Minutes of Meeting of Board of Studies

Department of Mathematics

UIET CSJM University

Kanpur

Date: May 24, 2022

The Board of studies, online meeting (on Google meet) of Department was held on 24 May 2022 at 10:00 am in UIET, CSJM University. Syllabus of M. Sc. Mathematics according to NEP was put forward and a discussion was there on it. Certain suggestions were given which were incorporated. Following members attend meeting:

1. Dr. Lalit Kumar Vashisht, Department of Mathematics, Delhi University, Delhi
2. Dr. Sanjeev Singh, Department of Mathematics, IIT Indore
3. Dr. D. K. Singh, Department of Mathematics, School of Basic Sciences, CSJMU, Kanpur
4. Dr. P. N. Pathak, Department of Mathematics, School of Basic Sciences, CSJMU, Kanpur
5. Dr. NamitaTiwari, Department of Mathematics, School of Basic Sciences, CSJMU, Kanpur
6. Dr. Poonam Dixit, Department of Mathematics, School of Basic Sciences, CSJMU, Kanpur
7. Dr. SnaddepPorwal, Department of Mathematics, School of Basic Sciences, CSJMU, Kanpur

Dr. S.K. Porwal

Proposed NEP Syllabus of M.Sc. (Mathematics)
Department of Mathematics
School of Basic Sciences, CSJM University Campus, Kanpur.

Semester wise- Distribution of Course
Full Marks: 2000, Total Credit: 100

First Year				Second Year			
I[st] Semester		2[nd] Semester		3[rd] Semester		4[th] Semester	
Paper/Type	Credit/ Total Marks	Paper/Type	Credit	Paper/Type	Credit	Paper/Type	Credit
Linear Algebra **Core**	5/100	Abstract Algebra **Core**	5/100	Measure Theory and Integration **Core**	4/100	Fluid Dynamics **Core**	4/100
Real Analysis **Core**	5/100	Partial Differential Equations **Core**	5/100	Topology **Core**	4/100	Discrete Mathematics **Core**	4/100
Ordinary Differential Equations **Core**	5/100	Probability and Statistics **Core**	5/100	Functional Analysis **Core**	4/100	Elective-3 1. Mathematical Statistics 2. Number Theory 3. Theory of Bounded Operators 4. Special Theory of Relativity	4/100
Complex Analysis **Core**	5/100	Elective-1 1. Mechanics 2. Integral equations and Calculus of Variations 3. Financial Mathematics	5/100	Numerical Method **Core**	4/100	Elective-4 1. History and Development of Indian Mathematics 2.Cryptography 3.Mathematical Modeling 4.Operation Research	4/100

Integral Transform **Minor**	4/100			Elective-2 1. Vedic Ganita 2. Special Functions 3. Graph Theory 4. Wavelet Analysis	4/100	Programming Languages (Lab) **Practical**	4/100
Research Project	-	Research Project	8/100	Research Project		Research Project	8
Total credits	20/400		28/500		20/500		28/600
Minor elective from other department faculty to be taken in I[st] year only I[st] semester							
Minimum credits annually	**52**			**48**			

***Research Project will be evaluated in the second and fourth semester.**

Semester-I, Total Marks: 500, Credit: 24

Sl.No.	Course Code	Name of Paper	Maximum mark	Credit
1	MMC-101	Linear Algebra **Core**	100	5
2	MMC-102	Real Analysis **Core**	100	5
3	MMC-103	Ordinary Differential Equations **Core**	100	5
4	MMC-104	Complex Analysis **Core**	100	5
5	MMM-105	Integral Transform **Minor**	100	4
6	MMR-106	ResearchProject	-	-

Semester-II, Total Marks:500, Credit:28

Sl. No.	Course Code	Name of Paper	Maximum mark	Credit
7	MMC-201	Abstract Algebra **Core**	100	5
8	MMC-202	Partial Differential Equations **Core**	100	5
9	MMC-203	Probability and Statistics **Core**	100	5
10	MME-204(A) MME-204(B) MME-204(C)	Elective-I 1. Mechanics 2. Integral equations and Calculus	100	5

		of Variations 3. Financial Mathematics		
11	MMR-205	Research Project	100	8

Semester-III, Total Marks: 500, Credit: 20

Sl. No.	Course Code	Name of Paper	Maximum mark	Credit
12	MMC-301	Measure Theory and Integration **Core**	100	4
13	MMC-302	Topology **Core**	100	4
14	MMC-303	Functional Analysis **Core**	100	4
15	MMC-304	Numerical Method **Core**	100	4
16	MME-305(A) MME-305 (B) MME-305 (C) MME-305(D)	Elective-2 1. Vedic Ganita 2. Special Functions 3. Graph Theory 4. Wavelet Analysis	100	4
17	MMR-306	Research Project	-	-

Semester-IV, Total Marks: 600, Credit: 28

Sl. No.	Course Code	Name of Paper	Maximum mark	Credit
18	MMC-401	Fluid Dynamics **Core**	100	4
19	MMC-402	Discrete Mathematics **Core**	100	4
20	MME-403 (A) MME-403 (B) MME-403 (C) MME-403 (D)	Elective-3 1. Mathematical Statistics 2. Number Theory 3. Theory of Bounded Operators 4. Special Theory of Relativity	100	4
21	MME-404 (A) MME-404 (B) MME-404 (C)	Elective-4 1.History and Development of Indian	100	4

	MME-404 (D)	Mathematics 2.Cryptography 3.Mathematical Modeling 4. Operation Research		
22	MMP-405	Programming Languages (Lab) **Practical**	100	4
23	MMR-406	Research Project	100	8

Students may select one of the following elective papers.

Semester I

MMC-101 Linear Algebra

Unit I

Finite dimensional vector spaces over real or complex fields, Basis and Dimensions, Linear transformations and their matrix representations, rank and nullity, systems of linear equations.

Unit II

Characteristic polynomial, Eigen values and eigenvectors, Cayley-Hamilton Theorem, Algebraic and Geometric Multiplicity, Annihilating Polynomial, minimal polynomial, Block Matrices, Diagonalization.

