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B.Sc (Hons) Ordinance & Syllabus

w.e.f 2015-16

M J P Rohilkhand University, Bareilly
To,
The Registrar
M. J. P. R. University, Bareilly.

Sir,

Board of Studies (Mathematics) on 18.8.15 authorise me for correction and mark distribution in B.Sc (Home) Mathematics course.

Hereby I am sending the copy of B.Sc (Home) Mathematics syllabus for mention correction and distribution of marks.

Thank you

Yours faithfully,

Dr. Ravish Kumar Yadav
Associate Professor

Hindu College, Meerut
FACULTY OF SCIENCE

Ordinances Governing B. Sc. (Hons.) Degree Programme

(Effective from 2015-16)

Structure of the Course

1. B.Sc. (Hons.) Degree shall be awarded to candidates on successful completion of Three Years Programme of study.

2. Admission, studies, examinations, continuance from Year to Year, promotion and Declaration of results for the B. Sc. (Hons.) Degree is given in the following ordinances.

3. Candidates shall choose a combination of three main subjects from the list given below.

Combination of Subjects in B.Sc.(Hons.)

<table>
<thead>
<tr>
<th>Honours</th>
<th>Effective General Subjects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physics</td>
<td>Chemistry and Mathematics</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Physics and Mathematics</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Physics and Chemistry</td>
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<td>Botany</td>
<td>Zoology and Chemistry</td>
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<td>Zoology</td>
<td>Botany and Chemistry</td>
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<tr>
<td>Chemistry</td>
<td>Botany and Zoology</td>
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</tbody>
</table>

4. There will be one compulsory subject in first year and second year along with above combination of subjects.

First Year - Professional Communication (100 Marks)
Second Year - Computer Fundamentals (100 Marks) and

There will be a project work of Hons subject in the final year along with combination of subjects.

Third Year – Project Work (200 Marks)

5. B.Sc (Hons) I year will be of 500 marks out of which 200 marks will be for honours subject, 200 marks for general subjects (i.e. 100 marks be for each subject) and 100 marks for professional communication.

6. B.Sc (Hons) II year will be of 700 marks out of which 200 marks will be for honours subject, 400 marks for general subjects (i.e. 200 marks for each subject) and 100 marks for Computer Fundamentals.
7. B.Sc(Hons) III year will be of 800 marks out of which 400 marks will be for honours subject, 200 marks for general subjects (i.e. 100 marks be for each subject) and 200 marks for Project Work.

Eligibility for Admission

A candidate shall be eligible for direct admission to B. Sc. (Hons.) Part I, if he/she has passed 10+2 or equivalent examination with a minimum of 45% marks (5% relaxation for SC/ST candidates).

Admission in B.Sc. (Hons) Part I programme of study shall be made on merit basis only.

Promotion Policies:

1. A candidate shall be promoted to Second Year of B.Sc (Hons) only when he/she pass 50 % of the theory papers out of all the papers of First Year. However, he / she has to Pass at least One Theory Paper of Honour Subject of First Year.

2. A candidate shall be promoted to Third Year of B.Sc (Hons) only when he/she Pass 50 % of the theory papers out of all the papers of Second Year. However, the he / she has to pass at least One Theory Paper of Honour Subject of Second Year. Further, there should be no back paper in First Year.

3. Rest of the policies of this course i.e re-admission, grace marks etc. shall remain same as mentioned in University guidelines.

Change of Subjects:

No change in the optional or elective subjects is permitted after the finalization of the same by the candidate.

Benefit of the Course

A candidate who has completed his/her B.Sc (Hons) will be entitled to take admission in M.Sc. with any subject, amongst those which he /she studied during his/her B.Sc (Hons).

However, he/she will get 5% extra weightage in admission to the M.Sc. course of his / her honours subject.
For Example: Suppose, while pursuing B.Sc (Hons), a candidate studied the combination of three subjects namely Chemistry, Zoology and Botany. But, finally he/she completed his/her B.Sc (Honrs) in Chemistry (as the main subject). And he/she want to take admission in M.Sc. with Chemistry as the main subject. Then, because of B.Sc (Hons) in Chemistry, that candidate will get preference (5% extra weightage) in admission in M.Sc (Chemistry).

Though, admission in M.Sc. with other subject would be treated normally.

Further Clarifications

A student has to pass the whole B.Sc. (Hons.) programme in NOT MORE THAN SIX YEARS from the latest admission to the First year of the programme. Even after that if a student fails, he/she shall have to leave the programme.

Break in the Course

Any student taking admission in B.Sc. (Hons.) Degree programme of the Faculty shall not be allowed to pursue any other full time programme/course in the Faculty or elsewhere in the entire period of the programme meaning thereby that if a student leaves the programme after passing some of the semesters/years courses and takes up a full-time programme/course elsewhere, then he/she shall not be allowed to continue the programme further in the Faculty.
MJP RU Bareilly Syllabus of Professional Communication for B Sc (Hons) I year

PROFESSIONAL COMMUNICATION (100 marks)

Unit I
Written skills:
  a. Proposal writing formats.
  c. Business letters.
  d. Applications.
  e. Covering letters.
  f. Curriculum Vitae designing.

Unit II
  a. Barriers to communication, time management simulation exercise.
  b. Leadership skills.
  c. Team work BSC (Boss, subordinates and colleagues).

Unit III
  1. Group discussions (GDs).
     a. Tips. b. GD.
  2. Non verbal aspects of communication.

Unit IV
  a. Corporate communication, corporate expectation, office etiquettes.
  b. Extempore.

Unit V
  1. Interview Tips:
     a. What should be done before the interview, during the interview, after the interview and on the day of interview?
     b. Various questions that may be asked in an interview.
     c. Model interview (video-shooting and displaying optional).
  2. Exit interview.

BOOKS RECOMMENDED
COMPUTER FUNDAMENTALS

Unit I
Definition and overview of computer, computer classification, computer organization, computer code, input devices, output devices, storage devices. Computer software, types of software. overview of computer networks, LAN, MAN, WAN. Internet, network topology. Internetworking: Bridges, repeaters and routers.

Unit II
Introduction: Operating system and function, evolution of operating system, batch, interactive, time sharing and real time system. Single user operating system and multi-user operating system. Basics in MS-DOS, internal and external commands in MS-DOS.

Unit III
Introduction to MS-OFFICE-2007, word 2007 document creation, editing, formatting table handling, mail merge. Excel-2007, editing, working retrieval, important functions, short cut keys used in EXCEL.

Unit IV
MS-Power point 2007-Job Profile, elements of Power point , ways of delivering presentation, concept of Four P's (planning, preparation, practice and presentation) ways of handling presentations e.g. creating, saving slides show controls, adding formatting, animation and multimedia effects. Database system concepts, data models schema and instance , database language. Introduction to MS-Access 2007, main components of access tables, queries, reports, forms table handling, working on query and use of database.

