Scheme of Examination and Syllabi
For the programme
M.Sc. Mathematics
(Regular Course)

(w.e.f. Session 2016-17)

as per
Choice Based Credit System (CBCS)
## Scheme of Examination of M.Sc. Mathematics, Semester- I
(w.e.f. Session 2016-17)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Theory Marks</th>
<th>Internal marks</th>
<th>Practical Marks</th>
<th>Credits (L:T:P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16MAT21C1</td>
<td>Abstract Algebra</td>
<td>80</td>
<td>20</td>
<td>--</td>
<td>4:1:0</td>
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<tr>
<td>16MAT21C2</td>
<td>Mathematical Analysis</td>
<td>80</td>
<td>20</td>
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<tr>
<td>16MAT21C3</td>
<td>Ordinary Differential Equations</td>
<td>80</td>
<td>20</td>
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<tr>
<td>16MAT21C4</td>
<td>Complex Analysis</td>
<td>80</td>
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<tr>
<td>16MAT21C5</td>
<td>Mathematical Statistics</td>
<td>80</td>
<td>20</td>
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</tbody>
</table>

**Total Credits : 25**

**Note 1 :** The Criteria for awarding internal assessment of 20 marks shall be as under:
- A) Class test : 10 marks.
- B) Assignment & Presentation : 5 marks
- C) Attendance : 5 marks
  - Less than 65% : 0 marks
  - Upto 70% : 2 marks
  - Upto 75% : 3 marks
  - Upto 80% : 4 marks
  - Above 80% : 5 marks

**Note 2 :** The syllabus of each course will be divided into four Sections of two questions each. The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section - V shall be compulsory and contain eight short answer type questions without any internal choice covering the entire syllabus.
16MAT21C1: Abstract Algebra

**Time:** 03 Hours

**Max Marks:** 80

**Credits:** 4:1:0

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**Section - I**
Conjugates and centralizers in $S_n$, p-groups, Group actions, Counting orbits.
Sylow subgroups, Sylow theorems, Applications of Sylow theorems, Description of group of order $p^2$ and $pq$, Survey of groups upto order 15.

**Section - II**
Normal and subnormal series, Solvable series, Derived series, Solvable groups, Solvability of $S_n$, the symmetric group of degree $n \geq 2$, Central series, Nilpotent groups and their properties, Equivalent conditions for a finite group to be nilpotent, Upper and lower central series.
Composition series, Zassenhaus lemma, Jordan-Hölder theorem.

**Section - III**
Modules, Cyclic modules, Simple and semi-simple modules, Schur lemma, Free modules, Torsion modules, Torsion free modules, Torsion part of a module, Modules over principal ideal domain and its applications to finitely generated abelian groups.

**Section - IV**
Noetherian and Artinian modules, Modules of finite length, Noetherian and Artinian rings, Hilbert basis theorem.
$\text{Hom}_{R}(R,R)$, Opposite rings, Wedderburn – Artin theorem, Maschke theorem, Equivalent statement for left Artinian rings having non-zero nilpotent ideals.
Radicals: Jacobson radical, Radical of an Artinian ring.

**Note:** The question paper of each course will consist of **five** Sections. Each of the sections **I to IV** will contain **two** questions and the students shall be asked to attempt **one** question from each. **Section-V** shall be **compulsory** and will contain **eight** short answer type questions without any internal choice covering the entire syllabus.

**Books Recommended:**
Section - I
Riemann-Stieltjes integral, Existence and properties, Integration and differentiation, The fundamental theorem of calculus, Integration of vector-valued functions, Rectifiable curves.

Section - II
Sequence and series of functions, Pointwise and uniform convergence, Cauchy criterion for uniform convergence, Weirstrass M test, Abel and Dirichlet tests for uniform convergence, Uniform convergence and continuity, Uniform convergence and differentiation, Weierstrass approximation theorem.

Section - III
Power series, uniform convergence and uniqueness theorem, Abel theorem, Tauber theorem. Functions of several variables, Linear Transformations, Euclidean space $\mathbb{R}^n$, Derivatives in an open subset of $\mathbb{R}^n$, Chain Rule, Partial derivatives, Continuously Differentiable Mapping, Young and Schwarz theorems.

Section - IV
Taylor theorem, Higher order differentials, Explicit and implicit functions, Implicit function theorem, Inverse function theorem, Change of variables, Extreme values of explicit functions, Stationary values of implicit functions, Lagrange multipliers method, Jacobian and its properties.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
Section - I
Preliminaries, \( \varepsilon \)-approximate solution, Cauchy-Euler construction of an \( \varepsilon \)-approximate solution of an initial value problem, Equicontinuous family of functions, Ascoli-Arzela Lemma, Cauchy-Peano existence theorem.
Lipschitz condition, Picards-Lindelof existence and uniqueness theorem for \( \frac{dy}{dt} = f(t,y) \).
Solution of initial-value problems by Picards method, Dependence of solutions on initial conditions (Relevant topics from the books by Coddington & Levinson, and Ross).

Section - II
Strum Theory, Self-adjoint equations of the second order, Abel formula, Strum Separation theorem, Strum Fundamental comparison theorem.
(Relevant topics from chapters 7 and 11 of book by Ross)

Section - III
Nonlinear differential systems, Phase plane, Path, Critical points, Autonomous systems, Isolated critical points, Path approaching a critical point, Path entering a critical point, Types of critical points- Center, Saddle points, Spiral points, Node points, Stability of critical points, Asymptotically stable points, Unstable points, Critical points and paths of linear systems. Almost linear systems. (Relevant topics from chapter 13 of book by Ross).

Section - IV
Nonlinear conservative dynamical system, Dependence on a parameter, Liapunov direct method, Limit cycles, Periodic solutions, Bendixson nonexistence criterion, Poincare-Bendixson theorem(statement only), Index of a critical point.
Strum-Liouville problems, Orthogonality of characteristic functions. (Relevant topics from chapters 12 and 13 of the book by Ross).

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
16MAT21C4: Complex Analysis

**Time: 03 Hours**

**Max Marks: 80**

**Credits: 4:1:0**

**Section - I**

Function of a complex variable, Continuity, Differentiability, Analytic functions and their properties, Cauchy-Riemann equations in cartesian and polar coordinates, Power series, Radius of convergence, Differentiability of sum function of a power series, Branches of many valued functions with special reference to argz, logz and za.

**Section - II**

Path in a region, Contour, Complex integration, Cauchy theorem, Cauchy integral formula, Extension of Cauchy integral formula for multiple connected domain, Poisson integral formula, Higher order derivatives, Complex integral as a function of its upper limit, Morera theorem, Cauchy inequality, Liouville theorem, Taylor theorem.

**Section - III**


**Section - IV**

Calculus of residues, Cauchy residue theorem, Evaluation of integrals of the types ∫₀²π f(cosθ, sinθ)dθ, ∫₋∞∞ f(x)dx, ∫₋∞∞ f(x)sin mx dx and ∫₋∞∞ f(x)cos mx dx. Conformal mappings.