Unit III

Jordan canonical forms, diagonal forms, triangular forms, bilinear forms, Symmetric Bilinear Forms, Quadratic forms, Definiteness of Quadratic forms. Reduction and classification of quadratic forms.

Unit IV

Finite dimensional inner product spaces, Cauchy Schwartz Inequality, Bessel's Inequality, Orthogonal and Orthonormal basis, Orthogonal projections, Gram-Schmidt Orthogonalization process, linear functional, Dual spaces.

Recommended Books:

1. Linda Gilbert and Jimmie Gilbert, Elements of Modern Algebra, Seventh edition, Cengage Learning.
2. Herstein,I.N, Topics in Algebra, 7th edition, John Wiley & Sons,2004
3. Hoffman,K and Kunze,R, Linear Algebra, Pearson Education (Asia)Pvt.Ltd/Prentice Hall of India 2004
4.Leon, S.J, Linear Algebra with Applications, 8th Edition, Pearson 2009.

MMC- 102 Real Analysis

Unit I

Elementary set theory, Countable and Uncountable sets, Real number system and its order completeness, Dedekind's theory of real numbers, Construction of real field from the field of rational numbers.

Unit II

Definition and existence of Riemann-Stieltjes integral, Properties of the integral integration and differentiation, Fundamental theorem of integral calculus, Riemann- Stieljes integration, integration of vector valued functions, Rectifiable curves.

Unit III

Sequences and series of functions Point wise and uniform convergence of sequences of functions, Equicontinuity, Weierstrass approximation theorem, Power Series, Uniqueness

theorem for power series, Abel's theorems. Arzelà-Ascoli Theorem, Dini's Theorem, Stone-Weierstrass Theorems.

Unit IV

Functions of several variables, Euclidian spaces, concept of functional of several variables, Linear transformations, continuous functions, Derivatives in an open subset of R^n , Chain rule, Partial derivatives, Interchange of the order differentiation, Inverse function theorem, Implicit Function theorem, Derivatives of higher order.

Recommended Books:

1. GF Simmons, Introduction to Topology and Modern Analysis, Mc Graw Hill, 1963.
2. JL Kelly, Topology, Von Nostrand Reinhold Co. New York, 1995
3. Real Analysis by H.L. Royden
4. Measure Theory and Integration, by G.de Barra

MMC– 103 Ordinary Differential Equations

Unit I

Existence and uniqueness of solution; Continuity and differentiability of solution w.r.t. initial condition and parameters; General theory of linear deferential equations; Methods of solving non homogeneous linear equations; Cauchy Euler equation; Linear equations with periodic co efficient; System of linear deferential equations; Stability theory for system of linear deferential equations.

Unit II

Eigen Value Problem, Orthogonality of Eigen Function, Eigen function expansion in series of orthonormal function, Matrix method for linear system of homogenous and non-homogenous equation.

Unit III

System of first order equation: Nonlinear system, Volterra's prey & predator equation, Non Linear equation: Autonomous system. The phase plane & its phenomena, types of critical points & stability. Critical points & stability for linear system, stability by Liapunov's direct method simple critical points of nonlinear system & nonlinear mechanics. Conservative system, Periodic solution, Poincare – Bendixson Theorem.

Unit IV

Second order differential equation Introduction, Preliminary results, Boundedness of solution, Oscillatory equation, number of zeroes, Pruffer's transformation, Strum Liouville boundary value problems Oscillation theory, Green's function.

Recommended Books:

1. E. A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, McGraw Hill, 1955.
2. S. L. Ross, Differential Equations, John Wiley sons, New York.
3. Shair Ahmad and M.R.M Rao, Theory of ordinary differential equations. Affiliated East-West Press Private Ltd. New Delhi, 1999.
4. G.F. Simmons, Differential Equations, McGraw Hill, 1991.

5. E. D. Renville and P. E. Bedient, Elementary Differential Equations, McGraw Hill, 1969.

MMC– 104 Complex Analysis

Unit I

Analytic Function, Cauchy- Riemann Equation, harmonic conjugates, Power series, Radius of Convergence of Power series, Power series representation of an analytic function, Cauchy Hadamard's theorem.

Unit II

Elementary function: Branch Point, Branch cut, branch of multivalued function, Analyticity of branches of Log z, z^a, Mobius transforms, Conformal mapping, Cauchy's theorem, Cauchy integral formula, Morera's theorem, Open mapping theorem, Cauchy's inequality, Liouville's theorem and applications, Taylor's and Laurent's series, Maximum modulus principle and Schwarz's Lemma.

Unit III

Singularity: zeroes of an analytic function, Singular point, different types of singularities, limiting point of zeroes and poles, Weierstrass theorem.

Unit IV

Calculus of Residue's: Residue at pole, Residue at infinity, Cauchy's residue theorem, Jordan's lemma, Evaluation of real definite integral, evaluation of improper integral, Meromorphic function, Argument principle and Rouche's theorem.

Recommended Books:

1. J. B. Conway, Functional of one complex variable, Narosa, 1987.
2. L. V. Ahlfors, Complex analysis, McGraw Hil, 1986.
3. Churchill, J. W. and Brown, R.V., Complex Analysis, McGraw Hill. 2009.
4. S. Ponnusamy, Herb Silverman, Complex Variables with Applications, Birkhäuser Boston, MA, 2006.

MMM – 105 Integral Transforms

Unit I

Laplace Transform: Existence of Laplace Transform, Function of exponential order, a function of Class A, Laplace Transform of some elementary function, First and Second translation, change of scale property, Laplace transform of the derivative, Laplace transform of Integral, Multiplication, Division , Periodic function.

Unit II

Inverse Laplace Transform: Null Function, Lerch's Theorem, first and second Translation, Change of scale, Derivatives, Integrals, Multiplication, Division, Convolution Theorem, Heviside's expansion, The complex inversion formula.

Applications: Solution of Ordinary Differential equations. Solution of Simultaneous Ordinary differential equations, Solution of Partial differential equation, Application to Electric circuits, Mechanics. Integral equations, Initial and Boundary value problem.