Unit V
Computer applications in pharmaceutical and clinical studies, uses of internet in pharmaceutical industry
MJP ROHILKHAND UNIVERSITY, BAREILLY

SYLLABI

FOR

THREE-YEAR HONOURS & GENERAL DEGREE COURSES OF STUDIES

MATHEMATICS
2015
MATHEMATICS HONOURS

PAPER-WISE DISTRIBUTION:

Part - I

1st year:
- Paper IA (50 Marks)
- Module-01: 50 Marks
- Paper IB (50 Marks)
- Module-02: 50 Marks
- Paper IIA (50 Marks)
- Module-03: 50 Marks
- Paper IIB (50 Marks)
- Module-04: 50 Marks

Part - II

2nd year:
- Paper IIIA (50 Marks)
- Module-05: 50 Marks
- Paper IIIB (50 Marks)
- Module-06: 50 Marks
- Paper IVA (50 Marks)
- Module-07: 50 Marks
- Paper IVB (50 Marks)
- Module-08: 50 Marks

Part - III

3rd year:
- Paper VA (50 Marks)
- Module-09: 50 Marks
- Paper VB (50 Marks)
- Module-10: 50 Marks
- Paper VIA (50 Marks)
- Module-11: 50 Marks
- Paper VIB (50 Marks)
- Module-12: 50 Marks
- Paper VIIA (50 Marks)
- Module-13: 50 Marks
- Paper VIIIB (50 Marks)
- Module-14: 50 Marks
- Paper VIII A (50 Marks)
- Module-15: 50 Marks
- Paper VIII B (50 Marks)
- Module-16: 50 Marks
- Project Work/Dissertation (200 marks)
MATHEMATICS HONOURS

DISTRIBUTION OF MARKS

MODULE I  : Group A : Classical Algebra (35 marks)
            Group B : Modern Algebra I (15 marks)

MODULE II : Group A : Analytical Geometry of Two Dimensions (20 marks)
            Group B : Analytical Geometry of Three Dimensions I (15 marks)
            Group C : Vector Algebra (15 marks)

MODULE III : Group A : Analysis I (40 marks)
            Group B : Evaluation of Integrals (10 marks)

MODULE IV : Group A : Linear Algebra (35 marks)
            Group B : Vector Calculus I (15 marks)
MODULE V  :  Group A : Modern Algebra II (15 marks)
            Group B : Linear Programming and Game Theory (35 marks)

MODULE VI  :  Group A : Analysis II (15 marks)
              Group B : Differential Equations I (35 marks)

MODULE VII :  Group A : Real-Valued Functions of Several Real Variables (30 marks)
              Group B : Application of Calculus (20 marks)

MODULE VIII :  Group A : Analytical Geometry of Three Dimensions II (15 marks)
               Group B : Analytical Statics I (10 marks)
               Group C : Analytical Dynamics of A Particle I (25 marks)

MODULE IX  :  Group A : Analysis III (50 marks)

MODULE X  :  Group A : Linear Algebra II and Modern Algebra II (20 marks)
            Group B : Tensor Calculus (15 marks)
            Group C : Differential Equation II (15 marks)
Or
            Group C : Graph Theory (15 marks)

MODULE XI :  Group A : Vector calculus II (10 marks)
            Group B : Analytical Statics II (20 marks)
            Group C : Analytical Dynamics of A Particle II (20 marks)

MODULE XII :  Group A : Hydrostatics (25 marks)
              Group B : Rigid Dynamics (25 marks)

MODULE XIII :  Group A : Analysis IV (20 marks)
               Group B : Metric Space (15 marks)
               Group C : Complex Analysis (15 marks)

MODULE XIV :  Group A : Probability (30 marks)
              Group B : Statistics (20 marks)

MODULE XV :  Group A : Numerical Analysis (25 marks)
             Group B : Computer Programming (25 marks)

MODULE XVI :  Practical (50 marks)
             \{  Problem : 30 \\
              Sessional Work : 10 \\
            \}
Module I

Group A (35 marks)

Classical Algebra

1. Statements of well ordering principle, first principle of mathematical induction, second principle of mathematical induction. Proofs of some simple mathematical results by induction. Divisibility of integers. The division algorithm \( a = gb + r, \ b \neq 0, 0 \leq r < b \). The greatest common divisor (g.c.d.) of two integers \( a \) and \( b \). [This number is denoted by the symbol \( (a,b) \)]. Existence and uniqueness of \( (a,b) \). Relatively prime integers. The equation \( ax + by = c \) has integral solution iff \( (a,b) \) divides \( c \). \( (a, b, c \ are \ integers) \). Prime integers. Euclid's first theorem: If some prime \( p \) divides \( ab \), then \( p \) divides either \( a \) or \( b \). Euclid's second theorem: There are infinitely many prime integers. Unique factorization theorem. Congruences. Linear Congruence. Statement of Chinese Remainder Theorem and simple problems. Theorem of Fermat. Multiplicative function \( \phi \) \( (n) \). [15]

2. Complex Numbers: De-Moivre's Theorem and its applications, Exponential, Sine, Cosine and Logarithm of a complex number. Definition of \( \cos^n (a\pi) \). Inverse circular and Hyperbolic functions. [8] \( \phi \)


5. Inequalities AM ≥ GM ≥ HM and their generalizations: the theorem of weighted means and m-th. Power theorem. Cauchy's inequality (statement only) and its direct applications. [8]

Group B (15 marks)

Modern Algebra I


2. Group Theory: Semigroup, Group, Abelian Group. Examples of groups from number system, root of unity, matrices, symmetries of squares, triangles etc. Groups of congruence classes. Klein's 4 group. Properties deducible from definition of group including solvability of equations like \( ax = b, \ ya = b \). Any finite semigroup having both cancelation laws is a group. Integral power of elements and laws of indices in a group. Order of an element of a group; Order of a group. Subgroups: Necessary and sufficient condition for a subset of group to be a subgroup. Intersection and union of subgroups. Necessary and sufficient condition for union of two subgroups to be a subgroup.
Module II

Group A (20 marks)

Analytical Geometry of Two Dimensions

1. (a) Transformation of Rectangular axes: Translation, Rotation and their combinations. Theory of Invariants. [2]
   (b) General Equation of second degree in two variables: Reduction into canonical form. Classification of conics, Lengths and position of the axes. [2]

2. Pair of straight lines: Condition that the general equation of second degree in two variables may represent two straight lines. Point of intersection of two intersecting straight lines. Angle between two lines given by $ax^2 + 2hxy + by^2 = 0$. Angle bisector. Equation of two lines joining the origin to the points in which a line meets a conic.

3. Polar equation of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equations of tangent, normal, chord of contact.

4. Circle, Parabola, Ellipse and Hyperbola: Equations of pair of tangents from an external point, chord of contact, poles and polars, conjugate points and conjugate lines.

Note: Euclid's Axiom and its Consequences.

Group B (15 marks)

Analytical Geometry of Three Dimensions I


Group C (15 marks)

**Vector Algebra**


Module III

Group A (40 marks)

**Analysis I**

1. Real number system:

   (a) Intuitive idea of numbers. Mathematical operations revisited with their
properties


2. Sets in IR:

(a) Intervals. [1]

(b) Neighbourhood of a point. Interior point. Open set. Union, intersection of open sets.
Every open set can be expressed as disjoint union of open intervals (statement only).

[2]

(c) Limit point and isolated point of a set. Criteria for L.U.B. and G.L.B. of a bounded set
to be limit point of the set. Bolzano-Weierstrass theorem on limit point. Definition of
derived set. Derived set of a bounded set A is contained in the closed interval
[inf A, sup A]. Closed set. Complement of open set and closed set. Union and
intersection of closed
sets as a consequence. No nonempty proper subset of IR is both open and
closed. [3]

(d) Dense set in IR as a set having non-empty intersection with every open
interval. Q and IR - Q are dense in IR. [2]

3. Sequences of real numbers:

(a) Definition of a sequence as function from IN to IR. Bounded sequence.
Convergence
(formalization of the concept of limit as an operation in IR) and non-convergence. Examples. Every convergent sequence is bounded and limit is unique.
Algebra of limits. [4]
(b) Relation between the limit point of a set and the limit of a convergent sequence of distinct elements. Monotone sequences and their convergence. Sandwich rule. Nested interval theorem.

Limit of some important sequences: \( \{ n^{1/n} \} \), \( \{ x^n \} \), \( \{ x^n/n \} \), \( \{ x_n \} \) with $\frac{x_{n+1}}{x_n} \to 1$ and $|1| < 1$. \( \{(1+1/n)^n\} \), \( \sum_{k=1}^{\infty} \frac{1}{k!} + \frac{1}{2!} + \ldots + \frac{1}{n!} \to e \), \( \{ a^n \} \), \( (a > 0) \).

