SYLLABUS
M. Sc. (Mathematics)
(CBCS)
With effect from June-2016

(Reaccredited “A” Grade by NAAC)
(CGPA 3.05)
Course Structure and Scheme of Examination
For Choice based Credit System (CBCS)
(With effect from June-2016)

- Course: M.Sc. (Mathematics)
- Eligibility for the admission: B.Sc. (Mathematics)
- Duration: Two years

### Semester 1

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Title of the Course</th>
<th>Course Credits</th>
<th>No. of Hrs. Per Week</th>
<th>Weightage For Internal Examination</th>
<th>Weightage For Semester End Examination</th>
<th>Total Marks</th>
<th>Duration Of Semester end Exam in hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMT – 1001</td>
<td>Algebra 1</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td>2.5hrs</td>
</tr>
<tr>
<td>CMT – 1002</td>
<td>Real Analysis</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td>2.5hrs</td>
</tr>
<tr>
<td>CMT – 1003</td>
<td>Topology 1</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td>2.5hrs</td>
</tr>
<tr>
<td>CMT – 1004</td>
<td>Theory of Ordinary Differential Equations</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td>2.5hrs</td>
</tr>
<tr>
<td>CMT – 1005</td>
<td>Seminar and Problem Session</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>100</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>EMT – 1001</td>
<td>Classical Mechanics 1</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td>2.5hrs</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>24</strong></td>
<td></td>
<td></td>
<td><strong>600</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Semester 2

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Title of the Course</th>
<th>Course Credits</th>
<th>No. of Hrs. Per Week</th>
<th>Weightage For Internal Examination</th>
<th>Weightage For Semester End Examination</th>
<th>Total Marks</th>
<th>Duration Of Semester end Exam in hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMT – 2001</td>
<td>Algebra 2</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td>2.5hrs</td>
</tr>
<tr>
<td>CMT – 2002</td>
<td>Complex Analysis</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td>2.5hrs</td>
</tr>
<tr>
<td>CMT – 2003</td>
<td>Topology 2</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td>2.5hrs</td>
</tr>
<tr>
<td>CMT – 2004</td>
<td>Methods in Partial Differential Equations</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td>2.5hrs</td>
</tr>
<tr>
<td>CMT – 2005</td>
<td>Seminar and Problem Session</td>
<td>4</td>
<td>4</td>
<td>-</td>
<td>100</td>
<td>100</td>
<td>-</td>
</tr>
<tr>
<td>EMT – 2001</td>
<td>Classical Mechanics 2</td>
<td>4</td>
<td>4</td>
<td>30</td>
<td>70</td>
<td>100</td>
<td>2.5hrs</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>24</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>600</strong></td>
<td></td>
</tr>
</tbody>
</table>

**M.Sc.(Mathematics) - SEMESTER 1**

CMT - 1001 Algebra- I  
CMT - 1002 Real Analysis  
CMT - 1003 Topology- I  
CMT - 1004 Theory of Ordinary Differential Equations  
CMT - 1005 Seminar and Problem Session  
EMT - 1001 Classical Mechanics- I
M.Sc.(Mathematics) - SEMESTER 2

CMT - 2001 Algebra- II
CMT - 2002 Complex Analysis
CMT - 2003 Topology- II
CMT - 2004 Methods in Partial Differential Equations
CMT - 2005 Seminar and Problem Session
EMT - 2001 Classical Mechanics- II

* CMT – Core Subject, EMT –Elective Subject, PMT - Practical

- Passing Standard is 40% in Internal as well as in external examinations for all the courses.
- Student will have to clear internal as well as external examinations. (i.e. internal examination with minimum 40% and external examination with minimum 40% is compulsory) and student can earn credits mentioned against each course.
- There will be two internal examinations in each course and average of both the examinations will be considered.
M.Sc. SEMESTER 1

Sub. Code: **CMT-1001**
Core Sub. 1: **Algebra- 1**

**Unit 1**
Basic concepts of group theory:
Group, abelian group, cyclic group, normal subgroup, quotient group, permutation group, Group isomorphism and their properties, Cayley’s theorem, Automorphisms of groups.

**Unit 2**
Direct Products, Finitely Generated Abelian Groups, Invariants of a finite Abelian Groups, Sylow Theorems.

**Unit 3**
Quick look at basic ring theory:
Euclidean ring, Quotient ring and zero divisors, Ideals, principal ideal, maximal ideal and prime ideal, Homomorphisms of ideals, Sum and Direct Sum of Ideals, Nilpotent and Nil Ideals.

**Unit 4**
Euclidean domains, Principal Ideal Domains, Unique Factorization Domains and Polynomial Rings over UFD. Polynomial rings over rational field, irreducible polynomials, Einstein irreducibility criterion.