Unit III
Fourier Integral theorem, Fourier Transform, Convolution, Relation between Fourier and Laplace Transform, Parseval's Indentity for Fourier Transform, Relationship between Fourier and Laplace Transforms, Fourier Transform of derivative of function, Finite Fourier Transform, Application of Fourier transform in Initial and Boundary value problems.

Unit IV
Hankel Transfrom, Inversion formula for the Hankel Transform, Some important results for Bessel function, Hankel Transform of derivative of Function, Parsevals Theorem, Finite Hankel Transform, Application of Hankel Transform in initial and Boundary value Problems.

Unit V
Mellin Transform, The Mellin inversion Theorem, Linear property, some elementary properties,, Mellin transform of derivative, Mellin transform of Integral, convolution Theorem. Z-transform.

Recommended Books:

1. Ian N Senddon, The Use of Integral Transform, McGraw Hill, 1972.
2. L. Dobanth and D. Bhatta, Integral Transforms and Their Applications, 2nd edition, Taylor and Francis Group.
3. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons 2011

MMR-106: Research Project

Semester II

MMC– 201 Abstract Algebra

Unit I
An overview of Groups, Conjugacy Relation, Class equation, Cauchy's Theorem, Sylow's theorems and their applications, Normal and Subnormal Series, Composition Series, Jordan – Holder Theorem, Solvable Groups, Nilpotent Groups.

Unit II
An overview of Rings and Fields, Prime and Maximal ideals, Quotient rings, unique factorization domain, principal ideal domain, Euclidean domain, Polynomial rings, Gaussian Rings, Irreducible Polynomials.

Unit III
Field extensions, Algebraically Closed Fields, Splitting Fields, Algebraic and Transcendental Extensions, Seperable and inseperable extensions, Normal Extensions, Automorphism of Extensions, Galois Extension.

Unit IV
Fundamental Theorem of Galois Theory, Construction and representation of finite fields using polynomials over Zp, Modules, Noetherian modules, Hilbert basis theorem.

Recommended Books:

1. Serge Lang, Algebra, Addison Wesley
2. V. Sahai & V. Bist, Algebra, Second edition, Narosa.
3. I. N. Herstain, Topic in Algebra, Wiley Eastern limited, New Delhi 1975

MMC – 202 Partial Differential Equation

Unit I

Introduction, basic concept and definition, classification of second order linear equation and method of characteristics, canonical form, Equations with constant coefficients, Supper position principle. Method of separation of variables.

Unit II

Boundary Value Problems, Maximum and Minimum Principles, Uniqueness and Stability theorem, Dirichlet problem for a Circle, Dirichlet Problem for a Circular annulus, Neumann problem for a Circle, Dirichlet problem for a Rectangular, Dirichlet problem involving Poisson equation.

Unit III

The Cauchy problem: The Cauchy problem, Cauchy-Kowalewsky Theorem, Hadmard example, Cauchy problem for homogeneous wave equations, Initial value problem, The Cauchy problem for Non-homogenous wave equation., The vibration string problem, Existence and uniqueness solution of the vibrating problem.

Unit IV

Fourier transform and Initial boundary value problems. Properties of Fourier Transform, Convolution (Fourier Transform), Step and impulse Function Fourier Transform, Semi-infinite region, Green's functions and boundary value problem.

Recommended Books:

1 L. C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, AMS, 1999.
2. Jurgen Jost, Partial Differential Equations: Graduate Text in Mathematics, Springer Verlag Heidelberg, 1998.
3. Robert C Mcowen, Partial Differential Equations: Methods and Applications, Pearson Education Inc. 2003.
4. Fritz John, Partial Differential Equations, Springer-Verlag, 1986.
5. I. N. Sneddon, Elements of Partial Differential Equations, McGraw-Hill, 1988.

MMC – 203 Probability and Statistics

Unit I

Probability: Axiomatic and statistical definition, Properties, addition and multiplications theorem of probability, Conditional probability, Bayes theorem and independence of events, Random variables, Distribution function, Probability mass and density functions, Discrete distribution function, Mathematical Expectation, Moments, Moment generating function and cumulants.

Unit II

Probability distributions: Binomial, Geometric, Negative -Binomial, Poisson, Uniform, Exponential, Gamma, Normal distributions, characteristic function, Covariance, Correlation.

Unit III

Statistics: Origin of the theory of sampling, Objects of sampling, Population, Sample, Parameters, test of significance, critical region, standard error, Fiducial limit.

Test of Hypotheses: z-test and t-test for means, variance, two sample problems and for proportions, Chi-square goodness of fit tests, Contingency tables.

Unit IV

Estimation Theory: Types of estimation, Unbiasedness, Method of moment, Confidence interval, Relation between confidence intervals and tests of hypotheses, estimation for mean, difference of means, variance and proportions.

Recommended Books:

1. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons New Delhi.
2. V. K. Rohatgi and A. K. Md. Ehsanes Saleh, An Introduction to Probability and Statistics", John Wiley and Sons, 2nd edition.2000.
3. R. V. Hogg and A. Craig, Introduction to Mathematical Statistics, Pearson Education, 6th Edition, 2005.

Elective-I (One of the following is to be chosen)

MME – 204 (A) Mechanics

Unit I

Lagrangian Formulation: Mechanics of a particle, mechanics of a system of particles, constraints, generalized coordinates, generalized velocity, generalized force and potential. D'Alembert's principle and Lagranges equations, some applications of Lagrangian formulation.

Unit II

Hamilton's principle, derivation of Lagrange's equations from Hamilton's principle, extension of Hamilton's principle to non-holonomicsystems.

Unit III

Hamiltonian formulation: Legendre transformations and the Hamilton equations of motion, cyclic coordinates and conservation theorems, derivation of Hamilton's equations from a variational principle, the principle of least action, the equation of canonical transformation.

