DUM DUM MOTIJHEEL COLLEGE

DEPARTMENT OF MATHEMATICS

M. SC. IN MATHEMATICS

PROGRAM SPECIFIC OUTCOMES

After successful completion of the two-year M.Sc. course in Mathematics students will enable to

1. Approach and analyse the problems arising in their chosen careers in a logical manner and apply these skills to any real-life situation.
2. Apply computational and modelling skills to specific tasks, especially in the emerging and developing processes and industries.
3. Independently pursue research work in any area of Pure or Applied Mathematics; work in a group confidently and contribute significantly to any research project.
4. Acquire a systematic knowledge of fundamental aspects of various branches of Mathematics which would help them in qualifying National and State-level examinations
5. Think and analyse independently, and apply their skills in mathematical logic to any profession of their choice.
6. Take up pedagogy in Mathematics or related subjects if they are so inclined.

Course Code : MTMP COR01T

Paper: Algebra

Course Outcomes: On successful completion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge mainly on the following :

i) Sylow's theorems and its applications,
ii) Jordan Holder Theorem, Solvable groups,
iii) Prime and maximal ideals,
iv) Jacobsons radical, semisimple ring, Hilbert Basis Theorem, Unique Factorization Domain,
v) Basics of Field extension & Galois theory.

Also there is a scope for applying the acquired knowledge of the above methods/ tools of Algebra, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions. It also helps to crack lectureship and fellowship exams approved by UGC & CSIR, GATE and SET.

Course Code : MTMP COR 02T

Paper: Linear Algebra

Course Outcomes: Oncompletion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge on the following:

i) Modules with chain conditions (Noetherian and Artinian), Dual Modules, Free Modules,
ii) Dual Spaces, Dual Basis, Dimension of Quotient space,
iii) Minimal Polynomial, Diagonalization of Matrices, Reduction to Triangular Forms,
iv) Jordan Canonical Forms, Rational Canonical Forms, Smith Normal Form,
v) Bilinear Forms , Quadratic Forms, Hermitian Forms,
vi) Direct sum decomposition theorem, Principal Minor Criterion,
vi) Sylvester Law Of Inertia, Simultaneous Reduction of Pair of Forms.

Also there is a scope for applying the acquired knowledge of the above methods/ tools of Linear Algebra, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions. It also helps to crack lectureship and fellowship exams approved by UGC & CSIR, GATE and SET.

Course Code : MTMP COR 03T

Paper : Real Analysis

Course Outcomes: Upon completion of this course, the student will be able to understand the basics of Real Analysis and improve the logical thinking.

Course Code : MTMP COR 04T

Paper: Complex Analysis

Course Outcomes: On completion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge mainly on the following :

i) Stereographic Projection, Riemann's sphere, point at infinity, extended complex plane,
ii) Cauchy-Goursat Theorem, Cauchy's integral formulas, Morera's theorem, Liouville's theorem,
iii) Fundamental theorem of classical algebra, Schwarz Reflection Principle, Maximum Modulus Principle,
iv) Cauchy-Hadamard Theorem, Taylor's theorem and Laurent's theorem,
iv) Riemann's Removal singularity thorem, Weierstrass-Casorati,
v) The Cauuchy's Residue Theorem, Argument principle and their applications
vi) Conformal mapping, Bilinear transformation, Idea of analytic continuation.

Also there is a scope, for applying the acquired knowledge of the above concepts/ methods/ tools of Complex Analysis, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions. It also helps to crack lectureship and fellowship exams approved by UGC & CSIR, GATE and SET.

Course Code: MTMP COR 05T

Paper: Mechanics

Course Outcomes :

1. Students will be able to apply the equations of motion to solve analytically the problems of motion of a single particle/a system of particle or rigid body under conservative force fields.
2. Use the Hamilton's principle for deriving the equations of motion of a system.
3. Gain knowledge of Hamiltonian system and phase planes from the point of view of mechanics.
4. Use the theory of normal modes for solving problems related to oscillations and vibrations.
5. Students will learn the basics of classical mechanics and STR required for further studies in solid and quantum mechanics.

