5	Foundation Paper	Paper - XX	4T5	Elementary Discrete Mathematics -I	5	5	25	100	125
OR	Subject Centric	Paper - XX	4T5	Operation Research - II	5	5	25	100	125

Detailed Syllabus

M. Sc. Mathematics

Semester-I

Paper – I (Code: 1T1)

Algebra -I

Unit I:

Permutation Group. Normal subgroups, Quotient groups Dihedral group. Commutator group. Isomorphism Theorems. Automorphisms. Characteristic subgroup. Conjugacy and G-Sets, - Cyclic Decomposition - Alternating group An – Simplicity of An.

Unit II:

Normal Series. Solvable groups. Nilpotent groups. Cyclic decomposition of permutation group. Alternating groups. Simplicity of An.

Unit III:

Direct product, semi-direct product of groups, initely generated abelian groups - Invariants of a finite abelian group, Sylows theorems. Groups of order 2 p and pq.

Unit IV:

Ideals and Homomorphisms. Sum and direct sum of ideals. Maximal and prime ideals. Nilpotent and Nil ideals. Modules. Submodules. Direct sums. R-homomorphisms and quotient modules. Completely reducible modules. Free modules.

Text Book:

Basic Abstract Algebra :Bhattacharya, Jain, and Nagpal ,Second Edition,
Cambridge University Press.

Reference Books:

1. Topics in Algebra, I. N. Herstein, Second Edition, John Wiley.

2. Abstract Algebra: David S.Dummit and Richard M. Foote, John Wiley.

M. Sc. Mathematics

Semester-I

Paper – II (Code: 1T2)

Real Analysis-I

Unit I:

Uniform convergence. Uniform convergence and continuity. Uniform convergence and integration. Uniform convergence and differentiation. Equicontinuous families of functions. The Stone-Weierstrass theorem.

Unit II:

Differentiation. The Contraction Principle. The Inverse Function Theorem. The Implicit Function Theorem. The Rank Theorem. Partitions of unity.

Unit III:

The space of tangent vectors at a point of Rn. Another definition of Ta (Rn). Vector fields on open subsets of Rn. Topological manifolds. Differentiable manifolds. Real Projective space. Grassman manifolds. Differentiable functions and mappings.

Unit IV:

Rank of a mapping. Immersion. Sub manifolds. Lie groups. Examples of Lie groups.

Text Books:

1. Principles of Mathematical Analysis (Third Edition): Walter Rudin Mc GRAW – HILL Book Company.

2. An Introduction to Differentiable Manifolds and Riemannian Geometry: W. Boothby, Academic Press, 1975.

Reference Books:

1. Methods of Real Analysis: R. R. Goldberg, John Wiley.

2. Calculus of Several Variables: C Goffman, Harper and Row.

M. Sc. Mathematics

Semester-I

Paper – III (Code: 1T3)

Topology-I

Unit I:

Countable and Uncountable sets. Examples and related Theorems. Cardinal Numbers and related Theorems. Topological Spaces and Examples.

Unit II:

Open sets and Limit points, Derived Sets. Closed sets and closure operators. Interior, Exterior and boundary operators. Neighbourhoods, bases and relative topologies.

Unit III:

Connected sets and components. Compact and countably compact spaces. Continuous functions and homeomorphisms, Arc wise connectivity.

Unit IV:

To and T1-spaces, T2-spaces and sequences. Axioms of countability. Separability. Regular and normal spaces.

Text Book:

Foundations of General Topology: W.J. Pervin, Academic press, 1964.

Reference Books:

1. Topology: J.R. Munkres, (second edition), Prentice Hall of India, 2002.

2.Introduction to Topology and Modern Analysis: G.F. Simmons, Mc Graw Hill 1963.

3. General Topology: J.L. Kelley, Van Nostrand, 1995.

4. Introduction to general Topology: K.D. Joshi, Wiley Eastern Ltd. 1983

M. Sc. Mathematics

Semester-I

Paper – IV (Code: 1T4)

Ordinary Differential Equations

Course Outcomes: The aim of this course is to study basic notions in Differential Equations and use the results in developing advanced mathematics. After completion of this course students will able to solve application problems modeled by linear differential equations and will able to use power series methods to solve differential equations about ordinary points and regular singular points.

Unit I:

Linear Equations with variable coefficients: Initial value problems for the homogeneous equations. Solutions of the homogeneous equations, The Wronskian and linear independence, Reduction of the order of a homogeneous equation, The non-homogenous equations, Homogeneous equations with analytic coefficients, The Legendre equations.

Unit - II:

Linear Equations with regular singular points: The Euler equations, Second order equations with regular singular points, The Bessel equation, Regular singular points at infinity.

Unit III:

Existence and uniqueness of solutions to first order equations: The method of successive approximations, The Lipschitz condition of the successive approximation. Convergence of the successive approximation, Non-local existence of solutions, Approximations to solutions and uniqueness of solutions.

Unit IV:

Existence and Uniqueness of Solutions to System of first order ordinary differential equations: An example- Central forces and planetary motion, Some special equations, Systems as vector equations , Existence and uniqueness of solutions to systems, Existence and uniqueness for linear systems, Green's function, Sturm Liouville theory.

Text Book:

1) E.A.Coddington: An introduction to ordinary differential equations (2012), Prentice Hall of India Pvt.Ltd. New Delhi.

2) G. Birkoff and G.G.Rota: Ordinary Differential equations, John Willey and Sons

3) Mark Pinsky: Partial differential equations and boundary-value problems with applications, AMS, 3rd edition(2011).