Unit IV

Poisson and Lagrange brackets and their invariance under canonical transformation. Jacobi's identity; Poisson's Theorem. Equations of motion infinitesimal canonical transformation in the Poisson bracket. Hamilton Jacobi Equations for Hamilton's principal function, the harmonic oscillator problem as an example of the Hamilton-Jacobi method.

Recommended Books:

1. H. Goldstein, Classical mechanics, 2nd edition, Narosa Publishing House.

2. W. Rindler, Relevant topics from Special relativity, Oliver & Boyd, 1960.

MME – 204 (B) Integral Equations and Calculus of Variation

Unit I

Integral equation: Basic concept, solution of integral equation, conversion of differential equation to integral equation, Intial value problem and boundary value problem, solution of Fredlholm's integral equation, symmetric kernel, Hilbert's-Schmidt theory, Risz – Fischer theorem.

Unit II

Solution of Fredhlom integral equation of second kind by successive substitution and successive approximation, Solution of Voltera integral equation of second kind by successive substitution and successive approximation, Reduction of Voltera integral equation into differential equation, reduction of Voltera integral equation of first kind to a Voltera integral equation of second kind, classical Fredhlom theory.

Unit III

Variational problems with fixed boundary: Eulear's equation, the Brachistochorn problem, functional, Euler's poission eqution, Isoperimetric problem, variational problem with moving boundary: transversality condition, variational problem with moving boundary with implicit from, one sided variation.

Unit IV

Sufficient condition for an extremum: Jacobi condition, legendre condition, Lagrenges equation from hamilton's principle, direct method in variational problem: Ritz method, Galerkin's method, Collocation method and least square method.

Recommended Books:

1. Gupta A.S., Calculas of Variations with Applications, Prentice hall of India.
2. Elsgolts L., Differential equations and calculus of variations, MIR publisher, 1980.

MME – 204 (C) Financial Mathematics

Unit I

Introduction- a simple market model: basic notions and assumptions, no– arbitrage principle. Risk-free assets: time value of money, future and present values of a single amount, future and present values of an annuity, Intra-year compounding and discounting, continuous compounding.

Unit II

Valuation of bonds and stocks: bond valuation, bond yields, equity valuation by dividend discount model and the P/E ratio approach. Risky assets: risk of a single asset, dynamics of stock prices, binomial tree model, other models, geometrical interpretations of these models, martingale property.

Unit III

Portfolio management: risk of a portfolio with two securities and several securities, capital asset pricing model, minimum variance portfolio, some results on minimum variance portfolio. Options: call and put option, put-call parity, European options, American options, bounds on options, variables determining option prices, time value of options.

Unit IV

Option valuation: binomial model (European option, American option), Black-Scholes model (Analysis, Black-Scholes equation, Boundary and final conditions, Black-Scholes formulae etc).

Recommended Books:

1 Capinski M. and Zastawniak T., Mathematics for Finance- An introduction to financial engineering, Springer 2003.

2 Teall J. L. and Hasan L. Quantitative methods for finance and investments, Blackwell publishing 2002.

3 Hull J.C., Options, futures and other derivatives, Pearson education 2005.

4 Chandra P., Financial Management – Theory and Practice, Tata McGraw Hill 2004.

5 Wilmott P., Howison S. and Dewynne J., The mathematics of financial derivatives- A student introduction, Cambridge university press 1999.

MMR-205: Research Project

Semester III

MMC – 301 Measure Theory and Integration

Unit I

Lebesgue outer measure, Measurable sets, Regularity, Measurable functions, Borel and Lebesgue measurability, Non-measurable sets, Riemann integral, Lebesgue Integration of nonnegative functions, General integral, Comparison of Riemann integral and Lebesgue integrals.

Unit II

Dini's four derivatives, Functions of bounded variation, Differentiation of an integral, Absolute continuity.

Unit III

Measures and outer measures, Measure spaces, Integration with respect to a measure, L p -spaces, Holder and Minkowski inequalities, Completeness of L p -spaces, Convergence in measure, Almost uniform convergence, Egorov's theorem.

Unit IV

Product measure, Fubini Theorem, Tonelli Theorem, Signed measures, Hahn and Jordan

decomposition theorems, Mutually singular measures, Radon-Nikodym theorem, Lebesgue decomposition.

Recommended Books:

1. G. de Barra, Measure Theory and Integration, New Age International (P) Ltd., New Delhi, 2014.

2. H.L. Royden and P.M. Fitzpatrick, Real Analysis, Fourth Edition, Pearson, 2015.

MMC – 302 Topology

Unit I

Completeness of a metric space, Cantor's intersection theorem, Dense sets, Bair category theorem, Separable spaces, Continuous function, Extension theorem, Uniform Continuity, Isometry and homeomorphism, equivalent matrics, Compactness, Sequential compactness, Totally bounded spaces, Finite intersection property, Continuous function and compact sets.

Unit II

Axiom of choice, Zermelo's postulate, Zorn's lemma, Well ordering theorem, Cardinal number and its arithmetic, Schroeder- Bernstein theorem, Cantor's theorem and the continuous hypothesis.

Unit III

Topological spaces: Definitions and Examples, Basis and Sub basis for a Topology, limit points, closure, interior; Continuous functions, Homeomorphisms; Subspace Topology, Metric Topology, Product & Box Topology, Order Topology; Quotient spaces.

Unit IV

Characteristics of Topology in terms of Kuratowski closures operator and fundamental system in neighborhood, continuous map and homomorphism, first and second countable space, Lindeloff theorem , separable spaces, second countability and separability, Separation axioms, T_0, T_1, T_2, T_3, and T_4 spaces their characterization and basic property.

Recommended Books:

1. James R Munkres, Topology, A first course, Prentice Hall, New Delhi, 2000
2. GF Simmons, Introduction to Topology and Modern Analysis, Mc Graw Hill, 1963.
3. JL Kelly, Topology, Van Nostrand Reinhold Co. New York, 1995.

MMC-303 Functional Analysis

Unit I

Baires Category theorem: Complete Metric Space, Category, Baires Category Theorem, Fixed point theorem: Contraction Mapping, Banach Fixed Point Theorem.