Cauchy's first and second limit theorems.

(c) Subsequence. Subsequential limits. Lim sup upper (limit) and lim inf (lower limit) of a sequence using inequalities. Alternative definitions of lim sup and lim inf of a sequence \( \{x_n\} \) using L.U.B. and G.L.B. of the set containing all the subsequential limits or by the properties of the set \( \{ x_n, x_{n+1}, \ldots \} \) (Equivalence between these definitions are assumed). A bounded sequence \( \{ x_n \} \) is convergent if lim sup \( x_n = \liminf x_n \) (statement only). Every sequence has a monotone subsequence.

Bolzano-Weierstrass theorem. Cauchy's general principle of convergence

[5]

4. Countability of sets: Countability (finite and infinite) and uncountability of a set. Subset of a countable set is countable. Every infinite set has a countably infinite subset. Cartesian product of two countable sets is countable. Q is countable. Non-trivial intervals are uncountable. IR is uncountable. [4]

5. Continuity of real-valued functions of a real variable:

(a) Limit of a function at a point (the point must be a limit point of the domain set of the function). Sequential criteria for the existence of finite and infinite limit of a function at a point. Algebra of limits. Sandwich rule. Important limits like $\sin x \to 0$ as $x \to 0$.

[3]
(b) Continuity of a function at a point. Continuity of a function on an interval and at an isolated point. Familiarity with the figures of some well known functions: \( y = x^a (a = 2, 3, \frac{1}{2}, 1), |x|, \sin x, \cos x, \tan x, \log x, e^x \). Algebra of continuous functions as a consequence of algebra of limits. Continuity of composite functions. Examples of continuous functions. Continuity of a function at a point does not necessarily imply the continuity in some neighbourhood of that point.

(e) Bounded functions. Neighbourhood properties of continuous functions regarding boundedness and maintenance of same sign. Continuous function on \([a,b]\) is bounded and attains its bounds. Intermediate value theorem.

(d) Discontinuity of function, type of discontinuity. Step function. Piecewise continuity. Monotone function. Monotone function can have only jump discontinuity. Set of points of discontinuity of a monotone function is at most countable. Monotone bijective function from an interval to an interval is continuous and its inverse is also continuous.[3]

(e) Definition of uniform continuity and examples. Lipschitz condition and uniform continuity. Functions continuous on a closed and bounded interval is uniformly continuous. A necessary and sufficient condition under which a continuous function on a bounded open interval \( I \) will be uniformly continuous on \( I \). A sufficient condition under which a continuous function on an unbounded open interval \( I \) will be uniformly continuous on \( I \) (statement only).

**Group B (10 marks)**

**Evaluation of Integrals**

Evaluation of Integrals: Indefinite and suitable corresponding definite integrals for the functions 

\[
\frac{1}{(a + b \cos x)^n} \cdot k \cos x + m \sin x, \quad \frac{1}{(x^2 + a^2)^n} \cdot \cos^n x, \quad \sin^n x \cos x + q \sin x, \quad (x^2 + a^2)^n \\
\text{etc. where } l, m, p, q, n \text{ are integers. Simple problems on definite integral as the limit of a sum.}
\]
Module IV

Group A (30 marks)

Linear Algebra


2. Determinants: Definition, Basic properties of determinants, Minors and cofactors. Laplace’s method. Vandermonde’s determinant. Symmetric and skew-symmetric determinants. (No proof of theorems) (problems of determinants of order > 4 will not be asked).

Adjoint of a square matrix. For a square matrix A, adj A = adj A = (det A)I. Invertible matrix, Non-singular matrix. A square matrix is invertible if and only if it is non-singular. Inverse of an orthogonal matrix.


4. Vector / Linear space: Definitions and examples, Subspace, Union and intersection of subspaces. Linear sum of two subspaces. Linear combination, independence and dependence. Linear span. Generators of vector space. Finite dimensional vector space. Replacement Theorem, Extension theorem. Statement of the result that any two bases of a finite dimensional vector space have same number of elements. Dimension of a vector space. Extraction of basis, formation of basis with special emphasis on RN. (n ≥ 1).

Row space and column space of matrix. Row rank and column rank of matrix. Equality of row rank, column rank and rank of a matrix.


5. Congruence of matrices: Statement of applications of relevant results, Normal form of a matrix under congruence, Real Quadratic Form involving three variables. Reduction to Normal Form (Statements of relevant theorems and applications). [5]

Group B (15 marks)

Vector Calculus I


Module V

Group A (15 marks)

Modern Algebra II

1. Cosets and Lagrange's theorem. Cyclic groups. Generator, Subgroups of cyclic groups. Necessary and sufficient condition for a finite group to be cyclic.

2. Rings and Fields: Properties of Rings directly following from the definition, Unitary and commutative rings. Divisors of zero, Integral domain, Every field is an integral domain, every finite integrals domain is a field. Definitions of Sub-ring and sub-field. Statement of Necessary of sufficient condition for a subset of a ring (field) to be sub-ring (resp. subfield). Characteristic of ring and integral domain. Permutation : Cycle, transposition, Statement of the result that every permutation can be expressed as a product of disjoint cycles. Even and odd permutations, Permutation Group. Symmetric group. Alternating Group. Order of an alternating group.

Group B (35 marks)

Linear Programming and Game Theory

1. Definition of L.P.P. Formation of L.P.P. from daily life involving

2. Hyperplane, Convex set, Cone, extreme points, convex hull and convex polyhedron. Supporting and Separating hyperplane. The collection of all feasible solutions of an L.P.P. constitutes a convex set. The extreme points of the convex set of feasible solutions correspond to its D.F.S. and conversely. The objective function has its optimal value at an extreme point of the convex polyhedron generated by the set of feasible solutions. (the convex polyhedron may also be unbounded). In the absence of degeneracy, if the L.P.P. admits of an optimal solution then at least one B.F.S. must be optimal. Reduction of a F.S. to a B.F.S.


5. Duality theory: The dual of the dual is the primal. Relation between the objective values of dual and the primal problems. Relation between their optimal values. Complementary slackness, Duality and simplex method and their applications.


Module VI

Group A (15 marks)

Analysis II

1. Infinite Series of real numbers:
   [11]
   b) Series of non-negative real numbers: Tests of convergence - Cauchy's condensation test. Comparison test (ordinary form and upper limit and lower limit criteria), Kummer's test. Statements and applications of: Abel – Pringsheim's Test, Ratio Test, Root test, Raabe's test, Bertrand's test, Logarithmic test and Gauss's test.
   [3]
   c) Series of arbitrary terms: Absolute and conditional convergence
   [1]
   d) Alternating series: Leibnitz test (proof needed).
   e) Non-absolute convergence: Abel's and Dirichlet's test (statements and applications). Riemann's rearrangement theorem (statement only) and rearrangement of absolutely convergent series (statement only).