Space of analytic functions and their completeness, Hurwitz theorem, Montel theorem, Riemann mapping theorem.

**Note:** The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

**Books Recommended:**

Section - I
Probability: Definition and various approaches of probability, Addition theorem, Boole inequality, Conditional probability and multiplication theorem, Independent events, Mutual and pairwise independence of events, Bayes theorem and its applications.

Section - II
Random variable and probability functions: Definition and properties of random variables, Discrete and continuous random variables, Probability mass and density functions, Distribution function. Concepts of bivariate random variable: joint, marginal and conditional distributions.

Section - III
Discrete distributions: Uniform, Bernoulli, Binomial, Poisson and Geometric distributions with their properties.
Continuous distributions: Uniform, Exponential and Normal distributions with their properties.

Section - IV
Testing of hypothesis: Parameter and statistic, Sampling distribution and standard error of estimate, Null and alternative hypotheses, Simple and composite hypotheses, Critical region, Level of significance, One tailed and two tailed tests, Two types of errors.
Tests of significance: Large sample tests for single mean, Single proportion, Difference between two means and two proportions.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books recommended:
Scheme of Examination of
M.Sc. Mathematics, Semester-II
(w.e.f. Session 2016-17)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Theory Marks</th>
<th>Internal Marks</th>
<th>Practical Marks</th>
<th>Credits (L:T:P)</th>
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<tbody>
<tr>
<td>16MAT22C1</td>
<td>Theory of Field Extensions</td>
<td>80</td>
<td>20</td>
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<td>3:1:0</td>
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<tr>
<td>16MAT22C2</td>
<td>Measure and Integration Theory</td>
<td>80</td>
<td>20</td>
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<td>3:1:0</td>
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<tr>
<td>16MAT22C3</td>
<td>Integral Equations and Calculus of Variations</td>
<td>80</td>
<td>20</td>
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<td>4:1:0</td>
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<tr>
<td>16MAT22C4</td>
<td>Partial Differential Equations</td>
<td>80</td>
<td>20</td>
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<td>4:1:0</td>
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<tr>
<td>16MAT22C5</td>
<td>Operations Research Techniques</td>
<td>80</td>
<td>20</td>
<td>--</td>
<td>4:1:0</td>
</tr>
</tbody>
</table>

**Foundation Elective**

To be Chosen from the pool of foundation electives provided by the university.  2

**Open Elective**

To be Chosen from the pool of open electives provided by the university
(excluding the open elective prepared by the Department of Mathematics).  3

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Theory Marks</th>
<th>Internal Marks</th>
<th>Practical Marks</th>
<th>Credits (L:T:P)</th>
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</thead>
<tbody>
<tr>
<td>16MAT22SO1</td>
<td>Mathematics for Finance and Insurance</td>
<td>80</td>
<td>20</td>
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<td>3:0:0</td>
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<tr>
<td>16MAT22SO2</td>
<td>Statistics through SPSS</td>
<td>40</td>
<td>--</td>
<td>60</td>
<td>1:0:2</td>
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</tbody>
</table>

**Total Credits : 28**

**Note 1 :** The Criteria for awarding internal assessment of 20 marks shall be as under:
A) Class test : 10 marks.
B) Assignment & Presentation : 5 marks
C) Attendance : 5 marks
  Less than 65% : 0 marks
  Upto 70% : 2 marks
  Upto 75% : 3 marks
  Upto 80% : 4 marks
  Above 80% : 5 marks

**Note 2 :** The syllabus of each course will be divided into **four** Sections of **two** questions each. The question paper of each course will consist of **five** Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt **one** question from each. Section - V shall be compulsory and contain **eight** short answer type questions without any internal choice covering the entire syllabus.

**Note 3 :** Elective courses can be offered subject to availability of requisite resources/faculty.
16MAT22C1: Theory of Field Extensions

Time: 03 Hours
Max Marks: 80
Credits: 3:1:0

Section - I

Section - II

Section - III
Normal basis, Galois fields, Cyclotomic extensions, Cyclotomic polynomials, Cyclotomic extensions of rational number field, Cyclic extension, Wedderburn theorem.

Section - IV
Ruler and compasses construction, Solutions by radicals, Extension by radicals, Generic polynomial, Algebraically independent sets, Insolvability of the general polynomial of degree \( n \geq 5 \) by radicals.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
16MAT22C2: Measure and Integration Theory

Time: 03 Hours Credits : 3:1:0
Max Marks : 80

Section - I
Set functions, Intuitive idea of measure, Elementary properties of measure, Measurable sets and their fundamental properties. Lebesgue measure of a set of real numbers, Algebra of measurable sets, Borel set, Equivalent formulation of measurable sets in terms of open, Closed, $F_\sigma$ and $G_\delta$ sets, Non measurable sets.

Section - II

Section - III

Section - IV
Vitali covering lemma, Differentiation of monotonic functions, Function of bounded variation and its representation as difference of monotonic functions, Differentiation of indefinite integral, Fundamental theorem of calculus, Absolutely continuous functions and their properties.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
Section - I
Linear Integral equations, Some basic identities, Initial value problems reduced to Volterra integral equations, Methods of successive substitution and successive approximation to solve Volterra integral equations of second kind, Iterated kernels and Neumann series for Volterra equations. Resolvent kernel as a series. Laplace transform method for a difference kernel. Solution of a Volterra integral equation of the first kind.

Section - II

Section - III
Green function, Use of method of variation of parameters to construct the Green function for a nonhomogeneous linear second order boundary value problem, Basic four properties of the Green function, Alternate procedure for construction of the Green function by using its basic four properties. Reduction of a boundary value problem to a Fredholm integral equation with kernel as Green function, Hilbert-Schmidt theory for symmetric kernels.

Section - IV
Motivating problems of calculus of variations, Shortest distance, Minimum surface of resolution, Brachistochrone problem, Isoperimetric problem, Geodesic. Fundamental lemma of calculus of variations, Euler equation for one dependant function and its generalization to 'n' dependant functions and to higher order derivatives. Conditional extremum under geometric constraints and under integral constraints.

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
16MAT22C4: Partial Differential Equations

Time: 03 Hours  Credits : 4:1:0
Max Marks : 80

Section – I
Method of separation of variables to solve Boundary Value Problems (B.V.P.) associated with one dimensional heat equation. Steady state temperature in a rectangular plate, Circular disc, Semi-infinite plate. The heat equation in semi-infinite and infinite regions. Solution of three dimensional Laplace equations, Heat Equations, Wave Equations in cartesian, cylindrical and spherical coordinates. Method of separation of variables to solve B.V.P. associated with motion of a vibrating string. Solution of wave equation for semi-infinite and infinite strings. (Relevant topics from the book by O’Neil)

Section - II
Laplace equation – Fundamental solution, Mean value formula, Properties of harmonic functions, Green function.