Unit II

Normed Linear Spaces: Linear Metric Space, Normed Linear Space, Basic Theorems on Normed Linear Spaces.

Unit III

Banach Space, Hahn-Banach theorem, Open mapping and Closed graph theorems,Uniform boundedness principle.

Unit IV

Operator Theory: Linear Operator, Self Adjoint Operators, Compact Operator, Normal and unitary operators.

Unit V

Hilbert Spaces: Inner Product Spaces, Orthonormal Sets, Riesz Representation Theorem, Bounded Linear Operator on Hilbert Spaces.

Unit-VI Banach Algebras: Normed Algebra, Spectrum, Self adjoint, normal and unitary operators; Commutative Banach Algebra.

Recommended Books:

1. G.F. Simmons: Topology and Modern Analysis

2. B. V. Limaye: Functional Analysis

3. K. Yoshida : Functional Analysis , Springer

4. S. Nanda and B Choudhari, Functional Analysis With Application, New Age International Ltd

5. S C Bose, Introduction to Functional Analysis, Macmillan India Lt

MMC – 304 Numerical Methods

Unit I

Roots of transcendental equations and polynomial equations, Bisection method, Iteration based on first degree equations, Regula-Falsi methods, Rate of convergence, Generalized Newton- Raphson method.

Unit II

System of linear equation: Direct method-: Gauss Elimination method, Triangularization method, Iterative methods-: Jacobi's method, Gauss-Seidel method, SOR method, Givens power method for Eigen value and Eigen vectors.

Unit III

Interpolation and Approximation: Lagrange's and Newton's divided difference, Finite difference operators, Hermite interpolation, piecewise & cubic spline interpolation, Least square approximation, Min-Max polynomial approximation method, Chebyshev polynomial, Lanczos economization.

Unit IV

Newton cotes methods, Method based on undetermined coefficients, Gauss Legendre integration method.

Unit V

Numerical Methods for ODE: Single step method- Euler's method, Taylor series method, Runge- Kutta method of 2^{nd} and 4^{th} order, Numerical methods for BVP, Multistep method-:predictor -corrector method, Adams Bashforth method, Adams Moulton method, Milne method, convergence and stability.

Recommended Books:

1. Gerald, C.F and Wheatly, P.O, Applied Numerical Analysis", 6^{th} edition,Wesley,2002
2. Jain, M.K, Iyengar, S.R.K and Jain, R.K, "Numerical methods for Scientific and Engineering computation , New Age Pvt.Pub,New-Delhi,2000
3. Introduction to Numerical Analysis by S.S Sastry, Prentice Hall,Flied
4. Krishnamurthy, E.V & Sen, S.K , Applied Numerical analysis, East West Publication

Elective-II (One of the following is to be chosen)

MME – 305(A) Vedic Ganita

Unit I

History of Vedic Ganita, Why Vedic Ganita, Silent features of Vedic Ganita, Vedic Ganita fonnulas, 16 sutras, 13 sub sutras, Terms and operations, High speed addition by using the concept of computing the whole and from left to right, Superfast subtraction by Nikhilamsutram from basis 100, 1,000, 10,000.

Unit II

Multiplication by Urdhavtrighbhyam sutram, Multiplication by vinculum sutram. Multiplication by Nikhilam sutram, Fast multiplication by 11, Multiplication of numbers consisting of all 9s, Multiplication of numbers nearest to the base 10 and multiplication of numbers with sub base 50,500,5000.

Unit III

Meaning of Ekadhiken sutram and its. applications in finding squaring or numbers ending in 5, squares by Anurupeyana sutram, Square by Yavdunam thava dunikritya vargamcha yojyjet sutram, Squaring by Dwandvayoga sutram, Squaring numbers nearest SO, Square roots of perfect square, General method of square roots, Cubes by Anurnpeyana sutram.

Unit IV

Decimal and fractions. Division by Nikhilam Sutram, Division of 1/19. 1/29 by Ekadhikenpurven sutram, Division by Paravartya sutram, Division by Anurupeyana sutra111. Division of polynomial. Factors of general second-degree equation by Lopsthapanabhyam sutram.

Recommended book.

1. Vedic Mathematics. published by Motilal Oannrasi Dns 1965. ISBN 81-2 08-0163-6.
2. Vedic Ganita, Vihangam Drishti-1. Shiksha Sanskriti Utthan Nyasa. New Delhi

MME – 305(B) Special Functions

Unit I

Infinite products: Definition of infinite product, necessary condition for convergence, the associated series of logarithms, absolute convergence, uniform convergence. The gamma function, The beta function, Legendre's duplication formula, Gauss multiplication formula,

summation formula due to Euler, behavior of log gamma z for log mod z. Asymptotic series, Watson's lemma.

Unit II

Hypergeometric function, integral representation, contiguous function relation, hypergeometirc differential equation, logarithmic solution of the hypergeometric function, elementary series manipulation, simple transformation, generalized hypergeometric function, confluent hypergeometric function.

Unit III

Bessel function: Definition of Bessel function, Bessel differential equation, recurrence relation, generating function, Bessel integral, modified Bessel functions, Neumann polynomial, Neumann series. Legendre Polynomial, Hermite polynomial Jacobi Polynomial : Generating function, differential equation, recurrence relation, Rodrigues formula, Hypergeometric form of Legendre polynomial, special properties, orthogonality, an expansion theorem, expansion of x^{n}.

Unit IV

Elliptic function: Doubly periodic function, Elliptic function, elementary properties, order of an Elliptic function, The Weierstrass function P(z), other Elliptic function, A differential equation for P(z), connection with Elliptic integral. Theta function: Definition, Elementary properties, the basic properties table. Jacobain Elliptic Function: A differential equation, involving Theta function, The function sn(u), The function cn(u) and dn(u), relation involving square and derivatives.

Recommended Books:

1. E. D. Rainville, Special function, MacMillan Co., 1971.
2. L. C. Andrews, Special function of Mathematics for Engineering, SPIE Publications, 1997.
3. George E. Andrews, Richard Askey, Ranjan Roy- Special Functions, Cambridge University Press, 1999.

MME – 305 (C) Graph Theory

Unit I

Graph and its terminology, Directed and undirected graph, Multi graph, Simple graph, Complete graph, Weighted graph, Planar and non-planar graph, Regular graph, Graph isomorphism and homeomorphism, Euler's formula, Statement and applications of Kuratowski's theorem, Path factorization of a graph, representing graphs in computer system, Coloring of graph.

Unit II

Graph connectivity, Konigsberg bridge problem, Euleria path and Elerian circuit, Hamiltonian path and Hamiltonian circuit, Shortest path, Dijkstra's algorithm, Paths between the vertices, Path matrix, Warshall's algorithm, Cut point, bridge, cut sets and connectivity, Menger's theorem.

Unit III

Tree and related terminology, spanning tree, Finding minimum spanning tree by Kruskal's algorithm and Prim's algorithm, inorder, preorder, and postorder tree traversals, Binary tree, Expression trees and reverse polish notation (RPN), RPN evaluation by stack.

Unit IV

Flow network, Feasible flows, Multiple sources and multiple sinks, Cutsets in flow network, Relation between flows and cuts, Max flow problem, Max flow min-cut therem, Matching, Covering, Application of networks in Operations Research – CPM/PERT.

Recommended Books:

1. Graph Theory, Harary, Addison- Wesley 1969.
2. Introduction to Graph Theory, D. B. West, Prentice Hall 1996.
3. Graph Theory and Its Applications, Jonathan Gross and Jay Yellan, CRC 1998.

MME-305(D) Wavelet Analysis

Unit I

Review of Fourier Analysis, Wavelet Transform and Time Frequency Analysis: The Gabor transform, Short time Fourier transforms and the uncertainty principle.The integral wavelet transform – Diadic Wavelets and inversions – Frames.

Unit II

Multi Resolution Analysis and Wavelets: The Haar wavelet construction – Multi resolution analysis – Riesz basis to orthonormal basis – Sealing function and scaling identity – Construction of wavelet basis.

Unit III

Compactly Supported Wavelets: Vanishing moment's property – Meyer's wavelets – Construction of a compactly supported wavelet – Smooth wavelets.

Unit IV

Applications: Digital Filters – Discrete wavelet transforms and Multi resolution analysis – Filters for perfect reconstruction – Para unitary filters and orthonormal wavelets – Filter design for orthonormal wavelets – Biorthogonal filters.

Recommended Books:

1. C.K. Chui, An introduction to Wavelets", Academic Press, San Diego, CA, 1992.
2. P. Wojtaszczyk, A mathematical introduction to Wavelets", London Mathematical Society Student Texts 37, Cambridge University Press, 1997.
3. Y.T. Chan, Wavelet Basics, Kluwer Academic Publishers, 1995.

MMR-306: Research Project.

Semester IV

MMC – 401 Fluid Dynamics

Unit I

Introduction to fluid dynamics, Normal and Shearing stress, Different types of flows, Lagrangian and Eulerian method, local and individual time rate of change, vortricity vector, Beltrami flow, stream line and path line, vortricity equation, equation of continuity by Euler's method, equation of continuity in orthogonal curvilinear coordinates, cartisian coordinates

and cylindrical coordinates, Euler's equation of motion in general vector form, Bernoulli's equation.

Unit II

Viscous flow: Definition of viscosity, general theory of stress and rate of strain in fluid flow, stress analysis in fluid motion, nature of strain, relation between stress and rate of strain, Navier Stokes equation, dissipation of energy, Reynold's number, study flow between parallel plates , Laminar flow between parallel plates.

Unit III

Gas dynamics: speed of sound, equation of motion, subsonic, sonic and supersonic flow, isentropic gas flow, Reservoir discharge through a channel of varying cross-section, Shock waves, formation of shock waves, elementary analysis of normal shock waves.

Unit IV

Magneto Hydrodynamics: nature of magneto hydro dynamics, Maxwell electromagnetic field equation, equation of motion of conducting fluid, rate of flow of charge, magnetic Reynold's number, Alfven's theorem, Ferraro's law of isorotation.

Recommended Books:

1. Hermann Schilichting, Klaus Gersten, Krause E., Jr. Oertel H., Mayes C, "Boundary – Layer theory" , 8th edition springer 2004.
2. Kundu, Pijush K., and Cohen Ira M., fluid mechanics. 3rd ed. Burlington, MA: Elsevier, 2004 .
3. Bachelor G.K, An introduction to fluid dynamics, Publisher, Cambridge University Press, 2000.

MMC-402 Discrete Mathematics

Unit I

Logic: Introduction to logic, Rules of Inference, Validity of arguments, Normal forms, Direct and Indirect proofs, Proof by contradiction.

Unit II

Recurrence relations with examples of Fibonacci numbers, the tower of Hanoi problem, Difference equation, Generating function, solution of recurrence relation using generating functions.

Unit III

Definition and types of relations, representing relations using digraphs and matrices, closure of relations, paths in diagraph,Transitive closure using Warshall's algorithm, Posets, Hasse diagram, Lattices.

Unit IV

Boolean algebra and Boolean functions, different representations of Boolean function, application to synthesis of circuits, circuit minimization and simplification, Karnaugh map.

Unit V

Automata theory, Finite state automaton, Types of automaton, Deterministic finite state automaton, Non-deterministic finite state automaton, Non-deterministic finite state automaton

with ϵ , Equivalence of NFA and DFA, Equivalence of NFA and NFA-ϵ , Equivalence of NFA-ϵ and DFA, Finite state machines :Moore and Mealy machine and their conversion, Turning machine.

Recommended Books:

1. C.L Liu, Elements of Discrete Mathematics, Tata McGraw- Hill, 2000.
2. Kenneth Rosen, WCB McGraw-Hill, 6th edition, 2004.
3. J.P Tremblay and R.P Manohar, Discrete Mathematical structures with Application to Computer science, McGraw-Hill(1975).