Reference books:

1. G.F. Simmons Differential Equations with Applications and Historical note, MeGraw Hill, Inc. New York. (1972)

2. E.A. Coddington and Levinson: Theory of ordinary differential equations McGraw Hill, New York(1955) 3.E.D. Rainvills :Elementary differential equations, The Macmillan company, New York. (1964)

M. Sc. Mathematics

Semester-I

Paper – V (Code: 1T5)

Integral Equations

Unit 1:

Preliminary concepts of integral equations. Some problems which give rise to integral equations. Conversion of ordinary differential equations into integral equations. Classification of linear integral equations. Integro-differential equations.

Unit 2:

Fredholm equations. Degenerate kernels. Hermitian and symmetric kernels. The Hilbert- Schmidt theorem. Hermitization and symmetrization of kernels. Solutions of integral equations with Green's function type kernels.

Unit 3:

Types of Voltera equations. Resolvent kernel of Voltera equations, Convolution type kernels. Some miscellaneous types of Voltera equations. Non-linear Voltera equations. Fourier integral equations. Laplace integral equations.

Unit 4:

Hilbert transform. Finite Hilbert transforms. Miscellaneous integral transforms. Approximate methods of solutions for linear integral equations. Approximate evaluation of Eigen values and Eigen functions.

Text Book:

Integral Equations: A short course: L. G. Chambers: International text book company Ltd, 1976.

Reference books:

1. Integral equations by Shanti Swaroop, Shiv Raj Singh
2. Linear integral equation, Theory and techniques, Academic press, New York 1971
3. R.P. Kanwal, Linear Integral Equation, Theory and Techniques, Academic Press, N.Y. (1971).
4. S.G. Mikhlin, Linear Integral Equations, Hindustan Book Agency, (1960).
5. A.M. Viazwaz, A First Course in Integral Equations, World Scientific (1997).
6. L.I.G. Chambers, Integral Equation: A Short Course, International Text Book Company Ltd. (1976).
7. Larry Andrews, Bhimsen Shiramoggo, Integral Transform for Engineers, Prentice Hall of India (2003).
8. Integral equations and boundary value problems by M. D. Raisinghania, S. Chand publication

M. Sc. Mathematics

Semester-II

Paper – VI (Code: 2T1)

Algebra-II

Unit 1:

Unique factorization domains. Principal Ideal domains. Euclidean domains. Polynomial rings over unique factorization domains.

Unit 2:

Irreducible polynomials and Eisenstein criterion. Adjunction of roots. Algebraic extensions. Algebraically closed fields. Splitting fields. Normal extensions. Splitting fields, multiple roots.

Unit 3:

Finite fields. Separable extensions. Automorphism groups, and fixed fields. Fundamental theorem of Galois theory. Fundamental theorem of algebra.

Unit 4:

Roots of unity and Cyclotomic polynomials. Cyclic extensions. Polynomials solvable by radicals. Ruler and compass constructions.

Text Book:

Basic Abstract Algebra: Bhattacharya, Jain, Nagpaul; Second Edition, Cambridge University Press.

Reference Books :

1. Topics in Algebra, I. N. Herstein, Second Edition, John Wiley.

2. Abstract Algebra, David S.Dummit and Richard M.Foote, John Wiley.

M. Sc. Mathematics

Semester-II

Paper – VII (Code: 2T2)

Real Analysis -II

Unit 1:

Outer measure.Measurable sets and Lebesgue measure. Anon-measurable set, Measurable functions, Littlewood's three principles.

Unit 2:

The Riemann integral. Lebesgue integral of a bounded function over a set of finite measure. Integral of a non-negative function. General Lebesgue integral. Convergence in measure. Differentiation of monotone functions. Functions of bounded variation. Differentiation of an integral.

Unit 3:

Absolute continuity.Convex functions. Lp-spaces. Holder and Minkowski inequality. Riesz-Fischer theorem. Approximation in Lp. Bounded linear functionals on Lp-spaces.

Unit 4:

Compact metric spaces. Baire category theorem. Arzela Ascoli theorem.
Locally compact spaces. Sigma compact spaces.

Text Book :

Real Analysis, H.L. Royden, Third edition, Prentice Hall, 1988.

Reference Books :

1. Measure theory and Integration, G. de Barra Wiley Eastern Limited, 1981.

2. An introduction to Measure & Integration, Inder K. Rana, Narosa Publishing House

M. Sc. Mathematics

Semester-II

Paper – VIII (Code: 2T3)

Topology-II

Objectives : To study topological spaces, continuous functions, connectedness, compactness, countability and separation axioms.

Unit I :

Continuous Functions: Continuous functions - the product topology - The metric topology. Chapter 2 : Sections 18 to 21 [Omit Section 22]

Unit II:

Connectedness: Connected spaces - connected subspaces of the Real line - Components and local connectedness. [Chapter 3 : Sections 23 to 25]

Unit III:

Compactness: Compact spaces - compact subspaces of the Real line - Limit Point Compactness - Local Compactness. [Chapter 3 : Sections 26 to 29]

Unit IV:

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]

Text Book:

James R. Munkres, Topology (2nd Edition) Pearson Education Pve. Ltd., Delhi-2002 (Third Indian Reprint)

Reference Books

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.Subhash, Counter Examples in Topology, Holt, Rinehart and Winston, New York, 1970.

5. S.Willard, General Topology, Addison - Wesley, Mass., 1970

M. Sc. Mathematics

Semester-II

Paper – IX (Code: 2T4)

Differential Geometry

Course outcome: The course introduces the fundamentals of differential geometry primarily by focusing on the theory of curves and surfaces in three space. The theory of curves studies global properties of curves such as the four vertex theorem. The theory of surfaces introduces the fundamental quadratic forms of a surface, intrinsic and extrinsic geometry of surfaces, and the Gauss-Bonnet theorem.

Unit I:

Definition of surface. Curves on a surface. Surfaces of revolution. Helicoids. Metric. Direction coefficients. Families of curves. Isometric correspondence. Intrinsic properties. Geodesics. Canonical geodesic equations.

Unit II:

Normal property of geodesics. Existence theorems. Geodesic parallels. Geodesic curvature. Gauss Bonnet theorem. Gaussian curvature. Surfaces of constant curvature. Conformal mapping. Geodesic mapping.

Unit III:

Second fundamental form. Principal curvatures. Lines of curvature. Developable. Developable associated with space curves. Developable associated with curves on surfaces. Minimal surfaces and ruled surfaces. Fundamental equations of Surface theory. Parallel surfaces.

Unit IV:

Compact surfaces whose points are umbilics. Hilbert's lemma. Compact surfaces of constant Gaussian or mean curvature. Complete surfaces. Characterisation of complete surfaces. Hilbert's theorem. Conjugate points on geodesics. Intrinsically defined surfaces. Triangulation. Two dimensional Riemannian manifolds. Problem of metrization. Problem of continuation.

Text Book:

An introduction to Differential Geometry: T.J. Wilmore; Oxford University Press

References:

1. W . Klingenberg (Springer), A course in Differential Geometry
2. Geometry of curves and surfaces: do Carmo, Academic Press.
3. Weatherburn, C. Riemannian Geometry and Tensor Calculus
4. D. Somasundaram, Differential Geometry a first course, Narosa Publishing House, 2008

M. Sc. Mathematics

Semester-II

Paper – X (Code: 2T5)

Classical Mechanics

Unit I:

Variational principle and Lagranges Equations : Hamilton's principle, some techniques of the calculus of variations. Derivation of Lagrange' s Equations from Hamilton's Principle. Extension of principle to nonholonomic systems. Conservation theorems and symmetry properties.

Unit II: Legendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorems, Routh's equations, Derivation of Hamilton's equations from a variational principle, the principle of least action.

Unit III:

Canonical transformations : The equations of Canonical transformation, examples of canonical transformations. Symmetric approach to Canonical Transformation, Poisson's bracket & other canonical invariants.

Unit IV:

Equations of motion. Infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, the angular momentum poisson bracket relations, Hamilton-Jacobi theory for Hamilton's principle, and Hamilton-Jacobi theory for characteristic functions.

Text Book:

H.Goldstein, Classical Mechanics, Second edition, Narosa Publishing House, New Delhi

References:

1. T.M. Karade, G.S.Khadekar, Lectures on Advanced Mechanics, Sonu-Nilu publication

2. A.S.Ramsey Dynamics Part-II, the English Language Book Society and Cambridge University Press.

3. Gupta, Kumar and Sharma, Classical Mechanics

4. I.D. Landau and E.M. Lifchitz, Vol. I third edition, Perguman press, New Delhi

5. N. C. Rana & P .S. Joag ,Classical Mechanics ,Tata Mc Graw Hill

6. L. M. Katkar, Classical Mechanics(Mathematics), Shivaji University Kolhapur, 2007

M. Sc. Mathematics

Semester-III

Paper – XI (Code: 3T1)

Complex Analysis

Unit I:

Impossibility of ordering Complex numbers. Extended complex plane and stereographic projection. Elementary properties and examples of analytic Functions: Power series, analytic functions.

Unit II:

Analytic functions as mappings, Mobius transformations. Power series representation of analytic functions, zeros of an analytic function, index of a closed curve.

Unit III:

Cauchy's theorem and integral formula, the homotopic version of cauchy's theorem and simple connectivity, counting zeros; the open mapping theorem, Goursat's theorem, Classification of singularities, residues, the argument principle.

Unit IV:

The maximum principle. Schwarz's lemma. convex functions and Hadamards three circles theorem. Phragmen-Lindel of theorem.

Text Book:

Functions of one complex variable: John B. Conway, Second edition, Springer international Student Edition.

Reference Book:

Complex Analysis, L.V. Ahlfors. Mc-Graw Hill, 1966.

M. Sc. Mathematics

Semester-III

Paper – XII (Code: 3T2)

Functional Analysis

Unit I:

Normed spaces, Banach spaces, Further properties of normed spaces. Finite dimensional normed spaces and subspaces. Compactness and finite dimension. Bounded and continuous linear operators.

Unit II:

Linear functionals. Normed spaces of operators. Dual spaces. Inner product space. Hilbert space. Further properties of inner product spaces. Orthogonal complements and direct sums. Orthonormal sets and sequences. Total orthonormal sets and sequences.

Unit III:

Representation of functionals on Hilbert spaces. Hilbert adjoint operators, self adjoint, unitary and normal operators. Hahn-Banach Theorem, Hahn-Banach Theorem for complex vector spaces and normed spaces. Reflexive spaces.

Unit IV:

Category theorem, Uniform boundedness theorem, strong and weak convergence, Convergence of sequences of operators and functionals. Open mapping theorem, Closed linear operators and closed graph theorem.

Text Book:

Introductory Functional Analysis with Applications by E. Kreyszig, John Wiley and Sons.

Reference Books:

1. Introduction to Functional Analysis by A.E. Taylor and D.C. Lay, John Wiley and Sons.

2. Introduction to Topology and Modern Analysis: G.F. Simmons, Mc Graw Hill

M. Sc. Mathematics

Semester-III

Paper – XIII (Code: 3T3)

Mathematical Methods

Unit I:

Fourier integral theorem. Fourier transform. Fourier cosine and sine transform. The convolution integral. Multiple Fourier transform. Solution of partial differential equation by means of Fourier transform.

Unit II:

Calculations of the Laplace transform of some elementary functions. Laplace transform of derivatives. The convolution of two functions. Inverse formula for the Laplace transform. Solutions of ordinary differential equations by Laplace transform.

Unit III:

Finite Fourier transform. Finite Sturm-Liouville transforms. Generalized finite Fourier transform.

Unit IV:

Finite Hankel transform. Finite Legendre transform. Finite Mellin transform.

Text Book:

The use of integral transforms: I N. Sneddon, Tata Mc Graw Hill Publishing Company Ltd.

References Books:

Modern Mathematics For Engineers: Edwin F Beckenbach, Second series, Mc Graw Hill Book Company.

M. Sc. Mathematics

Semester-III

Core Elective*

Paper – XIV (Code: 3T4)

(i) Fluid Dynamics-I

Unit I:

Real fluids and ideal fluids. Velocity of a fluid at a point. Stream lines and path lines. Steady and unsteady flows. Velocity potential. Velocity vector. Local and particle rate of change. Equation of continuity. Acceleration of a fluid. Condition at a rigid boundary. General analysis of fluid motion. Euler's equation of motion. Bernoulli's equation. Worked examples. Discussion of the case of steady motion under conservative body forces. Some further aspects of vortex motion.

Unit II:

Sources, sinks and doublets. Images in a rigid infinite plane. Images in solid spheres. Axisymmetric flows. Stokes' stream function. The complex potential for two-dimensional irrotational, incompressible flow. Complex velocity potential for standard two dimensional flow. Uniform stream. Line source and line sink. Line doublets. Line vortices. Two dimensional image systems. The Milne-Thomson circle theorem. Circle Theorem. Some applications of circle theorem. Extension of circle theorem. The theorem of Blasius.

Unit III:

The equations of state of a substance, the first law of thermodynamics, internal energy of a gas, functions of state, entropy, Maxwell's thermodynamic relation, Isothermal Adiabatic and Isentropic processes. Compressibility effects in real fluids, the elements of wave motion. One dimensional wave equation, wave equation in two and three dimensions, spherical waves, progressive and stationary waves.

Unit IV:

The speed of sound in a gas, equation of motion of a gas. Sonic, subsonic, supersonic flows; isentropic gas flow. Reservoir discharge through a channel of varying section, investigation of maximum mass flow through a nozzle, shock waves, formation of shock waves, elementary analysis of normal shock waves.

Text Book:

F. Chorlton, Text book of Fluid Dynamics, CBS Publishers, Delhi 1985.

Reference Books:

1. G.K. Batchelor, An Introduction to fluid Mechanics, Foundation Books, New Delhi 1994.

2. M.D. Raisinghania, fluid Mechanics, S. Chand and Company, Delhi.

M. Sc. Mathematics

Semester-III

Core Elective

Paper – XIV (Code: 3T4)

(ii) General Relativity

Unit I:

Tensor Algebra, Riemannian geometry, Curvature Tensor: Covariant Curvature tensor, Ricci tensor, Einstein Tensor, The Bianchi identity.

Unit II:

The principle of covariance, The principle of equivalence, Geodesic principle, Newton's equations of motion as an approximation of geodesic equations, Poisson's equations as an approximation to Einstein field equations.

Unit III:

Gravitational field equations in free space, Exterior Schwarzchild's solution and its isotropic form, Birkhoff's theorem, Schwarzchild singularity, planetary orbit, Advance of Perihelion of a planet, Bending of light rays in the gravitational filed, Gravitational Red shift in the spectral lines.

Unit IV:

Newtonian Incompressible star, The pressure contribution mass of static, spherically symmetric System, The Tolman-Oppenheimer-Volkoff Equation, Schwarzchild's Interior solution,

Text Book:

(i) Introduction to General Relativity: Ronald Adler, Maurice Bezin and Manamen Schiffer, McGraw-Hill Kogakusha Ltd.

(ii) Lecture Notes on General Theory of Relativity, **Øyvind Gron** (Oyvind Gron) , Springer publication

Unit 4 : Chapter 10 , articles [10.1, 10.2,10.3, 10.4]

References Books:

1. Introduction to theory of relativity, Rosser W.G.V., ELBS(1972).
2. Lecture on General Relativity, T M Karade, G S Khadekar and Maya S Bendre, Sonu Nilu Publication (2004)
3. Relativity Special, General and Cosmology, Rindler W., Pub. Oxford University Press (2003).
4. The Classical Theory of Fields By Landau I.D. and Lifshitz E.M., Pub. Pergamon Press (1978).

M. Sc. Mathematics

Semester-III

Core Elective

Paper – XIV (Code: 3T4)

(iii) Measure and Integration Theory

Unit-I:

Lebesgue outer measure, measurable sets, Regularity,Measurable functions, Borel and **Lesbesgue measurability.**

Unit II:

Integration of Non-negative function, the general integral, integration of series, Riemann and Lebesgue integrals.

Unit-III:

The Four derivatives, continuous non-differentiable functions, functions of bounded variation, Lebesgue differentiation theorem, differentiation and integration.

Unit-IV: Measures and outer measures, Extension of a measure, : The uniqueness of Extension, completion of a measure, measure spaces, integration with respect to a measure. spaces, convex functions, Jensen's inequality

Text Book:

Bartle R.G ., The Elements of Integration, John Wiley & Sons, Inc.,New York, 1966.

References :

1. Bartle R.G ., The Elements of Integration, John Wiley & Sons, Inc.,New York, 1966.
2. G .de Barra, Measure Theory and Integration. Wiley Eastern Limited,1981.
3. Halmos P .R. Measure Theory, Van Nostrand Princeton, 1950.
4. Hawkins T. G., Lebesgue' s Theory of Integration, its origins and Development, Chelsea, New York, 1979.
5. Inder K. Rana, An Introduction to Measure and Integration, Narosa Publishing House, Delhi, 1997.
6. Karade T .M., Salunke J.N., Lectures on Advanced Real Analysis, Sonu Nilu Publication, Nagpur, 2004.
7. Royden H.L., Real Analysis, Macmillan Pub. Co. Inc., 4th Edition, New York, 1993
8. P.K. Jain and V.K.Gupta, Leabegue Measure and integration, June-2010

M. Sc. Mathematics

Semester-III

Core Elective

Paper – XIV (Code: 3T4)

(iv) Number Theory

Unit I:

Introduction, The Mobius function u(n), The Euler totient function φ(n), A relation connecting φ and μ. A product formula for φ (n),The Dirichlet product of arithmetical functions, Dirichlet inverses and Mobius Inversions formula. The Mangoldt function π(n), Multiplicative functions. Multiplicative functions and Dirichlet multiplication, The inverse of a completely multiplicative function, Liouville's function (n), The divisor function (n). Generalised convolutions.

Unit II:

Introduction, The big oh notation Asymptotic equality of functions, Euler's summation formula, some elementary asymptotic formulas, the average order of d(n), the average order of divisor functions (n), the average order of φ(n), An application to the distribution of lattice points visible from the origin. The average order of μ(n) and π(n), The partial sums of a Dirichlet product, Applications to μ(n) and π(n), Another identity for the partial sums of a Dirichlet product.

Unit III:

Introduction, Chebyshev's functions Ψ(x)and v(x). Relations connecting Ψ (x)and v(x), some equivalent forms of the prime number theorem, Inequlities of π(n) and Pn Shapiro's Tauberian theorem. Application of Shapiro's theorem. An asymptotic formulae for the partial sums $\sum (1/p)$.

Unit-IV:

Definition and basic properties of congruences. Residue classes and complete residue systems. Linear congruences. Reduced residue systems and Euler - Format theorem, Polynomial congruences modulo p, Lagrange's theorem. Simultaneous linear congruences, the Chinese remainder theorem. Applications of the Chinese remainder theorem. Polynomial congruences with prime power moduli.

Sections: 2.2 to 2.14 3.1 to 3.12 4.1 to 4.9 5.1 to 5.9

Text Book:

Introduction to analytic number theory - by Tom M-Apostol, Narosa Publishing House, New Delhi.

M. Sc. Mathematics

Semester-III

Core Elective

Paper – XIV (Code: 3T4)

(v) Algebraic Topology- I

Unit I:

The Elements of Homotopy theory: Introduction. Homotopic mappings. Essential and inessential mappings. Homotopically equivalent spaces. Fundamental group. Knots and related embedding problems. Higher homotopy groups. Covering spaces.

Unit II:

Polytopes and triangulated spaces: E^n as a vector space over E^1.Barycentric coordinates. Geometrical complexes and polytopes. Barycentric subdivision. Simplicial mappings and simplicial approximation theorem.

Unit III:

Abstract simplicial complexes. Embedding theorem for polytopes. Simplicial homology theory: Introduction. Oriented complexes. Incidence numbers. Chains, cycles and groups.

Unit IV:

Decomposition theorem for abelian groups. Betti numbers and torsion coefficients. Zero dimensional homology groups. Universal coefficients. Euler Poincare formula. Universal coefficients.

Text Book:

Topology : J.G. Hocking and G.S. Young : Addison Wesley, 1961

Reference Books :

1. Topology : J.R.Munkres, Prentice Hall, Second Edition, 2000

2. Basic Concepts of Algebraic Topology : Fred H.Croom , Springer Verlag 1978.

NOTE*: Candidates can choose any one paper from Core elective.

M. Sc. Mathematics

Semester-III

PAPER XV : FOUNDATION (For Students other than Mathematics)

Paper – XV (Code: 3T5)

MATHEMATICS-I

Elementary Mathematics-I

Unit I:

Differentiation: Derivative of a constant function, derivative of trigonometric functions, derivative of inverse trigonometric functions, derivative of hyperbolic function, derivation of parametrically defined functions, logarithmic differentiation.

Unit II:

Integration: Methods of integration, integration by substitution, three important forms of integrals, six important integrals, integration by parts, definite integrals, reduction formulae.

Unit III:

Matrices & Determinant: Transpose of matrix, orthogonal matrices, unitary matrices, Hermitian and Skew-Hermitian matrices, idempotent matrix, Involutory matrix, minors and factors, properties of determinants, determinants-general treatment, symmetric & Skew-symmetric determinant.

Unit IV:

Complex Number: Definition, conjugate, modulus and argument, Algebra of complex number (Addition, Subtraction, Multiplication and Division), power and square root of complex number, properties of complex number, Argand diagram, solution of quadratic equation in complex number system.

Text Books:

1. Differential Calculus by Shanti Narayan (Unit 1 & Unit 2)

2. An Introduction to Matrices by S.C. Gupta (Unit 3 & Unit 4)

M. Sc. Mathematics

Semester-III

CORE SUBJECT CENTRIC (Only Students of Mathematics)

Paper – XV (Code: 3T5)

Operational Research-I

Unit I:

Revised simplex method (with and without artificial variables). Post Optimality Analysis: changes in (i) objective function, (ii) requirement vector, (iii) coefficient matrix; Addition and deletion of variables, Addition of constraints.

Unit II:

Integer Programming: Gomory's cutting plane algorithm (All integer and mixed integer algorithms), Branch and Bound method.

Unit III:

Bounded variable technique for L.P.P. Unconstrained optimization, Constrained optimization with equality constraints- Lagrange's multiplier method, Interpretation of Lagrange multiplier.

Unit IV:

Inventory control: Deterministic inventory models including price breaks. Multi-item inventory model with constraints. Queueing Theory: Basic features of queueing systems, operating characteristics of a queueing system, arrival and departure (birth & death) distributions, inter-arrival and service times distributions, transient, steady state conditions in queueing process. Poisson queueing models- M/M/1, M/M/C for finite and infinite queue length.