Section - III
Wave Equation – Solution by spherical means, Non-homogeneous equations, Energy methods.

Section - IV

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
Section - I
Operations Research: Origin, Definition and scope.
Linear Programming: Formulation and solution of linear programming problems by graphical and simplex methods, Big - M and two-phase methods, Degeneracy, Duality in linear programming.

Section - II

Section - III
Concepts of stochastic processes, Poisson process, Birth-death process, Queuing models: Basic components of a queuing system, Steady-state solution of Markovian queuing models with single and multiple servers (M/M/1, M/M/C, M/M/1/k, M/M/C/k)

Section - IV
Inventory control models: Economic order quantity (EOQ) model with uniform demand, EOQ when shortages are allowed, EOQ with uniform replenishment, Inventory control with price breaks.
Game Theory: Two person zero sum game, Game with saddle points, The rule of dominance; Algebraic, Graphical and linear programming methods for solving mixed strategy games.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books recommended:
1. H.A. Taha, Operation Research-An introduction, Printice Hall of India.
16MAT22SO1 : Mathematics for Finance and Insurance

Time: 03 Hours
Max Marks : 80

Credits : 3:0:0

Section - I
Time value of Money - Interest rate and discount rate. Present value and future value-discrete case as well as continuous compounding case. Annuities and its kinds.

Section - II

Section - III

Section - IV

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
2. John C. Hull, Options, Futures, and Other Derivatives, Prentice-Hall of India Private Ltd.
5. C.D. Daykin, T. Pentikainen and M. Pesonen, Practical Risk Theory for Actuaries, Chapman & Hall.

16MAT22SO2: Statistics through SPSS

Credits : 1:0:2

Part-A (Theory)

Time : 03 Hours
Max Marks : 40

Section – I
Data: Qualitative and quantitative data, Cross-sectional and time series data, Univariate and multivariate data. Scales of measurement of data.
SPSS data file: Opening a data file in SPSS, SPSS Data Editor, Creating a data file, Editing and manipulating data, Missing values, Editing SPSS output, Copying SPSS output, Printing from SPSS, Importing data.

Section – II
Descriptive statistics with SPSS: Measures of central tendency, Dispersion, Skewness, Kurtosis.
Charts and graphs with SPSS: Frequencies, Bar charts, Pie charts, Line graphs, Histograms, Box plots.

Section – III
Statistical tests using SPSS: Normality tests, t-tests, F-test, One way and Two way ANOVA, Non-parametric tests- Chi Square, Spearman rank, Maan Whitney U and Wilcoxon signed rank test.

Section – IV
Correlation and regression using SPSS: Linear correlation and regression, Multiple regression.
Factor analysis using SPSS.

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
2. A. Field, Discovering Statistics using SPSS, SAGE Publications.
3. V. Gupta, SPSS for Beginners, VJ Books Inc.
4. A. Rajathi and P. Chandran, SPSS for you, MJP Publishers

Part-B (Practical)

Time: 03 Hours
Max Marks : 60

There will be a separate practical course based on the above theory course. All practicals are required to be done using SPSS (i.e. 16MAT22SO2: Statistics through SPSS).
# Scheme of Examination of M.Sc. Mathematics, Semester-III (w.e.f. Session 2017-18)

<table>
<thead>
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<th>Title of the Course</th>
<th>Theory Marks</th>
<th>Internal Marks</th>
<th>Practical Marks</th>
<th>Credit (L:T:P)</th>
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<td>17MAT23C1</td>
<td>Functional Analysis</td>
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<td>17MAT23C2</td>
<td>Elementary Topology</td>
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<tr>
<td>17MAT23C3</td>
<td>Fluid Dynamics</td>
<td>80</td>
<td>20</td>
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<tr>
<td>17MAT23DA1</td>
<td>Discrete Mathematics</td>
<td>80</td>
<td>20</td>
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<tr>
<td>17MAT23DA2</td>
<td>Fuzzy Set Theory</td>
<td>80</td>
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<tr>
<td>17MAT23DA3</td>
<td>Mechanics of Solids</td>
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<tr>
<td>17MAT23DA4</td>
<td>Difference Equations</td>
<td>80</td>
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<tr>
<td>17MAT23DA5</td>
<td>Statistical Inference</td>
<td>80</td>
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<td>17MAT23DA6</td>
<td>Programming in C</td>
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<tr>
<td>17MAT23DB1</td>
<td>Analytical Number Theory</td>
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<tr>
<td>17MAT23DB2</td>
<td>Advanced Complex Analysis</td>
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<tr>
<td>17MAT23DB3</td>
<td>Mathematical Modeling</td>
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<tr>
<td>17MAT23DB4</td>
<td>Computational Fluid Dynamics</td>
<td>80</td>
<td>20</td>
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<td>4:1:0</td>
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<tr>
<td>17MAT23DB5</td>
<td>Sampling Techniques and Design of Experiments</td>
<td>80</td>
<td>20</td>
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<td>4:1:0</td>
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<tr>
<td>17MAT23DB6</td>
<td>Computer Graphics</td>
<td>60</td>
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<td><strong>Group B (Any One)</strong></td>
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Open Elective
To be Chosen from the pool of open electives provided by the university (excluding the open elective prepared by the Department of Mathematics). 3

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Theory</th>
<th>Practical</th>
<th>Total</th>
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<tbody>
<tr>
<td>17MAT23SO1</td>
<td>Multivariate Analysis</td>
<td>80</td>
<td>20</td>
<td>3:0:0</td>
</tr>
<tr>
<td>17MAT23SO2</td>
<td>MATLAB</td>
<td>40</td>
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Total Credits : 31

Note 1: The Criteria for awarding internal assessment of 20 marks shall be as under:
   A) Class test : 10 marks.
   B) Assignment & Presentation : 5 marks
   C) Attendance : 5 marks
      Less than 65% : 0 marks
      Upto 70% : 2 marks
      Upto 75% : 3 marks
      Upto 80% : 4 marks
      Above 80% : 5 marks

Note 2: The syllabus of each course will be divided into four Sections of two questions each. The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section - V shall be compulsory and contain eight short answer type questions without any internal choice covering the entire syllabus.

Note 3: Elective courses can be offered subject to availability of requisite resources/faculty.
17MAT23C1: Functional Analysis

Time: 03 Hours
Max Marks : 80

Credits : 4:1:0

Section - I

Section - II
Finite dimensional normed linear spaces and Subspaces, Bounded linear transformation, Equivalent formulation of continuity, Spaces of bounded linear transformations, Continuous linear functional, Conjugate spaces. Hahn-Banach extension theorem (Real and Complex form).

Section - III
Riesz Representation theorem for bounded linear functionals on $L^p$ and $C[a,b]$. Second conjugate spaces, Reflexive space, Uniform boundedness principle and its consequences, Open mapping theorem and its application, Projections, Closed Graph theorem.