Elective III (One of the following is to be chosen)

MME – 403 (A) Mathematical Statistics

Unit I

CORRELATION AND REGRESSION: Method of Least Squares - Linear Regression - Normal Regression Analysis Normal Correlation AnalysisPartial and Multiple Correlation - Multiple Linear Regression.

Unit II

TESTING OF HYPOTHESIS: Type I and Type II errors Tests based on Normal, t, Chi-square and F distributions for testing of mean, variance and proportions-Tests for Independence of attributes and Goodness of fit.

Unit III

SAMPLING DISTRIBUTIONS AND ESTIMATION THEORY: Sampling distributions Characteristics of good estimators Method of Moments, Maximum Likelihood Estimation Interval estimates for mean variance and proportions.

Unit IV

DESIGN OF EXPERIMENTS: Analysis of Variance - One-way and two-way Classifications - Completely Randomized Design - Randomized Block Design-Latin Square Design.

Unit V

MULTIVARIATE ANALYSIS: Covariance matrix – Correlation Matrix - Normal density function -Principal components - Sample variation by principal components-Principal components by graphing.

Recommended Books:

1. J.E. Freund: Mathematical Statistica, Prentice Hall of India, 5th Edition, 2001.
2. R.A. Johnson and D.W. Wichern, Applied Multivariate Statistical Analysis, Pearson Education Asia, 5th Edition, 2002.
3. S. C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, SultanChand & Sons, 11th Edition, 2003.

MME – 403 (B) Number Theory

Unit I

Introduction to Modular forms: Congruences Residue classes and complete residue system. Linear congruence's. Reduced residue system and the Euler-Fermat theorem. Polynomials congruence's modulo p, Lagrange's theorem. Simultaneous linear congruence's, The Chinese

remainder theorem, Application of Chinese remainder theorem, introduction to cryptography.

Unit II
Prime numbers, estimate of prime numbers, primality test, Polynomial congruences with prime power modulli, Fermat's little theorem and pseudoprime, Carmichael numbers, Wilson's theorem, Fermat-Kraitchik factorization method, Euler phi function and use of it in RSA cryptanalysis, Euler's generalization of Fermat's little theorem, modular exponentiation by repeated squaring method.

Unit III
Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, theory of indices, application of primitive roots to cryptography.

UNIT IV
Quadratic residues, Euler's criterion, Legendre's Symbol and its properties Gauss Law, the quadratic reciprocity law, Applications of reciprocity law. The Jacobi symbol and reciprocity law for Jacobi symbols. Applications of reciprocity law to Diophantine equations.

Recommended Books:

1. A course in number theory and cryptography, Neal Koblitz, Springer-Verlag.
2. An introduction to the theory of number, Ivan Niven, Zuckerman, Montgomery, willy India edition.
3. Elementary number theory, David M. Burton, Tata McGraw Hill Edition.
4. Introduction to cryptography, Johannes A. Buchmann, Springer.

MME – 403(C) Theory of Bounded Operators

Unit I
Review of Results on Operators: Basic definitions and results on bounded operators on a Banach space, Dual space, Adjoint of bounded operators on a Hilbert space, Statements of Hahn-Banach theorem, closed graph theorem, and uniform boundedness principle.

Unit II
Banach Algebras and Spectral Theory for Operators on A Banach Space: Properties and examples of Banach algebras, ideals and quotients, Spectrum and Riesz functional calculus on Banach algebras, Spectrum of bounded operators on a Banach space, Spectral theory of compact operators.

Unit III
C*-Algebras: Properties and examples, Abelian C*-algebras and functional calculus, Positive elements in C*-algebra.

Unit IV
Spectral theory for Hilbert space Operators Spectral measures and representations of abelian C*-algebras, Spectral theorem for normal operators, some applications of the spectral theorem, Topologies on the space of bounded operators, Commuting operators.

Unit V
Unbounded Operators on A Hilbert Space and Spectral Theory Closed and closable operators, adjoint and their properties, Symmetric and self adjoint operators, Cayley transform, Spectral theorem for unbounded normal operators.

Recommended books:

1. J.B. Conway, A Course in Functional Analysis. 2 nd Edition, Springer, (Relevant topics from Chapters VII - X), 1997.
2. G. Bachmann and L. Naricii, Functional Analysis. Academic Press, 1966. B.V.
3. Limaye, "Functional Analysis . 2 nd Edition, New Age International, 1996.
4. M. Thamban Nair, (2001/2020). Functional Analysis: A First Course. Prentice Hall of India, PHI-Learning, 2nd Edition, 2020

MME – 403(D) Special Theory of Relativity

Unit I

Historical background and postulates of special relativity, Relativity of simultaneity. Lorentz.: transformation and its consequences . Relativistic addition of velocities.

Unit II

Doppler effect, Space-time diagrams. Time order and Space-time separation of event s. Null cone, The twin-paradox.

Unit III

Relativistic mass and momentum, The equivalence of mass and energy, The relativistic force law and dynamics or a single particle, Energy moment urn tensor of incoherent matter.

Unit IV

Principle of equivalence. Principle of general covariance. Criteria for gravitational field equations. Einstein field equations, Gravity as a geometric Phenomenon. The energy momentum tensor, Inclusion of forces in the field equations and their classical limits.

Recommended books:

1. Rindler W., Special Relativity, 1966.
2. Resnick, R., Introduction to special relativity, Wiley-Eastern, 1990.
3. Special Theory of Relativity, Anshan Publishers-2009.

Elective IV (One of the following is to be chosen)

MME– 404 (A) History and Development of Indian Mathematics

Unit I

Indian contributions to decimal system and place value, The mathematical sophistication of the Harappan culture, The Vedic period and the sulva geometry.

Unit II

Contribution of the Jainas, Chandas Sutras of Pingala and binary arithmetic, The Baksali Manuscript, Aryabhata I, Varahamihir, Brahmagupta, Bhaskara I.

Unit III

Sridharacharya, Mahaveeracharya, Shripati, Aryabhata II, Bhaskaracharya 11, Contributions of Kerala School as Madhava, Nilkantha.