2. Derivatives of real-valued functions of a real variable:
   [1]
   b) Successive derivative: Leibnitz theorem.
   [1]
   c) Theorems on derivatives: Darboux theorem, Rolle's theorem, Mean value theorems of Lagrange and Cauchy - as an application of Rolle's theorem. Taylor's theorem on closed and bounded interval with Lagrange's and Cauchy's form of remainder deduced from Lagrange's and Cauchy's mean value theorem respectively. Maclaurin's theorem as a consequence of Taylor's theorem. Statement of Maclaurin's Theorem on infinite series expansion. Expansion of $e^x$, $\log(1 + x), (1 + x)^n, \sin x, \cos x$ with their range of validity.
   [3]
   d) Statement of L'Hospital's rule and its consequences. Point of local extremum (maximum, minimum) of a function in an interval. Sufficient condition for the existence of a local maximum/minimum of a function at a point (statement only). Determination of local extremum using first order derivative. Application of the principle of maximum/minimum in geometrical problems.
   [3]
Group B (35 marks)

Differential Equation I


3. First order linear equations : Integrating factor (Statement of relevant results only). Equations reducible to first order linear equations. [2]


5. Applications : Geometric applications, Orthogonal trajectories. [2]


7. Second order linear equations with variable co-efficients : 
\[ \frac{d^2y}{dx^2} + P(x) \frac{dy}{dx} + Q(x)y = F(x) \] . Reduction of order when one solution of the homogeneous part is known. Complete solution. Method of variation of parameters. Reduction to Normal form. Change of independent variable. Operational Factors. [3]

8. Simple eigenvalue problems. [2]


Module VII

Group A (30 marks)

Real-Valued Functions of Several Real Variables

1. Point sets in two and three dimensions: Concept only of neighbourhood of a point, interior point, limit point, open set, closed set.
   [2]

   [3]

   [10]

4. Jacobian of two and three variables, simple properties including function dependence. Concept of Implicit function: Statement and simple application of implicit function theorem for two variables Differentiation of Implicit function.
   [8]

5. Taylor’s theorem for functions two variables. Lagrange’s method of undetermined multipliers for function of two variables (problems only).
   [5]

Group B (20 marks)

Application of Calculus

   [9] [3]

2. Rectilinear asymptotes of a curve (Cartesian, parametric and polar form).
   [3]

3. Curvature-Radius of curvature, centre of curvature, chord of curvature, evolute of a curve.
   [4] [3]
4. Envelopes of families of straight lines and curves (Cartesian and parametric equations only).

5. Concavity, convexity, singular points, nodes, cusps, points of inflexion, simple problems on species of cusps of a curve (Cartesian curves only).

6. Familiarity with the figure of following curves: Periodic curves with suitable scaling, Cycloid, Catenary, Lemniscate of Bernoulli, Astroid, Cardiode, Folium of Descartes, equiangular spiral.

7. Area enclosed by a curve, determination of C.G., moments and products of inertia (Simple problems only).

Module VIII

Group A (15 marks)

**Analytical Geometry of 3 Dimensions II**

1. (a) Sphere: General Equation. Circle, Sphere through the intersection of two spheres. Radical Plane, Tangent, Normal.

2. Cone: Right circular cone. General homogeneous second degree equation. Section of cone by a plane as a conic and as a pair of lines. Condition for three perpendicular generators. Reciprocal cone.


4. Ellipsoid, Hyperboloid, Paraboloid: Canonical equations only.

2. Tangent planes, Normals, Enveloping cone.

Generating lines of hyperboloid of one sheet and hyperbolic paraboloid.


5. Knowledge of Cylindrical, Polar and Spherical polar co-ordinates, their relations (No deduction required).

Group B (10 marks)

Analytical Statics I

1. Friction: Law of Friction, Angle of friction, Cone of friction, To find the positions of equilibrium of a particle lying on a (i) rough plane curve, (ii) rough surface under the action of any given forces.

2. Astatic Equilibrium, Astatic Centre, Positions of equilibrium of a particle lying on a smooth plane curve under action of given force. Action at a joint in a frame work.

Group C (25 marks)

Analytical Dynamics of A Particle I


Tangent and normal accelerations. Circular motion. Radial and cross-radial accelerations.

Damped harmonic oscillator. Motion under gravity with resistance proportional to some integral power of velocity. Terminal velocity. Simple cases of a constrained motion of a particle.

Motion of a particle in a plane under different laws of resistance. Motion of a projectile in a resisting medium in which the resistance varies as the velocity. Trajectories in a resisting medium where resistance varies as some integral power of the velocity.

Module IX

**Analysis III (50 marks)**

1. Compactness in IR: Open cover of a set. Compact set in IR, a set is compact iff it is closed and bounded.

2. Function of bounded variation (BV): Definition and examples. Monotone function is of BV. If $f$ is on BV on $[a,b]$ then $f$ is bounded on $[a,b]$. Examples of functions of BV which are not continuous and continuous functions not of BV. Definition of variation function. Necessary and sufficient condition for a function $f$ to be of BV on $[a,b]$ is that $f$ can be written as the difference of two monotonic increasing functions on $[a,b]$. Definition of rectifiable curve. A plane curve $\gamma = (f,g)$ is rectifiable if $f$ and $g$ both are of bounded variation (statement only). Length of a curve (simple problems only).

3. Riemann integration:
   (a) Partition and refinement of partition of a closed and bounded interval. Upper Darboux sum $U(P,f)$ and lower Darboux sum $L(P,f)$ and associated results. Upper integral and lower integral. Darboux’s theorem. Darboux’s definition of integration over a closed and bounded interval. Riemann’s definition of integrability. Equivalence with Darboux definition of integrability (statement only). Necessary and sufficient condition for Riemann intergrability. Continuous functions are Riemann integrable. Definition of a set of measure zero (or negligible set or zero set) as a set covered by countable number of open intervals sum of whose lengths is arbitrary small. Examples of sets of measure zero: any subset of a set of measure zero, countable set, countable union of sets of measure zero.
Concept of oscillation of a function at a point. A function is continuous at $x$ if its oscillation at $x$ is zero. A bounded function on a closed and bounded interval is Riemann integrable if the set of points of discontinuity is a set of measure zero (Lebesgue's theorem on Riemann integrable function). Problems on Riemann integrability of functions with sets of points of discontinuity having measure zero.

(c) Integrability of sum, scalar multiple, product, quotient, modulus of Riemann integrable functions. Properties of Riemann integrable functions arising from the above results.

(d) Function defined by definite integral $\int_a^b f(t)\,dt$ and its properties. Antiderivative (primitive or indefinite integral).

(e) Fundamental theorem of integral calculus. First mean value theorem of integral calculus. Statement of second mean value theorems of integrals calculus (both Bonnet's and Weierstrass' form).

4. Sequence and Series of functions of a real variable:

(a) Sequence of functions defined on a set: Pointwise and uniform convergence. Cauchy criterion of uniform convergence. Dini's theorem on uniform convergence (statement only). Weierstrass's $M$-test.

(b) Limit function: Boundedness, Repeated limits, Continuity, Integrability and differentiability of the limit function of sequence of functions in case of uniform convergence.


(d) Sum function: boundedness, continuity, integrability, differentiability of a series of functions in case of uniform convergence.

Module X

Group A (20 marks)

Linear Algebra II & Modern Algebra III

Section – I: Linear Algebra II (10 marks)

1. Linear Transformation (L.T.) on Vector Spaces: Definition of L.T., Null space, range space of an L.T., Rank and Nullity, Sylvester's Law of Nullity. \([\text{Rank (T)} + \text{Nullity (T)} = \dim (V)]\). Determination of rank (T), Nullity (T) of linear transformation \(T : \mathbb{R}^n \rightarrow \mathbb{R}^m\). Inverse of Linear Transformation. Non-singular Linear Transformation. [5]


Section – II: Modern Algebra III (10 marks)


4. Homomorphism and Isomorphism of Groups. Kernel of a Homomorphism. First Isomorphism Theorem. Properties deducible from definition of morphism. An infinite cyclic group is isomorphic to \((\mathbb{Z}, +)\) and a finite cyclic group of order \(n\) is isomorphic to the group of residue classes modulo \(n\). [5]

Group B (20 marks)

Tensor Calculus

A tensor as a generalized concept of a vector in an Euclidean space \(E^3\). To generalize the idea in an n-dimensional space. Definition of \(E^n\). Transformation of co-ordinates in \(E^n\) (n = 2, 3 as example). Summation convention. [5]

Group C (10 marks)

Differential Equations II


Or

Group C (10 marks)

Graph Theory


2. Euler graphs: Necessary and Sufficient condition for a Euler graph. Königsberg Bridge Problem.
3. Planar graphs: Face-size equation, Euler's formula for a planar graph. To show: the graphs $K_5$ and $K_3$, 3 are non-planar.


Module XI

Group A (10 marks)

Vector Calculus II

Line integrals as integrals of vectors, circulation, irrotational vector, work done, conservative force, potential orientation. Statements and verification of Green's theorem, Stokes' theorem and Divergence theorem.

Group B (20 marks)

Analytical Statics II

1. Centre of Gravity: General formula for the determination of C.G. Determination of position of C.G. of any arc, area of solid of known shape by method of integration. [3]

2. Virtual work: Principle of virtual work for a single particle. Deduction of the conditions of equilibrium of a particle under coplanar forces from the principle of virtual work. The principle of virtual work for a rigid body. Forces which do not appear in the equation of virtual work. Forces which appear in the equation of virtual work. The principle of virtual work for any system of coplanar forces acting on a rigid body. Converse of the principle of virtual work.

4. Forces in the three dimensions. Moment of a force about a line. Axis of a couple. Resultant of any two couples acting on a body. Resultant of any number of couples acting on a rigid body. Reduction of a system of forces acting on a rigid body. Resultant force is an invariant of the system but the resultant couple is not an invariant.

Conditions of equilibrium of a system of forces acting on a body. Deductions of the conditions of equilibrium of a system of forces acting on a rigid body from the principle of virtual work. Poinsot's central axis. A given system of forces can have only one central axis. Wrench, Pitch, Intensity and Screw. Condition that a given system of forces may have a single resultant. Invariants of a given system of forces. Equation of the central axis of a given system of forces.

Group C (20 marks)

Analytical Dynamics of A Particle II


3. Motion of a smooth curve under resistance. Motion of a rough curve under gravity e.g., circle, parabola, ellipse, cycloid etc.


5. Linear dynamical systems, preliminary notions: solutions, phase portraits, fixed or critical points. Plane autonomous systems. Concept of Poincare phase plane. Simple examples of damped oscillator and a simple pendulum. The two-variable case of a linear plane autonomous system. Characteristic polynomial. Focal, nodal and saddle points.

[20]
Module XII

Group A (25 marks)

Hydrostatics

1. Definition of Fluid. Perfect Fluid, Pressure. To prove that the pressure at a point in fluid in equilibrium is the same in every direction. Transmissibility of liquid pressure. Pressure of heavy fluids. To prove

(i) In a fluid at rest under gravity the pressure is the same at all points in the same horizontal plane.
(ii) In a homogeneous fluid at rest under gravity the difference between the pressures at two points is proportional to the difference of their depths.
(iii) In a fluid at rest under gravity horizontal planes re surfaces of equal density.
(iv) When two fluids of different densities at rest under gravity do not mix, their surface of separation is a horizontal plane.

Pressure in heavy homogeneous liquid. Thrust of heavy homogeneous liquid on plane surface.

2. Definition of centre of pressure. Formula for the depth of the centre of pressure of a plane area. Position of the centre of pressure. Centre of pressure of a triangular area whose angular points are at different depths. Centre of pressure of a circular area. Position of the centre of pressure referred to coordinate axes through the centroid of the area. Centre of pressure of an elliptical area when its major axis is vertical or along the line of greatest slope. Effect of additional depth on centre of pressure.

3. Equilibrium of fluids in given fields of force: Definition of field of force, line of force. Pressure derivative in terms of force. Surface of equi-pressure. To find the necessary and sufficient conditions of equilibrium of a fluid under the action of a force whose components are X, Y, Z along the co-ordinate axes. To prove (i) that surfaces of equal pressure are the surfaces intersecting orthogonally the lines of force, (ii) when the force system is conservative, the surfaces of equal pressure are equi-potential surfaces and are also surfaces of equal density. To find the differential equations of the surfaces of equal pressure and density.

4. Rotating fluids. To determine the pressure at any point and the surfaces of equal pressure when a mass of homogeneous liquid contained in a vessel, revolves uniformly about a vertical axis.

5. The stability of the equilibrium of floating bodies. Definition, stability of equilibrium of a floating body, metacentre, plane of floatation, surface of buoyancy. General propositions about small rotational displacements. To derive the condition for stability.

Group B (25 marks)

Rigid Dynamics


4. Equations of motion under impulsive forces: Equation of motion about a fixed axis under impulsive forces. To show that (i) of there is a definite straight line such that the sum of the moments of the external impulses acting on a system of particles about it vanishes, then the total angular momentum of the system about that line remains unaltered, (ii) the change of K.E. of a system of particles moving in any manner under the application of impulsive forces is equal to the work done by the impulsive forces.

(25 marks)
Module XIII

Group A (20 marks)

Analysis IV

1. Improper Integral:

(a) Range of integration, finite or infinite. Necessary and sufficient condition for convergence of improper integral in both cases. [2]

(b) Tests of convergence: Comparison and µ-test. Absolute and non-absolute convergence and interrelations. Abel’s and Dirichlet’s test for convergence
(c) Convergence and working knowledge of Beta and Gamma function and their interrelation \( \int_0^1 n \sin^2 x \, dx \) existing when they exist (using Beta and Gamma function).


**Group B (10 marks)**

**Metric Space**


2. Subspace of a metric space. Convergent sequence. Cauchy sequence. Every Cauchy sequence is bounded. Every convergent sequence is Cauchy, not the converse. Completeness: definition and examples. Cantor intersection theorem. IR is a complete metric space. Q is not complete.

**Group C (10 marks)**

**Complex Analysis**

1. Extended complex plane. Stereographic projection.
Module XIV

Group A (30 marks)

Probability

Mathematical Theory of Probability:


Group B (20 marks)

Statistics


Confidence intervals. Interval estimation for parameters of normal population. Statistical hypothesis. Simple and composite hypothesis. Best critical region of a test. Neyman-Pearson theorem (Statement only) and its application to normal population. Likelihood ratio testing and its application to normal population. Simple applications of hypothesis testing.
Module XV

Group A (25 marks)

**Numerical Analysis**

What is Numerical Analysis?
Errors in Numerical computation: Gross error, Round off error, Truncation error.
Approximate numbers. Significant figures. Absolute, relative and percentage error.

Operators: $\Delta$, $\bullet$, $E$, $\mu$, $\delta$ (Definitions and simple relations among them).

Interpolation formulae using the values of both $f(x)$ and its derivative $f(x)$: Idea of Hermite interpolation formula (only the basic concepts).
Numerical Differentiation based on Newton's forward & backward and Lagrange's formulae.
Numerical Integration: Integration of Newton's interpolation formula. Newton-Cote's formula. Basic Trapezoidal and Simpson's $\frac{1}{3}$rd. formulae. Their composite forms. Weddle's rule (only statement). Statement of the error terms associated with these formulae. Degree of precision (only definition).


Numerical solution of a system of linear equations: Gauss elimination method. Iterative method – Gauss-Seidal method. Matrix inversion by Gauss elimination method (only problems – up to $3 \times 3$ order).

Numerical solution or Ordinary Differential Equation: Basic ideas, nature of the problem. Picard, Euler and Runge-Kutta (4th order) methods (emphasis on the problems only).

Group B (25 marks)

**Computer Programming**

Fundamentals of Computer Science and Computer Programming:

Computer fundamentals: Historical evolution, computer generations, functional description, operating system, hardware & software.
Positional number system: binary, octal, decimal, hexadecimal system. Binary arithmetic.
Storing of data in a computer: BIT, BYTE, Word. Coding of data – ASCII, EBCDIC, etc.
Programming languages: General concepts, Machine language, Assembly Language, High Level Languages, Compiler and Interpreter. Object and Source Program. Ideas about some major HLL.