Section - IV

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
**Section - I**
Definition and examples of topological spaces, Comparison of topologies on a set, Intersection and union of topologies on a set, Neighbourhoods, Interior point and interior of a set, Closed set as a complement of an open set, Adherent point and limit point of a set, Closure of a set, Derived set, Properties of Closure operator, Boundary of a set, Dense subsets, Interior, Exterior and boundary operators, Alternative methods of defining a topology in terms of neighbourhood system and Kuratowski closure operator.

**Section - II**
Relative(Induced) topology, Base and subbase for a topology, Base for Neighbourhood system. Continuous functions, Open and closed functions, Homeomorphism. Connectedness and its characterization, Connected subsets and their properties, Continuity and connectedness, Components, Locally connected spaces.

**Section - III**
Compact spaces and subsets, Compactness in terms of finite intersection property, Continuity and compact sets, Basic properties of compactness, Closeness of compact subset and a continuous map from a compact space into a Hausdorff and its consequence. Sequentially and countably compact sets, Local compactness and one point compatification.

**Section - IV**
First countable, Second countable and separable spaces, Hereditary and topological property, Countability of a collection of disjoint open sets in separable and second countable spaces, Lindelof theorem. $T_0$, $T_1$, $T_2$ (Hausdorff) separation axioms, their characterization and basic properties.

**Note:** The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

**Books Recommended:**
Section - I

Section - II

Section - III
Axially symmetric flows. Liquid streaming past a fixed sphere. Motion of a sphere through a liquid at rest at infinity. Equation of motion of a sphere. Kinetic energy generated by impulsive motion. Motion of two concentric spheres. Three-dimensional sources, sinks and doublets. Images of sources, sinks and doublets in rigid impermeable infinite plane and in impermeable spherical surface.

Section - IV

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
2. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
17MAT23DA1: Discrete Mathematics

Time: 03 Hours
Max Marks: 80
Credits: 4:1:0

Section - I
Recurrence Relations and Generating Functions, Some number sequences, Linear homogeneous recurrence relations, Non-homogeneous recurrence relations, Generating functions, Recurrences and generating functions, Exponential generating functions.

Section - II
Statements Symbolic Representation and Tautologies, Quantifiers, Predicates and validity, Prepositional Logic.
Lattices as partially ordered sets, their properties, Lattices as Algebraic systems. Sub lattices, Direct products and Homomorphism, Some special lattices e.g. complete, Complemented and Distributive Lattices.

Section - III
Boolean Algebras as Lattices, Various Boolean Identities, The switching Algebra. Example, Subalgebras, Direct Products and Homomorphism, Joint-irreducible elements, Atoms and Minterms, Boolean forms and their equivalence, Minterm Boolean forms, Sum of Products, Cononical forms, Minimization of Boolean functions, Applications of Boolean Algebra to Switching Theory ( using AND, OR and NOT gates.) The Karnaugh method.

Section - IV
Finite state Machines and their Transition table diagrams, Equivalence of Finite State, Machines, Reduced Machines, Homomorphism. Finite automata, Acceptors, Non-deterministic, Finite Automata and equivalence of its power to that of deterministic Finite automata, Moore and Mealy Machines.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
17MAT23DA2: Fuzzy Set Theory

Time: 03 Hours
Max Marks : 80

Credits : 4:1:0

Section - I
Definition of Fuzzy Set, Expanding Concepts of Fuzzy Set, Standard Operations of Fuzzy Set, Fuzzy Complement, Fuzzy Union, Fuzzy Intersection, Other Operations in Fuzzy Set, T-norms and T-conorms. (Chapter 1, 2 of [1])

Section - II

Section - III
Graph and Fuzzy Graph, Fuzzy Graph and Fuzzy Relation, \( \alpha \)-cut of Fuzzy Graph, Fuzzy Network, Reflexive Relation, Symmetric Relation, Transitive Relation, Transitive Closure, Fuzzy Equivalence Relation, Fuzzy Compatibility Relation, Fuzzy Pre-order Relation, Fuzzy Order Relation, Fuzzy Ordinal Relation, Dissimilitude Relation, Fuzzy Morphism, Examples of Fuzzy Morphism. (Chapter 4 of [1])

Section - IV
Interval, Fuzzy Number, Operation of Interval, Operation of \( \alpha \)-cut Interval, Examples of Fuzzy Number Operation, Definition of Triangular Fuzzy Number, Operation of Triangular Fuzzy Number, Operation of General Fuzzy Numbers, Approximation of Triangular Fuzzy Number, Operations of Trapezoidal Fuzzy Number, Bell Shape Fuzzy Number. (Chapter 5 of [1]).

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
17MAT23DA3: Mechanics of Solids

Time: 03 Hours  Credits: 4:1:0
Max Marks: 80

Section - I
Cartesian tensors of different orders, Contraction of a tensor, Multiplication and quotient laws for tensors, Substitution and alternate tensors, Symmetric and skew symmetric tensors, Isotropic tensors, Eigenvalues and eigenvectors of a second order symmetric tensor.

Section - II
Analysis of Stress: Stress vector, Normal stress, Shear stress, Stress components, Cauchy equations of equilibrium, Stress tensor of order two, Symmetry of stress tensor, Stress quadric of Cauchy, Principal stresses, Stress invariants, Maximum normal and shear stresses, Mohr diagram.

Section - III
Analysis of Strain: Affine transformations, Infinitesimal affine deformation, Pure deformation, Components of strain tensor and their geometrical meanings, Strain quadric of Cauchy, principal strains, Strain invariants, General infinitesimal deformation, Saint-Venant conditions of compatibility, Finite deformations.

Section - IV

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
Section - I

Section - II
Linear Difference Equations: First Order Equations, General Results for Linear Equations, Solving Linear Equations, Applications, Equations with Variable Coefficients, Nonlinear Equations that can be Linearized, The z-Transform.

Section - III

Section - IV

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Recommended Books:
3. Saber Elaydi, An Introduction to Difference Equations, Springer
17MAT23DA5: Statistical Inference

Time: 03 Hours
Max Marks: 80
Credits: 4:1:0

Section – I
Point and interval estimation, Unbiasedness, Efficiency, Consistency and Sufficiency. Methods of maximum likelihood and Moments for estimation.

Section – II
Definition of Chi-square statistic, Chi-square tests for goodness of fit and independence of attributes. Definition of Student ‘t’ and Snedcor F-statistics. Testing for the mean and variance of univariate normal distributions, Testing of equality of two means and two variances of two univariate normal distributions. Related confidence intervals.

Section – III

Section – IV
Definition of order statistics and their distributions, Non-parametric tests, Sign test for univariate and bi-variate distribution, Run test, Median test and Mann Whitney-U-test.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
17MAT23DA6: Programming in C

Credits : 3:0:2

Part-A (Theory)

Time : 03 Hours
Max Marks : 60

Section - I

Section - II

Section - III

Section - IV

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:

Part-B (Practical)

Time: 03 Hours
Max Marks : 40

There will be a separate practical course based on the above theory course (i.e. 17MAT23DA6: Programming in C).
17MAT23DB1: Analytical Number Theory

Time: 03 Hours
Max Marks: 80

Credits: 4:1:0

Section - I
Distribution of primes, Fermat and Mersenne numbers, Farey series and some results concerning Farey series, Approximation of irrational numbers by rationals, Hurwitz theorem, Irrationality of e and π.

