# SHRI GURU RAM RAI UNIVERSITY

(Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017)

# Syllabus of M.Sc. Mathematics

## Effective from Academic Session 2020-2021

**Patel Nagar, Dehradun, Uttarakhand**

## Master of Science (Mathematics)-Two Year Programme- Choice Based Credit System

Admission to Master's Program in Mathematics shall be through entrance examination conducted by University/Merit of qualifying exam and the program shall be based on the choice based credit system in which credit defines the quantum of content/ syllabus prescribed for a course system and determines the number of hours of instruction per week.

The student shall be eligible for admission to a Master's Degree Program in Mathematics after he/she has successfully completed a three year undergraduate degree or earned prescribed number of credits through the examinations conducted by University as equivalent to an undergraduate degree with minimum 45% marks in undergraduate course.

Core courses prescribed for every Semester shall be mandatory for all students registered for the Master's Program in Mathematics and shall carry minimum 86 credits. There shall be Elective courses offered in semester III and IV and shall carry a minimum of 21 credits. A self-study course would comprise of maximum 04 credits which shall not be included while calculating grades. There will be seminar/viva in each semester of credit 2 and will be based upon the concerned papers in that semester. In order to qualify for a two year master's degree, a student must acquire a minimum of 86 credits including a minimum of 21 credits in both $3^{rd}$ and $4^{th}$ semester offered either by the parent department or other departments. A candidate has to obtain a minimum passing percentage shall be as per SGRR University norms which will be determined by adding both internal and external marks.(Two Sessional Tests marks plus End-Term Examination marks) to pass.

# M.Sc. Mathematics SYLLABUS

## Semester I

| Course Code | Course Name | L-T-P | Credits |
|---|---|---|---|
| **MMTC101** | Differential Equations | 4-0-0 | 4 |
| **MMTC102** | Abstract Algebra –I | 4-0-0 | 4 |
| **MMTC103** | Mechanics | 4-0-0 | 4 |
| **MMTC104** | Complex Analysis | 4-0-0 | 4 |
| **MMTC105** | Operations Research –I | 4-0-0 | 4 |
| **MMTP106** | Presentation / Viva | 0-0-2 | 2 |
| | | | **Total Core Credits = 22** |

## Semester II

| Course Code | Course Name | L-T-P | Credits |
|---|---|---|---|
| **MMTC201** | Abstract Algebra- II | 4-0-0 | 4 |
| **MMTC202** | Discrete Structures | 4-0-0 | 4 |
| **MMTC203** | Operations Research- II | 4-0-0 | 4 |
| **MMTC204** | Real Analysis | 4-0-0 | 4 |
| **MMTC205** | Topology-I | 4-0-0 | 4 |
| **MMTP206** | Presentation / Viva | 0-0-2 | 2 |
| | | | **Total Core Credits = 22** |

# Semester III

| Course Code | Course Name | L-T-P | Credits |
|---|---|---|---|
| **MMTC301** | Topology-II | 4-0-0 | 4 |
| **MMTC302** | Functional Analysis | 4-0-0 | 4 |
| **MMTP303** | Presentation / Viva | 0-0-2 | 2 |
| | **Elective Course:** | Students have to select any three elective papers out of four | 3 x 4 = 12 |
| **MMTE304** | Differential Geometry | 4-0-0 | |
| **MMTE305** | Mathematical Statistics | | |
| **MMTE306** | Calculus of Variations | | |
| **MMTE307** | Algebraic Coding Theory | | |
| | **Self-Study Course:** | Students have to select any one self-study paper out of two. | 4 |
| **MMTS308** | Computer Fundamentals and Data Structures | | |
| **MMTS309** | Mathematical Methods | | |
| **Total Credits (excluding Self-study Course) = 22** | | | |

# Semester IV

| Course Code | Course Name | L-T-P | Credits |
|---|---|---|---|
| **MMTC401** | Measure and Integration | 4-0-0 | 4 |
| **MMTC402** | Fluid Dynamics | 4-0-0 | 4 |
| **MMTP403** | Presentation/Viva | 0-0-3 | 3 |
| **MMTE404**<br>**MMTE405**<br>**MMTE406**<br>**MMTE407** | **Dissertation/ Elective Course**:<br>Linear Integral Equations<br>Fluid Mechanics<br>Fuzzy Set Theory<br>Number Theory | Dissertation/Students have to select any three elective papers out of four.<br>3-0-0 | 3 x 3 = 09 |
| **MMTS408**<br>**MMTS409** | **Self-Study Course:**<br>Mathematical Modeling<br>Special Theory of Relativity | Students have to select one self- study paper out of two. | 4 |
| **Total Credits (excluding Self-study Course) = 20** | | | |