Students are required to opt for any one of the following two programming languages:
(i) Programming with FORTRAM 77/90.
Or
(ii) Introduction to ANSI C.

Programming with FORTRAN 77/90:

Introduction, Keywords, Constants and Variables – integer, real, complex, logical, character, double precision, subscripted. Fortran expressions. I/O statements-formatted and unformatted. Program execution control-logical if, if-then-else, etc. Arrays-Dimension statement. Repetitive computations – Do. Nested Do, etc. Sub-programs: Function sub program and Subroutine sub program. Application to simple problems: Evaluation of functional values, solution of quadratic equations, approximate sum of convergent infinite series, sorting of real numbers, numerical integration, numerical solution of non-linear equations, numerical solution of ordinary differential equations, etc.

Introduction to ANSI C:

Character set in ANSI C. Key words: if, while, do, for, int, char, float etc.
Data type: character, integer, floating point, etc. Variables, Operators: =, ==, !=, <, >, etc. (arithmetic, assignment, relational, logical, increment, etc.). Expresions: e.g. (a = = b) ! (b == c), Statements: e.g. if (a>b) small = a; else small = b. Standard input/output. Use of while, if.... Else, for, do...while, switch, continue, etc. Arrays, strings. Function definition. Running simple C Programs. Header File.

Module XVI

Practical
(Problem:30, Sessional Work:10, Viva:10)

(A) Using Calculator

(1) INTERPOLATION:
   Newton’s forward & Backward Interpolation.
   Stirling & Bessel’s Interpolation.
   Lagrange’s Interpolation & Newton’s Divided Difference Interpolation.
   Inverse Interpolation.
(2) Numerical Differentiation based on Newton’s Forward & Backward Interpolation Formulae.
(3) Numerical Integration: Trapezoidal Rule, Simpson’s ½ Rule and Weddle’s Formula.
(4) Solution of Equations: Bisection Method, Regula Falsi, Fixed Point Iteration.
   Newton-Raphson formula (including modified form for repeated roots and complex roots).
(6) Dominant Eigenpair of a (4x4) real symmetric matrix and least eigen value of a (3x3) real symmetric matrix by Power Method.
(7) Numerical Solution of first order ordinary Differential Equation (given the initial condition) by:

(B) ON COMPUTER:

The following problems should be done on computer using either FORTRAN or C language:

(i) To find a real root of an equation by Newton-Raphson Method.
(ii) Dominant eigenpair by Power Method.
(iii) Numerical Integration by Simpson’s ½ Rule.
(iv) To solve numerically Initial Value Problem by Euler’s and RK4 Method.
LIST OF BOOKS FOR REFERENCE

Module I Group A:

Module I Group B & Module V Group A:
2. First Course in Abstract Algebra – Fraleigh.
3. Topics in Algebra – Hernstein.

Module IV Group A:
1. Linear Algebra – Hadley
2. Test Book of Matrix – B. S. Vaatsa

Module II Group A, Group B & Module VIII Group A:

Module III Group A, Module VI Group A Module VII Group A, Module IX & Module XIII Group A:
2. A First Course in Real Analysis – M. H. Protter & G. B. Morrey (Springer Verlag, NBHM).
4. Problems in Mathematical Analysis – B. P. Demidovich (Mir).
5. Problems in Mathematical Analysis – Berman (Mir).
8. Introduction to Real Analysis – Bartle & Sherbert (John Wiley & Sons.)
12. Mathematical Analysis – Shantinarayan (S. Chand & Co.).
15. Charles Chapman Pugh: Real mathematical analysis; Springer; New York; 2002
16. Sterling K. Berberian: A First Course in Real Analysis; Springer; New York; 1994
17. Steven G. Krantz: Real Analysis and Foundations; Chapman and Hall/CRC; 2004
19. T. M. Apostol: Mathematical Analysis, Addison-Wesley Publishing Co. 1957
22. Robert G Bartle, Donald R Sherbert: Introduction to real analysis; John Wiley Singapore; 1994
23. Integral Calculus – Shanti Narayan & P. K. Mittal (S. Chand & Co. Ltd.)
24. Integral Calculus – H. S. Dhami (New Age International)

Module VII:
2. Integral Calculus – Shantinarayan.
4. Advanced Calculus – David V. Widder (Prentice Hall)
5. Real Analysis – Ravi Prakash & Siri Wasan (Tata McGraw Hill)
7. Differential Calculus – Shanti Naryaan (S. Chand & Co. Ltd.)

Module II Group C, Module IV Group B, Module XI Group A:
2. Vector Analysis – Barry Spain.

Module V Group B :
2. Linear Programming – G. Hadley.

Module VI Group B :

Module VIII Group C & Module XI Group C :

Module XV :
1. The elements of probability theory and some of its applications - H. Cramer.
7. Structured FORTRAN 77 for engineers and scientists – D. M. Etter (The Benjamin/Cummings Publishing Co. Inc.).
10. FORTRAN 77 and numerical methods – C. Xavier (Wiley Eastern limited).
18. Introduction to numerical analysis – Carl Erik Froberg (Addison Wesley Publishing).

Module XII Group A:

1. Vector Analysis – Spiegel (Schaum).
2. Vector Calculus – C. E. Weatherburn.
4. Dynamics of Particle and of Rigid Bodies – S. L. Loney.

Module X:

1. Advanced Calculus – David Widder (Prentice Hall)
5. Graph Theory with applications to Engineering and Computer Science – Deo, Narsingh (Prentice Hall, 2000).
11. J. B. Conway: Functions of One Complex Variables; Narosa Publishing; New Delhi; 1973973.
## GENERAL

(Total 8 modules each of 50 marks)

### 1Year

**PAPER 1A (Module 1) 50 marks 3 hrs**
- **MODULE I**
  - Group A: Classical Algebra (20 marks)
  - Group B: Analytical Geometry of two dimensions (15 marks)
  - Group C: Vector Algebra (15 marks)

**PAPER 1 B**
- (Module 2) 50 marks 3 hrs
- **MODULE II**
  - Group A: Differential Calculus (25 marks)
  - Group B: Integral Calculus (10 marks)
  - Group C: Differential Equations (15 marks)

### 2 Year

**PAPER 2 A (MODULE III) 50 MARKS**
- **MODULE III**
  - Group A: Modern Algebra (25 marks)
  - Group B: Analytical Geometry of three dimensions (25 marks)

**PAPER 2 B (MODULE IV) 50 MARKS**
- **MODULE IV**
  - Group A: Differential Calculus (25 marks)
  - Group B: Integral Calculus (15 marks)
  - Group C: Differential Equations (10 marks)

**PAPER 3A (MODULE V) 50 MARKS**
- **MODULE V**
  - Group A: Numerical Methods (20 marks)
  - Group B: Linear Programming (30 marks)

**PAPER 3B**
- (MODULE VI) 50 MARKS
- **MODULE VI**: Any one of the following groups:
Group A: Analytical Dynamics (50 marks)
Group B: Probability & Statistics (50 marks)

3 Year

PAPER 5A (MODULE VII) 50 MARKS
MODULE VII: Computer Science & Programming (50 marks)

PAPER 5B (MODULE VIII) 50 MARKS
MODULE VIII: Any one of the following groups:

Group A: A Course of Calculus (50 marks)
Group B: Discrete Mathematics (50 marks)

MODULE I

Group A (20 marks)

Classical Algebra

01. Complex Numbers: De Moivre's Theorem and its applications. Exponential, Sine, Cosine and Logarithm of a complex number. Definition of $a^x$ (a≠0). Inverse circular and Hyperbolic functions.


Statements of:

(i) If the polynomial $f(x)$ has opposite signs for two real values of $x$, e.g. $a$ and $b$, the equation $f(x) = 0$ has an odd number of real roots between $a$ and $b$; if $f(a)$ and $f(b)$ are of same sign, either no real root or an even number of roots lies between $a$ and $b$.

(ii) Rolle's Theorem and its direct applications.


03. Determination up to the third order: Properties, Cofactor and Minor. Product of two determinants. Adjoint, Symmetric and Skew-symmetric determinants. Solutions of linear equations with not more than three variables by Cramer's Rule.


Rank of a matrix: Determination of rank either by considering minors or by sweep-out process. Consistency and solution of a system of linear of equations.
with not more than 3 variables by matrix method.

**Group B (15 marks)**

**Analytical Geometry of 2 Dimensions**

01. Transformations of Rectangular axes: Translation, Rotation and their combinations. Invariants.
02. General equation of second degree in \( x \) and \( y \): Reduction to canonical forms. Classification of conic.
03. Pair of straight lines: Condition that the general equation of 2nd degree in \( x \) and \( y \) may represent two straight lines. Points of intersection of two intersecting straight lines. Angle between two lines given by \( ax^2 + 2hxy + by^2 = 0 \). Equation of bisectors. Equation of two lines joining the origin to the points in which a line meets a conic.
04. Equations of pair of tangents from an external point, chord of contact, poles and polars in case of General conic: Particular cases for Parabola, Ellipse, Circle, Hyperbola.
05. Polar equation of straight lines and circles. Polar equation of a conic referred to a focus as pole. Equation of chord joining two points. Equations of tangent and normal.

**Group C (15 marks)**

**Vector Algebra**


**MODULE II**

**Group A (25 marks)**

**Differential Calculus**

01. Rational Numbers. Geometrical representation. Irrational number. Real number represented as point on a line - Linear Continuum. Acquaintance with basic properties of real number (No deduction or proof is included).
02. Sequence: Definition of bounds of a sequence and monotone sequence. Limit of a sequence. Statements of limit theorems. Concept of convergence and divergence of monotone sequences - applications of the theorems, in particular, definition of \( e \). Statement of Cauchy's general principle of convergence and its application.


Acquianance (no proof) with the important properties of continuous functions on closed intervals. Statement of existence of inverse function of a strictly monotone function and its continuity.


06. Successive derivative – Leibnitz’s Theorem and its application.

07. Application of the principle of Maxima and Minima for a function of single variable in geometrical, physical and other problems.


Group B (10 marks)

Integral Calculus

01. Integration of the form:

\[ \int \frac{dx}{a + b \cos x}, \quad \int \frac{l \sin x + m \cos x}{n \sin x + p \cos x} \]

and Integration of Rational functions.
02. Evaluation of definite integrals.

03. Integration as the limit of a sum (with equally spaced as well as unequal intervals)

**Group C (15 marks)**

**Differential Equations**

01. Order, degree and solution of an ordinary differential equation (ODE) in presence of arbitrary constants. Formation of ODE.
   First order equations :
   (i) Variables separable.
   (ii) Homogeneous equations and equations reducible to homogeneous forms.
   (iii) Exact equations and those reducible to such equation.
   (iv) Euler's and Bernoulli's equations (Linear).
   (v) Clairaut's Equations : General and Singular solutions.

02. Simple applications : Orthogonal Trajectories.

**MODULE III**

**Group A (25 marks)**

**Modern Algebra**

   Mappings, One-One and onto mappings. Composition of Mappings concept only, Identity and Inverse mappings. Binary Operations in a set.
   Identity element. Inverse element.

02. Introduction of Group Theory : Definition and examples taken from various branches (examples from number system, roots of unity, 2 x 2 real matrices, non-singular real matrices of a fixed order). Elementary properties using definition of Group. Definition and examples of sub-group - Statement of necessary and sufficient condition - its applications.

03. Definitions and examples of (i) Ring, (ii) Field, (iii) Sub-ring, (iv) Sub-field.

04. Concept of Vector space over a Field : Examples, Concepts of Linear combinations, Linear dependence and independence of a finite set of vectors, Sup-space. Concepts of generators and basis of a finite-dimensional vector space. Problems on formation of basis of a vector space (No proof required).
05. Real Quadratic Form involving not more than three variables – Problems only.
06. Characteristic equation of a square matrix of order not more than three –
    determination of Eigen Values and Eigen Vectors – Problems only. Statement
    and illustration of Cayley-Hamilton Theorem.

Group B (25 marks)

Analytical Geometry of 3 dimensions

01. Rectangular Cartesian co-ordinates: Distance between two points. Division
    of a line segment in a given ratio. Direction cosines and direction ratios of a
    straight line. Projection of a line segment on another line. Angle between two
    straight lines.
02. Equation of a Plane: General form. Intercept and Normal form. Angle
    between two planes. Signed distance of a point from a plane. Bisectors of
    angles between two intersecting planes.
03. Equations of Straight line: General and symmetric form. Distance of a point
    from a line. Coplanarity of two straight lines. Shortest distance between two
    skew-lines.
04. Sphere and its tangent plane.
05. Right circular cone.

MODULE IV

Group A (25 marks)

Differential Calculus

01. Statement of Rolle’s theorem and its geometrical interpretation. Mean Value
    Theorems of Lagrange and Cauchy. Statements of Taylors and Maclaurin’s
    Theorems with Lagrange’s and Cauchy’s form of remainders. Taylor’s and
    Maclaurin’s Infinite series for functions like
    \[ e^x, \sin x, \cos x, (1+x)^n, \log(1+x) \] [with restrictions wherever
    necessary]
02. Indeterminate Forms: L’Hospital’s Rule: Statement and problems only.
03. Functions of two and three variables: Their geometrical representations.
    Limit and Continuity (definitions only) for functions of two variables. Partial
    derivatives: Knowledge and use of Chain Rule. Exact differentials (emphasis
    on solving problems only). Functions of two variables – Successive partial
    derivatives: Statement of Schwarz’s Theorem on commutative property of
    mixed derivatives. Euler’s theorem on homogeneous function of two and three
    variables. Maxima and minima of functions of not more than three variables –
    Lagrange’s Method of undetermined multiplier – Problems only. Implicit
    function in case of function of two variables (existence assumed) and
    derivative.

Group B (15 marks)

Integral Calculus
01. Reduction formulae of \( \int \sin^m x \cos^n x \, dx \), \( \int \cot x \, dx \), and associated problems (\( m \) and \( n \) are non-negative integers).

02. Definition of Improper Integrals: Statements of (i) \( \int_{-\infty}^{\infty} \) test, (ii) Comparison test (Limit form excluded) – Simple problems only. Use of Beta and Gamma functions (convergence and important relations being assumed).

03. Working knowledge of Double integral.

04. Applications: Rectification, Quadrature, Volume and Surface areas of solids formed by revolution of plane curve and areas – Problems only.

Group C (10 marks)

**Differential Equations**


**MODULE V**

Group A (20 marks)

**Numerical Methods**

01. Approximate numbers, Significant figures, Rounding off numbers. Error – Absolute, Relative and Percentage.

02. Operators - \( \otimes \), \( \oplus \) and \( \ominus \) (Definitions and some relations among them).


(Note: emphasis should be given on problems)

Group B (30 marks)

**Linear Programming**

Feasible Solutions (B.F.S.) Degenerate and Non-degenerate B.F.S.

The set of all feasible solutions of an L.P.P. is a convex set. The objective function of an L.P.P. assumes its optimal value at an extreme point of the convex set of feasible solutions. A B.F.S. to an L.P.P. corresponds to an extreme point of the convex set of feasible solutions.

Fundamental Theorem of L.P.P. (Statement only). Reduction of a feasible solution to a B.F.S. Standard form of an L.P.P. Solution by graphical method (for two variables), by simplex method and method of penalty. Concept of duality. Duality theory. The dual of the dual is the primal. Relation between the objective values of dual and the primal problems. Dual problems with at most one unrestricted variable, one constraint of equality.