Section - II
The arithmetic in \( Z_n \), The group \( U_n \), Primitive roots and their existence, the group \( U_p^n \) (p-odd) and \( U_2^n \), The group of quadratic residues \( Q_n \), Quadratic residues for prime power moduli and arbitrary moduli, The algebraic structure of \( U_n \) and \( Q_n \).

Section - III
Riemann Zeta Function \( \zeta(s) \) and its convergence, Application to prime numbers, \( \zeta(s) \) as Euler product, Evaluation of \( \zeta(2) \) and \( \zeta(2k) \).
Diophantine equations \( ax + by = c \), \( x^2 + y^2 = z^2 \) and \( x^4 + y^4 = z^4 \), The representation of number by two or four squares, Waring problem, Four square theorem, The numbers \( g(k) \) & \( G(k) \), Lower bounds for \( g(k) \) & \( G(k) \).

Section - IV
Arithmetic functions \( \phi(n) \), \( \tau(n) \), \( \sigma(n) \) and \( \sigma_k(n) \), \( U(n) \), \( N(n) \), \( I(n) \), Definitions and examples and simple properties, Perfect numbers, Mobius inversion formula, The Mobius function \( \mu_n \), The order and average order of the function \( \phi(n) \), \( \tau(n) \) and \( \sigma(n) \).

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
17MAT23DB2: Advanced Complex Analysis

**Time:** 03 Hours  
**Credits:** 4:1:0  
**Max Marks:** 80

**Section - I**
Integral Functions, Factorization of an integral function, Weierstrass primary factors, Weierstrass’ factorization theorem, Gamma function and its properties, Stirling formula, Integral version of gamma function, Riemann Zeta function, Riemann functional equation, Mittag-Leffler theorem, Runge theorem (Statement only).

**Section - II**

**Section - III**
Harnack inequality, Harnack theorem, Dirichlet region, Green function, Canonical product, Jensen formula, Poisson-Jensen formula, Hadamard three circles theorem, Growth and order of an entire function, An estimate of number of zeros, Exponent of convergence, Borel theorem, Hadamard factorization theorem.

**Section - IV**
The range of an analytic function, Bloch theorem, Schottky theorem, Little Picard theorem, Montel Caratheodory theorem, Great Picard theorem, Univalent functions, Bieberbach conjecture (Statement only) and the “1/4 theorem”.

**Note:** The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

**Books Recommended**
Section - I

Section - II

Section - III

Section - IV

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
2. J.N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East-West Press (P) Ltd.
17MAT23DB4: Computational Fluid Dynamics

**Time:** 03 Hours  
**Max Marks:** 80  
**Credits:** 4:1:0

**Section - I**  
Basic equations of Fluid dynamics. Analytic aspects of partial differential equations-classification, Boundary conditions, Maximum principles, Boundary layer theory.  

**Section - II**  
Incompressible Navier-Stokes equations. Boundary conditions. Spatial discretization on collocated and on staggered grids. Temporal discretization on staggered grid and on collocated grid.

**Section - III**  
Iterative methods for incompressible Navier-Stokes equations.  
Shallow-water equations – One and two dimensional cases. Godunov order barrier theorem.

**Section - IV**  

**Note:** The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

**Books Recommended:**  
Section - I
Concepts of census and sample survey, Principal steps involved in a sample survey, sampling and non-sampling errors, Bias, Precision and accuracy. Simple random sampling (SRS) with and without replacement. Use of random number tables, Estimate of population mean and its variance in case of simple random sampling, Simple random sampling of attributes.

Section - II
Stratified random sampling, Estimate of population mean and its variance in case of stratified sampling; Proportional and optimum allocation; Comparison of stratified random sampling with simple random sampling without stratification. Idea of systematic sampling and its various results (without derivation).

Section - III
Terminology in experimental designs: Experiment, Treatments, experimental unit, Blocks, Yield, Experimental error, Replication, Precision, Efficiency of a design, Uniformity trials; Fundamental principles of experimental design, Size and shape of plots and blocks; Layout and analysis of completely randomised design (CRD) and randomised block design (RBD); Efficiency of RBD relative to CRD.

Section - IV
Latin Square Design (LSD) and its analysis, Efficiency of LSD relative to RBD and CRD. Factorial designs – $2^2$ and $2^3$ designs, Illustrations, Main effects, Interaction effects and analysis of these designs.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books recommended:
17MAT23DB6: Computer Graphics

Credits : 3:0:2

Part-A (Theory)

Time : 03 Hours
Max Marks : 60

Section – I
Line drawing algorithms: DDA, Bresenham Line Drawing Algorithm.
Circle drawing algorithms: Bresenham circle drawing, Midpoint circle drawing algorithm.

Section - II
Two/Three Dimensional Viewing: The 2-D Viewing Pipeline, Windows, Viewports, Window to View Port Mapping.
Two dimensional transformations: Transformations, Translation, Scaling, Rotation, Reflection, Composite Transformation.
Three dimensional transformations: Three dimensional graphics concept, Matrix representation of 3-D Transformations, Composition of 3-D transformation.

Section - III
Clipping: Point and Line Clipping - 4 Bit Code Algorithm, Sutherland-Cohen Algorithm
Polygon Clipping: Sutherland-Hodgeman Polygon Clipping Algorithm.

Section – IV
Filled area algorithms: Scanline Polygon filling algorithm, Boundary filled algorithm.

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
8. Introduction to Computer Graphics By N. Krishnamurthy T.M.H 2002

Part-B (Practical)

Time: 03 Hours
Max Marks : 40

There will be a separate practical course based on the above theory course (i.e. 17MAT23DB6: Computer Graphics).
17MAT23SO1: Multivariate Analysis

**Time**: 03 Hours

**Max Marks**: 80

**Credits**: 3:0:0

**Section - I**
Multivariate normal distribution, Marginal and conditional distributions, Characteristic function. Distribution of linear combinations of normal vector

**Section - II**
Maximum likelihood estimators of mean vector and covariance matrix. Distribution of sample mean vector, Distribution of quadratic forms. Correlation coefficient of a bivariate sample, Partial and multiple correlation coefficients.

**Section - III**
Derivation of generalised $T^2$-statistic and its distribution, Uses of $T^2$-statistic. The problem of classification, Procedures of classification of one of the two populations with known probabilities. Wishart matrix - its distribution(without proof) and properties. Generalised variance.