Text book:

Operations Research: Kanti Swarup P.K. Gupta and Man Mohan: Sultan Chand and Sons New Delhi.

Recommended Books:

1. H. A. Taha, Operations Research – An Introduction, Prentice-Hall, 1997.

2. J. K. Sharma, Operations Research: Theory and Applications, Macmillan, 1997

3. S. D. Sharma, H. Sharma, Operations Research: Theory, Methods and Applications, Kedar Nath Ram Nath, 1972

4. S. S. Rao, Optimization-Theory and Applications, Wiley Eastern Ltd., 1977.

5. F. S. Hillier, G. J. Lieberman, Introduction to Operations Research, McGraw-Hill, 2001

6. M. S. Bazaraa, H. D. Sherali, C. M. Shetty, Nonlinear Programming-Theory and Algorithms, Wiley-Interscience, 2006

7. A. K. Bhunia and L. Sahoo, Advanced Operations Research, Asian Books Private Limited, New Delhi, 2011.

8. M. Aokie, Introduction to Optimization Techniques: Fundamentals and Applications of Nonlinear Programming, The Macmillan Company, 1971.

M. Sc. Mathematics

Semester-IV

Paper – XVI (Code: 4T1)

Dynamical Systems

Unit I:

Dynamical systems and vector fields. The fundamental theorem. Existence and uniqueness. Continuity of solutions in initial conditions. On extending solutions. Global solutions. The flow of a differential equation.

Unit II:

Nonlinear sinks. Stability. Liapunov function. Gradient systems. Gradients and inner products.

Unit III:

Limit sets, local sections and flow boxes, monotone sequences in planar dynamical systems. The Poincare Bendixson theorem, Applications of Poincare-Bendixson theorem; one species, predator and prey, competing species.

Unit IV:

Asymptotic stability of closed orbits, discrete dynamical systems. Stability and closed orbits. Non Autonomous equations and differentiability of flows. Persistence of equilibria, persistence of closed orbits. Structural stability.

Text Book:

Differential equations, dynamical systems & linear algebra: M.W. Hirsch & S. Smale, Academic Press, 1975.

Reference Book:

Dynamical systems: V.I. Arnold, Springer Verlag, 1992.

M. Sc. Mathematics

Semester-IV

Paper – XVII (Code: 4T2)

Partial Differential Equations

Course Outcomes: Upon successful completion of this course, the student will be able to:

i. Classify partial differential equations and transform into canonical form

ii. Solve linear partial differential equations of both first and second order.

iii. Solve boundary value problems for Laplace's equation, the heat equation, the wave equation by separation of variables, in Cartesian, polar, spherical and cylindrical coordinates.

Unit I:

Curves and surfaces, First order Partial Differential Equations, classification of first order partial differential equations, classifications of Integrals, Linear equations of first order. Pfaffian differential equations, Criteria of Integrability of a Pfaffian differential equation. Compatible systems of first order partial differential equations.

Unit II:

Charpits method, Jacobi method of solving partial differential equations, Integral surfaces through a given curve for a linear partial differential equations: Cauchy Problem, Quasi Linear Equations: Geometry of Solutions, Non-linear First Order partial differential equations.

Unit III:

Second order Partial Differential Equations, Classification of second order partial differential equation, Vibration of an infinite string (both ends are not fixed), Physical Meaning of the solution of the wave equation. Vibration of an semi infinite string, Vibration of a string of finite length:(Method of separation of variables), Uniqueness of solution of wave equation. Heat conduction Problems with finite rod and infinite rod.

Unit IV:

Laplace equation, Boundary Value Problems: Dirichlets problems and Neumann problems, Maximum and minimum principles . Dirichlet Problems and Neumann problems for a circle, for a rectangle and for a upper half plane, Families to

equipotential surfaces, Solution of Laplace equation, Laplace equation in polar form, Laplace equation in spherical polar coordinates. Kelvin's inversion theorem, Stability theorem, Duhamel's Principle.

Text Book:

1. T. Amarnath: An elementary course in Partial differential equations, 2nd edition, Narosa publishing House (2012).

Reference Books:

1. Mark Pinsky: Partial differential equations and boundary-value problems with applications, AMS,3rd edition(2011).

2. I. N. Sneddon: Elements of Partial Differential Equations, McGraw Hill Int.

3. Fritz John: Partial Differential Equations, Springer(1952).

M. Sc. Mathematics

Semester-IV

Paper – XVIII (Code: 4T3)

Advance Numerical Methods

Unit I:

Simple enclosure methods, Secant method, Newton's method, general theory for one point iteration methods. Aitken extrapolation for linearly convergent sequences, Error tests, Numerical evaluation of multiple roots, roots of polynomials, Mullers method, Non-linear systems of equations, Newton's method for non- linear systems.

Unit II:

Polynomial interpolation theory, Newton's divided differences, finite difference and table oriented interpolation formulas. Forward-differences. Hermite interpolation.

Unit III: The Weierstrass theorem and Taylor's theorem. The minimax approximation problem, the least square approximation problem, orthogonal polynomial, economisation of Taylor series, minimax approximation.

Unit IV:

The trapezoidal rule and Simpson's rule, Newton- Cotes integration formulas.

Text book:

An Introduction to Numerical Analysis by K. E. Atkinson, Johan Wiley and sons, Inc.

M. Sc. Mathematics

Semester-IV

Core Elective

Paper – XIX (Code: 4T4)

(i) Fluid Dynamics-II

Unit I:

Stress components in a real fluid, relation between Cartesian components of stress translation motion of fluid elements, the rate of strain quadric and principal stresses, some further properties of the rate of the strain quadric, stress analysis in fluid motion, relation between stress and rate of strain, the coefficient of viscosity and laminar flow, the Navier-Stokes equations of motion of a viscous fluid, some solvable problems in viscous flow, diffusion of vorticity, energy dissipation due to viscosity, steady flow past a fixed sphere.