# SEMESTER - I

## MMTC101: DIFFERENTIAL EQUATIONS

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Ordinary differential equations: Qualitative properties of solution, Oscillation, Wronskian, Sturm separation and comparison theorem, Picard iteration methods, Uniqueness and existence theorem.

### UNIT II

Ordinary points, Regular and singular points, Frobenius series solution for Legendre's and Bessel's differential equations with generating functions.

### UNIT III

Classification of PDE of 2nd order and canonical forms, Concept of separation of variable solution.

### UNIT IV

Solution of heat diffusion, Laplace and wave equations, Non-linear partial differential equation of second order.

TEXT / REFERENCE BOOKS:

1. Differential equation with Applications and Historical notes: G.F. Simmons, CRC Press, Taylor & Francis Group.

2. A Course in ODE : B. Rai, D.P. Chaudhary &H.I.Freedman, Alpha Sci. Int. Ltd.

3. Advanced Differential Equations: M.D. Raisinghania, S. Chand Pvt. Ltd., 2008.

## MMTC102: ABSTRACT ALGEBRA- I

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Simple groups, Conjugacy, Normalization, Centre of a group, Class equation of a group and its consequences, Theorems for finite groups, Cauchy's theorem, Sylow's theorem.

### UNIT II

Homomorphism, Endomorphism, Automorphism, Inner automorphism, Kernel of a homomorphism, Fundamental theorem on homomorphism of group, Group of automorphisms , Results on group homomorphism.

### UNIT III

Maximal subgroups, Composition series, Jordan-Holder theorem, Solvable groups, Commutator subgroups, Direct products.

### UNIT IV

Ideals, Algebra of ideals, Principal ideal ring, Units and associates, Polynomials ring, Division and Euclidean algorithm for polynomials, unique factorization theorem

TEXT / REFERENCE BOOKS:

1. Contemporary Abstract Algebra:JoshephA. Gallian, NarosaPub.House P. Ltd.

2. A First course in Abstract Algebra:John. B. Fraleigh, Pearson Edu. Inc. , 2003.

3. Abstract Algebra :V.K. Khanna and S.K. Bhambri, Vikash Pub. House P. Ltd.

4. Topics in Algebra:I. N. Herstein, John Wiley & Sons, New York.

## MMTC103: MECHANICS

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Conservation of linear and angular momentum under finite and impulsive forces, Conservation of energy.

### UNIT II

Generalized coordinates, Lagrange's equations of motion, Small oscillations. Hamiltonian's canonical equations, Hamilton's principle and principle of least action.

### UNIT III

Euler's equations of motion, Kinetic energy, Eulerian angles, Instantaneous axis of rotation.

TEXT / REFERENCE BOOKS:

1. Dynamics- Part II :A.S. Ramsey, Cambridge University Press, 1944.

2. Classical Mechanics: H. Goldstein, Pearson Education.

3. A Text Book on Dynamics :Ray and Sharma, S. Chand Ltd., 2005.

4. Dynamics of Rigid Body: S.L. Loney, Cambridge University Press.

## MMTC104: COMPLEX ANALYSIS

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Power series of analytic functions, Convergence of power series, Radius of convergence, Taylor's and Laurent's series, Residue and poles, Singularities, Classification of singularities.

### UNIT II

Residues, Residue at infinity, Cauchy residue theorem, Applications of residue theorem in evaluation of improper real integrals.

### UNIT III

Conformal mapping: properties, Mobius transformation, Elementary examples.

### UNIT IV

Maximum modulus theorem, Mittag-Leffler theorem, Rouche's theorem, Concept of entire functions with simple example, Analytic continuation.