**Section - IV**

**Note**: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

**Books Recommended**
2. C.R. Rao, Linear Statistical Inference and its Applications, John Wiley
17MAT23SO2: MATLAB

Credits : 1:0:2

Part-A (Theory)

Time : 03 Hours
Max Marks : 40

Section-I
Introduction to MATLAB Programming: Basics of MATLAB programming, Anatomy of a program, Variables and assignments, Data types, Operators, Working with complex numbers, Mathematical operations, Functions for input and output, Good programming style. Introduction to vectors in Matlab: Defining a Vector, Accessing elements within a vector, Basic operations on vectors

Section-II
Strings, String functions, Cell array, Creating cell array, Introduction to Matrices in Matlab: Defining Matrices, Matrix functions, Matrix operations, Vector functions
Loops: for loops, While loops, Branching (conditional statements) - if statement, If else statement, Else if statement, Executable files, Subroutines, Built in functions and user-defined functions, Function handles, Function handles in m-files, Inline functions.

Section-III

Section-IV
Data files: Saving and recalling data, Saving a session as text, C style read/write, Graphs and plots - Basic 2-D plots, Overlay plots, Specialized 2-D plots, 3-D plots, Interpolated surface plots, Using subplots for multiple graphs, Saving and printing graphs, Mesh, Contour, Contourf, Using built-in algorithms: optimization and numerical integration (areas), Root-finding.

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
1. Amos Gilat, MATLAB An Introduction With Applications 5ed, Publisher: Wiley.
5. Rudra Pratap, Getting Started with MATLAB, Oxford University Press.

Part-B (Practical)

Time: 03 Hours
Max Marks : 60

There will be a separate practical course based on the above theory course (i.e. 17MAT23SO2: MATLAB).
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<thead>
<tr>
<th>Course Code</th>
<th>Title of the Course</th>
<th>Theory Marks</th>
<th>Internal Marks</th>
<th>Practical Marks</th>
<th>Credit (L:T:P)</th>
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<tr>
<td>17MAT24C1</td>
<td>Inner Product Spaces and Measure Theory</td>
<td>80</td>
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<td>Classical Mechanics</td>
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<td>17MAT24C3</td>
<td>Viscous Fluid Dynamics</td>
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**Core**

**Discipline Specific Elective**

**Group A (Any One)**

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<th>Course Code</th>
<th>Title of the Course</th>
<th>Theory Marks</th>
<th>Internal Marks</th>
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<th>Credit (L:T:P)</th>
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<tr>
<td>17MAT24DA1</td>
<td>General Topology</td>
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<td>17MAT24DA2</td>
<td>Graph Theory</td>
<td>80</td>
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<td>17MAT24DA3</td>
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<td>17MAT24DA4</td>
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<td>17MAT24DA5</td>
<td>Information Theory</td>
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<tr>
<td>17MAT24DA6</td>
<td>Object Oriented Programming with C++</td>
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**Group B (Any One)**

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<th>Internal Marks</th>
<th>Practical Marks</th>
<th>Credit (L:T:P)</th>
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<tr>
<td>17MAT24DB1</td>
<td>Algebraic Number Theory</td>
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<td>17MAT24DB2</td>
<td>Harmonic Analysis</td>
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<td>Bio-Fluid Dynamics</td>
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<td>17MAT24DB5</td>
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<td>17MAT24DB6</td>
<td>Information and Communication Technology</td>
<td>60</td>
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<td>40</td>
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**Total Credits**: 25

**Note 1**: The Criteria for awarding internal assessment of 20 marks shall be as under:

A) Class test : 10 marks.
B) Assignment & Presentation : 5 marks
C) Attendance : 5 marks
   Less than 65% : 0 marks
   Upto 70% : 2 marks
   Upto 75% : 3 marks
   Upto 80% : 4 marks
   Above 80% : 5 marks
Note 2: The syllabus of each course will be divided into four Sections of two questions each. The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section - V shall be compulsory and contain eight short answer type questions without any internal choice covering the entire syllabus.

Note 3: Elective courses can be offered subject to availability of requisite resources/faculty.
Section - I
Hilbert Spaces: Inner product spaces, Hilbert spaces, Schwarz inequality, Hilbert space as normed linear space, Convex sets in Hilbert spaces, Projection theorem, Orthonormal sets, Separability, Total Orthonormal sets, Bessel inequality, Parseval identity.

Section - II
Conjugate of a Hilbert space, Riesz representation theorem in Hilbert spaces, Adjoint of an operator on a Hilbert space, Reflexivity of Hilbert space, Self-adjoint operators, Positive operators, Product of Positive Operators.

Section-III
Projection operators, Product of Projections, Sum and Difference of Projections, Normal and unitary operators, Projections on Hilbert space, Spectral theorem on finite dimensional space. Convex functions, Jensen inequalities, Measure space, Generalized Fatou lemma, Measure and outer measure, Extension of a measure, Caratheodory extension theorem.

Section - IV
Signed measure, Hahn decomposition theorem, Jordan decomposition theorem, Mutually signed measure, Radon–Nikodym theorem, Lebesgue decomposition, Lebesgue - Stieltjes integral, Product measures, Fubini theorem, Baire sets, Baire measure, Continuous functions with compact support.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
17MAT24C2: Classical Mechanics

Time: 03 Hours  Credits: 4:1:0
Max Marks: 80

Section – I
Moments and products of inertia, Angular momentum of a rigid body, Principal axes and principal moment of inertia of a rigid body, Kinetic energy of a rigid body rotating about a fixed point, Momental ellipsoid and equimoment systems, Coplanar mass distributions, General motion of a rigid body. (Relevant topics from the book of Chorlton).

Section – II
Free & constrained systems, Constraints and their classification, Holonomic and non-holonomic systems, Degree of freedom and generalised coordinates, Virtual displacement and virtual work, Statement of principle of virtual work (PVW), Possible velocity and possible acceleration, Ideal constraints, General equation of dynamics for ideal constraints, Lagrange equations of the first kind. D' Alembert principle, Independent coordinates and generalized forces, Lagrange equations of the second kind, Generalized velocities and accelerations. Uniqueness of solution, Variation of total energy for conservative fields. Lagrange variable and Lagrangian function L(t, Qi, q̇i), Lagrange equations for potential forces, Generalized momenta p_i.

Section - III

Section - IV
Canonical transformation, Necessary and sufficient condition for a canonical transformation, Univalent Canonical transformation, Free canonical transformation, Hamilton-Jacobi equation, Jacobi theorem, Method of separation of variables in HJ equation, Lagrange brackets, Necessary and sufficient conditions of canonical character of a transformation in terms of Lagrange brackets, Jacobian matrix of a canonical transformation, Conditions of canonicity of a transformation in terms of Poisson brackets, Invariance of Poisson Brackets under canonical transformation.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
17MAT24C3: Viscous Fluid Dynamics

Time: 03 Hours
Max Marks : 80

Credits : 4:1:0

Section - I

Section - II

Section - III

Section - IV

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
2. F. Chorlton, Text Book of Fluid Dynamics, C.B.S. Publishers, Delhi, 1985
17MAT24DA1: General Topology

Time: 03 Hours
Max Marks: 80

Credits : 4:1:0

Section - I
Regular, Normal, T$_3$ and T$_4$ separation axioms, Their characterization and basic properties, Urysohn lemma and Tietze extension theorem, Regularity and normality of a compact Hausdorff space, Complete regularity, Complete normality, T$_{5rac{1}{2}}$ and T$_5$ spaces, Their characterization and basic properties.

