Swami Ramanand Teerth Marathwada University, Nanded.
M.A./M. Sc. (Mathematics)(CBCS) Syllabus
Effective from June-2015

Semester	Paper No.	Name of the paper	Hrs./ Week	Credits	Max. Marks		
					IA	EA (ESE)	Total
I	I	Abstract Algebra-I (Group and Ring Theory)	6	4	25	75	100
	II	Real Analysis	6	4	25	75	100
	III	Ordinary Differential Equations	6	4	25	75	100
	IV	Complex Analysis-I	6	4	25	75	100
	Elective-I V(A) V(B) V(C) V(D)	Choose any one Discrete Mathematics Dynamics and Continuum Mechanics-I Theory of Probability Differential Geometry of Manifolds- I	6	4	25	75	100
	VI	Tutorial-I/Lab Work (Compulsory)		5		125	125
II	VII	Linear Algebra	6	4	25	75	100
	VIII	Measure and Integration Theory	6	4	25	75	100
	IX	Partial Differential Equations	6	4	25	75	100
	X	Complex Analysis-II	6	4	25	75	100
	Elective-II XI(A) XI(B) XI(C) XI(D)	Choose any one Combinatorics Dynamics and Continuum Mechanics-II Operation Research Differential Geometry of Manifolds- II	6	4	25	75	100
	XII	Tutorial-II/Lab work (Compulsory)		5		125	125
		Total		50			1250

III	XIII	Functional Analysis	6	4	25	75	100
	XIV	Topology	6	4	25	75	100
	Elective-III XV(A) XV(B) XV(C)	Choose any one Analytical Number Theory Theory of Linear operators-I Fuzzy Sets and their Applications-I	6	4	25	75	100
	Elective-IV XVI(A) XVI(B) XVI(C)	Choose any one Fluid Mechanics-I Difference Equations-I Mathematical Softwares-I (Theory and Practical)	6	4	25	75	100
	Elective-V XVII(A) XVII(B) XVII(C)	Choose any one Integral Transforms Wave Propogation-I Fractional Calculus and its Applications-I	6	4	25	75	100
	XVIII	Tutorial-III (Compulsory)		5		125	125
IV	XIX	Numerical Analysis	6	4	25	75	100
	XX	Abstract Algebra-II (Field Theory)	6	4	25	75	100
	Elective –VI XXI(A) XXI(B) XXI(C)	Choose any one Classical Mechanics Theory of Linear operators-II Fuzzy Sets and their Applications-II	6	4	25	75	100
	Elective-VII XXII(A) XXII(B) XXII(C)	Choose any one Fluid Mechanics-II Difference Equations-II Mathematical Softwares-II (Theory and Practical)	6	4	25	75	100
	Elective-VII XXIII(A) XXIII(B) XXIII(C)	Choose any one Integral Equations Wave Propogation -II Fractional Calculus and its Applications-II	6	4	25	75	100
	XXIV	Project Work (Compulsory)		5		125	125
		Grand Total		100			2500

Swami Ramanand Teerth Marathwada University, Nanded.

M.A. /M. Sc. Syllabus (Mathematics)

Effective from June-2015

Aims and Objectives of the new curriculum

To maintain updated curriculum.

- To take care of fast paced development in the knowledge of mathematics.
- To meet the needs and requirements of the society and to enhance the quality and standards of Mathematics Education.
- To provide a broad common frame work, for exchange, mobility and free dialogue across the Indian Mathematical and associated community.
- To provide multidisciplinary profile and to allow a flexible cafeteria like approach including initiating new papers to cater to frontier developments in the subject like Mathematics.
- To create and aptitude for Mathematics in those students who show a promise for higher studies and creative work in Mathematics.
- To create confidence in others, for equipping themselves with that part of Mathematics which is needed for various branches of Sciences or Humanities in which they have aptitude for higher studies and original work.

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Swami Ramanand Teerth Marathwada University, Nanded.

M.A./M. Sc. First Year Syllabus (Mathematics)
Effective from June-2015

First Semester		Second Semester	
Paper No.	**Name of the paper**	**Paper No.**	**Name of the paper**
I	Abstract Algebra-I (Group and Ring Theory)	VII	Linear Algebra
II	Real Analysis	VIII	Measure and Integration Theory
III	Ordinary Differential Equations	IX	Partial Differential Equations
IV	Complex Analysis-I	X	Complex Analysis-II
One paper to be chosen from following papers which are taught in the department.			
V(A)	Discrete Mathematics	XI(A)	Combinatorics
V(B)	Dynamics and Continuum Mechanics-I	XI(B)	Dynamics and Continuum Mechanics-II
V(C)	Theory of Probability	XI(C)	Operation Research
V(D)	Differential Geometry of Manifolds- I	XI(D)	Differential Geometry of Manifolds- II
VI	Tutorial-I (Compulsory)	VII	Tutorial-II (Compulsory)

Semester-I

Paper-I

Abstract Algebra-I (Group and Ring Theory)

Max. Periods: 60(04 Credits)

Prerequisites: Semi groups and groups, Subgroups and Cosets. Rings, Examples of rings, Types of rings, Subrings and Characteristic of a ring.

Unit-I:

Cyclic groups, Generators and relations, Normal subgroup and quotient group, Isomorphism theorems, Automorphism, Conjugacy and *G*-sets, Normal series, Solvable groups, Nilpotent groups.

Unit-II:

Group Homomorphism, First Isomorphism Theorem, Fundamental Theorem of Finite Abelian Groups, Permutation Groups, Cyclic decomposition, Alternating group A_n, Structure of groups, Direct product, Finitely Generated Abelian Groups, Invariants of a finite abelian group, Sylow Theorems.

Unit-III:

Ideals and homeomorphisms, Maximal and prime ideals, Principal ideal, Nilpotent and nil ideals, Zorn's lemma, Unique Factorization Domains, Principal Ideal Domains, Euclidean Domains, Polynomials over UFD.

Text Book:

1. **P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul**, "Basic Abstract Algebra", (Second Ed.), Cambridge Univ. Press (Indian Ed.1995).

Reference Books:

1. **Joseph A. Gallian**, "Contemporary Abstract Algebra", (Fourth Ed.), Narosa, 1999.
2. **I. S. Luthar and I. B. S. Passi**, "Algebra-Vol. 1: Groups", Narosa, New Delhi, 1996.
3. **V.K. Khanna, S.K. Bhambri**, "A Course in Abstract Algebra", Vikas Publicing House. (Second Edition)
4. **David Dummit and Richard Foote**, "Abstract Algebra", John Wiley and Sons.

Paper-II

Real Analysis

Max. Periods: 60(04 Credits)

Unit-I:

The Riemann Stieltjes Integral: Definition and existence of integral, Properties of the integral, Integration and Differentiation.

Unit-II:

Sequence and series of functions: Discussion of main problem, Uniform Convergence, Uniform Convergence and Continuity, Uniform Convergence and integration, Uniform Convergence and Differentiation, Equicontinuous Families of Functions.

Unit-III:

Derivative, Continuously differentiable functions, Chain rule, Inverse Function Theorem, Implicit Function Theorem.

Text books:

1. **Walter Rudin**, "Principals of mathematical analysis", McGraw Hill, International Editions.
2. **J.R. Munkres**, "Analysis on Manifolds",

Reference books:

1. **Robert G. Bartle, Donald R. Sherbert**, "Introduction to Real Analysis", Wiley India Edition
2. **N.L. Carothers**, "Real Analysis", Cambridge University Press.
3. **H.L. Royden**, "Real Analysis', PHI Learning Pvt. Ltd.(Third Edition)

Paper–III

Ordinary Differential Equations

Max. Periods: 60(04 Credits)

Prerequisites: Linear equations of first order, Initial Value Problem for second order equations, Initial value problems, Solutions of the homogeneous equation.