Course Code: MTMP AEC 01M
Paper: Computational Techniques and Introduction to LaTeX

Course Outcomes: At the end of this course a student should be able to :

- understand the purpose of basic computer programming language,
- understand and apply control statements, implementation of arrays, functions, etc.,
- enhance ability to program writing skills for solving several real life and Mathematical problems,
- use LaTeX and develop typeset documents containing tables, figures, formulas, common book elements like bibliographies, indexes etc. and modern PDF features.

Semester : II

Course Code: MTMP COR 06T

Topic: Topology

Course Outcomes: On completion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge on the following :

i) Axiom of choice, Continuum hypothesis, Cardinal and Ordinal numbers,
ii) Basics of Topological spaces, Relative topology, homeomorphism and topological properties ,
iii) Alternative methods of defining a topology in terms of Kuratowski closure operator, interior operator and neighbourhood systems,
iv) Countability axioms, Heinei's continuity criterion,
v) Lower & higher separation axioms, Urysohn's lemma and Tieze's extension theorem and their applications,
vi) Connected and disconnected spaces, path connected spaces, Compactness, Alexander subbase theorem, equivalence of various compactness in metric spaces,
vii) Product and box topology, Tychonoff product theorem,
viii) Quotient spaces, Local Connectedness, Path- connectedness, Total disconnectedness,

Also there is a scope, for applying the acquired knowledge of the above topological methods/ tools, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions. It also helps to crack lectureship and fellowship exams approved by UGC & CSIR, GATE and SET.

Course Code: MTMP COR 07T

Paper: Functional Analysis

Course Outcomes : On successful completion of this course, students will be able to appreciate how functional analysis uses and unifies ideas from vector spaces, the theory of metrics, and complex analysis. Moreover, students will be able to understand and apply fundamental theorems from the theory of normed and Banach spaces, Hilbert spaces.

Course Code: MTMP COR 08T
Paper: Ordinary Differential Equations and Special Functions

Course Outcomes:

1. Students will learn about existence and uniqueness of solutions and Picard's method of approximation . This can be directly applied for a numerical approximation.
2. Knowledge of the properties of eigenvalues and eigenfunctions will be useful in studying Mathematical physics.
3. An acquaintance with special functions will be useful for students interested in research in continuum mechanics or theoretical physics.
4. An acquaintance with special functions will be useful for students interested in research in continuum mechanics or theoretical physics.
5. Introductory ideas of phase plane analysis and stability can be utilised by students while studying dynamical systems or mathematical biology.
6. Students will be able to solve/analyse odes arising in different areas of physics.

Course Code: MTMP COR 09T

Paper: Gr. A - Numerical Analysis and Gr. B - Integral Transforms

Course Outcomes: After completion of the course, the student is expected to :

- understand basic theories of numerical analysis,
- formulate and solve numerically problems from different branches of science,
- grow insight on computational procedures,
- learn theory and properties of Fourier transform, Laplace Transform and Z-Transform and their applications to relevant problems.

Course Code: MTMP COR 10T
Paper: Differential Manifold

Course Outcomes: Oncompletion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge mainly on the following :

i) tangent and cotangent spaces; submanifolds,
ii) vector fields and their flows; the Frobenius Theorem,
iii) multilinear algebra, differential forms, the Lie derivative,
iv) Lie groups and Lie algebras,
v) Integration on manifolds, theorems of Stoke, integration on a Lie group,

Also there is a scope, for applying the acquired knowledge of the above methods/ tools of Differentiable manifolds to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions.

Course Code: MTMP SEC 01M
Paper: Computer Aided Numerical Analysis using C/ Matlab/ Mathematica

Course Outcomes: At the end of this course a student should be able to :

- solve different type of numerical problems,
- understand better relevant theoretical concepts,
- apply programming skills in interdisciplinary areas such as biological system, physical system etc.,
- analyze data set of various size and interpret outcomes helping her/him to compete in the financial sector.
- apply programming skills in graphics animation, computerized abstract art.

Semester : III

Course Code: MTMP COR 11T

Paper: Partial Differential Equations and Calculus of Variations

Course Outcomes: At the end of this course a student should be able to :

- learn to solve different types of PDE,
- test the stability of the solution,
- apply PDE to problems of geometry and physics,
- understand basic theories of calculus of variations,
- formulate and solve problems from allied branches of science.

Course Code: MTMP COR 12T
Paper: Nonlinear Differential Equations and Dynamical Systems

Course Outcomes:

1. On the completion of this course students will be able to study the nature linear stability and general stability of critical points and solutions ; also investigate the existence of periodic solutions ; and identify a bifurcation through change of parameters ; further, have a basic idea of perturbation methods.