Section - II
Embedding and Metrization : Embedding lemma and Tychonoff embedding theorem, Metrizable spaces, Urysohn metrization theorem.

Section - III
Nets : Nets in topological spaces, Convergence of nets, Hausdorffness and nets, Subnet and cluster points, Compactness and nets, Filters : Definition and examples, Collection of all filters on a set as a poset, Methods of generating filters and finer filters, Ultra filter and its characterizations, Ultra filter principle, Image of filter under a function, Limit point and limit of a filter, Continuity in terms of convergence of filters, Hausdorffness and filters, Canonical way of converting nets to filters and vice versa, Stone-Cech compactification(Statement Only).

Section - IV
Covering of a space, Local finiteness, Paracompact spaces, Paracompactness as regular space, Michael theorem on characterization of paracompactness, Paracompactness as normal space, A. H. Stone theorem, Nagata- Smirnov Metrization theorem.

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
Section - I
Definition and types of graphs, Walks, Paths and Circuits, Connected and Disconnected graphs, Applications of graphs, operations on Graphs, Graph Representation, Isomorphism of Graphs.

Section - II
Eulerian and Hamiltonian paths, Shortest Path in a Weighted Graph, The Travelling Salesperson Problem, Planar Graphs, Detection of Planarity and Kuratowski Theorem, Graph Colouring.

Section - III
Directed Graphs, Trees, Tree Terminology, Rooted Labeled Trees, Prefix Code, Binary Search Tree, Tree Traversal.

Section - IV

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
2. F. Harary: Graph Theory, Addition Wesley, 1969.
Section - I
Two dimensional problems: Plane strain deformation, State of plane stress, Generalized plane stress, Airy stress function for plane strain problems, Solutions of a two-dimensional biharmonic equation using Fourier transform as well as in terms of two analytic functions, Expressions for stresses and displacements in terms of complex potentials, Deformation of a thick-walled elastic tube under external and internal pressures.

Section - II
Torsion of Beams: Torsion of a circular cylindrical beam, Torsional rigidity, Torsion and stress functions, Lines of shearing stress, Torsion of a beam of arbitrary cross-section and its special cases for circular, elliptic and equilateral triangular cross-sections, Circular groves in an circular beam.
Extension of Beams: Extension of beams by longitudinal forces, Beams stretched by its own weight.

Section - III
Bending of Beams: Bending of beams by terminal couples, Bending of a beam by transverse load at the centroid of the end section along a principal axis.
Variational Methods: One-dimensional Ritz method, Two - dimensional Ritz method, Galerkin method, Application to torsion of beams (Relevant topics from the Sokolnikof book).

Section - IV

Note : The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
Section - I
Newton equations of motion, Mathematical modeling, Continuum approach, Segmental movement and vibrations, Lagrange equations, Normal modes of vibration, Decoupling of equations of motion.
Flow around an airfoil, Flow around bluff bodies, Steady state aeroelastic problems, Transient fluid dynamics forces due to unsteady motion, Flutter.

Section - II
Kutta-Joukowski theorem, Circulation and vorticity in the wake, Vortex system associated with a finite wing in nonsteady motion, Thin wing in steady flow.
Blood flow in heart, lungs, arteries, and veins, Field equations and boundary conditions, Pulsatile flow in arteries, Progressive waves superposed on a steady flow, Reflection and transmission of waves at junctions.

Section - III
Micro- and macrocirculation, Rheological properties of blood, Pulmonary capillary blood flow, Respiratory gas flow, Intraaction between convection and diffusion, Dynamics of the ventilation system.

Section - IV
Laws of thermodynamics, Gibbs and Gibbs – Duhem equations, Chemical potential, Entropy in a system with heat and mass transfer, Diffusion, Filtration, and fluid movement in interstitial space in thermodynamic view, Diffusion from molecular point of view.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
Section - I

Section - II

Section - III
Discrete memoryless channel - Classification of channels. Information processed by a channel. Calculation of channel capacity. Decoding schemes. The ideal observer. The fundamental theorem of information theory.

Section - IV
Continuous channels - The time-discrete Gaussian channel. Uncertainty of an absolutely continuous random variable. The converse to the coding theorem for time-discrete Gaussian channel. The time-continuous Gaussian channel. Band-limited channels.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
17MAT24DA6 : Object Oriented Programming with C++

Credits : 3:0:2

**Part-A (Theory)**

**Time : 03 Hours**  
**Max Marks : 60**

**Section - I**

C++ programming basics: Input/Output, Data types, Operators, Expressions, Control structures, Library functions.

**Section - II**

Functions in C++ : Passing arguments to and returning values from functions, Inline functions, Default arguments, Function overloading.  
Classes and objects : Specifying and using class and object, Arrays within a class, Arrays of objects, Object as a function arguments, Friendly functions, Pointers to members.

**Section - III**

Constructors and destructors. Operator overloading and type conversions.  
Inheritance : Derived class and their constructs, Overriding member functions, Class hierarchies, Public and private inheritance levels.  
Polymorphism, Pointers to objects, This pointer, Pointers to derived classes, Virtual functions.

**Section - IV**

Streams, Stream classes, Unformatted Input/Output operations, Formatted console Input/Output operations, Managing output with manipulators.  

**Note :** The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

**Books Recommended:**


**Part-B (Practical)**

**Time: 03 Hours**  
**Max Marks : 40**

There will be a separate practical course based on the above theory course (i.e. 17MAT24DA6 : Object Oriented Programming with C++).
Section - I
Algebraic Number and Integers : Gaussian integers and its properties, Primes and fundamental theorem in the ring of Gaussian integers, Integers and fundamental theorem in \( \mathbb{Q}(\omega) \) where \( \omega^3 = 1 \), Algebraic fields, Primitive polynomials, The general quadratic field \( \mathbb{Q}(\sqrt{m}) \), Units of \( \mathbb{Q}(\sqrt{2}) \), Fields in which fundamental theorem is false, Real and complex Euclidean fields, Fermat theorem in the ring of Gaussian integers, Primes of \( \mathbb{Q}(\sqrt{2}) \) and \( \mathbb{Q}(\sqrt{5}) \).

Section - II
Countability of set of algebraic numbers, Liouville theorem and generalizations, Transcendental numbers, Algebraic number fields, Liouville theorem of primitive elements, Ring of algebraic integers, Theorem of primitive elements.