TEXT / REFERENCE BOOKS:

1. Complex Analysis:J.W. Brown and R.V.Churchill, McGraw-Hill Ed.Private Ltd.2015.

2. Complex Analysis:Dennis G. Zill, Jones &Bartlet Learning,2016.

3. Complex Analysis:H. S. Kasana, PHI Learning.

4. Foundation of Complex Analysis:S. Ponnusamy, Alpha Int. Sci.

## MMTC105: OPERATIONS RESEARCH- I

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

An introduction to operations research, Methodology of O.R., Features of O.R. problems, Different models in O.R., Opportunities and shortcomings of O.R. approach.

### UNIT II

Dual simplex method, Revised simplex method, Sensitivity analysis.

### UNIT III

Assignment and Transportation problems.

### UNIT IV

Theory of games, Integer linear programming.

TEXT / REFERENCE BOOKS:

1. Operations Research: KantiSwarup, P.K. Gupta & Man Mohan, S. Chand, 1978.

2. Operations Research: Theory and Applications: J.K. Sharma, Trinity Press, 2016.

3. Operations Research: H.A. Taha, Prentice Hall of India, 2011.

4. Operations Research: R. Bronson, Schaum's Outline Series.McGraw Hill, 1982.

## MMTP 106: PRESENTATION / VIVA

**M.M:100** **Credit: 02**

There will be presentation or viva based on the subjects of semester first.

# SEMESTER - II

## MMTC201: ABSTRACT ALGEBRA- II

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Embedding of rings, Ring of residue classes, Fundamental theorem on homomorphism of ring , Prime ideals, Maximal ideal.

### UNIT II

Euclidean ring, Properties of Euclidean ring, Module, sub-module, Module homomorphism, Linear sum and direct sum of sub-module

### UNIT III

Extension fields, Simple field extension, Algebraic field extension, Minimal polynomial, Roots of polynomials, Multiple roots, Splitting field.

### UNIT IV

Automorphism of field, Fixed field, Normal extension, Galois group: Examples and characterizations, Construction with straight edge and compass.

TEXT / REFERENCE BOOKS:

1. Contemporary Abstract Algebra :Josheph A. Gallian, Narosa Pub. House P. Ltd.

2. A First course in Abstract Algebra : John. B. Fraleigh, Pearson Edu. Inc. , 2003.

3. Abstract Algebra : V.K. Khanna and S.K. Bhambri, Vikash Pub. House P. Ltd.

4. Topics in Algebra : I. N. Herstein, John Wiley & Sons, New York.

## MMTC202: DISCRETE STRUCTURE

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Recurrence relations, Linear homogeneous recurrence relations, Non-homogeneous recurrence relations, Solutions of recurrence relations.

### UNIT II

Partially ordered sets, Different type of lattices, Sub-lattices, Direct product, Ideal Lattice, Modular and distributive lattices.

### UNIT III

Boolean algebra, Ideals in Boolean algebra, Boolean rings, Boolean functions, Karnaugh maps, Application of Boolean algebra to switching theory.

### UNIT IV

Graphs, Direct graphs, Undirected graphs, Relations and graphs, Path and circuits, Eulerian and Hamiltonian graphs, Planner graphs, Connected graphs.

TEXT / REFERENCE BOOKS:

1. Element of Discrete Mathematics: C. I. Liu, Mcgraw Higher Edu. ,2012.

2. Discrete Mathematical Structures : H. G. S. Rao, Galgotia Pub. Pvt. Ltd.

3. Lattice and Boolean Algebra: V. K. Khanna, Vikash Pub. House.

4. Discrete Mathematics: R. Johnsonbaugh , Pearson Edu. Ltd., 2014.

## MMTC203: OPERATIONS RESEARCH- II

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Inventory control, Functional role of inventory control, Classification of EOQ models with shortages and without shortages.

### UNIT II

Queuing theory, Characteristics of Queuing system, Probability distribution in queuing system, Single served queuing model, M|M|1 queuing models, Multiple server queuing models.

### UNIT III

Markov chain, Application of Markov analysis, State and transition probabilities, Steady state conditions, Sequencing problems, Processing n jobs through two and three machines.

### UNIT IV

Dynamic programming, Dynamic programming under certainty, Non-linear programming methods, Quadratic programming, Kuhn- Tucker conditions.