Unit II:

Nature of magneto-hydrodynamics, Maxwell electromagnetic field equations; Motion at rest, Motion in medium , Equation of motion of conducting fluid, Rate of flow of charge, Simplification of electromagnetic field equation. Magnetic Reynold number; Alfven's theorem, The magnetic body force. Ferraro's Law of Isorotation.

Unit III:

Dynamical similarity, Buckingham Theorem. Renold number. Prandtl's boundary layer, Boundary layer equation in two dimensions, Blasius solutions, Boundary layer thickness, Displacement thickness. Karman integral conditions, Separation of boundary layer flow.

Unit IV:

Turbulence: Definition of turbulence and introductory concepts. Equations of motion for turbulent flow. Reynolds Stresses Cylindrical coordinates. Equation for the conservation of a transferable scalar quantity in a turbulent flow. Double correlations between turbulence-velocity components. Change in double velocity correlation with time. Introduction to triple velocity correlations. Features of the double longitudinal and lateral correlations in a homogeneous turbulence. Integral scale of turbulence.

Text Books:

1. Text book of Fluid Dynamics: F. Chorlton; CBS Publishers, Delhi 1985.

2. Fluid Mechanics: Joseph Spurk; Springer.

3. Turbulence by J.O. Hinze, 2nd edition, Mc Graw-Hill, chapter 1 sections 1.1 to 1.7

4. Fluid Mechanics by M.D. Raisinghania, S. Chand and Company, Delhi.

Reference Books:

1. An Introduction to fluid Mechanics: G.K. Batchelor; Foundation Books, New Delhi, 1994.
2. Boundary Layer Theory: H. Schichting; Mc Graw Hill Book Company, New York 1971.

M. Sc. Mathematics

Semester-IV

Core Elective

Paper – XIX (Code: 4T4)

(ii) Cosmology

Unit I:

Static cosmological models of Einstein and de Sitter and their derivation and its Properties: (i) The geometry of the Universe (ii) Density and pressure (iii) Motion of test particle (iv) Doppler shift (v) comparison with actual universe, Comparison between Einstein and de-Sitter models.

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Unit II:

Cosmological principle, Hubble law, Weyl's postulate, Derivation of Robertson Walker Metric and its properties, Motion of a particle and light rays in FRW model, Red shift, Decelerationparameter and Hubble's constant, Matter Dominated era.

Unit III:

Friedman Model, Fundamental equation of dynamical cosmology, density and pressure of the present universe, Matter dominated era of the universe, critical density, flat, closed and open universe, age of the universe.

Unit IV:

Steady state cosmology, Distance measure in cosmology, Comoving distance, Apparent luminosity and luminosity distance, Angular diameter and Lookback time, Horizons and the Hubble radius; Galaxy count**,** the Particle horizons, the Event Horizon.

Text Books:

1. Relativity, Thermodynamics and Cosmology: Richard C. Tolman, Oxford Press

2. Gravitation and Cosmology : Principles and Applications of the General Theory of Relativity by Steven Weinberg.

References Books:

1. The Classical Theory of Fields, By Landau I.D. and Lifshitz E.M., Pub. Pergamon Press (1978).

2. ecture on General Relativity , Sonu Nilu Publication (2004) by T M Karade, G S Khadekar and Maya S Bendre

3. The Theory of Relativity Moller C, Pub. Oxford University Press (1982).

4. Introduction to theory of relativity, Rosser W.G.V., ELBS (1972).
5. Relativity Special, General and Cosmology, Rindler W., Pub. Oxford University Press (2003).
6. Relativity: The General Theory, Synge J.L., North Holland Pub. Comp. (1971).

M. Sc. Mathematics

Semester-IV

Core Elective

Paper – XIX (Code: 4T4)

(iii) Cryptography

Unit I:

Time estimates for doing arithmetic, divisibility and Euclidean algorithm, congruence's, quadratic residues and reciprocity, Fermat's little theorem, applications to factoring, finite fields.

Unit II:

Classical cryptosystems, Public key cryptography, Hash function, Probabilistic encryption, RSA cryptosystem, Pseudo primes, Pollard's P-1 method, The Rho method.

Unit III:

The El Gamal cryptosystem, discrete logarithm, Diffee-Hellman key exchange system, Algorithms for discrete logarithm problem- Shank's algorithm, the Pollard Rhoalgorithm, the Pohlig-Hellman Algorithm, security of ElGamal systems, the ElGamal signature scheme.

Unit IV:

Elliptic curves, Elliptic curve cryptosystems, Elliptic curve primality test, Elliptic curve factorization.

Text books:

1. Neal Koblitz, A Course in Number Theory and Cryptography (second edition), SpringerVerleg.
2. Douglas R. Stinson, Cryptography: Theory and practice (Third Edition), CRC Press.

Scope :

Unit I- From Koblitz's book (Chapter 1 and Chapter 2 excluding Existence and uniqueness of finite fields with prime power number of elements)

Unit II – From Koblitz's book (Chapter 4 –sections 1 and 2, Chapter 5- sections 1 and 2)

Unit III – From Stinson's book (Chapter 6- section 1and 2, Chapter 7- section 3)

Unit IV - From Koblitz's book (Chapter 6)

Reference Books:

1. William Stallings, Cryptography and Network Security, Prentice Hall.

M. Sc. Mathematics

Semester-IV

Core Elective

Paper – XIX (Code: 4T4)

(iv) Algebraic Topology- II

Unit I:

Simplicial mappings. Chain mappings. Barycentric Subdivision. The Brouwer Degree.
The fundamental theorem of algebra.