**Reference Books:**

M.Sc. SEMESTER 1

Sub. Code: **CMT-1002**
Core Sub. 2: **Real Analysis**

**Unit 1**
Algebra of sets, σ-algebra of sets, Borel sets, Lebesgue outer measure, Measurable sets and Lebesgue measure, A nonmeasurable set, Measurable Functions, and Littlewood's three principles.

**Unit 2**

**Unit 3**
Differentiation of monotone functions, Functions of bounded variation, Differentiation of an integral, and Absolute continuity.

**Unit 4**

The course is covered by Chapter 1 Section 4, Chapter 2 Section 7, Chapter 3 (full), Chapter 4(full), Chapter 5 (Sections 1 to 4), and Chapter 6 (Sections 1 to 3) from the book Real Analysis by H. L. Royden, Third Edition, PHI Learning Private Limited (2009) New Delhi.

**Reference Books:-**

M.Sc. SEMESTER 1

Sub. Code: **CMT-1003**
Core Sub. 3: **Topology -1**

**Unit-1**
Topology, Open sets and closed sets, Finer and Coarser topology, Basis for a topology, Simply ordered topology.

**Unit-2**
Subspace topology, Product topology, Continuous functions, Homeomorphism.

**Unit-3**
Limit points, Closure, Interior points and interior, Convergent Sequence.

**Unit-4**
Metric topology, Uniform convergence, Topology of \( \mathbb{R}^n \).

**Unit-5**
Connectedness, Local connectedness, Components, Path connectedness

The Course is covered by following Chapter 1, 2 and 3(Upto article 25) of Topology-A first course, J. M. Munkres, Printice Hall of India (2000).

**Reference Books:-**

M.Sc. SEMESTER 1

Sub. Code: CMT-1004
Core Sub. 4: Theory of Ordinary Differential Equations

Unit 1: Linear System of Differential Equations
The existence and uniqueness theorem, Linear Homogenous systems, Linear Non-Homogenous systems, Nonlinear system of first order equations.

Unit 2: Linear System with constant coefficients
The exponential of matrix, Eigen values and eigen vectors of matrices, calculation of fundamental matrix, two dimensional linear systems, some population problems, an electric circuit.

Unit 3: Series solutions of Linear Differential Equations
Review of properties of power series, second order linear equations with analytic coefficients, theorem on solutions in power series, singular points of linear differential equations, solutions about a regular singular point, exceptional cases, the Bessel equation and some properties of Bessel functions, singularities at infinity, irregular singular points with an introduction to asymptotic expansions

Unit 4: Existence theory
Existence of solutions, uniqueness of solutions, continuation of solutions, the non linear simple pendulum, existence theory for system of first order equations and higher order equations, linear systems, dependence on initial conditions.
Unit 5: Laplace Transforms


This course is covered by “*Ordinary Differential Equations*”, First course by R. Brauer and J. A. Nohel, Second edition, Benjamin Inc.

**Reference Books:-**


Unit 1: D’Alemberts principle and Lagrange’s Equations
- Conservation theorem for linear momentum and angular momentum for a particle.
- Conservation theorem for linear momentum and angular momentum for a system of particles.
- Classification of dynamical system.
- Constraints.
- Virtual displacement and principle of virtual work.
- Generalized force in holonomic system
- Mathematical expression for principle of virtual work
- D’Alembert’s principle
- Lagrange’s equation for holonomic system
- Lagrange’s equation for conservative non-holonomic system
- Problems on above topics

Unit 2: Variational principle and Lagrange’s equations
- Variational principle
- Calculus of variations
- Hamilton’s principle
- Derivation of Hamilton’s principle from Lagrange’s equation
- Derivation of Lagrange’s equations from Hamilton’s principle
• Cyclic co-ordinates
• Conservation theorems
• Problems on above topics

Unit 3: Two Body Central force problem
• Reduction to equivalent one body problem
• The equations of motion and first integrals
• The equivalent one dimensional problem and classification of orbits
• The inverse square law of force.

Unit 4: Equations of Motion and Rigid bodies

Independent co-ordinates of rigid bodies, generalized co-ordinates of a rigid bodies, Euler angles, Cayley-Klein parameters and related quantities, components of angular velocity along the body set of axes, Euler’s theorem on the motion of a rigid body, rate of change of a vector, the coriolis force, Euler’s equations of motion for a rigid body, finite rotations, infinitesimal rotations.

The course is covered by the above topics from the book:

M.Sc. SEMESTER 2

Sub. Code: **CMT-2001**
Core Sub. 1: **Algebra- 2**

**Unit 1**
Division ring and Field, Extension fields, algebraic and transcendental extensions, Splitting fields, Normal extensions, Multiple roots, Finite fields, Separable extensions.