2. These methods can be applied by the students to study problems of population biology and nonlinear wave propagation.

Course Code: MTMP COR 13T
Paper: Gr. A-Electromagnetic Theory & Gr. B- Integral Equations

Course Outcomes: After completing this course, the student will be able to:

- build up strong application capability of graduate level mathematics,
- understand and apply the basic theories of electromagnetism,
- get an exposure to the Einstein's Theory of Relativity,
- grow interest in electrical engineering,
- distinguish between differential and integral equations,
- understand the theory of existence and uniqueness of solutions of linear integral equations,
- find solutions of linear integral equations of first and second type (Volterra and Fredhlom) and singular integral equations using several techniques.

Course Code: MTMP COR 14T
Paper: Measure and Integration

Course Outcomes: On completion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge mainly on the following :

i) Lebesgue measure, Vitali's theorem concerning existence of non-measurable sets,
ii) measurable functions, Theorem relating to non negative μ-measurable function as a limit of a monotonically increasing sequence of non negative simple μ-measurable functions,
iii) Lebesgue's monotone convergence theorem and its applications, Fatou's lemma, Lebesgue's dominated convergence Theorem,
iv) Interrelation between Riemann & Lebesgue integration,
v) Concept of L^p-spaces and its completeness,
vi) Characterizations of Convergence in Measure, Almost Uniform Convergence, Egoroff theorem,
vii) Product Measure. Fubini's Theorem,
viii) Signed Measure and the Hahn Decomposition, Radon-Nikodym Theorem.

Also there is a scope, for applying the acquired knowledge of the above methods/ tools of Measure and Integration, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions. It also helps to crack lectureship and fellowship exams approved by UGC & CSIR, GATE and SET.

Course Code: MTMP DSE 01T
(Optional Paper*)

Pure Stream

Paper: P1.Operator Theory and Banach Algebra

Course Outcomes : Students will be able to understand the fundamentals of spectral theory, and appreciate some of its power. Students will have the knowledge and skills to apply problem solving using functional analysis techniques applied to diverse situations in physics, engineering and other mathematical contexts.

Paper: P2.Number Theory and Equations over Finite Fields

Course Outcomes: On completion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge mainly on the following :

i) Wilsons Theorem, Linear congruence; $ax \equiv b(\text{mod } n)$,
ii) Chinese Remainder Theorem, Euler's Theorem,
iii) applications of primitive roots, Structure of $U(Z/nZ)$,
iv) law of quadratic reciprocity,
v) Equations over Finite Fields: Chevalley-Warning Theorem,

vi) Quadratic Forms over finite fields,

vii) p-adic numbers and its applications.

Also there is a scope, for applying the acquired knowledge of the above methods/ tools ofNumber Theory and Equations over Finite Fields, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions.

Applied Stream

Paper: A1.Continuum Mechanics

Course Outcomes:

- The students will learn a new approach, namely, the continuum approach for both solid and fluid motion.
- Students will learn the general forms of balance laws and energy equation.
- This course will prepare the students for further courses on fluid and/or solid dynamics.

Paper: A2. Magneto-hydrodynamics

Course Outcomes: At the end of this course a student should be able to :

- describe the properties of Magneto-hydrodynamic equations,
- explain MHD waves,
- apply the MHD equations to a number of astrophysical problems as well as to problems related to laboratory physics.

Course Code: MTMP GEC 01T

Paper: Mathematics and Some Applications - I

Course Outcomes: On completion of this course, the students will be able to identify, analyze, demonstrate and apply the acquired knowledge of the following :

i) Basics of Group, Subgroups, Normal Subgroups, Abelian Groups, Cyclic groups,
ii) Symmetric Groups, Lagrenge's Theorem, Cayley's Theorem,
iii) Ring, sub-ring. Field, sub-field
iv) Basic game theory and graph theory,
v) Inner Product Space, Orthogonal sets and Bases, Eigenvalues, Eigenvectors, Diagonalization of matrices and metric spaces,
vi) Solve partial differential equations and its application to physical problems.
vii) Laplace transforms and its application in differential equations.