TEXT / REFERENCE BOOKS:

1. Operations Research: Kanti Swarup, P.K. Gupta & Man Mohan, S. Chand, 1978.

2. Operations Research: Theory and Applications: J.K. Sharma, Trinity Press, 2016.

3. Operations Research: H.A. Taha, Prentice Hall, 2011.

4. Operations Research: R. Bronson, McGraw Hill, 1982.

## MMTC204: REAL ANALYSIS

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

The Riemann-Stieltjes Integral: Definition and existence of Riemann-Stieltjes integral, Properties of integrals, Integration and differentiation, Fundamental theorem of calculus, Integration of vector-valued functions.

### UNIT II

Sequences and series of functions, Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Uniform convergence and continuity, Uniform convergence and Riemann- Stieltjes integral, Uniform convergence and differentiation, Weierstrass approximation theorem.

### UNIT III

Power series, Algebra of power series, Uniqueness theorem for power series, Abel's theorem , Taylor's theorem.

### UNIT IV

Functions of several variables, Concept of functions of two variables, Continuity,Partial derivatives, Differentiability, Change of variables, The inverse function theorem, The implicit function theorem, Chain rule.

TEXT / REFERENCE BOOKS:

1. Mathematical Analysis:S.C. Malik and Savita Arora, New Age Int. 1992.

2. Mathematical Analysis:T.M. Apostol, Pearson Edu. , Taiwan Ltd., 1974.

3. Real analysis: H.L. Royden, Pearson, 2017.

4. Real Analysis:Terence Tao, Springer.

## MMTC205: TOPOLOGY I

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Metric on a set, Pseudo-metrics, Equivalent metrics, Limit point, Closed sets, Adherent point, Dense subsets, Interior of a set and its properties, Subspaces, Product spaces.

### UNIT II

Convergent sequences, Cauchy sequences, Algebra of convergent sequences, Subsequences, Continuity at a point, Continuity over a apace, Algebra of real valued continuous functions in a metric space, Homeomorphism, Isometrics, Uniform continuity.

### UNIT III

Complete metric spaces, Completeness and continuous mappings, Cantor's intersection theorem, Contraction mapping theorem, Connectedness in metric spaces, Properties of connectedness.

### UNIT IV

Compact spaces, Compact subsets of the real line, Compactness and continuous mappings, Sequential compactness, Countable compactness, B-W property, B-W property and boundedness, B-W property and compactness, Compactness and uniform continuity, Lebesgue covering Lemma.

TEXT / REFERENCE BOOKS:

1. Introduction to Topology and Modern Analysis: G.F. Simmons, Tata McGraw-Hill.

2. Metric Spaces: E.T. Copson, Cambridge University Press, 1968.

3. Topology :Robert H.Kasriel, Dover Pub. , 2009.

4. Topology of Metric Spaces: S.Kumaresan, Alpha Science Int. , 2011.

## MMTP 206: PRESENTATION / VIVA

**M.M:100** **Credit: 02**

There will be presentation or viva based on the subjects of semester second.

## SEMESTER - III

### MMTC301: TOPOLOGY- II

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

**UNIT I**

Definition and examples of topological spaces, Closed sets, Closure, Dense subsets, Neighborhoods, Interior, Exterior and accumulation points, Bases and sub bases, subspaces, Product spaces and relative topology.

**UNIT II**

Continuous function, Homeomorphism, Connected and disconnected sets, Components, Locally connected spaces.

**UNIT III**

Countability axioms, First and second countable spaces, Lindelof's theorem, Separable spaces, Second countable and separability, Separable axioms: T0, T1 , T2 , T3 , T4 and their characterizations.

**UNIT IV**

Compactness, Continuity and compact sets, Basic properties of compactness, Compactness and finite intersection property,Sequentially and countably compact sets, Local compactness, Tychonoff's theorem.

TEXT / REFERENCE BOOKS:

1. Topology: A First Course:James R. Munkres, Prentice Hall, Incorporated, 2000.

2. General Topology:J.L. Kelly, Springer, 1975.

3. Topology and Modern Analysis:G.F. Simmons, Tata McGraw-Hill.

4. General Topology: Seymour Lipchitz, Schaum Outline Series.

## MMTC302: FUNCTIONAL ANALYSIS

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Normed linear spaces, Banach spaces, Subspaces, Quotient Spaces, Equivalent, Norms.

### UNIT II

Bounded linear Transformation/operators, Hahn- Banach theorem, Open mapping theorem, Closed graph theorem, Uniform boundedness principle.

### UNIT III

Inner product spaces, Hilbert spaces, Orthogonality of vectors, Orthogonal Complements and projection theorem, Riesz representation theorem, Orthonormal Sets.