Unit-I:

Linear Equations with constant coefficients: Linear dependence and independence, A formula for the Wronskian, The non-homogeneous equations of order two, The homogeneous equations of order n, Initial Value Problem for n^{th} order equations, Equations with real constants, The non-homogeneous equations of order-n, A special method for solving the non-homogeneous equation, Algebra of constant coefficient operators.

Unit-II:

Linear equations with variable coefficients: Wronskian and linear independence, Reduction of order, Non-homogeneous equations, Legendre equation, Linear Equations with regular singular points: Euler equation, Second order equation with regular singular points, Exceptional cases, The Bessel equation, The Bessel equation (Continued).

Unit-III: Existence and uniqueness of solutions to first order equations: Separation of variables, Exact equations, Method of successive approximations, Lipschitz condition, Convergence of the successive approximations, Non local existence of solutions, Approximations to, and uniqueness of solutions, Equations with complex valued functions, Green's function, Sturm-Liouville Boundary Value Problems.

Text Book:

1. **E. A. Coddington**, "An Introduction to Ordinary Differential Equations", (Prentice- Hall).
2. **William F. Trench**, "Elementary Differential Equations with Boundary Value Problems."

Reference Books:

1. **G. F. Simmons and S. G. Krantz, "**Differential Equations", (Tata McGraw-Hill).
2. **Daniel A. Murray, "**Introductory Course in Differential Equation"**,** Universities Press.

Paper–IV

Complex Analysis–I

Max. Periods: 60(04 Credits)

Prerequisites: Complex Number, Complex Field, Modulus, Argument and Conjugate of complex numbers, Algebra of complex numbers, Rectangular and Polar representation of Complex numbers, Point sets in the plane, Sequences.

Unit-I:

Stereographic Projection, Basic Mappings, Linear Fractional Transformation, Other Mappings, The Exponential Function, Mapping Properties, The Logarithmic Function, Complex Exponents.

Unit-II:

Cauchy–Riemann Equation, Analyticity, Harmonic Functions, Sequences of Functions, Uniform Convergence, Maclaurin and Taylor Series, Operations on Power series.

Unit-III:

Curves, Parameterizations, Line Integrals, Cauchy's Theorem.

Text Book:

1. **S. Ponnusamy and Herb Silverman**, "Complex Variables with Applications", Birkhauser Publication.

Reference Books:

1. **Silverman Herb**, "Complex Analysis",
2. **John B. Convey**, "Function of one complex variable", Narosa Pub. House, 1980.
3. **Lars V. Ahlofors**, "Complex Analysis", McGraw Hill Co.
4. **S. Ponnusamy**, " Foundations of Complex Analysis", Narosa Publishing House.

Paper-V(A)

Discrete Mathematics

Max. Periods: 60(04 Credits)

Unit-I: Lattices and Algebraic systems, Principle of duality, Basic properties of algebraic systems defined by lattices, Distributive and Complemented lattices, Boolean lattices and Boolean algebras, Uniqueness of finite Boolean algebras, Boolean functions and Boolean expressions, Propositional Calculus, Design and implementation of Digital Networks, Switching Circuits.

Unit-II: Definition and types of graphs, Applications of graphs, Finite and infinite graphs, Incidence and degree, Isolated vertex, Pendant vertex, Null graph, Brief history of graph theory, Isomorphism, Subgraphs, Walks, Paths and Circuits, Connected and Disconnected graphs, Euler graphs, More on Euler graphs, Operations on graphs, Hamiltonian paths and circuits, The travelling salesman problem, Trees, Properties of trees, Pendant vertices in a tree, Distance and centre in a tree, Rooted and binary tree, On counting trees, Spanning trees, Fundamental circuits, Finding all spanning trees of a graph, Spanning trees in a weighted graph, Planar graph, Kurtatowski's two graphs, Different representations of a planar graph, Detection of planarity, Geometrical planarity, Thickness and crossings.

Unit-III: Matrix representation of graphs, Incidence matrix, Sub matrices of A(G), Circuit matrix, Fundamental circuit matrix and its rank, An application to a switching network, Adjacency matrix, Directed graphs, Types, Digraphs and binary relations, Directed paths and Connectedness, Euler digraphs, Trees with directed edges, Fundamental circuits in digraphs.

Text books: 1. C L Liu, "Elements of Discrete Mathematics", Tata McGraw-Hill, Publishing Company (Second Edition).

2. Narsingh Deo, "Graph theory with applications to engineering and computer science", Prentice –Hall of India Pvt. Ltd.

Reference books:

1. **J.P. Tremblay, R. Manohar**, "Discrete mathematical structures with applications to computer science", Tata-McGraw Hill Education Pvt.Ltd.
2. **Kenneth N Rosen**, "Discrete Mathematics and its applications with combinatorics and graph theory", Tata-McGraw Hill Education Pvt.Ltd.
3. **Sanjeev Kumar, Sanjay Chaudhary**, "Applied Discrete Mathematics Theory and applications", Ram Prasad and Sons (India) Educational Publishers.

Paper-V (B)

Dynamics and Continuum Mechanics-I

Max. Periods: 60(04 Credits)

Unit I:

Vector moment about a point and scalar moment about an axis, Vector and scalar couples, Centroids, Vector calculus, Velocity and acceleration of a Particle along a curve, Motion in plane – radial and transverse components, Relative velocity and acceleration, Vector angular velocity, General motion of rigid body, Moving axes.

Unit-II:

Mass, Momentum, Force, Newton's laws of motion, Work, Energy and Power, Conservative forces, Potential energy, Impulsive forces, Linear momentum of system of particles, Angular momentum, Rate of change of angular momentum, Use of centroids, Moving origin, Impulsive force.

Unit-III:

Moments and products of Inertia, The theorem of parallel and perpendicular axes, Angular Momentum, Principal axes, Kinetic Energy of a rigid body, Momental Ellipsoid, Coplanar distribution, General motion of a rigid body, Problems illustrating the laws of motion, Problems illustrating the law of conservation of energy, Problems illustrating impulsive motion.

Text Book:

i) **F. Chorlton**, "A text book of Dynamics", (E.L.B.S.)(2nd Edition).

Reference Books:

i) **J.L. Synge and Griffith**, "Classical Mechanics",

ii) **Atkin R.H**., "Classical Dynamics",

Paper-V(C)

Theory of Probability

Max. Periods: 60(04 Credits)

Unit-I:

Basic Definitions, Mathematical and statistical probability, Subjective Probability, Axiomatic approach to probability, Theorems on probability, Conditional probability, Multiplication theorem of probability of independent events, Examples, Extended axiom of axiom of addition and axiom of continuity, Baye's theorem.

Unit-II:

Random variables, Types , Probability function of discrete random variable, Continuous random variable, Probability density function, Mathematical expectation, Properties of expectation, Variance, Properties of Variance, Moment generating function, Properties of Moment generating function, Cumulants and its properties.

Unit-III:

Discrete Probability distributions, Binomial distribution, Mean and Variance of binomial distribution, MGF and CGF of Binomial distribution, Fitting of binomial distribution, Poisson distribution, Mean and variance of Poisson distribution, MGF and CGF of Poisson distribution, Fitting of Poisson distribution, Normal distribution, Properties of normal distribution, Moments of normal distribution, MGF and CGF and fitting of normal distribution.

Text Book:

1. **S .C. Gupta, V. K. Kapoor**, "Fundamentals of Mathematical Statistics", S. Chand and Sons, New Delhi.

Reference Books:

1. **S.C. Gupta, V.K. Kapur**, "Fundamental of Mathematical Statistics", S. Chand and Co. Ltd.
2. **S. C. Saxena**, "Mathematical Statistics", S. Chand and Co. Ltd.