Semester : IV

Course Code: MTMP COR 15T

Paper: Graph Theory/ Operations Research/ Fuzzy sets & Their applications

Course Outcomes : After the course the student will have a strong background of graph theory. The students will be able to apply principles and concepts of graph theory in practical situations such as computer science, physical and engineering sciences.

Paper: Operations Research

Course Outcomes: After completing this course, the student will be able to :

- solve nonlinear programming problems using Lagrange multiplier, Kuhn-Tucker conditions, Wolfe's and Beale's method,
- find optimal solution of dynamic programming problem,
- learn theory of sequencing models and inventory control and their applications,
- understand Queueing Theory and its applications,
- identify and formulate some real life problems into nonlinear programming problem.

Paper: Fuzzy sets & Their applications

Course Outcomes: After completing this course, the student will be able to:

- understand basic knowledge of Fuzzy sets and Fuzzy logic,
- apply basic Fuzzy inference and approximate reasoning,
- apply basic Fuzzy system modeling methods.

Courses Codes: MTMP DSE 02T, MTMP DSE 03T and MTMP DSE 04T

Pure Stream

Paper: P1. Advanced Topology I

Course Outcomes: On completion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge on the following :

i) Inadequacy of sequences, Nets and Filters , Chracterizations of compactness and continuity and adherent point in terms of nets and filters,
ii) Local Compactness and One Point Compactification, Stone- CechCompactification, Extension property of βX and Cardinality of βN,
iii) The UrysohnMetrization Theorem. The Nagata – Smirnov Metrzation Theorem,
iv) Paracompactness, Partition of unity, A. H. Stone's Theorem,
v) Uniform spaces and Uniform topology, uniform continuity and product uniformity, Uniformity generated by a family of pseuometrics, Completion of uniform spaces,
vi) Inductive and projective limits, Function spaces.

Also there is a scope, for applying the acquired knowledge of the above methods/ tools of Advanced Topology I, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions. It also helps to crack lectureship and fellowship exams approved by UGC & CSIR, GATE and SET.

Paper: P2. Advanced Topology II

Course Outcomes: On completion of this course, the students will be able to identify , analyze, classify, demonstrate and explain the acquired knowledge mainly on the following :

i) Covering spaces and covering maps, Path lifting property and Homotopy ifting,
ii) Monodromy theorems, Deck transformation, Van Kampen's theorem,
iii) Singular Homology, Mayer-Vietoris sequence, Idea of Cohomology,
iv) C-embedding & C -embedding and their relation, Urysohn's extension theorem,
v) maximal ideals, prime ideals, Z- ideals; Z-filters, Z- ultrafilters,
vi) fixed maximal ideals of C (X) and C (X), their characterizations,Structure spaces.
vii) Topological groups.

Also there is a scope, for applying the acquired knowledge of the above methods/ tools of Advanced Topology II, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher

research and its extensions. It also helps to crack lectureship and fellowship exams approved by UGC & CSIR, GATE and SET.

Paper: P 3. Advanced Functional Analysis

Course Outcomes: Upon successful completion, students will have the knowledge and skills to explain the fundamental concepts of functional analysis and their role in modern mathematics and applied contexts. Moreover, students will be able to demonstrate accurate and efficient use of functional analysis techniques.

Paper: P4. Algebraic Topology

Course Outcomes: On completion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge mainly on the following :

i) Homotopy, Contractible spaces, deformation, strong deformation retraction,
ii) Covering spaces and covering maps,Path lifting property and Homotopy lifting,
iii) Fundamental groups of Circle, Cylinder, punctured plane, Torus, etc.,
iv) Simplicial complexes Polyhedra and Triangulation, barycentric subdivision and simplicial approximation theorem,
v) Simplicial Homology, homology groups, no-retraction theorem, Brower's fixed point theorem.

Also there is a scope, for applying the acquired knowledge of the above methods/ tools of algebraic topology to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues that facilitates for higher research and its extensions. It also helps to crack lectureship and fellowship exams approved by UGC & CSIR, GATE and SET.

Paper: P5. Advanced Real Analysis

Course Outcomes: After completing the course, the students should be able to recognize, understand and apply concepts and methods in advanced real analysis. Also, they will be able to apply the acquired knowledge in signals and Systems, Digital Signal Processing etc. and conduct researches on high international level in advanced real analysis.