**Unit 2**

**Unit 3**
Modules (Definitions and examples), Submodules and Operation on modules

**Unit 4**
Homomorphisms of modules and quotient modules, completely reducible modules, finitely generated modules.

**Reference Books:**

M.Sc. SEMESTER 2

Sub. Code: CMT-2002
Core Sub. 2: Complex Analysis

Unit 1

The extended complex plane and its spherical representation, analytic functions, bilinear transformations, their properties and classifications, Branches of many valued functions with special reference to \( \arg z \), \( \log z \) and \( z^a \), elementary Riemann surfaces, definition and properties of conformal mapping.

Unit 2

Riemann – Steiltjes integral and its properties, line integral and its properties, fundamental theorem of calculus for line integral, Leibnitz rule, Taylor’s theorem, Cauchy’s integral formula dn Cauchy’s theorem for analytic functions on an open disc, winding number of a closed rectifiable curve with respect to a point outside the curve and its properties, Cauchy’s integral formula first version and second version, Cauchy’s theorem first version, second version, third version and forth version.

Unit 3

Cauchy – Goursat theorem, Moreras theorem, Cauchy’s inequality, entire functions, Llouville’s theorem, identity theorem, fundamental theorem of algebra, maximum modulus theorem and minimum modulus theorem.

Unit 4

Schwartz lemma, meromorphic functions, argument principle, Rouche’s theorem, Open Mapping Theorem, Inverse function theorem.

Unit 5

Isolated singularities, classifications of singularities, Laurent’s series, residue theorem, evaluation of integrals.

**Reference Books:-**


4) Complex Analysis by S. Lang, Addison-Wesley, 1977.


M.Sc. SEMESTER 2

Sub. Code: **CMT-2003**
Core Sub. 3: **Topology - 2**

**Unit – 1:**
Separation Axioms: $T_1$ – Spaces, $T_2$ – Spaces (Hausdorff Spaces).

**Unit – 2:**
Separation Axioms: Regular Spaces, Completely Regular Spaces, Normal Spaces.

**Unit – 3:**
Compact Spaces, Locally Compact Spaces, Limit Point Compact Spaces.

**Unit – 4:**
Sequentially Compact Spaces, Compact Metric Spaces.

**Unit – 5:**
Complete Metric Spaces.

**Reference Books:**–

1) Topology – A First Course, J.R.Munkres, Prentice Hall of India (2000). Chapter 3 (Article no. 26 to 29), Chapter 4 (Article no. 31,32,33 and 35) and Chapter 7 (Article no. 43)
M.Sc. SEMESTER 2

Sub. Code: **CMT-2004**

Core Sub. 4: **Methods in Partial Differential Equations**

**Unit 1**
Surfaces and Curves in three dimensions. Simultaneous differential equations of the first order and the first degree in three variables, Methods of solutions of \( \frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R} \), Orthogonal trajectories of a system of curves on a surface. Pfaffian Differential forms and equations, Solution of Pfaffian differential equations in three variables, and Miscellaneous problems.

**Unit 2**
Partial differential equations, Origins of First-order partial differential equations, Linear equations of the first order, Integral Surfaces passing through a given curve, Surfaces orthogonal to a given system of surfaces.

**Unit 3**
Non-linear partial differential equations of the first order, Charpit's method, Special types of first order equations, Solutions satisfying the given conditions, Jacobi's method, and Miscellaneous problems.

**Unit 4**
The origin of second order equations, Linear partial differential equations with constant coefficients, and Equations with variable coefficients.

This course is covered by the relevant portions from the book ‘Elements of Partial Differential Equations’ by Ian Sneddon, McGraw-Hill Book Company.

**Reference Books:**
Elective Sub. 1: Classical Mechanics -2

Unit 1: The Rigid Body Equations of Motion
Angular momentum and kinetic energy of motion about a point, the inertia tensor and moment of inertia, the heavy symmetrical top with one point fixed.

Unit 2: Special Relativity in Classical Mechanics
The basic program of special relativity, The Lorentz transformation, Lorentz transformations in real four dimensional spaces, Further descriptions of the Lorentz transformation, Covariant four – dimensional formulations, The force and energy equations in relativistic mechanics.

Unit 3: Hamilton’s equation of Motion
Derivation of Hamilton’s equation of motion, Routh’s procedure, derivation of Hamilton’s equation from Hamilton’s Principle, principle of least action, problem related to above topics.

Unit 4: Canonical transformations and Generating functions
Poisson’s brackets and their properties, Hamilton-Jacobi theory, problem related to above topics.

The course is covered by the above topics from the book: