①

**Annexure-I**

# Outline of Scheme of M.Sc. (Mathematics) Semester System According to Choice Based Credit System (CBCS) For Department of Mathematics, CDLU, Sirsa

The following types of courses shall be covered under choice based credit system:

(a) Core Courses (CC)
(b) Core Elective Courses (CEC)
(c) Open Elective courses (OEC)

Outline of Scheme of M.Sc. (Mathematics) Semester System according to Choice Based Credit System (CBCS) is as under:

**1. For Core Courses and Core Elective Courses**

| Semester \ Courses | Core Courses | Core Elective Courses | Total Credit (Sem. wise) |
|---|---|---|---|
| 1st | 5 Theory Papers & 1 Comp. Practical (Each of Credit 4) | --------- | 24 |
| 2nd | 4 Theory Papers (Each of Credit 4) | 2 Papers (Each of Credit 4) | 24 |
| 3rd | 2 Theory Papers (Each of Credit 4) | 3 Theory Papers (Each of Credit 4) | 20 |
| 4th | 2 Theory Papers & 1 Comp. Practical (Each of Credit 4) | 3 Theory Papers (Each of Credit 4) | 24 |
| **Total Credit (Course wise)** | 60 | 32 | 92 |

**2. For Open Elective Courses**

**(a) For the students of Department of Mathematics:**
In addition of the above Core Courses and Core Elective Courses, students of this department have to opt open elective course(s) offered by University Teaching Departments (except Open Elective Courses offered by Mathematics Department) of total credit at least 10 and maximum 12 in all four semesters.

**(b) For the students of the Departments (other than Department of Mathematics) of the University:**
Department of Mathematics offers following open elective courses for the students of other teaching departments of the University.

| Sr. No. | Paper Code | Title of the paper/ Subject | Remarks |
|---|---|---|---|
| 01 | MTHOE-1301 | Basic mathematics | To be offered in odd semesters |
| 02 | MTHOE-2402 | Descriptive Statistics | To be offered in even semesters |

Detailed syllabi is attached as **Annexure-'A'**

**Note:** All the terms and conditions are strictly according to Ordinance of Choice Based Credit System of the University circulated vide letter no. AC-II/16/2525-52, Dated 25-07-2016.

05/07/17

# Scheme/Structure of Examination
# M.Sc. (Mathematics) Semester System
# According to Choice Based Credit System (CBCS)
# For Department of Mathematics, CDLU, Sirsa

**M. Sc. (Previous) Mathematics (with effect from session 2017-18)**

| Paper Code No. | Title of the paper/ Subject | Hrs per week L+P | Marks (Theory) | Marks (Internal Assessment) | Marks (Practical) | Total Marks | Credit |
|---|---|---|---|---|---|---|---|
| **Semester-I (Core Courses)** | | | | | | | |
| MTHCC-2101 | Abstract Algebra | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2102 | Real Analysis | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2103 | Mechanics | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2104 | Complex Analysis | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2105 | Ordinary Differential Equations | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2106 | Computer Programming in ANSI C | 0+4 | 00 | 00 | 100 | 100 | 4 |
| **Semester-II (Core Courses)** | | | | | | | |
| MTHCC-2201 | Advanced Abstract Algebra | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2202 | Measure & Integration Theory | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2203 | Mechanics of Solids | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2204 | System of Differential Equations | 4+0 | 70 | 30 | 00 | 100 | 4 |
| **(Core Elective Courses) (Any two of the following)** | | | | | | | |
| MTHCE-2205 | Computer Programming in FORTRAN 90 & 95 | 2+2 | 30 | 20 | 50 | 100 | 4 |
| MTHCE-2206 | Methods of Applied Mathematics | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2207 | Differential Geometry | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2208 | Mathematical Modeling | 4+0 | 70 | 30 | 00 | 100 | 4 |

05/07/17

# Scheme/Structure of Examination
# M.Sc. (Mathematics) Semester System
# According to Choice Based Credit System (CBCS)
# For Department of Mathematics, CDLU, Sirsa

**M. Sc. (Final) Mathematics (with effect from session 2018-19)**

| Paper Code No. | Title of the paper/ Subject | Hrs per week L+P | Marks (Theory) | Marks (Internal Assessment) | Marks (Practical) | Total Marks | Credit |
|---|---|---|---|---|---|---|---|
| **Semester-III** | | | | | | | |
| **(Core Courses)** | | | | | | | |
| MTHCC-2301 | Topology | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2302 | Fluid Mechanics | 4+0 | 70 | 30 | 00 | 100 | 4 |
| **(Core Elective Courses) (Any three of the following)** | | | | | | | |
| MTHCE-2303 | Integral Equations | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2304 | Mathematical Statistics | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2305 | Advanced Complex Analysis | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2306 | Advanced Mechanics of Solids | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2307 | Advanced Discrete Mathematics | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2308 | Fuzzy Sets and Fuzzy Logic | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2309 | Information Theory | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2310 | Difference Equations | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2311 | Financial Mathematics | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2312 | Number Theory | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2313 | Wavelet Analysis | 4+0 | 70 | 30 | 00 | 100 | 4 |

05/07/17

| Paper Code No. | Title of the paper/ Subject | Hrs per week L+P | Marks (Theory) | Marks (Internal Assessment) | Marks (Practical) | Total Marks | Credit |
|---|---|---|---|---|---|---|---|
| **Semester-IV** | | | | | | | |
| **(Core Courses)** | | | | | | | |
| MTHCC-2401 | Functional Analysis | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2402 | Partial Differential Equations | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCC-2403 | Computer Programming in MATLAB | 0+4 | 00 | 00 | 100 | 100 | 4 |
| **(Core Elective Courses) (Any three of the following)** | | | | | | | |
| MTHCE-2404 | Mathematical Aspect of Seismology | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2405 | Operation Research | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2406 | Advanced Fluid Mechanics | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2407 | Boundary Value Problem | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2408 | Algebraic Topology | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2409 | Analytic Number Theory | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2410 | Algebraic Coding Theory | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2411 | Control Theory | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2412 | Bio-Mechanics | 4+0 | 70 | 30 | 00 | 100 | 4 |
| MTHCE-2413 | Algebraic Number Theory | 4+0 | 70 | 30 | 00 | 100 | 4 |

05/07/17

Annexure-'A'

## MTHOE–1301: Basic Mathematics

**Marks (Theory): 70**
**Marks (Internal Assessment): 30**

**Marks (Total): 100**
**Time: 03 Hours**
**Total Credit: 04**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**
**Matrices & Determinants:** Definition of a matrix. Types of matrices; Algebra of matrices; Properties of determinants; Calculation of values of determinants upto third order, Adjoint of a matrix, elementary row or column operations; Finding inverse of a matrix through adjoint and elementary row or column operations. Solution of a system of linear equations.

**Unit: 2.**
**Matrices & Determinants:** Characteristic equation, Statement of Cayley Hamilton theorem. Rank of matrix, Eigen vectors and eigen values using matrices, Diagonalization, similarity transformation of matrices.

**Unit: 3. Differential Calculus:** Differentiation of standard functions, theorems relating to the derivative of the sum, difference, product and quotient of functions, derivative of trigonometric functions, inverse trigonometric functions, logarithmic functions and exponential functions, differentiation of implicit functions, logarithmic differentiation, derivative of fuctions, expressed in parametric form, derivatives of higher order. (Only formulae to be given and applications to be emphasized). Maxima and minima.

**Unit: 4.**
**Integral Calculus:**
Integration as an inverse of differentiation summation, area under a curve, indefinite integrals of standard form, method of substitution, method of partial fractions, integration by parts, definite integrals, reduction formulae, definite integrals of limit of sum and geometrical interpretation.

**Recommended Books:**

1. Seymour Lipschutz; Linear Algebra, Schaum's series publications.
2. Santi Narayan; Differential Calculus.
3. Santi Narayan; Integral Calculus.

05/07/17

# MTHOE–2402: Descriptive Statistics

**Marks (Theory): 70**
**Marks (Internal Assessment): 30**

**Marks (Total): 100**
**Time: 03 Hours**
**Total Credit: 04**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**
Introduction of Statistics, Basic knowledge of various types of data, Collection, classification and tabulation of data. Presentation of data: histograms, frequency polygon, frequency curve and ogives. Stem- and- Leaf and Box plots.

**Unit: 2.**
Measures of Central Tendency and Location: Mean, median, mode, geometric mean, harmonic mean, partition values.

**Unit: 3.**
Measures of Dispersion: Absolute and relative measures of range, quartile deviation, mean deviation, standard deviation ($\sigma$), coefficient of variation.

**Unit: 4**
Moments, Skewness and Kurtosis: Moments about mean and about any point and derivation of their relationships, effect of change of origin and scale on moments.
Correlation for Bivariate Data: concept and types of correlation, scatter diagram, Karl Pearson Coefficient (r) of correlation and rank correlation coefficient.

**Recommended Books:**

1. A.M. Goon, M.K. Gupta, and B. Das Gupta: Fundamentals of Statistics, Vol-I.
2. S. Bernstein and R. Bernstein, Elements of Statistics, Schaum's outline series, McGraw-Hill.
3. S.C. Gupta and V.K. Kapoor, Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 2002.

05/07/17

7

Annexure-II

## MTHCC–2101: Abstract Algebra

**Marks (Theory): 70**
**Marks (Internal Assessment): 30**

**Marks (Total): 100**
**Time: 03 Hours**
**Total Credit: 04**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**

Automorphisms and Inner automorphisms of a group G. The groups Aut(G) and Inn(G). Automorphism group of a cyclic group. Normalizer and Centralizer of a non-empty subset of a group G. Conjugate elements and conjugacy classes. Class equation of a finite group G and its applications. Derived group (or a commutator subgroup) of a group G. perfect groups. Simplicity of the Alternating group $A_n$ ($n\geq5$). Zassenhaus's Lemma. Normal and Composition series of a group G. Scheier's refinement theorem. Jordan Holder theorem. Composition series of groups of order $p^n$ and of finite Abelian groups. Caunchy theorem for finite groups. p-groups. Finite Abelian groups. Sylow p-subgroups. Sylow's Ist, IInd and IIIrd theorems. Application of Sylow theory to groups of smaller orders.

**Unit: 2.**

Commutators identities. Commutator subgroups. Three subgroups Lemma of P.Hall. Central series of a group G. Nilpotent groups. Centre of a nilpotent group. Subgroups and factor subgroups of nilpotent groups. Finite nilpotent groups. Upper and lower central series of a group G and their properties. Subgroups of finitely generated nilpotent groups. Sylow-subgroups of nilpotent groups. Solvable groups Derived series of a group G. Non-solvability of the symmetric group $S_n$ and the Alternating group $A_n$ ($n\geq5$).

**Unit: 3.**

Modules, submodules and quotient modules. Module generated by a non-empty subset of an R-module. Finitely generated modules and cyclic modules. Idempotents. Homomorphism of R-modules. Fundamental theorem of homomorphism of R-modules. Direct sum of modules. Endomorphism rings $End_Z(M)$ and $End_R(M)$ of a left R-module M. Simple modules and completely reducible modules (semi-simple modules). Finitely generated free modules. Rank of a finitely generated free module. Submodules of free modules of finite rank over a PID. Representation of linear mappings and their ranks.

**Unit: 4.**

Endomorphism ring of a finite direct sum of modules. Finitely generated modules. Ascending and descending chains of sub modules of an R-module. Ascending and Descending change conditions (A.C.C. and D.C.C.). Noetherian modules and Noetherian rings. Finitely co-generated modules. Artinian modules and Artinian rings. Nilpotent elements of a ring R. Nil and nilpotent ideals. Hilbert Basis Theorem. Structure theorem for finite Boolean rings. Wedeerburn-Artin theorem and its consequences. Uniform modules. Primary modules. Nother-laskar Theorem.

05/07/17

8

**Recommended Books:**

1. I.S. Luthar and I.B.S. Passi; Algebra Vol. 1 Groups (Narosa publication House)
2. P.B. Bhattacharya S.R. Jain and S.R. Nagpal; Basic Abstract Algebra
3. I.D. Macdonald; Theory of Groups
4. Vivek Sahai and Vikas Bist; Algebra (Narosa publication House)
5. Surjit Singh and Quazi Zameeruddin; Modern Algebra (Vikas Publishing House 1990)
6. W.R. Scott; Group Theory.

05/07/17

## MTHCC–2102: Real Analysis

**Marks (Theory): 70** **Marks (Total): 100**
**Marks (Internal Assessment): 30** **Time: 03 Hours**
**Total Credit: 04**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**
Definition and existence of Riemann Stieltjes integral, properties of the integral, reduction of Riemann Stieltjes integral to ordinary Riemann integral, change of variable, integration and differentiation, the fundamental theorem of integral calculus, integration by parts, first and second mean value theorems for Riemann Stieltjes integrals, integration of vector-valued functions, rectifiable curves. (Scope as in Chapter 6 of 'Principles of Mathematical Analysis' by Walter Rudin, Third Edition).

**Unit: 2.**
Sequences and series of functions : Pointwise and uniform convergence of sequences of functions, Cauchy criterion for uniform convergence, Dini's theorem, uniform convergence and continuity, uniform convergence and Riemann integration, uniform convergence and differentiation, convergence and uniform convergence of series of functions, Weierstrass M-test, integration and differentiation of series of functions, existence of a continuous nowhere differentiable function, the Weierstrass approximation theorem, the Arzela theorem on equicontinuous families. (Scope as in Chapter 9 (except 9.6) & Chapter 10 (except 10.3) of 'Methods of Real Analysis' by R.R. Goldberg).

**Unit: 3.**
Functions of several variables : Linear transformations, the space of linear transformations on $R^n$ to $R^m$ as a metric space, open sets, continuity, derivative in an open subset of $R^n$, chain rule, partial derivatives, directional derivatives, continuously differentiable mappings, necessary and sufficient conditions for a mapping to be continuously differentiable, contractions, the contraction principle (fixed point theorem), the inverse function theorem, the implicit function theorem. (Scope as in relevant portions of Chapter 9 of 'Principles of Mathematical Analysis' by Walter Rudin, Third Edition)

**Unit: 4.**
Power Series : Uniqueness theorem for power series, Abel's and Tauber's theorem, Taylor's theorem, Exponential & Logarithmic functions, trigonometric functions, Fourier series, Gamma function (Scope as in relevant portions of Chapter 8 of 'Principles of Mathematical Analysis' by Walter Rudin, Third Edition).

**Recommended Books:**

1. Walter Rudin; Principles of Mathematical Analysis (3rd Edition) McGraw-Hill, 1976.
2. R.R.Goldberg; Methods of Real Analysis, Oxford and IHB Publishing Company, New Delhi, 1970
3. T.M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
4. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar, Inc. New York, 1975

05/07/17

5. A.J. White, Real Analysis; an introduction. Addison-Wesley Publishing Co., Inc., 1968
6. E. Hewitt and K. Stromberg. Real and Abstract Analysis, Berlin, Springer, 1969
7. Serge Lang, Analysis I & II, Addison-Wesley Publishing Company Inc., 1969
8. S.C. Malik and Savita Arora, Mathematical Analysis, New Age International Limited, New Delhi, $4^{th}$ Edition 2010
9. D. Somasundaram and B. Choudhary : A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.


05/07/17

## MTHCC–2103: Mechanics

**Marks (Theory): 70**
**Marks (Internal Assessment): 30**

**Marks (Total): 100**
**Time: 03 Hours**
**Total Credit: 04**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**

Moments and products of Inertia, Angular momentum of a rigid body, principal axis and principal moment of inertia of a rigid body, Kinetic energy of a rigid body rotating about a fixed point, Momental ellipsoid and equimomental systems, coplanar mass distributions, general motion of a rigid body.

**Unit: 2.**

Free and constrained systems, constraints and their classification. Generalized coordinates. Holonomic and Non-Holonomic systems. Scleronomic and Rheonomic systems. Generalized Potential, Possible and virtual displacements, ideal constraints. Lagrange's equations of first kind, Principle of virtual displacements D'Alembert's principle, Holonomic Systems independent coordinates, generalized forces, Lagrange's equations of second kind. Uniqueness of solution. Theorem on variation of total Energy. Potential, Gyroscopic and dissipative forces, Lagrange's equations for potential forces equation for conservative fields.

**Unit: 3.**

Hamilton's variables. Don kin's theorem. Hamilton canonical equations. . Routh's equations. Cyclic coordinates Poisson's Bracket. Poisson's Identity. Jacobi-Poisson theorem. Hamilton's Principle, second form of Hamilton's principle. Poincare-Carton integral invariant. Whittaker's equations. Jacobi's equations. Principle of least action

**Unit: 4.**

Canonical transformations, free canonical transformations, Hamilton-Jacobi equation. Jacobi theorem. Method of separation of variables for solving Hamilton-Jacobi equation. Testing the Canonical character of a transformation. Lagrange brackets. Condition of canonical character of a transformation in terms of Lagrange brackets and Poisson brackets. Simplicial nature of the Jacobian matrix of a canonical transformations. Invariance of Lagrange brackets and Poisson brackets under canonical transformations.

**Recommended Books:**

1. F. Gantmacher; Lectures in Analytic Mechanics, Khosla Publishing House, New Delhi.
2. H. Goldstein; Classical Mechanics (2nd edition), Narosa Publishing House, New Delhi.
3. F. Chorlton; A Text Book of Dynamics, CBS Publishers & Dist., New Delhi.
4. Francis B. Hilderbrand; Methods of applied mathematics , Prentice Hall.
5. Narayan Chandra Rana & Pramod Sharad Chandra Joag; Classical Mechanics, Tata McGraw Hill, 1991.
6. Louis N. Hand and Janet D. Finch; Analytical Mechanics, Cambridge University Press, 1998.

05/07/17

## MTHCC–2104: Complex Analysis

**Marks (Theory): 70**
**Marks (Internal Assessment): 30**

**Marks (Total): 100**
**Time: 03 Hours**
**Total Credit: 04**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

### Unit: 1.

Analytic functions, Harmonic functions, Uniquely determined analytic function Reflection Principle ~~function~~, Path in a region, Smooth path, p. w. smooth path, contour, Simply connected region, Multiply connected region, Complex integration, Cauchy-Goursat theorem, Cauchy theorem for simply connected and multiply connected domains.

### Unit: 2.

Cauchy integral formula, Extension of Cauchy integral formula for multiply connected domain, Higher order derivative of Cauchy integral formula, Gauss mean value theorem, Morera's theorem, Cauchy inequality, Liouville's theorem Fundamental theorem of algebra, Taylor's theorem, Maximum modulus principle. Schwarz Lemma.

### Unit: 3.

Power series and its convergence, Radius of convergence, Sum and product, Differentiability of sum function of power series, Entire function, Radius of convergence of an entire function, Property of a differentiable function with derivative zero, exp z and its properties, log z, Power of a complex number z, their branches with analyticity, Zeros of an analytic function, Singularity and their classification, Pole of a function and its order.

### Unit: 4.

Laurent series, Cassorati-Weierstrass theorem, Meromorphic functions, The Argument principle, Rouche's theorem, Inverse function theorem, Cauchy residue theorem, Evaluation of integrals, Bilinear transformation, their properties and classification, Definition and examples of conformal mapping.

### Books Recommended:


1. H. A. Priestly; Introduction to Complex Analysis, Clarendon Press, Oxford, 1990.
2. J. B. Conway; Functions of one Complex variable, Springer-Verlag, International student-Edition, Narosa Publishing House, 1980.
3. L. V. Ahlfors; Complex Analysis, McGraw-Hill, 1979.
4. Mark J. Ablowitz and A. S. Fokas; Complex Variables: Introduction and Applications, Cambridge University Press, South Asian Edition, 1998.
5. S. Ponnusamy; Foundations of Complex Analysis, Narosa Publishing House, 1997.
6. J. W. Brown and R. V. Churchill; Complex Variables and Applications, McGraw Hill, 1996.


05/07/17

13

# MTHCC–2105: Ordinary Differential Equations

**Marks (Theory): 70**
**Marks (Internal Assessment): 30**

**Marks (Total): 100**
**Time: 03 Hours**
**Total Credit: 04**

Note: -

The examiner is required to set nine questions in all.

The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.

In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**

Preliminaries: Initial value problem and equivalent integral equation, ε-approximate solution, equicontinuous set of functions.Basic theorems: Ascoli- Arzela theorem, Cauchy –Peano existence theorem and its corollary. Gronwall's inequality.

Lipschitz condition.Uniqueness of solutions.Successive approximations.Picard-Lindelöf theorem.Continuation of solution, Maximal interval of existence, Extension theorem.

(Relevant portions from the book of 'Theory of Ordinary Differential Equations' by Coddington and Levinson.

**Unit: 2.**

Higher order equations: Linear differential equation (LDE) of order n; Linear combinations, Linear dependence and linear independence of solutions. Wronskian theory: Definition, necessary and sufficient condition for linear dependence and linear independence of solutions of homogeneous LDE. Abel's Identity, Fundamental set.More Wronskian theory.Reduction of order.

Non-homogeneous LDE.Variation of parameters.Adjoint equations, Lagrange's Identity, Green's formula.Linear equation of order n with constant coefficients.

(Relevant portions from the books of 'Theory of Ordinary Differential Equations' by Coddington and Levinson and the book 'Differential Equations' by S.L. Ross)

**Unit: 3.**

Linear second order equations: Preliminaries, self adjoint equation of second order, basic facts.Superposition Principle.Riccati's equation.Prüffer transformation.Zero of a solution.Abel's formula.Common zeros of solutions and their linear dependence.

Sturm theory: Sturm separation theorem, Sturm fundamental comparison theorem and their corollaries.

Oscillatory and non-oscillatory equations.Elementary linear oscillations.

(Relevant portions from the book 'Differential Equations' by S.L. Ross and the book 'Textbook of Ordinary Differential Equations' by Deo et al.)

**Unit: 4.**

Second order boundary value problems(BVP): Linear problems; periodic boundary conditions, regular linear BVP, singular linear BVP; non-linear BVP. Sturm-Liouville BVP: definitions, eigen values and eigen functions. Orthogonality of functions, orthogonality of eigen functions corresponding to distinct eigen values.

25/07/17

Green's function. Applications of Green's function for solving boundary value problems. Use of Implicit function theorem and Fixed point theorems for periodic solutions of linear and non-linear equations.
(Relevant portions from the book 'Textbook of Ordinary Differential Equations' by Deo et. al.)

**Recommended books:**


1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill , 2000
2. S.L. Ross, Differential Equations, John Wiley & Sons
3. S.G. Deo, V. Lakshmikantham and V. Raghavendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill , 2006
4. P. Hartman, Ordinary Differential Equations, John Wiley & Sons NY, 1971.
5. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons, 1978.
6. G.F. Simmons, Differential Equations, Tata McGraw-Hill , 1993.
7. I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
8. D. Somasundaram, Ordinary Differential Equations, A first Course, Narosa Pub., 2001.
9. Mohan C Joshi, Ordinary Differential Equations, Modern Perspective, Narosa Publishing House, 2006


05/07/17

15

## MTHCC–2106: Computer Programming in ANSI C

**Marks: 100**
**Total Credit: 04**

**Implementation of the following programs in ANSI C.**

1. Use of nested **if.. .else** in finding the smallest of four numbers.
2. To find if a given 4-digit year is a leap year or not.
3. To compute AM, GM and HM of three given real values.
4. To invert the order of digits in a given positive integral value.
5. Use series sum to compute **sin(x)** and **cos(x)** for given angle **x** in degrees. Then, check error in verifying $\mathbf{sin^2x+cos^2(x)=1}$.
6. Verify $\sum n^3 = \{\sum n\}^2$, (where n=1,2,..,m) & check that prefix and postfix increment operator gives the same result.
7. Compute simple interest and compound interest for a given amount, time period, rate of interest and period of compounding.
8. Program to multiply two given matrices in a user defined function.
9. Calculate standard deviation for a set of values {x(j) , j=l,2,...,n} having the corresponding frequencies {f(j) , j=l,2,...,n}.
10. Write the user-defined function to compute GCD of two given values and use it to compute the LCM of three given integer values.
11. Compute GCD of 2 positive integer values using recursion / pointer to pointer.
12. Check a given square matrix for its positive definite form.
13. To find the inverse of a given non-singular square matrix.
14. To convert a decimal number to its binary representation.
15. Use array of pointers for alphabetic sorting of given list of English words

25/07/17

16

**MTHCC–2201: Advanced Abstract Algebra**

**Marks (Theory): 70** **Marks (Total): 100**
**Marks (Internal Assessment): 30** **Time: 03 Hours**
**Total Credit: 4**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**
Characteristic of a ring with unity. Prime fields Z/pZ and Q. Characterization of prime fields. Field extensions. Degree of an extension. Algebraic and transcendental elements. Simple field extensions. Minimal polynomial of an algebraic element. Conjugate elements. Algebraic extensions. Finitely generated algebraic extensions. Algebraic closure and algebraically closed fields. Splitting fields.

**Unit: 2.**
Finite fields. Flobineous automorphism of a finite field. Roots of unity, Cyclotomic polynomials and their irreducibility over Q. Normal extensions. Finite normal extensions as Splitting fields. Separable elements, separable polynomials and separable extensions. Theorem of primitive element. Perfect fields.
(Scope of the course as given in the book at Sr. No. 2).

**Unit: 3.**
Galois extensions. Galois group of an extension. Dedekind lemma Fundamental theorem of Galois theory. Frobenius automorphism of a finite field. Klein's 4-group and Diheadral group. Galois groups of polynomials. Fundamental theorem of Algebra. Radicals extensions. Galois radical extensions. Cyclic extensions. Solvability of polynomials by radicals over Q. Symmetric functions and elementary symmetric functions. Construction with ruler and compass only. (Scope of the course as given in the book at Sr. No. 2).

**Unit: 4.**
Similar linear transformations. Invariant subspaces of vector spaces. Reduction of a linear transformation to triangular form. Nilpotent transformations. Index of nilpotency of a nilpotent transformation. Cyclic subspace with respect to a nilpotent transformation. Uniqueness of the invariants of a nilpotent transformation. Primary decomposition theorem. Jordan blocks and Jordan canonical forms. Cyclic module relative to a linear transformation. Rational Canonicals form of a linear transformation and its elementary divisior. Uniqueness of the elementary divisior. (Sections 6.4 to 6.7 of Topics in Algebra by I.N. Herstein).

**Recommended Books:**


1. I.N. Herstein; Topics in Algebra (Wiley Eastern Ltd.)
2. P.B. Bhattacharya S.R. Jain and S.R. Nagpal; Basic Abstract Algebra, (Cambridge University Press 1995)
3. Vivek Sahai and Vikas Bist; Algebra (Narosa publication House)
4. Surjit Singh and Quazi Zameeruddin; Modern Algebra (Vikas Publishing House 1990)
5. Patrick Morandi; Field and Galois Theory (Springer 1996).


05/07/17

## MTHCC–2202: Measure and Integration theory

**Marks (Theory): 70**
**Marks (Internal Assessment): 30**

**Marks (Total): 100**
**Time: 03 Hours**
**Total Credit: 4**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**

Lebesgue outer measure, elementary properties of outer measure, Measurable sets and their properties, Lebesgue measure of sets of real numbers, algebra of measurable sets, Borel sets and their measurability, characterization of measurable sets in terms of open, closed, $F\sigma$ and $G_\delta$ sets, existence of a non-measurable set.
Lebesgue measurable functions and their properties, the almost everywhere concept , characteristic functions, simple functions, approximation of measurable functions by sequences of simple functions, Borel measurability of a function.

**Unit: 2.**

Littlewood's three principles, measurable functions as nearly continuous functions. Lusin's theorem, almost uniform convergence, Egoroff's theorem, convergence in measure, F.Riesz theorem that every sequence which is convergent in measure has an almost everywhere convergent subsequence.
The Lebesgue Integral : Shortcomings of Riemann integral, Lebesgue integral of a bounded function over a set of finite measure and its properties, Lebsegue integral as a generalization of the Riemann integral, Bounded convergence theorem, Lebesgue theorem regarding points of discontinuities of Riemann integrable functions.

**Unit: 3.**

Integral of a non negative function, Fatou's lemma, Monotone convergence theorem, integration of series, the general Lebesgue integral, Lebesgue convergence theorem.
Differentiation and Integration : Differentiation of monotone functions, Vitali's covering lemma, the four Dini derivatives, Lebesgue differentiation theorem, functions of bounded variation and their representation as difference of monotone functions.

**Unit: 4.**

Differentiation of an integral, absolutely continuous functions, convex functions, Jensen's inequality.
The $L^p$ spaces, Minkowski and Holder inequalities, completeness of $L^p$ spaces, Bounded linear functionals on the $L^p$ spaces, Riesz representation theorem.

**Recommended Books:**


1. H.L.Royden; Real Analysis, Prentice Hall of India, 1999
2. G.de Barra, Measure theory and integration, Willey Eastern Ltd.,1981
3. P.R.Halmos, Measure Theory, Van Nostrans, Princeton, 1950.
4. I.P.Natanson, Theory of functions of a real variable, Vol. I, Frederick Ungar Publishing Co., 1961.
5. R.G.Bartle, The elements of integration, John Wiley & Sons, Inc.New York, 1966.


05/07/17

6. K.R.Parthsarthy, Introduction to Probability and measure, Macmillan Company of India Ltd.,Delhi, 1977.
7. P.K.Jain and V.P.Gupta, Lebesgue measure and integration, New age International (P) Ltd., Publishers, New Delhi, 1986

05/07/17

19

## MTHCC–2203: Mechanics of Solids

**Marks (Theory): 70** | **Marks (Total): 100**
**Marks (Internal Assessment): 30** | **Time: 03 Hours**
**Total Credit: 4**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**
Tensor Algebra: Coordinate-transformation, Cartesian Tensor of different order. Properties of tensors. Isotropic tensors of different orders and relation between them.Symmetric and skew symmetric tensors.Tensor invariants. Eigen-values and eigen-vectors of a tensor.
Tensor Analysis: Scalar, vector, tensor functions, Comma notation, Gradient, divergence and curl of a vector / tensor field.

**Unit: 2.**
Analysis of Strain: Affine transformation, Infinitesimal affine deformation, Geometrical Interpretation of the components of strain. Strain quadric of Cauchy. Principal strains and invariance, General infinitesimal deformation. Saint-Venant's equations of compatibility.
Analysis of Stress : Stress Vector, Stress tensor, Equations of equilibrium, Transformation of coordinates.Stress quadric of Cauchy, Principal stress and invariants.Maximum normal and shear stresses.Mohr's circles.Examples of stress.

**Unit: 3.**
Equations of Elasticity :Generalised Hooks Law, Anisotropic symmetries, Homogeneous isotropic medium.Elasticity moduli for Isotropic media.Equilibrium and dynamic equations for an isotropic elastic solid. Strain energy function and its connection with Hooke's Law.

**Unit: 4.**
Beltrami-Michell compatibility equations.Uniqueness of solution.Clapeyron's theorem.Saint-Venant's principle.
Variational Methods: Theorem of minimum potential energy. Theorem of minimum complementary energy.Reciprocal theorem of Betti and Rayleigh.

**Recommended Books:**


1. I.S. Sokolnikoff, Mathematical Theory of Elasticity, Tata-McGraw Hill Publishing Company Ltd., New Delhi, 1977.
2. D.S. Chandrasekharaiah and L. Debnath, Continuum Mechanics, Academic Press, 1994
3. A.E.H. Love, A Treatise on the Mathematical Theory of Elasticity Dover Publications, New York.
4. Y.C. Fung. Foundations of Solid Mechanics, Prentice Hall, New Delhi, 1965.
5. Shanti Narayan, Text Book of Cartesian Tensor, S. Chand & Co., 1950.
6. S. Timeshenko and N. Goodier. Theory of Elasticity, McGraw Hill, New York, 1970.
7. I.H. Shames, Introduction to Solid Mechanics, Prentice Hall, New Delhi, 1975

20

## MTHCC–2204: System of Differential Equations

**Marks (Theory): 70** | **Marks (Total): 100**
**Marks (Internal Assessment): 30** | **Time: 03 Hours**
**Total Credit: 4**

Note: -

The examiner is required to set nine questions in all.

The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.

In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**

Linear differential systems: Definitions and notations. Linear homogeneous systems; Existence and uniqueness theorem, Fundamental matrix,Adjoint systems, reduction to smaller homogeneous systems.

Non-homogeneous linear systems; variation of constants.Linear systems with constant coefficients.Linear systems with periodic coefficients; Floquet theory.

(Relevant portions from the book of 'Theory of Ordinary Differential Equations' by Coddington and Levinson)

**Unit: 2.**

System of differential equations.Differential equation of order n and its equivalent system of differential equations.Existence theorem for solution of system of differential equations. Dependence of solutions on initial conditions and parameters: Preliminaries, continuity and differentiability.

(Relevant portions from the book of 'Theory of Ordinary Differential Equations' by Coddington and Levinson)

**Unit: 3.**

Autonomous systems: the phase plane, paths and critical points, types of critical points; Node, Center, Saddle point, Spiral point. Stability of critical points. Critical points and paths of linear systems: basic theorems and their applications.Critical points and paths of quasilinear systems. (Relevant portions from the book 'Differential Equations' by S.L. Ross)

Maximal and Minimal solutions.Upper and Lower solutions.Differential inequalities. (Relevant portions from the book 'Textbook of Ordinary Differential Equations' by Deo et al.)

**Unit: 4.**

Stability of solution of system of equations with constant coefficients, linear equation with constant coefficients.Liapunov stability. Stability of quasi linear systems.

(Relevant portions from the book 'Textbook of Ordinary Differential Equations' by Deo et al.)

Limit cycles and periodic solutions: limit cycle, existence and non-existence of limit cycles, Benedixson's non-existence theorem. Half-path or Semiorbit, Limit set, Poincare-Benedixson theorem. (Relevant portions from the book 'Differential Equations' by S.L. Ross and the book 'Theory of Ordinary Differential Equations' by Coddington and Levinson)

**Recommended books:**


1. E.A. Coddington and N. Levinson, Theory of Ordinary Differential Equations, Tata McGraw-Hill, 2000.


05/7/17

(21)


2. S.L. Ross, Differential Equations, John Wiley & Sons
3. S.G. Deo, V. Lakshmikantham and V. Raghavendra, Textbook of Ordinary Differential Equations, Tata McGraw-Hill , 2006.
4. Mohan C Joshi, Ordinary Differential Equations, Modern Perspective, Narosa Publishing House, 2006.
5. P. Hartman, Ordinary Differential Equations, John Wiley & Sons NY, 1971.
6. G. Birkhoff and G.C. Rota, Ordinary Differential Equations, John Wiley & Sons, 1978.
7. G.F. Simmons, Differential Equations, Tata McGraw-Hill , 1993.
8. I.G. Petrovski, Ordinary Differential Equations, Prentice-Hall, 1966.
9. D. Somasundaram, Ordinary Differential Equations, A first Course, Narosa Pub., 2001.


05/07/17

22

## MTHCE–2205: Computer Programming in FORTRAN 90 & 95

**Marks (Theory): 30** — **Marks (Total): 100**
**Marks (Internal Assessment): 20** — **Time: 03 Hours**
**Marks (Practical): 50** — **Total Credit: 2+2=4**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of six short questions (1 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**
Numerical constants and variables; arithmetic expressions; input/output; conditional flow;

**Unit: 2.**
looping. Logical expressions and control flow; functions; subroutines; arrays.

**Unit: 3.**
Format specifications; strings; array arguments, derived data types.

**Unit: 4.**
Processing files; pointers; modules; FORTRAN 90 features; FORTRAN 95 features.

## Practical

### Implementation of the following programs in FORTRAN-90 & 95

1. Calculate the area of a triangle with given lengths of its sides.
2. Given the centre and a point on the boundary of a circle, find its perimeter and area.
3. To check an equation ax2+ by2+2cx+2dy+e=0 in (x, y) plane with given coefficients for representing parabola/ hyperbola/ ellipse/ circle or else.
4. For two given values x and y, verify g*g=a*h, where a, g and h denote the arithmetic, geometric and harmonic means respectively.
5. Use IF..THEN...ELSE to find the largest among three given real values.
6. To solve a quadratic equation with given coefficients, without using COMPLEX data type.
7. To find the location of a given point (x,y) i) at origin, ii) on x-axis or y-axis iii) in quadrant I, II, III or IV.
8. To find if a given 4-digit year is a leap year or not.
9. To find the greatest common divisor (gcd) of two given positive integers.
10. To verify that sum of cubes of first m positive integers is same as the square of the sum of these integers.
11. Find error in verifying sin(x+y)= sin(x) cos(y)+cos(x)sin(y), by approximating the sin(x) and cos(x) functions from the finite number of terms in their series expansions.
12. Use SELECT...CASE to calculate the income tax on a given income at the existing rates.

05/07/17

**Books Recommended:**

1. V. Rajaraman; Computer Programming in FORTRAN 90 and 95; Printice-Hall of India Pvt. Ltd., New Delhi, 1997.
2. V. Rajaraman; Computer Programming in FORTRAN 77, Printice-Hall of India Pvt. Ltd., New Delhi, 1984.
3. J.F. Kerrigan; Migrating of FORTRAN 90, Orielly Associates, CA, USA, 1993.
4. M.Metcalf and J.Reid; FORTRAN 90/95 Explained, OUP, Oxford, UK, 1996.

05/07/17

24

## MTHCE-2206: Methods of Applied Mathematics

**Marks (Theory): 70**
**Marks (Internal Assessment): 30**

**Marks (Total): 100**
**Time: 03 Hours**
**Total Credit: 4**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**

Curvilinear Co-ordinates: Co-ordinate transformation, Orthogonal Co-ordinates, Change of Co-ordinates, Cartesian, Cylindrical and spherical co-ordinates, expressions for velocity and accelerations, ds, dv and $ds^2$ in orthogonal co-ordinates, Areas, Volumes & surface areas in Cartesian, Cylindrical & spherical co-ordinates in a few simple cases, Grad, div, Curl, Laplacian in orthogonal Co-ordinates, Contravariant and Co-variant components of a vector, Metric coefficients & the volume element.