### UNIT IV

Operators on Hilbert Spaces, Self-ad joint, Normal and unitary operators, Orthogonal projection operators.

TEXT / REFERENCE BOOKS:

1. Functional Analysis:P.K. Jain, O.P. Ahuza and Khalil Ahamad, Wiley, 1996.

2. Topology and Modern Analysis: G.F. Simmons, Tata McGraw-Hill.

3. Introductory functional Analysis with Applications: E. Kreyszig, Wiley, 1989.

4. Functional Analysis: B.V. Limaye, New Age Int. Pvt. Ltd.

## MMTP 303: PRESENTATION / VIVA

**M.M:100** **Credit: 02**

There will be presentation or viva based on the subjects of semester third.

## MMTC304: DIFFERENTIAL GEOMETRY

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Curves in space; Arc length, Order of contact, Tangent, Normal, Binormal, Osculating, Plane, Serret-Frenet formulae, Curvature and torsion. Osculating circle and osculating sphere, Helix, Bertrand curves.

### UNIT II

Behaviour of a curve in the neighbourhood of a point. Concept of a surface, Envelope and developable surface, Parametric curves, Family of the surfaces, Edge of regression, Ruled surfaces, Central points.

### UNIT III

Fundamental forms and curvature of surfaces: First fundamental form. Second fundamental form of the surfaces of revolution, Weingarten's equation, Direction coefficients, Family of curves.

### UNIT IV

Local non-intrinsic properties of a surface Normal curvature, Principal directions, Principal curvatures, Minimal surface, Lines of curvature. Rodrigues and Monge's theorem, Euler's theorem, Joachimisthal's theorem, Dupin's indicatrix, Third fundamental form.

TEXT / REFERENCE BOOKS:

1. Differential Geometry: T.J. Willmore, Dover Pub. Inc., New York.

2. Differential Geometry of Three Dimensions: C.E. Weathrburn, Cambridge Univ. Press.

3. Elements of Differential Geometry: R.S. Millman& G.D. Parket, Prentice Hall.

4. Introduction to Differential Geometry: A. Goctz, Addison Wesley Pub. Co., 1970.

## MMTC305: MATHEMATICAL STATISTICS

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Elements of probability, Sample space, Discrete probability, Baye's theorem, Random variables and distribution functions, Mathematical expectations and moments.

### UNIT II

Some standard discrete and continuous univariate distributions: Binomial, Poisson, Normal, Gamma and Beta distributions.

### UNIT III

Correlation, Rank correlation, Regression line, Multiple and partial correlation of three variables only, Data reduction techniques, Canonical correlation.

### UNIT IV

Concepts of sampling, Stratified sampling and systematic sampling, Test of hypothesis: t,z , chi square test.

TEXT / REFERENCE BOOKS:

1. Fundamental of Mathematical Statistics : S.C. Gupta and V.K. Kapoor, S. Chand.

2. Advanced Theory of Statistics :M.G. Kandall.

3. A first Course on Mathematical Statistics: C.E.Weatherburn, Cambridge Univ. Press, 1968.

## MMTC306: CALCULUS OF VARIATIONS

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Variation of functional, Continuity and differentiability of functional, Necessary condition for an extremum, Euler's equation, Variational problems in parametric form, Functional depending on higher order derivatives and variational problems with subsidiary condition.

### UNIT II

The isoperimetric problem, Invariance of Euler's equation under Coordinate transformation, General variational of functional, Variable end point problems,Transversality condition transversal theorem, Weierstrass-Endmann corner condition.

### UNIT III

Sufficient condition for extremum: second variation, Legendre's and Jacobi's necessary condition, Canonical transformation, Noether's theorem, The principle of least action, Conservation law, Hamilton Jacobi's equations.

### UNIT IV

Transformation of ODE and PDE into functionals and their solutions by Ritze, Galerkin, Collocation and Kantrovitch methods.

TEXT / REFERENCE BOOKS:

1. Calculus of Variation:Gelfrand and Fomin, Dover Pub. Inc., New York.

2. Calculus of Variation:Elsgolt , University Press of the Pacific, 2003.

3. Calculus of Variation:A.S.Gupta, PHI Learning Pvt. Ltd., 2015.

## MMTC307: ALGEBRAIC CODING THEORY

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

The communication channel, The coding problem, Types of codes, Error detecting and error-correcting codes, Linear codes, Hamming metric, Description of linear block codes by matrices.

### UNIT II

Dual codes, Standard array, Step-by-step decoding, Modular representation, Error-correction, Capabilities of linear codes, Bounds of minimum distance for block codes, Plotkin bound, Hamming sphere packing bound, Bounds for burst-error detecting and correcting codes.

### UNIT III

Important linear block codes, Hamming codes, Golaycodes, Perfect codes, Quasiperfect codes, Reed-Muller codes, Codes derived from Hadamard matrices, Product codes, Concatenated codes.

### UNIT IV

A double error correcting decimal code and an introduction to BCH codes, BCH bounds, Cyclic codes, Matrix representation of cyclic codes, Error detection and cyclic codes, MDS codes.

TEXT / REFERENCE BOOKS:

1. Fundamental of Error- Correcting Codes: V. Pless and W.C. Huffman, Cambridge Univ. Press.

2. A First Course in Coding Theory: Ramond Hill, Oxford Univ. Press.

3. Error Correcting Coding Theory: M.Y. Rhee, McGraw-Hill, 1989.

4. Algebraic Coding Theory: E.R.Berlckamp, World Sci. Pub. Pvt. Ltd.

## MMTS308: COMPUTER FUNDAMENTALS AND DATA STRUCTURES

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

History and classification of computers, Fundamentals of computer system: Data types, Number system, Complements; Floating point representation, Normalized floating point representation, Fixed point represented arithmetic computations.

### UNIT II

Truth tables, Boolean algebra, De-Morgan's theorem, Logical gates, Logic diagram, Logical expressions/functions, Karnaugh maps, Sum of product and product of sum, Combinational circuits and integrated circuits.

### UNIT III

Introduction to data structures, Arrays, Stack and queues, Linked lists, Singly and doubly linked lists, Binary trees, Operations on binary trees and applications.

### UNIT IV

Sorting, Searching, Algorithms and graphs.

TEXT / REFERENCE BOOKS:

1. Fundamental of Computers : V. Raja Raman, PHI Learning Pvt. Ltd.

2. Introduction to Computers : P. Norto, Glencoe/ McGraw-Hill, 1998.

3. Data Structures with C: S. Lipschutz, Tata McGraw-Hill Pvt. Ltd.

## MMTS309: MATHEMATICAL METHODS

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Hermite polynomial.

### UNIT II

Chebyshev polynomials.

### UNIT III

Laguerre polynomials.

### UNIT IV

Integral transforms.

TEXT / REFERENCE BOOKS:

1. The Special Functions and their Applications: Y. L. Luke, Acad. Press, New York.

2. Special Functions: G.E. Andrews, R. Askey, R. Roy, Cambridge Univ. Press.

3. Integral Transform & Their Applications: L.Debnath&D.Bhatta, CRC Press.

# SEMESTER IV

## MMTC401: MEASURE AND INTEGRATION

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Lebesgue outer measure, Measure of open and closed sets, Borel sets, Measurable sets, Measure of cantor's ternary set, Non-measurable sets.

### UNIT II

Measurable functions, Algebra of measurable functions, Step functions, Characteristic function, Simple functions, Convergence in measure, Egoroff's theorem, Riesz theorem.

### UNIT III

Lebesgue Integral and their properties, General Lebesgue integrals, Lebesgue integrals for unbounded functions, Convergence theorems, Fatou Lemma.

### UNIT IV

Functions of bounded variations, Absolutely continuity, Variation function, Jordan-decomposition theorem, Indefinite integral and its characterizations, Differentiation of an integral, Lebesgue differentiation theorem.

TEXT / REFERENCE BOOKS:

1. Real Analysis: H.L. Royden, Pearson, 2017.

2. Measure and Integration: S.K. Berberian, The Macmillan Company, 1965.

3. Lebesgue Measure and Integration: P.K. Jain and V.P. Gupta, Wiley, 1986.

4. Measure Theory and Integration: G. De. Barra, Horwood, 2003.

## MMTC402: FLUID DYNAMICS

**M.M: 100** **Credit: 4 (Four Lectures Per Week)**

### UNIT I

Kinematics of fluids, Lagrangian and Eulerian methods, Local and individual time rates of change, Equation of continuity, Boundary surface.