Paper-V (D)

Differential Geometry of Manifolds-I

Max. Periods: 60(04 Credits)

Unit-I:

Definition and examples of Differentiable Manifolds, Tangent spaces, Jocobian map, One parameter group of transformations, Lie–derivatives, Immersions and imbedding, Distributions, Exterior algebra, Exterior Derivative.

Unit-II:

Topological groups, Lie groups and Lie algebras, Product of two Lie-groups, One parameter subgroups and exponential map, Examples of Lie-groups.

Unit-III:

Homomorphism and Isomorphism, Lie transformation groups, General linear groups.

Reference Books:

1. **R. S. Mishra**, "A course in tensors with applications to Riemannian Geometry", Potishala (Pvt) Ltd. 1965.
2. **R. S. Mishra**, "Structures on a differentiable manifold and their applications", Chandrama Prakashan, Allahabad, 1984.
3. **B. B. Sinha**, "An Introduction to Modern Differential Geometry", Kalyani Publishers, New Delhi, 1982.
4. **K. Yono and M. Kon**, "Structure of Manifolds", World Scientific Publishing, Co. Pvt. Ltd. 1984.

Paper-VI

Tutorial –I — 05 Credits

Papers	Marks	Credits
Tutorial on theory paper -I	25	1
Tutorial on theory paper-II	25	1
Tutorial on theory paper-III	25	1
Tutorial on theory paper-IV	25	1
Tutorial on theory paper – V(A/B/C/D)	25	1
Total	**125**	**5**

The format for scheme of marking for tutorial of 25 marks in each paper is as follows:

Tutorial : ----- Paper No. and name : -----

Name of the teacher :-----

Sr.No.	Name of the student	Seat No.	Seminar	Attendance	Viva	Total
			10 Marks	5 Marks	10 Marks	25Marks

Signature of Teacher

The format, in which, the marks obtained by students in tutorial of 125 marks, to be submitted by HOD through the Principal, to the department of examination S.R.T.M.U. Nanded is as follows:

Sr. No.	Name of the student	Seat No.	Tutorial					Total
			Paper No.----	Paper No.----	Paper No.----	Paper No.----	Paper No.----	
			Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 125

Head of the Department

Semester-II

Paper-VII

Linear Algebra

Max. Periods: 60(04 Credits)

Unit-I:

Introduction, Vector spaces, subspaces, Quotient Spaces, Linear combinations and system of linear equations, linear dependence and independence, Bases and dimension, Maximal Linear Independent Subsets. Linear Transformations, Null spaces, Ranges, The matrix representation of a linear transformation, Composition of linear transformations, Invertibility and Isomorphism, The change of Co-ordinate matrix, Dual spaces.

Unit-II:

Elementary Matrix Operations and elementary matrices, The rank of a matrix, System of linear equations-Theoretical Aspects, System of linear equations-Computational Aspects, Eigen values and Eigen vectors, Diagonalizability, Triangulable Operators, Invariant Subspaces, Cayley-Hamilton Theorem.

Unit-III:

Inner products and Norms, The Gram-Schmidt Orthogonalization process and orthogonal complements, the adjoint of a linear operator, Bilinear forms, Quadratic forms. Jordan Canonical form-I, Jordan Canonical form-II, The Minimal Polynomial, Rational Canonical form.

Text Book:

1. **S.H. Friedberg, A.J. Insel, L.E. Spence**, "Linear Algebra", Prentice-Hall, International, Inc., 3rd Edition.

Reference Books:

1. **Vivek Sahai and Vikas Bist**, "Linear Algebra", Narosa Publishing House, 2nd Edition.
2. **S.Lang**, "Introduction to Linear algebra", Springer International Edition, 2nd Edition.
3. **K.Hoffman, R.Kunze**, "Linear Algebra", Prentice Hall of India.
4. **S.Kumaresan**, "Geometrical approach to Linear Algebra",

Paper-VIII

Measure and Integration Theory

Max. Periods: 60(04 Credits)

Unit-I:

Lebesgue outer measure, Measurable sets, Measurable functions, Borel and Lebesgue measurability, Integration of non-negative functions, The general integral, Integration of series, Riemann and Lebesgue Integrals, The four derivatives, Continuous non-differentiable functions, Functions of bounded variations, Differentiation and integration.

Unit-II:

Abstract measure spaces: Measure and outer measure, Extension of measure, Uniqueness of the extension, Completion of measure, Measure spaces, Integration with respect to measure.

Unit-III:

Signed measure and their derivatives: Signed measure and the Hahn-Decomposition, the Jordan decomposition, the Raydon–Nikodym theorem (Statement only).

Text book:

1. **G.de Barra**, "Measure theory and integration", New Age International (P) Ltd. Publishers.

Reference Books:

1. **P.K. Jain and V.P. Gupta**, "Lebesgue measure and Integration" New Age International (P) Ltd. Publishers.
2. **P.R. Halmos**, "Measure theory", Van Mostranel Princeton, 1950.
3. **Inder K. Rana**, "An introduction to measure and Integration", Narosa Publishing House, Delhi,1997.

Paper–IX

Partial Differential Equations

Max. Periods: 60(04 Credits)

Unit-I:

Introduction, Linear Equation of first order, Charpit's Method, Jacobi's Method, Quasi-Linear Equations, Non-Linear First Order P.D.E, General solution of higher order PDE's with constant coefficients.

Unit-II:

Introduction, Method of separation of variables, Classification of Second order PDE, One Dimensional Wave Equation, Laplace Equation, Boundary Value Problems, the Cauchy's Problem,

Unit-III:

Dirichlet and Neumann Problem for different regions, Harnack's Theorem, Heat Conduction Problem, Duhamel's Principle, Classification of P.D.E. in the case of *n*-variables, Families of Equipotential Surfaces, Kelvin's Inversion Theorem.

Text Books:

1. **T. Amarnath,** "An Elementary Course in Partial Differential Equations", (2^{nd} edition), (Narosa Publishing House) [Chapters 1 & 2].
2. **I.N. Sneddon**, "Elements of partial differential equations", (Mc-Graw Hill Book Company).

Reference Books:

1. **K. Sankara Rao,** "Introduction to partial differential equation", 3^{rd} edition.
2. **W. E. Williams,** "Partial Differential equations", (Clarendon press-oxford)
3. **E. T. Copson,** "Partial differential equations", (Cambridge university press).
3. **H.K. Dass**, "Advanced Engineering Mathematics", S. Chand & Co. Ltd.

Paper–X

Complex Analysis–II

Max. Periods: 60(04 Credits)

Unit-I:

Cauchy's Integral Formulae, Cauchy's Inequality and Applications, Maximum Modulus Theorem. Laurent Series, Classification of Singularities, Evaluation of Real Integrals, Argument Principle

Unit-II:

Comparison with Analytic functions, Conformal Mapping, Riemann Mapping Theorem.

Unit-III:

Infinite Products, Weierstras's Product Theorem, Special Functions.

Text Book

1 **S. Ponnusamy and Herb Silverman,** "Complex Variables with Applications", Birkhauser Publication.

Reference Books:

1. **Silverman Herb**, "Complex Analysis",
2. **John B.Convey,** "Function of one complex variable", Narosa Pub. House, 1980.
3. **Lars V. Ahlofors,** "Complex Analysis", McGraw Hill Co.
4. **S. Ponnusamy,** " Foundations of Complex Analysis", Narosa Publishing House.

P-XI (A)

Combinatorics

Max. Periods: 60(04 Credits)

Unit-I:

Basic counting principles, Simple arrangements and selections, Arrangements and selection with repetition, Distributions, Binomial, Permutations and Combinations.

Unit-II:

Generating function models, Calculation of generating functions, Partitions, Exponential generating functions, A summation method, Recurrence relation model, Divide and conquer relations, Solution of inhomogeneous recurrence relation, Solution with generating functions.

Unit-III:

Counting with Venn diagrams Inclusion formulae, Restricted positions and Rook polynomials, Pigeonhole Principle.

Text Book:

1. **Alan Tucker**, "Applied Combinatorics", (3rd edition), John Wiley & sons, New York (1995)

Reference Books:

1. **V. Krishnamurthy**, "Combinatorial, Theory and Applications", East West Press, New Delhi (1989) Scientific, (1996).
2. **V.K. Balakrishnan**, "Theory and Problems of Combinatories ", Schaum outline series, Mcgraw Hill, New York.

Paper-XI (B)

Dynamics and Continuum Mechanics-II

Max. Periods: 60(04 Credits)

Unit-I:

Indicial Notation, Summation convention, Dumy indices, Free indices, Kronecker delta, Permutation symbol, Tensor as a linear transformation, Components, Sum, Dyadic product, Product of tensors, Identity, Transpose, Orthogonal tensors, Symmetric and antisymmetric tensors, Eigen values and Eigenvectors of a tensor, The dual vector of an antisymmetric tensor, Principal values and principal directions of real symmetric tensors, Scalar invariants of tensor, Scalar and vector fields, Gradient, Divergence and Curl of these fields.

Unit-II:

Description of motion of a continumm, Material and spatial description, Material derivatives, Deformation, Principle strain, Dilatation, Rate of deformation, Equation of conservation of mass, Compatibility conditions of infinitesimal strain components.

Unit-III:

Stress vector, Stress tensor, Components of symmetry of stress tensor, Principle of moment of momentum, Principal stresses, Maximum shearing stress, Equations of motion, Principle of linear momentum, Fluids, Compressible and incompressible fluid, Equations of hydrostatics, Newtonian Fluid, Interpretation of Incompressible Newtonian fluid.

Text Book:

1. **Lai W. M. Rubin D and Kremple E**, ‘‘Introduction to continuum Mechanics’’,

Reference Book :

1. **Lang R.R.**, “Mechanics of Solids and fluids”, Prentice hall.

Paper-XI(C)

Operation Research

Max. Periods: 60(04 Credits)

Unit-I:

Definitions, Graphical method, Simplex Method, Duel Simplex Method, Big-M method, Two Phase method.

Unit-II:

Introduction to the model, Definition of the Transportation Model, Matrix Terminology, Formulation and solution of transportation models, Variance in transportation problems, Least time transportation Problems, Post Optimality analysis in Transportation, Trans-Shipment Problems.

Unit-III:

Definition of Assignment Model, Mathematical representation of the assignment model, Comparison with the Transportation model, Solution of the assignment problem, Hungerian method for solution of the assignment problems, Formulation and solution of A.M., Variations of the A.P., Sensitivity analysis in A.P., Travelling Salesman problem. Two by Two and three by three Game Theory, Optimization.

Text Book:

1 **Premkumar Gupta**, **D. S. Hira**, "Operation Research", S. Chand and Co. Ltd.

Reference Books:

1. **H.A. Taha** , "Operation Research", Prentice Hall.
2. **Kanti Swarup**, "Operation Research", S. Chand Co.

Paper-XI (D)

Differential Geometry of Manifolds-II

Max. Periods: 60(04 Credits)

Unit-I:

Principal fibre bundle, Linear frame bundle, Associated fibre bundle, Vector bundle, Tangent bundle, Induced bundle, Bundle Homomorphisms.

Unit-II:

Riemannian manifolds, Riemannian connection, Curvature tensors, Sectional Curvature, Schur's theorem, Geodesics in a Riemannian manifold, Projective curvature tensor, Con-formal curvature tensor.

Unit-III:

Submanifolds and Hypersurfaces, Gauss formulae, Weingarten equations, Lines of Curvature, Generalized Gauss and Mainardi Codazzi equations, Almost complex manifolds, Nijenhuis tensor, Contravariant and covariant Almost Analytic vector field, F-connection.

Reference Books:

1. **R. S. Mishra**, "A course in tensors with applications to Riemannian Geometry", Potishala (Pvt) Ltd. 1965.
2. **R. S. Misiira**, **"**Structures on a differentiate manifold and their applications", Chandrama Prakashan, Allahabad, 1984.
3. **B. B. Sinha**, **"**An Introduction to Modern Differential Geometry", Kalyani Publishers, New Delhi, 1982.
4. **B. B. Sinha**, "Structure of Manifolds", World Scientific Publishing Co. Pvt. Ltd. 1984.

Paper-XII

Tutorial –II 05 Credits

Papers	Marks	Credits
Tutorial on theory paper -VII	25	1
Tutorial on theory paper-VIII	25	1
Tutorial on theory paper-IX	25	1
Tutorial on theory paper-X	25	1
Tutorial on theory paper -XI(A/B/C/D)	25	1
Total	**125**	**5**

The format for scheme of marking for tutorial of 25 marks in each paper is as follows:

Tutorial : ----- Paper No. and name : -----

Name of the teacher :-----

Sr.No.	Name of the student	Seat No.	Seminar	Attendance	Viva	Total
			10 Marks	5 Marks	10 Marks	25Marks

Signature of Teacher

The format, in which, the marks obtained by students in tutorial of 125 marks, to be submitted by HOD through the Principal, to the department of examination S.R.T.M.U. Nanded is as follows:

Sr. No.	Name of the student	Seat No.	Tutorial					Total
			Paper No.----	Paper No.----	Paper No.----	Paper No.----	Paper No.----	
			Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 125

Head of the Department

Swami Ramanand Teerth Marathwada University, Nanded.

Question Paper pattern

M.Sc. Mathematics First Year w. e. f. June-2014

Time:03.00 Hrs. **Max.Marks:75**

Q.1 Attempt the following: (two marks each)	12
(i) to (vi)	
Q.2 Attempt any two of the following: (ten marks each)	20
(a) Theory	
(b) Theory	
(c) Theory	
Q.3 Attempt any two of the following: (eight marks each)	16
(a) Theory	
(b) Theory	
(c) Theory	
Q.4 Attempt any two of the following: (six marks each)	12
(a) Problem	
(b) Problem	
(c) Problem	
Q.5 Attempt any two of the following: (four marks each)	08
(a) Problem	
(b) Problem	
(c) Problem	
Q.6 Attempt any one of the following:	07
(a) Theory / Problem	
(b) Theory /Problem	
Total	75

Swami Ramanand Teerth Marathwada University, Nanded.

M.A./M. Sc. Second Year Syllabus (Mathematics)
Effective from June-2015

Third Semester		Fourth Semester	
Paper No.	**Name of the paper**	**Paper No.**	**Name of the paper**
XIII	Functional Analysis	XIX	Numerical Analysis
XIV	Topology	XX	Abstract Algebra-II
One paper to be chosen from each of the following groups which are taught in the department.			
XV(A)	Analytical Number Theory	XXI(A)	Classical Mechanics
XV(B)	Theory of Linear operators-I	XXI(B)	Theory of Linear operators-II
XV(C)	Fuzzy Sets and their Applications-I	XXI(C)	Fuzzy Sets and their Applications-II
XVI(A)	Fluid Mechanics-I	XXII(A)	Fluid Mechanics-II
XVI(B)	Difference Equations-I	XXII(B)	Difference Equations-II
XVI(C)	Mathematical Softwares-I (Theory and Practical)	XXII(C)	Mathematical Softwares-II (Theory and Practical)
XVII(A)	Integral Transforms	XXIII(A)	Integral Equations
XVII(B)	Wave Prorogation-I	XXIII(B)	Wave Prorogation-II
XVII(C)	Fractional Calculus and its Applications-I	XXIII(C)	Fractional Calculus and its Applications-II
XVIII	Tutorial-III (Compulsory)	XXIV	Project Work (Compulsory)

Semester III

Paper-XIII
Functional Analysis

Max. Periods: 60(04 Credits)

Unit I : **Banach Spaces:**

The definition and some examples, Continuous linear transformations, The Hahn-Banach theorem, The natural embedding of N in N**. The open mapping theorem, The conjugate of an operator.

Unit II : **Hilbert Spaces:**

The definition and some simple properties, Orthogonal complements, Orthonormal sets, The conjugate space H*, The adjoint of on operator, Self adjoint operators, Normal and Unitary operators, Projections.

Unit III: **Finite Dimensional Spectral Theory:**

Introduction, The spectral theorem.

Text Book:

a. Introduction to "Topology and Modern Analysis" McGraw-Hill Book Company, International student Edition, New York.

Reference Books:

2. B.V. Limaye, "Functional Analysis", Wiley Eastern Ltd.

3. G. Bachman and L. Narici "Functional Analysis" Academic Press 1966.
4. D. Somasundaram , "A First Course in Functional Analysis" Narosa Publication.

Paper-XIV

Topology

Max. Periods: 60(04 Credits)

Prerequisites:

Cartesian Products, Finite Sets, Countable and Uncountable Sets, Infinite Sets and Axiom of Choice, Well Ordered Sets.

Unit 1. Topological Spaces :

Basis for a topology, Order topology, Subspace Topology, Product topology, closed sets and limit points, Continuous functions, Metric Topology.

Unit 2. Connected and Compact Spaces:

Connected spaces, Connected Subspaces of Real Line, Components and Local Connectedness, Compact spaces, Compact Subspaces of the Real Line, Limit point compactness, Local Compactness.

Unit 3. Countablity and Separation Axioms:

Countability Axioms, Separation axioms, Normal Spaces, Urysohn's Lemma (without proof), Tietze Extension Theorem (Without Proof), Metrization Theorem (without proof), Tychonoff's Theorem.

Prescribed Book:

1. J.R. Munkres, "Topology" Prentice Hall of India, Second Edition.

Reference Books:

1. Stephen Willard, "General Topology", Addison-Wesley Publishing Company, 1970
2. J. Dugundji Topology, Allya and Bacon. (1966) reprinted: Printice Hall of India.
3. W. J. Pervin : Foundations of general topology, academic press Inc. N.Y. H
4. S. T.Hu: Elements of general topology. Holden day Inc. 1965.

Paper-XV (A)

Analytical Number Theory

Max. Periods: 60(04 Credits)

Unit I:

Theory of congruences, Basic properties of congruences, Binary and decimal representation of integers, Linear congruences and Chinese Remainder theorem, Pierre de Fermat theorem, Fermat's little theorem and pseudoprimes, Wilson's theorem.

Unit-II:

The order of an integer modulo n, Primitive roots for primes, Composite numbers having primitive roots, Euler's criterion, The Legendre symbol and its properties, Quadratic reciprocity, Quadratic congruences with composite moduli, The equation $x^2+y^2=z^2$

Unit III: Arithmatical Functions & Dirichlet Multiplication:

The Mobius function, The Eular Totient function, The Managoldt function, Dirichlet Multiplication, Multipicative function, Inverse of Completely multiplicative function, Liouville's function, The divisor function, Formal power series, The Bell series, The Selberg identity.

Text Books:

1. David M. Burton, "*Elementary Number Theory*" Tata McGraw-Hill Pub. VI Edition.
2. Tom M. Apostol, "*Introduction to Analytic number theory*" Narosa Publishing house 1980.

Reference Books:

1. A course in arithmetic- J.P. Serre. GTM Vol.7, Springer Verlage 1973.

Paper XV (B)

Theory of Linear Operators-I

Max. Periods: 60 (04 Credits)

Unit-I:

Spectral theory in normed linear spaces, Resolvent set and spectrum, Spectral properties of bounded linear operators. Properties of Resolvent and Spectrum, Spectral maping theorem for polynomials, Spectral radius of a bounded linear operator on a complex Banach space, Elementary theory, Banach algebra.

Unit-II:

General properties of compact linear operators, Spectral properties of compact linear operators on normed spaces, Behavior of compact linear operators with respect to solvability of operator equations, Fredholm type theorems, Fredholm alternative theorm, Fredholm alternative for integral equations.

Unit-III:

Spectral properties of bounded self-adjoint linear operators on a complex Hibert space, Positive operators, Monotone Sequences theorem for bounded self-adjoint operators on a complex Hilbert space, Square roots of a positive operator.

Reference Books:

1. E. Kreyszig, Introductory functional analysis with applications, Johan-Wiley & Sons, New York, 1978.
2. P.R. Halmos, Introduction to Hilbert space and the theory of spectral multiplicity, 2nd Edn. Chelsea Pub., Co., N.Y. 1957.
3. G. Bachman & Narici, Functional analysis, Aca-demic Press, New York, 1966.
4. Akniezer, N.I. and I.M. Glazman, Theory of linear operators in Hilbert space, Frederick Ungar Pub. Co. NY, Vol. 1 (1961), Vol. 2(1963).
5. P.R. Halmos, A Hilbert space problem book, D.Van Nostrand Co. Inc, 1967.

Paper-XV(C)
Fuzzy Sets and their Applications-I

Max. Periods: 60(04 Credits)

Unit-I:

Crisps Sets & Fuzzy Sets, Operation on fuzzy sets The crisp sets, Fuzzy sets, Basic concepts of fuzzy sets, Fuzzy logic, Operation on fuzzy sets fuzzy complement, Fuzzy union, Fuzzy intersection,

Unit-II:

Combination of operation, General aggregation operations, Fuzzy Relation, Crisp & fuzzy relation, Binary relations, Binary relation on a single set.

Unit-III:

Equivalence & similarity relations, Tolerance relations, Ordering morphisms, Fuzzy relation equation.

Text Book:

1. Fuzzy sets, uncertainty & information By George J. Klir & Tina A. Folger. (Prentice Hall of India Pvt. Ltd.) Sixth Printing 2001.

Reference Books:

1. Introduction to Fuzzy control By-D. Drinkov, H. Hellendora & M. Reinfrank, Narosa Publishing House.
2. Fuzzy Set Theory & Its Applications By-H.J. Zimmermann, Allied Publishers Ltd. New Delhi-1991.
3. Fuzzy Sets & Fuzzy Logic By-G.J. Klir & B.Yuan.Prentice Hall of India New Delhi-1995.

Paper-XVI(A)

Fluid Mechanics-I

Max. Periods: 60(04 Credits)

Unit-I

Real fluids and ideal fluids, Velocity of fluid at a point, Streamlines and Pathlines, Steady and unsteady flows, The velocity potential, The Vorticity vector, Local and particle rates of change, The equation of continuity, Worked examples, Acceleration of fluid, Conditions at a rigid boundary, General analysis of fluid motion.

Unit-II

Pressure at a point in a fluid at rest, Pressure at a point in a moving fluid, Conditions at a boundary of two inviscid immiscible fluids, Euler's equation of motion, Bernoulli's equation, Worked examples, Discussion of the case of steady motion under conservative body forces, Some potential theorems (Statement only), Some flows involving axial symmetry, Some special two-dimensional flows, Impulsive motion, Some further aspects of vortex motion.

Unit-III

Meaning of two-dimensional flow, Use of cylindrical polar coordinates, The Stream function, The complex potential for two-dimensional irrotational, incompressible flow, Complex velocity potentials for standard two-dimensional flows, Uniform stream, Line sources and line sinks, Line doublets, Line vortices, Some worked example.

Text Book :

1. "Text book of Fluid Dynamics" by F. Charlton, Reprint 1998 C.B.S. Publishers and Distributors, Delhi-110 002.

Reference Books :

1. G.K. Batchelor-An Introduction to Fluid Mechanics. (Foundation Books-New Delhi-1994).
2. W.H. Besaint and A.S. Ramsey-A Treatise on Hydro Mechanics-Part II, C.B.S. Publishers-1998.
3. S.W. Yuan-Foundations of Fluids Mechanics. Prentice Hall of India Pvt. Ltd.-New Delhi-1976.

Paper-XVI(B)

Difference Equations-I

Max. Periods: 60(04 Credits)

Unit I : The Difference Calculus:

The Difference operator, Summation, Generating functions and approximate summation.

Unit II: Linear Difference Equations:

First order equations, General results for linear equations, Solving linear equations, Equations with variable coefficients, Nonlinear equations that can be linearized, The Z-Transform.

Unit III: Stability Theory:

Initial value problems for linear systems, Stability of linear systems, Stability of nonlinear systems.

Text Book:

1. Walter G. Kelley and Allan C. Peterson, "Difference Equations", Academic Press, Second Edition.

Reference Books:

1. Calvin Ahlbrandt and Allan C. Peterson, "Discrete Hamiltonian Systems: Difference Equations, Continued Fractions and Riccati Equations, "Kluwer, Boston, 1996.
2. Saber N. Elaydi "An Introduction to Difference Equations" Springer, Second Edition.

Paper-XVI(C)
Mathematical Softwares-I

(Scilab and LaTex)

Max. Periods: 60(04 Credits)

Unit-I:

Introduction of Scilab, Determinant, Rank, Eigen values, Eigen vector, Solving system of Equations, Plotting graph using Scilab.

Unit-II:

LaTex: Introduction, Class and package documentation, Definitions, From source code to typeset output, Creating simple document: Packages, Lists, Fonts, Aligning, Boxes.

Unit-III:

Structuring document, Graphic package, Floats, Figures, Tables, Defining commands, Mathematical Commands, Presentation using Beamer.

Text Book:

1. Programming in Scilab by Vinu V Das, New Age International Publisher.

2. Latex for Complete Novices by Nicola L.C. Talbot, Version 1.4

Reference Books:

1. Scilab by example by M. Affpif

2. A beginners Introduction to Typesetting with Lates by Peter Flym, Comprehensive Tex Archive Network.

Paper-XVII(A)

Integral Transforms

Max. Periods: 60(04 Credits)

Unit-I:

The Laplace Transform, The Laplace Transform of some typical functions, Basic operational properties, Transforms of more complicated functions, The inverse Laplace Transform, Applications involving Laplace Transform, Evaluating integrals, Solutions of ODEs, Solutions of PDEs.

Unit-II:

Fourier integrals and Fourier Transforms, Fourier integral representations, Proof of the Fourier integral theorem, Fourier transform pairs, The convolution integrals of Fourier, Transforms involving generalized functions, Hilbert transforms.

Unit-III:

Applications involving Fourier transforms, Boundary value problems, Heat conduction in solids, Mechanical vibrations, The Mellin transform, Evaluation of Mellin transform, Complex variable methods, Applications.

Text Book:

1. Larry C. Andrews, Bhimsen K. Shivamoggi, *Integral Transforms for Engineers*, Prentice Hall of India, New Delhi.

Reference Books:

1. J. K. Goyal, K. P. Gupta, *Integral Transforms*, Pragati Prakashan, Meerut.
2. A. R. Vasishtha, Dr. K. L. Gupta, *Integral Transforms*, Krishna Prakashan Mandir, Meerut.

Paper-XVII (B)
Wave Propogation-I

Max. Periods: 60(04 Credits)

Unit-I:

Introduction, SHM, Damped harmonic oscillations, Viscous damping, Damped forced oscillations, Wave equation in one, two & three dimensions, Harmonic waves, Spherical waves, Super position of waves & stationary waves, Solution of equation of wave motion of stationary types.

Unit-II:

Transverses waves on tightly stretched elastic string, Derivation of the wave equation, Normal vibration of finite continuous string with fixed ends, Fourier series solution for problem involving different initial conditions, Vibration of a string with damping, Expressions for kinetic & potential energy of a vibrating string, Reflection of a waves at discontinuity of string.

Unit-III:

Transverse vibration of thin membrane, Normal modes of vibrations of flexible rectangular drum head with fixed edges, Normal vibration of a rectangular flexible drum head with fixed edges having given initial displacements & released from rest.

Text Books:

1. Gosh P.K., "The mathematics of waves and vibrations," Mc Millan Company of India Limited.
2. Ceulson C.A., "Waves. A mathematical account of the common types of wave motion: Oliver and Boyed."
3. Ramsay A.S., "A treatise on Hydromechanics part II. (EL.B.S.)

Paper-XVII (C)

Fractional Calculus and its Applications-I

Max. Periods: 60(04 Credits)

Unit 1. Some special functions:

Definition of Gamma function and Beta function, Some properties of Gamma and Beta functions, Relation between Gamma and Beta functions, Definition of Mittag-Leffler functions of one and two parameters, Relations of Mittag-Leffler function in two parameters, Wright function, Definition of Wright function, Integral relation and relation to other functions.

Unit 2. Fractional Derivatives and Fractional Integrals:

Grunwald-Letnikov fractional derivatives, Riemann-Liouville fractional derivative, Caputo's fractional derivative, Fractional derivatives of standard functions and their graphical representation, Fractional integrals, Geometric and Physical interpretation of fractional integral and fractional differentiations, Left and right fractional derivatives.

Unit 3. Transforms of Fractional Derivatives:

Laplace transform of fractional derivatives, Fourier transform of fractional derivative and Mellin transform of fractional derivative.

Text Book:

1. Igor Podlubny, "Fractional Differential Equations", Academic Press, San Diego, California, 92101-4495.

Reference Books:

1. Miller K.S. and Ross B., "An Introduction to Fractional Calculus and Fractional Differential Equations", New York, John Wiley, 1993.
2. Oldham K.B. and Spanier J., "The Fractional Calculus", New York, Academic Press, 1974.

Paper-XVIII

Tutorial –III 05 Credits

Papers	Marks	Credits
Tutorial on theory paper -XIII	25	1
Tutorial on theory paper-XIV	25	1
Tutorial on theory paper- XV(A/B/C)	25	1
Tutorial on theory paper-XVI(A/B/C)	25	1
Tutorial on theory paper –XVII(A/B/C)	25	1
Total	**125**	**5**

The format for scheme of marking for tutorial of 25 marks in each paper is as follows:

Tutorial : ----- Paper No. and name : -----

Name of the teacher :-----

Sr.No.	Name of the student	Seat No.	Seminar	Attendance	Viva	Total
			10 Marks	5 Marks	10 Marks	25Marks

Signature of Teacher

The format, in which, the marks obtained by students in tutorial of 125 marks, to be submitted by HOD through the Principal, to the department of examination S.R.T.M.U. Nanded is as follows:

Sr. No.	Name of the student	Seat No.	Tutorial					Total
			Paper No.----	Paper No.----	Paper No.----	Paper No.----	Paper No.----	
			Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 25	Marks out of 125

Head of the Department

Semester-IV
Paper-XIX

Numerical Analysis

Max. Periods: 60(04 Credits)

Unit-I

Transcendental and Polynomial equations: Introduction, Bisection method, Iteration methods based on first degree equations and second degree equations, Rate of convergence, Polynomial Equations, Model problems.

Unit-II

System of Linear algebraic equations and Eigen value problems: Introduction, direct methods, Iteration methods, Eigen value and Eigen vectors, Model problems.

Unit-III

Interpolations and approximations: Introduction, Lagrange's, Newtonian Interpolation, finite difference operators, Interpolating polynomials using finite differences, Approximations, Least Square approximations.

Text Book :

1. M.K. Jain, SRK Iyengar, R.K. Jain, "Numerical methods for Scientific and Engineering computations." New Age International Limited Pub.
   Scope: Art. 2.1 to 2.5, 2.8, 2.9, 3.1, 3.2 3.4 3.5 3.6, 4.1 to 4.4, 4.8, 4.9

Reference Books:

1. S.S. Satry, "Introductory methods of Numerical Analysis" Prentice- Hall of India Private Ltd. (Second Edition) 1997.
2. E.V. Krishnamurthi & Sen. "Numerical Algorithm," Affiliate East. West press. Private Limited 1986.

Paper-XX

Abstract Algebra- II (Field Theory)

Maximum Periods: 60 (04 Credits)

Unit -I:

Irreducible polynomial and Eisenstein criterion, Adjunction of roots, Extension Fields, Algebraic extensions, Algebraically closed field, Splitting field, Normal extension, Roots of Polynomials, multiple roots, finite field, separable extensions.

Unit -II:

Automorphism groups and fixed fields, Galois theory, fundamental theorem of Galois theory, fundamental theorem of algebra.

Unit -III:

Roots of unity and cyclotomic polynomials, cyclic extension, polynomials solvable by radicals, symmetric functions, ruler and compass construction.

Text Book:

1. P. B. Bhattacharya, S. K. Jain and S. R. Nagpaul, "Basic Abstract Algebra (Second Ed.), Cambridge Univ. Press (Indian Ed.1995).

Reference Books:

1. Joseph A. Gallian, Contemporary Abstract Algebra (Fourth Ed.), Narosa, 1999.
2. I. S. Luthar and I. B. S. Passi, "Algebra-Vol. II: Groups", Narosa, New Delhi, 1996.
3. V.K. Khanna, S.K. Bhambri, "A Course in Abstract Algebra", Vikas Publicing House. (Second Edition)

Paper-XXI (A)

Classical Mechanics

Max. Periods: 60(04 Credits)

Unit I :

Mechanics of System of particles, Generalized co-ordinates, Holonomic and Noholonomic system, Scleronomic and Rheonomic system, D'Alembert's principles and Lagrange's Equation of Motion, Different forms of Lagrange's Equation, Generalized Potential, Conservative fields and its Energy Equation, Application of Lagrange's formulation.

Unit II:

Functional, Linear Functional, Fundamental lemma of calculus of variations, Simple variational problems, The variation of functional, The extremum of functional, Necessary condition for Extreme, Euler Equation, Eulers Equation of several variables, Invariance of Euler Equation, Motivating Problems of calculus of variation, Shortest Distance, Minimum surface of Revolution, Brachistochrone Problem, Isopermetric Problem, Geodesic, Variational problems in Parametric form, Generalization of Euler Equation, Variational Problems with subsidiary conditions.

Unit III:

Hamilton's Principle, Hamitton's canonical Equations, Lagrange's Equation from Hamiltons Principle, Extension of Hamiltons Principle to Nonholonomic systems, Application of Hamiltons formulation, cyclic co-ordinates and conservation theorems, Routn's Procedure, Hamilton's Equations from variational principle, The principle of least Action.

Text Book :

1. H. Goldstein, Charles Poole, John Sabko, "Classical Mechanics", Pearson 3rd Edition 2002.
2. I.M. Gelfand and S.V. Fomin "Calculus of Variations" Prentice Hall.

Reference Books:

1. N. Rana and B. Joag, "Classical Mechanics", Tata McGraw Hill 1991.
2. A.S. Ramsey, "Dynamics Part II" The English Language Book Society and Cambridge University press, 1972.

Paper –XXI(B)

Theory of Linear Operators -II

Max. Periods-60(04 Credits)

Unit-I:

Projection operators, Spectral family of a bounded self-adjoint linear operator and its properties, Spectral representation of bounded self-adjoint linear operators, Spectral theorems, Spectral measures, Spectral integrals, Regular spectral measures, Real and complex spectral measures, Complex spectral integrals,

Unit-III:

Description of the spectral subspaces, Characterization of the spectral subspaces, The spectral theorem for bounded normal operators, Unbounded linear operators in Hilbert space, Hellinger-Toeplitz theorem, Hilbert adjoint operators, Symmetric and self-adjoint linear operators.

Unit-III:

Closed linear operators and closures, Spectrum of an unbounded self-adjoint linear operators, Spectral theorem for unitary and self-adjoint linear operators, Multiplication operator and differentiation operator.

Reference Books:

1. E. Kreyszing, "Introductory Functional Analysis with applications," John-Wiley & Sons. New York. 1978.
2. P.R. Halmos, "Introduction to Hilbert Space and the theory of Spectral multiplicity," 2nd Edition, Chelsea Publishing Co, N.Y. 1957.
3. Akniezer, N.I. and I.M. Glazman, "Theory of Linear Operators in Hilbert Space," Frederick Ungar Pb. Co. NY.Vol. 1 (1961) Vol.2 (1963)
4. P.R. Halmos , "A Hilbert Space Problem Book," D.Van Nostrand Co. Inc.1967.

Paper XXI(C)

Fuzzy Sets and their applications-II

Max. Periods: 60(04 Credits)

Unit-I:

Fuzzy Measures Belief & plausibility measures, Probability measures, Possibility & necessity measures, Relationship among classes of fuzzy measures.

Unit-II:

Uncertainty & Information, Types of uncertainty, Measures of fuzziness, Classical measure of uncertainty, Measures of dissonance, Measure of non specificity, Uncertainty & information and complexity.

Unit-III:

Principles of uncertainty and information, Applications, General discussion, Natural, life & Social, Sciences, Engineering, Medicine, Management & decision making.

Text Book :

1. Fuzzy sets, Uncertainty & Information, By George J.Klir & Tina A. Folger. (Prentice Hall of India Pvt. Ltd.) Sixth printing 2001.

   Scope Chapter 4: Complete, Chapter 5: Complete, & Chapter 6:6.1 to 6.5.

Reference Books:

1. Introduction to Fuzzy Control, By-D. Drinkov, H. Hellendora & M. Reinfrank Narosa Publishing House.
2. Fuzzy Set Theory & its Applications, By-H.J. Zimmerman Allied Publishers Ltd. New Delhi-1991.
3. Fuzzy Sets & Fuzzy Logic, By- G.J. Klir & B. Yuan. Prentice Hall of India, New Delhi-1995.

Paper-XXII(A)

Fluid Mechanics-II

Max. Periods: 60(04 Credits)

UNIT I

Two-dimensional image systems, The Milne-Thomson circle theorem. Applications of the circle theorem, The theorem of Blasius.

UNIT II

Compressibility effects in real fluids, The elements of wave motion, The speed of sound in a gas, Equations of motion of a gas, Subsonic, Sonic and Supersonic flows, Isentropic gas flow, Reservoir discharge through a channel of varying section , Shockwaves.

UNIT III

Stress components in a real fluid, Relations between Cartesian components of stress, Translational motion of fluid element, The rate of strain quadric and principle stresses, Some further properties of the rate of strain quadric, Stress analysis in fluid motion, Relations 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, Steady viscous flow between concentric rotating cylinders. Diffusion of vorticity, Energy dissipation due to viscosity, Steady flow past a fixed sphere, Dimensional analysis; Reynolds number, Prandtl's Boundary Layer.

Text Book :

1. "Text book of Fluid Dynamics" by F. Charlton, Reprint 1998, C.B.S. Publishers and distributors, Delhi-110032.