**Unit: 2.**

Hankel transforms, Definition, Elementary properties, Basic operational properties, Inversion theorem, Hankel transform of derivatives and some elementary functions, Relation between Fourier and Hankel transforms, Application of Hankel transform to Boundary Value Problem.

**Unit: 3.**

Mellin transforms, Definition, Elementary properties, Inversion theorem, Mellin transform of some elementary functions, derivatives and integrals. Convolution or Faulting theorem for the Mellin Transforms. Definition and properties of Hypergeometric functions, Properties of Confluent Hypergeometric function (Relevant portion of the Book by W. W. Bell).

**Unit: 4.**

Motivating problems of calculus of variations, shortest distance, minimum surface of revolution, Branchistochrone problem, isoperimetric problem, geodesic. Fundamental lemma of calculus of variations, Euler's equation for one dependent function and its generalization to 'n' dependent functions and to higher order derivatives, conditional extremum under geometric constraints and under integral constraints. Ritz, Galerkin and Kantorovich methods.

**Books Recommended:**

1. I. N. Sneddon; The Use of Integral Transforms.
2. W. W. Bell; Special Functions for Scientists and Engineers.
3. Schaum's Series; Laplace transforms.
4. Schaum's Series; Vector Analysis.
5. Lokenath Debnath; Integral Transforms and their Applications, CRC Press, Inc.
6. J. M. Gelfand and S. V. Fomin; Calculus of Variations, Prentice Hall, New Jersy.
7. Weinstock; Calculus of Variations, McGraw Hill.

25/07/17

25

# MTHCE-2207: Differential Geometry

**Marks (Theory): 70**
**Marks (Internal Assessment): 30**

**Marks (Total): 100**
**Time: 03 Hours**
**Total Credit: 4**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**

Curves: Tangent, principal normal, curvature, binormal, torsion, Serret-Frenet formulae, locus of center of curvature, spherical curvature, locus of centre of spherical curvature, curve determined by its intrinsic equations, helices, spherical indicatrix of tangent, etc., involutes, evolutes, Bertrand curves.

**Unit: 2.**

Envelopes and Developable Surface : Surfaces, tangent plane, normal. One parameter family of surfaces; Envelope, characteristics, edge of regression, developable surfaces. Developables associated with a curve; Osculating developable, polar developable, rectifying developable. Two parameter family of surfaces; Envelope, characteristic points and examples.

**Unit: 3.**

Curvilinear Coordinates, First order magnitudes, directions on a surface, the normal, second order magnitudes, derivatives of **n**, curvature of normal section, Meunier's theorem.
Curves on a surface : Principal directions and curvatures, first and second curvatures, Euler's theorem, Dupin's indicatrix, the surface z = f(x, y), surface of revolution. Conjugate systems; conjugate directions, conjugate systems. Asymptotic lines, curvature and torsion. Isometric lines; isometric parameters. Null lines, minimal curves.

**Unit: 4.**

The equations of Gauss and of Codazzi: Gauss's formulae for $\boldsymbol{r}_{11}, \boldsymbol{r}_{12}, \boldsymbol{r}_{22}$ , Gauss characteristic equation, Mainardi-Codazzi relations, alternative expression, Bonnet's theorem, derivatives of the angle $\omega$.
Geodesics: Geodesic property, equations of geodesics, surface of revolution, torsion of a geodesic. Curves in relation to Geodesics; Bonnet's theorem, Joachimsthal's theorems, vector curvature, geodesic curvature, Bonnet's formula.

**Recommended Book:**


1. C.E. Weatherburn, Differential Geometry of Three Dimensions, Radha Publishing House, Calcutta.
2. J.A. Thorpe, Introduction to Differential Geometry, Springer-verlag.
3. B.O. Neill, Elementary Differential Geometry, Academic Press, 1966.
4. S. Sternberg, Lectures on Differential Geometry, Prentice- Hall , 1964.
5. R.S. Millman and G.D. Parker, Elements of Differential Geometry, Prentice-Hall, 1977.
6. W. Kleingenberg, A course in Differential Geometry, Springer-verlag.


25/07/17

26

## MTHCE-2208: Mathematical Modeling

**Marks (Theory): 70**
**Marks (Internal Assessment): 30**

**Marks (Total): 100**
**Time: 03 Hours**
**Total Credit: 4**

Note: -

The examiner is required to set nine questions in all.
The first question will be compulsory consisting of seven short questions (2 marks each) covering the whole syllabus.
In addition, eight more questions will be set unit-wise comprising two questions from each of the four units. The students shall be required to attempt five questions in all selecting one question from each unit including compulsory question.

**Unit: 1.**

The process of Applied Mathematics; mathematical modeling: need, techniques, classification and illustrative; mathematical modeling through ordinary differential equation of first order; qualitative solutions through sketching.

**Unit: 2.**

Mathematical modeling in population dynamics, epidemic spreading and compartment models; mathematical mode1ing through systems of ordinary differential equations; mathematical mode1ing in economics, medicine, arm-race, battle.

**Unit: 3.**

Mathematical modeling through ordinary differential equations of second order. Higher order (linear) models. Mathematical modeling through difference equations: Need, basic theory; mathematical modeling in probability theory, economics, finance, population dynamics and genetics.

**Unit: 4.**

Mathematical modeling through partial differential equations: simple models, mass-balance equations, variational principles, probability generating function, traffic flow problems, initial & boundary conditions.

**Recommended Book:**


1. J.N. Kapur: Mathematical Modeling, Wiley Eastern Ltd., 1990
   (Relevant portions; Chapters 1 to 6)


05/07/17