### UNIT II

Equation of motion of inviscid fluids, Euler's equation of motion, Bernoulli's equation, Lagrange's equation, Conservative field of force, Cauchy's Integral, Helm- Holtz's equation.

### UNIT III

Impulsive motion of a fluid, Energy equation of inviscid fluid, General theory of irrotational motion, Connectivity, Flow and circulation, Kelvin's circulation theorem, Stokes's theorem, Permanence of irrotational motions, Green's theorem, Kinetic energy of finite and infinite liquid, Kelvin's minimum energy theorem, Mean value of the velocity potential over a spherical surface.

### UNIT IV

Motion in two dimensions, Stream function, Complex potential, Source, Sink, Doublet, Complex potential and images with respect to straight line and circle, Milne- Circle theorem, Blausius theorem.

TEXT / REFERENCE BOOKS:

1. Foundation to Fluid Mechanics: S.W. Yuan, Prentice Hall Pvt. Ltd., 1960.

2. Text book of Fluid Dynamics: F. Chorlton, CBS Pub. & Dist. , 2004.

3. Theoretical Hydro-Dynamics: BansiLal, Skylark Pub., 1999.

4. A text book of Fluid – Dynamics: M. Ray & Sharma, S. Chand & Co. Ltd. 2005.

## MMTP 403: PRESENTATION / VIVA

**M.M:100** **Credit: 03**

There will be presentation or viva based on the subjects of semester fourth.

## MMTE404: LINEAR INTEGRAL EQUATIONS

**M.M: 100** **Credit: 03**

### UNIT I

Classification of integral equations, Relation between differential and integral Equations, Fredholm integral equations, Fredholm equations of second kind with Separable kernels, Eigen values and Eigen functions

### UNIT II

Volterra integral equations, Resolvent kernel of Volterra equation, Convolution type kernel, Integral equations with symmetric kernel.

### UNIT III

Method of successive approximation for Fredholm and Volterra equations of the second kind.

### UNIT IV

Classical Fredholm theory,Singular integral equations,Hilbert type integral equations,Integral equation with Green's function type kernels.

TEXT / REFERENCE BOOKS:

1. Integral Equations and Boundary Value Problem : M.D. Raisinghania, S. Chand.

2. Linear Integral Equations: W. V. Lovit, Dover Pub. Int. New York.

3. Linear Integral Equations: R.P. Kanwal, BirkhauserBoston, 1996.

4. Integral Equations: L. G. Chambers, International Textbook Co., 1976.

## MMTE405: FLUID MECHANICS

**M.M: 100** **Credit: 03**

### UNIT I

Motion of the cylindrical and elliptic cylinders.

### UNIT II

Motion of Sphere, Motion of a sphere in an infinite mass of the liquid at rest at infinity, Liquid streaming past a fixed sphere, Equation of motion of a sphere, Pressure distribution.

### UNIT III

General theory of stresses and rate of strains, Newton's law of viscosity, State of stress, Principal stresses and principal directions, Transformations of two and three stresses components and rate of strain components, Relation between stresses and rate of strain components,Translation, Rotation and rate of deformation.

### UNIT IV

Navier-Stokes equation of motion; Energy equation for viscous fluid, Energy dissipation due to viscosity.

TEXT / REFERENCE BOOKS:

1. Foundation to Fluid Mechanics: W.Yuan, Prentice Hall Pvt. Ltd., 1960.

2. Text book of Fluid Dynamics: F. Chorlton, CBS Pub. & Dist., 2004.

3. An Introduction to Fluid Mechanics: G.K. Batchlor, Cambridge Univ. Press.

4. Fluid Dynamics: M.D. Raisinghania, S. Chand.

## MMTE406: FUZZY SET THEORY

**M.M: 100** **Credit: 03**

### UNIT I

Fuzzy sets, Basic definitions, Alpha-cut sets, Convex fuzzy sets, Basic operation on fuzzy sets, Types of fuzzy sets, Cartesian products, Algebraic products, Bounded sum and differences, t-norms and t-corners.

### UNIT II

The extension principle, The Zadeh's extension principle, Images and inverse image of fuzzy sets, Fuzzy numbers, Element of fuzzy arithmetic.