Reference Books:

1. G.K. Batchelor-An Introduction to Fluid Mechanics. Foundation Books-New Delhi-1994).
2. W.H. Besaint and A.S. Ramsey-A Treatise on Hydro Mechanics-Part II, C.B.S. Publishers 1988.
3. S.W. Yuan-Foundations of Fluids Mechanics, Prentice Hall of India Pvt. Ltd.-New Delhi-1976.

Paper-XXII(B)

Difference Equations-II

Max. Periods: 60(04 Credits)

Unit I: The self-adjoint second order linear equation:

Introduction, Sturmian theory, Green's functions, Disconjugacy, The Riccati equations.

Unit II: The Sturm - Liouville problem:

Introduction, Finite Fourier analysis, Non-homogeneous problem.

Unit III: Boundary value problems for nonlinear equations:

Introduction, The Lipschitz case, Existence of solutions, Boundary value Problems for differential Equations.

Text Book:

1. Walter G. Kelley and Allon C. Peterson, "Difference Equations," Academic press, Second Edition.

Reference Books:

1. Calvin Ahlbrandt and Allan C. Peterson, "Discrete Hamittonian systems, Difference Equations, Continued Fractions and Riccat Equations," Kluwer, Boston, 1996.
2. Saber N. Elyadi, "An Introduction to difference Equations," Springer, second Edition.

Paper-XXII(C)
Mathematical Softwares-II

(Matlab)

Max. Periods: 60(04 Credits)

Unit-I:

Introduction, Current directory, The command window, The edit window, M-files, The figure window, Matrices, Operators, Functions, Matrix arithmetic, Operator precedence functions, Keyboard input, Formatted output, Plotting toolbox.

Unit-II:

Liner algebra in Matlab: Solution difficulties, Simultaneous equations, Inconsistent equations, Under-determined problems, Over-determined problems, Conditioned problems, Tap-down design and branching statements, Relational operators and logical operators, Plotting features.

Unit-III:

Loops: Repetition for loop, Modifying the control expression, While loop, Working with while loop, Control expression, Programming with loops, Logical arrays and logical indexing, User defined functions, Data types, Recursion, Solution of ordinary, partial and fractional differential equations

Text Book:

1. J.Michael Fitzpatrick and JohnD. Crocetti, “Introduction to Programming with Matlab”.

Reference Books:

1. Rudra Pratap, “Getting started with MATLAB”.

2. Marc E. Herniter, “Programming in MATLAB”, Books/Cole, Thomson learning inc.

Paper-XXIII(A)
Integral Equations

Max. Periods: 60(04 Credits)

Unit-I: Definition and classification of integral equations, Special kinds of kernels, Convolution integrals, Conversion of an initial value problem into a Volterra integral equation, Conversion of a boundary value problem into a Fredholm integral equation, Eigen values and eigen functions, Solution of homogeneous Fredholm integral equations of the second kind with separable kernel, Fredholm alternative.

Unit-II: Method of successive approximation, Iterated kernel, Resolvent kernel, Solution of Fredholm and Volterra integral equations of the second kind by the method of successive substitutions, Solution of Fredholm and Volterra integral equations of the second kind by the method of successive approximations: Neumann series.

Unit-III: Integral equations with symmetric kernels, Regularity conditions, Complex Hilbert space, An orthonormal system of functions, Fundamental properties of eigen values and eigen functions for symmetric kernels.

Expansion in eigen functions and bilinear form, Hilbert-Schmidt theorem and some immediate consequences. Singular integral equations, The Abel integral equation examples, Integral transform method, Application of Laplace transform to solve Volterra integral equations with convolution type kernels, Application of Fourier transform to solve integral equations, Examples.

Text Books:

1. R.P. Kanwal, *Linear Integral Equantions Theory and Technique*, Academic Press, Inc., New York.
2. Dr. M. D. Raisinghania, *Integral Equations and Boundary Value Problems*, S. Chand and Company Pvt. Ltd., New Delhi.

Reference Books:

1. S.G. Mikhlin, *Linear integral equations* (Translated from Russian) "Hindustan Book Agency 1960.
2. B.L. Moiseiwitsch, *Integral Equations*, Longman, London & New York.
3. M. Krasnov, A Kiselev, G.Makaregko, *Problems and Exercises in integral equations* (Translated from Russian) by George Yankovsky) MIR Publishers Moscow, 1971.

Paper XXIII(B)

Wave Propogation-II

Max. Periods: 60(04 Credits)

Unit-I:

Expressions for kinetic & potential energy of vibration membrance, Vibration of a stretched circular drum head fastened at the circumference & releases initially from rest, Propogation of waves in elastic solid media waves of dilatation & waves of distortion in isotropic elastic media plane waves, Rayleight waves, Love waves.

Unit-II:

Types of liquid waves, Tidal waves, Oscillator waves, Surface waves, Capillary waves, Group waves, Introduction, General form of wave equation, Wave equation for plane waves, Some examples of normal vibrations of air in a pipe, Spherical waves, Energy of sound waves, Illustrative examples (1).

Unit-III:

Solution for a source free empty space, Solution for a homogeneous isotropic medium in which there are free charges but no conduction current and the field vectors are independent of time, Uniform plane waves propagation in free space(vacuo), Wave in a conducting medium, Electromagnetic waves in a rectangular wave guide.

Reference Books:

1. Gosh P.K. "The mathematics of waves and Vibrations," Mc Millan Company of India Limited.
2. Ceulson C.A., "Waves. A mathematical account of the common types of wave motion", Oliver and Boyed.
3. Ramsay A.S., "A treatise on Hydromechanics", part II, (E.L.B.S.)

Paper XXIII(C)

Fractional Calculus and its Applications-II

Max. Periods: 60(04 Credits)

Unit 1. Linear Fractional Differential Equations:

Linear fractional differential equations, Homogeneous and Nonhomogeneous linear fractional differential equations, Existence and uniqueness theorem as a method of solution, Laplace transform method to solve fractional differential equatios.

Unit 2. Fractional Greens Function:

Definition and some properties, One-term equation, Two-term equation, Three-term equation, Four-term equation, General case: n-term equation.

Unit 3. Other Methods of Solution of Fractions Differential Equations:

Fourier transform method, Mellin transform method, Power series method, Numerical evaluation of fractional derivatives, Approximation of fractional derivatives.

Text Book:

1. Igor Podlubny, "Fractional Differential Equations", Academic Press, San Diego, California, 92101-4495.

Reference Books:

1. Miller K.S. and Ross B., "An Introduction to Fractional Calculus and Fractional Differential Equations", New York, John Wiley, 1993.
2. Oldham K.B. and Spanier J., "The Fractional Calculus", New York, Academic Press, 1974.

Paper-XXIV

Project Work

Marks: 125, **Credits-5**

Distribution of Marks:

Project Submission: 100 Marks **Viva-Voce: 25 Marks**

Project work as per S.R.T.M. University, Nanded Rules:

Swami Ramanand Teerth Marathwada University, Nanded.

Question Paper pattern

M.A./M.Sc. Mathematics Second Year w. e. f. June-2015

Time:03.00 Hrs. **Max.Marks:75**

Q.1 Attempt the following: (two marks each)	12
(i) to (vi)	
Q.2 Attempt any two of the following: (ten marks each)	20
(a) Theory	
(b) Theory	
(c) Theory	
Q.3 Attempt any two of the following: (eight marks each)	16
(a) Theory	
(b) Theory	
(c) Theory	
Q.4 Attempt any two of the following: (six marks each)	12
(a) Problem	
(b) Problem	
(c) Problem	
Q.5 Attempt any two of the following: (four marks each)	08
(a) Problem	
(b) Problem	
(c) Problem	
Q.6 Attempt any one of the following:	07
(a) Theory / Problem	
(b) Theory /Problem	
Total	75