Unit II:

No retraction theorem and Brouwer fixed point theorem. Mappings into spheres. Relative homology groups. The exact homology sequence. Homomorphisms of exact sequences.

Unit III:

The excision theorem. The Mayer-Vietoris sequence. Eilenberg-Steenrod axioms for homology theory. Relative homotopy theory. Cohomology groups. Relations between chain and cochain groups.

Unit IV:

Simplicial and chain mappings. The cohomology product. The cap product. Exact sequences in cohomology theory. Relations between homology and cohomology groups.

Text Book:

Topology : J.G. Hocking and G.S. Young : Addison Wesley, 1961

Reference Books :

1. Topology : J.R.Munkres, Prentice Hall, Second Edition, 2000

2. Basic Concepts of Algebraic Topology : Fred H.Croom , Springer Verlag 1978.

M. Sc. Mathematics

Semester-III

Core Elective

Paper – XIV (Code: 4T4)

(v) Operator Theory

Unit I:

Basic concepts about spectrum. Spactral properties of bounded linear operators. Further properties of resolvent and spectrum. Use of complex analysis in spectral theory.

Unit II:

Banach Algebras. Further properties of Banach Algebras. Compact linear operators on normed spaces. Further properties of Compact linear operators. Spectral properties of compact linear operators.

Unit III:

Further spectral properties of Compact linear operators. Operator equations involving compact linear operators. Further theorems of Fredholm type. Fredholm alternative.

Unit IV:

Spectral properties of bounded self adjoint linear operators. Further Spectral properties of bounded self adjoint linear operators. Positive operators. Square roots of a positive operator. Projection operator. Further properties of projections. Spectral family. Statement of spectral representation theorem.

Text Book:

Introductory Functional Analysis with Applications by E. Kreyszig, John Wiley and Sons

Reference Book :

1. Introduction to Functional Analysis by A.E.Taylor and D.C.Lay, John Wiley and Sons

NOTE*: Candidates can choose any one paper from Core elective

M. Sc. Mathematics

Semester-IV

PAPER XX : FOUNDATION (For Students other than Mathematics)

Paper – XX (Code: 4T5)

MATHEMATICS-II

Elementary Discrete Mathematics-II

Unit I:

Mathematical Logic: Introduction, Proposition, compound Proposition, Proposition and truth tables, logical equivalence, algebra of Proposition, conditional Proposition, converse, contra positive & inverse, bi conditional statement, negation of compound statements, tautologies & contradictions, normal forms, logic in proof.

Unit II:

Lattice: Lattice as partially ordered sets, their properties, lattices as algebraic system, sub lattices, and some special lattices eg. Complete, complemented and distributive lattices.

Unit III:

Boolean algebra and Logic Circuits: Boolean algebra, basic operations, Boolean functions, De-Morgan's theorem, logic gate, sum of products and product of sum forms, normal form, expression of Boolean function as a canonical form, simplification of Boolean expression by algebraic method, Boolean expression form logic & switching network.

Unit IV:

Graph Theory: Basic terminology, simple graph, multigraph, degree of a vertex, types of a graph, sub graphs of isomorphic graphs, matrix representation of graphs, Euler's theorem on the existence of Eulerian path & circuits, directed graph, weighted graphs, strong connectivity, chromatic number.

Text Book:

Discrete Mathematical structures with applications to computer science by J.P.

Tremblay and R. Manohar, McGraw-Hill book company,1997.

M. Sc. Mathematics

Semester-IV

CORE SUBJECT CENTRIC (Only Students of Mathematics)

Paper – XX (Code: 4T5)

Operations Research–II

Course Outcomes: Students would be able to:

CO1 Identify and develop operations research model describing a real life problem.

CO2 Understand the mathematical tools that are needed to solve various optimization problems.

CO3 Solve various linear programming, transportation, assignment, queuing, inventory and game problems related to real life.

Unit I:

Operations Research: Origin, Definition and scope. Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big - M and two-phase methods, Degeneracy, Duality in linear programming.

Unit II:

Transportation Problems: Basic feasible solutions, Optimum solution by stepping stone and modified distribution methods, Unbalanced and degenerate problems, Transhipment problem. Assignment problems: Hungarian method, Unbalanced problem, Case of maximization, Travelling salesman and crew assignment problems.

Unit III:

Concepts of stochastic processes, Poisson process, Birth-death process, Queuing models: Basic components of a queuing system, Steady-state solution of Markovian queuing models with single and multiple servers (M/M/1. M/M/C, M/M/1/k, M/MC/k).

Unit IV:

Inventory control models: Economic order quantity(EOQ) model with uniform demand, EOQ when shortages are allowed, EOQ with uniform replenishment, Inventory control with price breaks.

Text book:

Operations Research: Kanti Swarup P.K. Gupta and Man Mohan: Sultan Chand and Sons New Delhi.

Recommended Books:

1. H. A. Taha, Operations Research – An Introduction, Prentice-Hall, 1997.

2. J. K. Sharma, Operations Research: Theory and Applications, Macmillan, 1997

3. S. D. Sharma, H. Sharma, Operations Research: Theory, Methods and Applications, Kedar Nath Ram Nath, 1972

4. S. S. Rao, Optimization-Theory and Applications, Wiley Eastern Ltd., 1977.

5. F. S. Hillier, G. J. Lieberman, Introduction to Operations Research, McGraw-Hill, 2001

6. M. S. Bazaraa, H. D. Sherali, C. M. Shetty, Nonlinear Programming-Theory and Algorithms, Wiley-Interscience, 2006

7. A. K. Bhunia and L. Sahoo, Advanced Operations Research, Asian Books Private Limited, New Delhi, 2011.

8. M. Aokie, Introduction to Optimization Techniques: Fundamentals and Applications of Nonlinear Programming, The Macmillan Company, 1971.