### UNIT III

Fuzzy relation and fuzzy graphs. Fuzzy relation on fuzzy sets, composition of fuzzy relation, min-max composition and properties, equivalence relations, fuzzy compatibility relation, Fuzzy relation equations.

### UNIT IV

Fuzzy logic, An overview of classical logic, Multivalued logic, Fuzzy propositions, Fuzzy qualifiers, Linguistic variables and hedge.

TEXT / REFERENCE BOOKS:

1. Fuzzy sets and Fuzzy logic: G.L. Klir and Yuan, World Sci. Pub. Co. Pvt. Ltd.

2. Fuzzy set theory and its Applications: H.J. Zimmermann, Springer, 1991.

3. Fuzzy set theory, Fuzzy logic and their Applications: A.K. Bhargava, S. Chand.

4. First Course on Fuzzy Theory and Applications :Kwang H. Lee, Springer, 2004.

## MMTE407: NUMBER THEORY

**M.M: 100** **Credit: 03**

### UNIT I

The division algorithm, The gcd, The Euclidean algorithm, Diophantine equation $ax + by = c$, The fundamental theorem of arithmetic, The sieve of Eratosthenes, Goldbach conjecture.

### UNIT II

The theory of congruences, Binary and decimal representation of integers, Linear congruence and Chinese remainder theorem, Fermat's theorem, Wilson's theorem.

### UNIT III

Number theoretic function, Tau and sigma function, the Mobius inversion formula, The greatest integer function, Euler's phi function, Properties of phi function, Euler theorem.

### UNIT IV

The order of an integer modulo n, Primitive roots for primes, Composite numbers having primitive roots, The theory of indices, Continued fraction, Approximation of irrationals by rationals.

TEXT / REFERENCE BOOKS:

1. Elementary Number Theory: David M. Burton, McGraw-Hill.

2. Theory of Numbers: George Andrews, Courier Corporation, 1994.

3. Elementary Number Theory with Applications: Thomas Koshy, Harcourt Acad. Press.

4. Fundamental of Number Theory:William J. Lereque, Dover Pub. Inc. New York.

## MMTS408: MATHEMATICAL MODELING

**M.M: 100** **Credit: 03**

### UNIT I

Mathematical Modeling through ordinary differential equations of first order, Linear growth and decay models, Non-linear growth and decay models, Compartment models- dynamics problem, Geometrical problems.

### UNIT II

Mathematical Modeling through systems of ordinary differential equations of first order, Population dynamics, Epidemics-compartment models, Economics, Medicine, Arm- race, Battles and international trade- dynamics.

### UNIT III

Mathematical modeling through ordinary differential equations of second order, Planetary motions, Circular motion, Motion of satellites, Mathematical modeling through linear differential equations of second order, Miscellaneous mathematical models.

### UNIT IV

Mathematical modeling through difference equations, Simple models, Basic theory of linear difference equations with constant coefficients, Economics and finance- population- dynamics and genetics- probability theory.

TEXT / REFERENCE BOOKS:

1. Mathematical Modeling: J.N. Kapur, New Age Int. Pvt. Ltd. 2008.

2. Mathematical Models in Biology and Medicine: J. N. Kapur, New Delhi, Affiliated East-West Press, 1985.

3. Mathematical Modeling: Dick Clements, Cambridge Univ. Press, 2012.

4. The Nature of Mathematical Modeling: Neil Gershenfeld, Cambridge Univ. Press.

## MMTS409: SPECIAL THEORY OF RELATIVITY

**M.M: 100** **Credit: 04**

### UNIT I

Special theory of relativity, Galilean transformation, Maxwell's equations.

### UNIT II

The ether theory, The principle of relativity, Relativistic kinematics, Lorentz transformation equations.

### UNIT III

Events and simultaneity, Example of Einstein strain, Time dilation, Longitudinal Contraction.

### UNIT IV

Invariant Interval, Proper time and proper distance, World line, Example of twin paradox , Addition of velocities, Relativistic Doppler's effect.

TEXT / REFERENCE BOOKS:

1. Tensor Analysis: I.S. Sokolnikoff, John Wiley and Sons, New York, 1964.

2. Classical Dynamics: D. Greenwood, Prentice Hall of India, New Delhi, 1985.

3. Tensor Calculus, Toronto, 1949 :J.L. Synge and A. Schild.

4. An Introduction to Theory of Relativity, New York, 1942: P.G. Bergman.