Unit IV
Srinivasa Ramanujan, Swami Bharati Krishna Tirthaji, Prasanta Chandra Mahalanobis. Prof. Harishchandra.

Recommended books:

1. B. B. Datta and A. N. Singh, History of Hindu Mathematics, 2 Volumes. Bharatiya Kala Prakashan, Delhi, 2001.
2. C. N. Srinivasiengar, The history of Ancient Indian mathematics, World Press, 1988.

MME– 404 (B) Cryptography

Unit I
Secure communication, cryptographic applications, Symmetric cipher model, Substitution technique: Ceasar cipher, Monoalphabatic cipher, Playfair cipher, Hillcipher, polyalphabatic cipher, one time pad, Transposition techniques, pseudorandom bit generator, linear feedback shift register sequences.

Unit II
Stream cipher and block cipher, simplified DES, Feistel cipher, DES, AES, S-box design, Boolean functions, bent functions, construction of finite fields, modular polynomial arithmetic.

Unit III
Public key cryptosystem, RSA cryptosystem, RAS and factoring, Rabin encryption , Key management, Diffie Hellman key exchange, discrete logarithm, ElGamal encryption, cryptographick hash function, message authentication codes, digital signature.

Unit IV
Factoring: p-1 method, quadratic sieve, discrete logarithm: DL problem, Shanks Babystep Giant step algorithm, Pollard pho algorithm, Pohlig-Hellman algorithm, Elliptic curve cryptography.

Recommended Books:

1. Introduction to crypogrphy, Johannes A. Buchmann, Springer.
2. Cryptography and network security Principles and practices, William stallings, Pearson education.
3. Handbook of applied cryptography, Alferd J. Menezes, Paul C. Van Oorschot, Scott A. Vanstone, CRC press.
4. Introduction to cryptography and coding theory, Wade Trappe, Lawrance C. Washington

MME– 404 (C) Mathematical Modeling

Unit I
Introduction to mathematical modelling: need, classification, modelling process, Elementary

mathematical models; Role of mathematics in problem solving. Single species population model: The exponential model and the logistic model, Harvesting model and its critical value.

Unit II

Modelling with ordinary differential equations: Overview of basic concepts in ODE and stability of solutions: steady state and their local and global stability, Linear and non-linear growth and decay models. Compartment models. Mathematical modelling of geometrical problems, reaction kinetics. Some applications in economics, ecology, Modelling in epidemiology (SIS, SIR, SIRS models) and basic reproduction number.

Unit III

Mathematical models through difference equations, Some simple models, Basic Theory of linear difference equations with constant coefficients, Mathematical modeling through difference equations in economics and finance, Mathematical modeling through difference equations in population dynamics.

Unit IV

Mathematical Modelling through partial differential equations, Situations giving rise to of partial differential equation models. The one-dimensional heat equation: derivation and solution. Wave equation: Derivation and Solution.

Recommended Books:

1 J.N. Kapur, Mathematical Modelling, New Age Intern. Pub.
2. J.N. Kapur, Mathematical Models in Biology and Medicine, East-West Press.
3. Fred Brauer and Carlos Castillo-Chavez, Mathematical Models in Population Biology and Epidemiology, Springer.
4. Frank R. Giordano, William Price Fox, Maurice D. Weir, A First Course in Mathematical Modelling, 4th Ed., Charlie Van Wagner. 5. Walter J. Meyer, Concept of Mathematical Modelling, McGraw-Hill.
5. Zafar Ahsan, Differential Equations and Their Applications, PHI learning Private Limited, New Delhi.
6. Steven H. Strogatz, Nonlinear dynamics and chaos, With Applications to Physics, Biology, Chemistry, and Engineering.

MME– 404(D) Operations Research

Unit I

Origin of OR and its definition, Phases of OR problem approach, Formulation of Linear Programming problems, Graphical solution of LPP.

Unit II

Solution of LPP by Simplex method, Two phase method, Big-M method, Methods to solve degeneracy in LPP, Revised Simplex Methods and applications.

Unit III

Concept of duality in LPP, Comparison of solutions of Dual and Primal, Dual Simplex method, Sensitivity Analysis, Integer Programming.

Unit IV

Mathematical formulation Of Transportation problem, Tabular representation, Methods to find initial basic feasible solution, Optimality test, Method of finding Optimal solution, Degeneracy in Transportation problem, Unbalanced Transportation problem, Mathematical formulation of Assignment problem, Hungarian Assignment method.

Recommended Books:

1. Rao,S.S, Optimization theory and applications, 2nd edition,Willey Eastern Ltd., New-Delhi.
2. Hiller,F.S and Liberman, Introduction to Operations Research, 6th Ed. McGraw-Hill, International Edition, Industrial Engg. Series, 1995.
3. Taha, H.A, Operations Research, An Introduction, 8th Ed, Prentice Hall Publishers.
4. Gupta, P.K, Hira, D.S, Operations Research, S.Chand& Company Pvt. Ltd.
5. Sharma, S.D, Operations Research, Kedar Nath Ram Nath and Co. Meerut, 2002.

MMP-405 Programming Languages (Lab)

1. Writing a simple C-program: Learning the form of a C-program, declaring variables, designing program flow and control, using standard terminal I/O functions and datatypes. Control-Flow statements: Use of if-else, Loops: While, do-while, do, for and nested loops, break, continue, switch, etc.

2. Use of C-functions, Unions.

3. Arrays, Structures, Unions in C.

4. Writing a C++-program, Classes and Objects.

5. Constructors, destructors, pointers to objects.

6. Inheritance.

7. Basic of Python.

Recommended Books:

1. Herbert Schield, Complete Reference in C," TMH.

2. Yashwant Kanetkar," Let us C", BPB.

3. Balaguruswamy, "Programming in ANSI C," TMH 6.

4. Yashwant Kanetkar "Pointers in C" .

5. Budd,"Object Oriented Programming ", Addison Wesley.

6. Mastering C++ K.R Venugopal Rajkumar, TMH.

7. C++ Primer , "Lip man and Lajole", Addison Wesley.

MMR-406: Research Project.