Paper: P6. Advanced Complex Analysis

Course Outcomes: Oncompletion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge mainly on the following :

i) Basic properties of holomorphic functions,
ii) The Phragmen- Lindeloff Method, a converse of Maximum Modulus Theorem,
iii) the Mittag-Leffler's theorem for Meromorphic function,
iv) the Weierstrass Factorization Theorem, Jensen's formula, The Muntz-Szasz theorem,
v) Monodromy theorem and its consequence, the Little Picard Theorem,

vi) the Riemann mapping Theorem,
vii) multilinear algebra, differential forms, the Lie derivative..

Also there is a scope, for applying the acquired knowledge of the above methods/ tools of AdvancedComplex Analysis, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions.

Paper: P7 .Harmonic Analysis

Course Outcomes: On completion of this course, the students will be able to identify, analyze, classify, demonstrate and explain the acquired knowledge mainly on the following :

i) Fourier series, convergence of Fourier series, Riemann-Lebesgue lemma
ii) Basics of Topological groups,
iii) Haar measure and Haar integral
iv) Banach Algebra andGelfand topology,
v) Fourier transform on locally compact topological groups,
vi) Plancheral theorem, Pontrjagin Duality theorem.

Also there is a scope, for applying the acquired knowledge of the above methods/ tools of Harmonic Analysis, to solve complex mathematical problems in all of its relevant fields of applications, to develop abstract mathematical thinking as well as in discovering new avenues, that facilitates for higher research and its extensions.

Paper: P8.Commutative Algebra

Course Outcomes: On successful completion of this course, students will be able to apply its methods in related subjects of Mathematics. Moreover, they should be able to participate in scientific discussions and begin with own research in commutative algebra.

Applied Stream

Paper : A1.Quantum Mechanics

Course Outcomes: At the end of this course a student should be able to :

- Understand the fundamentals of quantum mechanics,
- Create better grasp on different branches of mathematical physics,
- Provide an opportunity to recapitulate application of higher pure mathematics,
- Open the gateway to modern electronics and nano science.

Paper: A2.Plasma Dynamics

Course Outcomes: At the end of this course a student should be able to :

- understand collective nature of plasma dynamics by developing concepts of Debye screening collective behavior and quasi neutrality,
- describe motion of charged particles in electric and magnetic fields,
- derive the basic set of fluid equations to study plasma properties,
- know the concept of Landau damping,
- describe the propagation of waves in plasmas and understand the concept of nonlinearity and dispersion relation.

Paper: A3.Theory of Waves in Solids

Course Outcomes:

1. On completion of the course, students will be conversant with propagation of waves in rods, plates and half-spaces.
2. They will be introduced to the basic seismological waves and acoustic waves.
3. The course will be beneficial to students interested in research in applied mechanics or geophysics.

Paper: A4.Advanced Dynamical Systems and Chaotic Dynamics

Course Outcomes: On completion of this course the students would be able to :

1. apply the ideas of dynamical systems theory to understand and explain various complex phenomena of physics and biology,

2. pursue research in complex dynamical systems, mathematical biology , fractal set theory and other related fields.

Paper: A5.Solid Mechanics

Course Outcomes:

- This course is intended to give the students an introduction to different types of problems arising in the Theory of linear Elasticity.
- On completion of this course students will have learnt the fundamental concepts required for research in Applied Mechanics or Geophysics.

Paper: A6.Mathematical Biology

Course Outcomes:

- After completion of this course, students should be able to formulate realistic mathematical models for diverse biological phenomena and analyse them mathematically to explain the observations as obtained from experiments, clinical trials and observations.
- Students would learn to mathematically predict the outcome in a situation by constructing and theoretically analysing a model.
- The students will learn how to develop mathematical models which provide ways to design and evaluate protocols to manage and control animal populations, natural resources like forests, wildlife, fisheries, and outbreak of diseases.

Paper: A7.Advanced Operations Research

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

- formulate operation research models to solve real life problem,
- understand the mathematical tools that are needed to solve optimization problems,
- describe Optimal Control Theory and their applications,
- analyze game theory,
- understand skills and knowledge of operations research and its application in industry.

Paper: A8.Advanced Fluid Dynamics

Course Outcomes:

1. This course introduces fundamental ideas of fluid dynamics which can be further applied to problems of mechanical engineering.

2. On completion of this course, students would be able to enter research work in Advanced Fluid Theory and Computational Fluid Dynamics (CFD).