Section - III
Norm and trace of an algebraic number, Non degeneracy of bilinear pairing, Existence of an integral basis, Discriminant of an algebraic number field, Ideals in the ring of algebraic integers, Explicit construction of integral basis, Sign of the discriminant, Cyclotomic fields, Calculation for quadratic and cubic cases.

Section - IV
Integral closure, Noetherian ring, Characterizing Dedekind domains, Fractional ideals and unique factorization, G.C.D. and L.C.M. of ideals, Chinese remainder theorem, Dedekind theorem, Ramified and unramified extensions, Different of an algebraic number field, Factorization in the ring of algebraic integers.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
2. G.H. Hardy and E.M. Wright, An Introduction to the Theory of Numbers
5. P. Riebenboim, Algebraic Numbers – Wiley Inter-science.
17MAT24DB2: Harmonic Analysis

Time: 03 Hours
Max Marks: 80
Credits: 4:1:0
Max Marks: 80

Section - I

Section - II
An abstract approach to Poisson integral, Poisson Kernel and its properties, Poisson integral of $L^1$ function, Harnack theorem, Mean value property, Poisson integral of a measure, Boundary behavior of Poisson integral, Maximal functions, Non-tangential limits.

Section - III
Subharmonic functions, Hardy space $H^p$, Blaschke product and its properties, Theorem of F. and M. Riesz, Inner and outer functions. Trigonometric series, Conjugate functions, Theorem of M. Riesz, Kolomogrov theorem, Zygmund theorem, Hardy- Littlewood theorem.

Section – IV
Subharmonic functions in upper half-plane, Hardy Spaces $H^p$ over the upper half plane, Poisson integral formula, Cauchy integral formula, Canonical factorization theorem, $H^p$ as a Banach space, Paley- Wiener theorem, Hilbert transform, Maximal Hilbert transform.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
Section - I
Basic concepts of fluid dynamics. Viscosity. Reynold transport theorem, Rates of change of material integrals, Continuity equation, Navier-Stokes equations of motion, Simplification of basic equations. Reynolds number of flows.

Section - II

Section - III

Section - IV
Non-Newtonian fluids and their classification. Laminar flow of non-Newtonian fluids.
Solutions when radial velocity at the wall decreases (i) linearly with z (ii) exponentially with z. Peristaltic flows. Peristaltic motion in a channel, Characteristic dimensionless parameters. Long- wavelength analysis.

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
2. J.N. Kapur; Mathematical Models in Biology and Medicine, Affiliated East-West Press Pvt. Ltd.
17MAT24DB4: Space Dynamics

*Time: 03 Hours*  
*Max Marks: 80*  

**Credits: 4:1:0**

**Section - I**
Basic formulae of a spherical triangle. The two-body problem. The motion of the center of mass. The relative motion. Kepler’s equation. Solution by Hamilton Jacobi theory.

**Section - II**
The determination of orbits – Laplace’s Gauss methods.  

**Section - III**
The n-body problem. The motion of the centre of mass. Classical integrals.

**Section - IV**
Lagrange’s planetary equations in terms of pertaining forces and in terms of a perturbed Hamiltonian.

**Note:** The question paper will consist of five sections. Each of the first four sections will contain two questions from section I, II, III, IV respectively and the students shall be asked to attempt one question from each section. Section five will contain eight short answer type questions without any internal choice covering the entire syllabus and shall be compulsory.

**Books Recommended**
17MAT24DB5: Stochastic Processes

Time: 03 Hours
Max Marks: 80

Credits: 4:1:0

Section - I
Stochastic Processes: definition, classification and examples.
Markov Chains: definition and examples, Transition matrix, Order of a Markov chain, Markov chain as graphs.

Section - II
Higher transition probabilities, Classification of states and chains. Determination of higher transition probabilities.

Section - III
Pure birth process. Birth and death process: Immigration-emigration process,
Definitions and simple examples of renewal process in discrete and continuous time,
Regenerative stochastic processes, Markov renewal and semi-Markov processes.

Section - IV

Note: The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

Books Recommended:
1. N.T.J. Bailey, Elements of Stochastic Processes
2. J. Medhi, Stochastic Processes, New Age International Publishers
17MAT24DB6: Information and Communication Technology

Credits : 3:0:2

Time : 03 Hours
Max Marks : 60

Part-A (Theory)

Section - I
Computer System: Classification of digital computers, System hardware, Memory units and auxiliary storage devices, Peripheral devices (Input and output devices), Software, Open source software and open standards.
Computer networks, Networking Instruments, Communication devices, Transmission media (Bound links and Unbound links) and Switches.

Section - II
World Wide Web – History, Difference between Internet and www, Search engines.
Web Servers: What is a server; Server software, Services provided by servers and their types.
Website: Definition, Portal, Components of website, Building a website, Elements of website, Software to create website.
Web pages: Definition, Working, Static and dynamic areas, Website vs. webpage, Web Browser: the tool bar, SSL, Names of various web browsers.
Blogs- Definition of blog and bloggers, Advantages and disadvantages of blogging.
URL: definition, Elements absolute and relative URL.
Protocols: definition, TCP/IP, HTTP, FTP which one to use when and why, Applications and examples.

Section - III
Concept of web services, Email: Definition, Protocols used in email services, Mail account and address, Sending and receiving an email, Features like cc, Bcc, Spam and junk, Email etiquettes-properstructure and layout, Case sensitivity, disclaimer to email, Care with abbreviations and emotions,
Chat : Definition, Chat room, Commonly used types of chat.
Video conferencing: definition, Areas of application, Advantages and disadvantages of videoconferencing.
e-learning: definition, Benefits, Application areas, E-learning software.
e-shopping: definition, Advantages and dis-advantages, Sites available, Threats and security concerns.
e-reservation: definition, Benefits, Application areas, Reservation process, Live and non-live reservation
e-group: definition, Features, Benefits.
Social Networking: definition, Names of various social networking web sites, Merits and demerits, Service providers, Features available, Ethics.

Section - IV
Virus- definition, Types, Virus spread, Protection, Current threats.
Worms- definition, Types, Spread, Protection, Current threats.
Trojans- definition, Trojan spread, Protection.
Spyware- definition, Symptoms, Prevention and protection.
Malware- definition, Types, Prevention.
Spams- definition, Detection and prevention.
Hackers and Crackers- definition, Tools available, Types of hacking, Difference between hackers and crackers. Antivirus tools- free and paid tools, Latest tools, There style of working, Importance of regular update.

**Note:** The question paper of each course will consist of five Sections. Each of the sections I to IV will contain two questions and the students shall be asked to attempt one question from each. Section-V shall be compulsory and will contain eight short answer type questions without any internal choice covering the entire syllabus.

**Books Recommended:**
3. Ann Hatherly, ICT and the greatest Technology: A Teacher Mind, Early Childhood Folio

**Part-B (Practical)**

*Time: 03 Hours  
Max Marks : 40*

There will be a separate practical course based on the above theory course (i.e. 17MAT24DB6: Information and Communication Technology).