Transportation and Assignment problem and their optimal solutions.

MODULE VI

(50 marks)

(Any one of the following groups)

Group A

Analytical Dynamics

01. Velocity and Acceleration of a particle. Expressions for velocity and acceleration in rectangular Cartesian and polar co-ordinates for a particle moving in a plane. Tangential and normal components of velocity and acceleration of a particle moving along a plane curve.

02. Concept of Force : Statement and explanation of Newton's laws of motion. Work, power and energy. Principles of conservation of energy and momentum. Motion under impulsive forces. Equations of motion of a particle (i) moving in a straight line, (ii) moving in a plane.

03. Study of motion of a particle in a straight line under (i) constant forces, (ii) variable forces (S.H.M., Inverse square law, Damped oscillation, Forced and Damped oscillation, Motion in an elastic string). Equation of Energy. Conservative forces.

04. Motion in two dimensions : Projectiles in vacuo and in a medium with resistance varying linearly as velocity. Motion under forces varying as distance from a fixed point.

05. Central orbit. Kepler's laws of motion. Motion under inverse square law.

OR

Group B

Probability and Statistics

random variables.
Theoretical Probability Distribution – Discrete and Continuous (p.m.f. pd.d.f.)
Binomial, Poisson and Normal distributions and their properties.

02. Elements of Statistical Methods. Variables, Attributes, Primary data and
Tabulation – Chart and Diagram, graph, Bar diagram, Pie diagram etc.
Frequency Distribution – Un-grouped and grouped cumulative frequency
distribution. Histogram, Frequency curve, Measure of Central Tendencies –
Average : AM, GM, HM, Mean, Median and Mode (their advantages and
disadvantages). Measures of Dispersions – Range, Quartile Deviation, Mean
Deviation, Variance/S.D., Moments, Skewness and Kurtosis.

03. Sampling Theory : Meaning and objects of sampling. Some ideas about the
methods of selecting samples. Statistic and Parameter, Sampling Distribution
– standard error of a statistic (e.g. sample mean, sample proportion). Four
fundamental distributions derived from the normal : (i) Standard Normal
Distribution, (ii) Chi-square distribution, (iii) Student’s distribution, (iv)
Snedecor’s F-distribution.

Estimation and Test of Significance. Statistical Inference. Theory of
estimation – Point estimation and Interval estimation. Confidence
Interval/Confidence Limit. Statistical Hypothesis – Null Hypothesis and
Alternative Hypothesis. Level of significance. Critical Region. Type I and
Type II error. Problems.

04. Bivariate Frequency Distribution. Scatter Diagram, Correlation co-efficient –
Definition and properties. Regression lines.

Measurement of Trend – (i) Moving Average Method, (ii) Curve Fittings
(linear and quadratic curve). (Ideas of other curves, e.g. exponential curve
etc.). Ideas about the measurement of other components.

06. Index Number : Meaning of Index Number. Construction of Price Index
Number. Consumer Price Index Number. Calculation of Purchasing Power of
Rupee.

MODULE VII

(50 marks)

Computer Science & Programming

01. Boolean algebra – Basic Postulates and Definition. Tow-element Boolean
DNF and CNF. Minterms and maxterms. Principle of Duality. Some laws and
theorem of Boolean algebra. Simplification of Boolean expressions –
Algebraic method and Karnaugh Map method. Application of Boolean algebra
– Switching Circuits, Circuit having some specified properties, Logical Gates
– AND, NOT, OR, NAND, NOR etc.

02. Computer Science and Programming : Historical Development, Computer
Generation, Computer Anatomy – Different Components of a Computer
System. Operating System, Hardware and Software.

Positional Number System. Binary to Decimal and Decimal to Binary.
Other systems. Binary Arithmetic. Octal, Hexadecimal, etc. Storing of data in
a Computer – BIT, BYTE, WORD, etc. Coding of a data – ASCII, etc.
Programming Language: Machine Language, Assembly language and High level language. Compiler and Interpreter. Object Programme and Source Programme. Ideas about some HLL – e.g. BASIC, FORTRAN, C, C++, COBOL, PASCAL, etc.

Algorithms and Flow Charts – their utilities and important features. Ideas about the complexities of an algorithm. Application in simple problems. FORTRAN 77/99 – Introduction, Data Type – Keywords, Constants and Variables – Integer, Real, Complex, Logical, Character, Subscripted Variables, Fortran Expressions.

I/O Statements – formatted and unformatted. Programme execution control – Logical if, if-then-else, etc. Arrays, dimension statement. Repetitive Computation – Do, Bested Do etc.

Sub Programs – (i) Function Sub Programme
(ii) Subroutine Sub Programme

Elements of BASIC Programming Language: Reading, Printing, Branch & Loop, Array, Functions.

Application to Simple Problems. An exposure to M.S. Office, e-mail, Internet (Through Demonstration only).

MODULE VIII
(50 marks)
(Any one of the following groups)

Group A

A Course of Calculus


Statement of properties of continuity of sum function power series. Term by term integration and Term by term differentiation of Power Series. Statements of Abel’s Theorems on Power Series. Convergence of Power Series. Expansions of elementary functions such as $e^x$, $\sin x$, $\log(1+x)$, $(1+x)^n$. Simple problems.


03. Third and Fourth order ordinary differential equation with constant coefficients. Euler’s Homogeneous Equation.

04. Second order differential equation: (a) Method of variation of parameters. (b) Method of undetermined coefficients. (c) Simple eigenvalue problem.

05. Simultaneous linear differential equation with constant coefficients.

06. Laplace Transform and its application to ordinary differential equation.


OR

Group B

Discrete Mathematics


02. Congruences : Congruence relation on integers, Basic properties of this relation. Linear Congruences, Chinese Remainder Theorem. System of Linear Congruences. (Definition of Congruence – to show it is an equivalence relation, to prove the following : \( a \equiv b \pmod{m} \) implies \( (i) (a+c) \equiv (b+c) \pmod{m} \) \( (ii) ac \equiv bc \pmod{m} \) \( (iii) a^n \equiv b^n \pmod{m} \), for any polynomial \( f(x) \) with integral coefficients \( f(a) \equiv f(b) \pmod{m} \) etc. Linear Congruence, to show how to solve these congruences, Chinese remainder theorem – Statement and proof and some applications. System of linear congruences, when solution exists – some applications).

03. Application of Congruences : Divisibility tests. Computer file, Storage and Hashing functions. Round-Robin Tournaments. Check-digit in an ISBN, in Universal Product Code, in major Credit Cards. Error detecting capability. (Using Congruence, develop divisibility tests for integers base on their expansions with respect to different bases, if \( d \) divides \( (b-1) \) then \( n = (a_0a_1a_2) \) is divisible by \( d \) if and only if the sum of the digits is divisible by \( d \) etc. Show that congruence can be used to schedule Round-Robin tournaments. A university wishes to store a file for each of its students in its computer. Systematic methods of arranging files have been developed based on Hashing functions \( h(k) \equiv k \pmod{m} \). Discuss different properties of this congruence and also problems based on this congruence. Check digits for different identification numbers – International standard book number, universal product code etc. Theorem regarding error detecting capability).

04. Congruence Classes : Congruence classes, addition and multiplication of congruence classes. Fermat’s little theorem. Euler’s Theorem. Wilson’s
Theorem. Some simple applications. (Definition of Congruence Classes, properties of Congruence classes, addition and multiplication, existence of inverse. Fermat’s little theorem. Euler’s theorem. Wilson’s theorem – Statement, proof and some applications).

05. Recurrence Relations and Generating functions: Recurrence Relations. The method of iteration. Linear difference equations with constant coefficients. Counting with generating functions.

06. Boolean Algebra: Boolean Algebra, Boolean functions, Logic gates, Minimization of circuits.