Proposed syllabus
for

B.Sc. (Prog.) Physical Sciences/Applied Physical Sciences

CBCS

Department of Mathematics
University of Delhi
Delhi-110007
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MATHEMATICS Papers for

B.Sc.(Prog.) Physical Sciences

Semester-I

Paper I Calculus and Matrices
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

Unit I. Matrices
R, R^2, R^3 as vector spaces over R. Standard basis for each of them. Concept of
Linear Independence and examples of different bases. Subspaces of R^2, R^3.
Translation, Dilation, Rotation, Reflection in a point, line and plane. Matrix form of
basic geometric transformations. Interpretation of eigenvalues and eigenvectors
for such transformations and eigenspaces as invariant subspaces. Matrices in
diagonal form. Reduction to diagonal form upto matrices of order 3. Computation
of matrix inverses using elementary row operations. Rank of matrix. Solutions of
a system of linear equations using matrices. Illustrative examples of above
concepts from Geometry, Physics, Chemistry, Combinatorics and
Statistics.

Unit II. Calculus
Sequences to be introduced through the examples arising in Science beginning
with finite sequences, followed by concepts of recursion and difference
equations. For instance, the sequence arising from Tower of Hanoi game, the
Fibonacci sequence arising from branching habit of trees and breeding habit of
rabbits. Convergence of a sequence and algebra of convergent sequences.
Illustration of proof of convergence of some simple sequences such as (-1)^n/n,
1/n^2, (1+1/n)^n, sin n/n, x^n with 0 < x < 1. Graphs of simple concrete functions such
as polynomial, trigonometric, inverse trigonometric, exponential, logarithmic and
hyperbolic functions arising in problems or chemical reaction, simple pendulum,
radioactive decay, temperature cooling/heating problem and biological
rhythms. Successive differentiation. Leibnitz theorem. Recursion formulae for
higher derivative. Functions of two variables. Graphs and Level Curves of
functions of two variables. Partial differentiation upto second order.
Computation of Taylor’s Maclaurin’s series of functions such as e^x,
log(1 + x), sin (2x), cos x. Their use in polynomial approximation and error
estimation. Formation and solution of Differential equations arising in population
growth, radioactive decay, administration of medicine and cell division.
Unit III.

Geometrical representation of addition, subtraction, multiplication and division of complex numbers. Lines half planes, circles, discs in terms of complex variables. Statement of the Fundamental Theorem of Algebra and its consequences, De Moivre’s theorem for rational indices and its simple applications.

Recommended Books
Semester-II

Paper II  **Calculus and Geometry**

Five Lectures per week + Tutorial as per University rules  
Max. Marks 100 (including internal assessment)  
Examination 3 hrs.

**Unit I: Calculus**


**Unit II: Geometry and Vector Calculus**


**Recommended Books**

Semester-III

Paper III - **Algebra**
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

**Groups:** Definition and examples of groups, examples of abelian and nonabelian groups: the group \( \mathbb{Z}_n \) of integers under addition modulo \( n \) and the group \( \mathbb{U}(n) \) of units under multiplication modulo \( n \). Cyclic groups from number systems, complex roots of unity, circle group, the general linear group \( \text{GL}(n, \mathbb{R}) \), groups of symmetries of (i) an isosceles triangle, (ii) an equilateral triangle, (iii) a rectangle, and (iv) a square, the permutation group \( \text{Sym}(n) \), Group of quaternions, Subgroups, cyclic subgroups, the concept of a subgroup generated by a subset and the commutator subgroup of group, examples of subgroups including the center of a group. Cosets, Index of subgroup, Lagrange’s theorem, order of an element, Normal subgroups: their definition, examples, and characterizations, Quotient groups.

**Rings:** Definition an examples of rings, examples of commutative and noncommutative rings, rings from number systems, \( \mathbb{Z}_n \) the ring of integers modulo \( n \), ring of real quaternions, rings of matrices, polynomial rings, and rings of continuous functions. Subrings and ideals, Integral domains and fields, examples of fields: \( \mathbb{Z}_p \), \( \mathbb{Q} \), \( \mathbb{R} \), and \( \mathbb{C} \). Field of rational functions.

**Vector spaces:** Definition and examples of vector spaces. Subspaces and its properties Linear independence, basis, invariance of basis size, dimension of a vector space. Linear Transformations on real and complex vector spaces: definition, examples, kernel, range, rank, nullity, isomorphism theorems.

**Recommended Books**

Semester-IV

Paper IV  **Real Analysis**

Five Lectures per week + Tutorial as per University rules  
Max. Marks 100 (including internal assessment)  
Examination 3 hrs.

**Unit I : Real Sequences**

**Unit II: Infinite Series**

**Unit III: Riemann Integration**
Riemann integral, integrability of continuous and monotonic functions

**Recommended Books**
Semester-V

DSE-1

(I) Differential Equations

Or

(ii) Mechanics and Discrete Mathematics

Paper V  Differential Equations

Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

Ordinary Differential equations

Partial Differential Equations

Recommended Books

Paper V Mechanics and Discrete Mathematics

Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs.

Mechanics
Conditions of equilibrium of a particle and of coplanar forces acting on a rigid Body, Laws of friction, Problems of equilibrium under forces including friction, Centre of gravity, Work and potential energy.

Velocity and acceleration of a particle along a curve: radial and transverse components (plane curve ), tangential and normal components (space curve), Newton’s Laws of motion, Simple harmonic motion, Simple Pendulum, Projectile Motion.

Graph Theory
Types of graphs : Simple graph, Directed graph, Multi graph, and Pseudo graph. Graph modeling, terminology and basics. Special Graphs : Complete Graph, Cycles, n-dimensional cubes, Bipartite Graph, Complete Bipartite Graph. Subgraph and basic algebraic operations on graphs, connectivity, path, cycles, tree to be introduced as a connected graph with no cycles, introduction to shortest path (least number of edges) problem, solution of shortest path problem for simple graphs using complete enumeration. Euler and Hamiltonian graphs (for undirected graphs only) : Koenigsburg Bridge Problem, statements and interpretations of (i) necessary and sufficient conditions for Euler cycles and paths (ii) sufficient condition for Hamiltonian cycles, finding Euler cycles and Hamiltonian cycles in a given graph.

Recommended Books
Semester-VI

DSE-2

(I) Numerical Methods

or

(ii) Probability and Statistics

Paper VI Numerical Methods
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs

Unit-I


Unit-II

Gauss elimination method (with row pivoting) and Gauss–Jordan method, Gauss Thomas method for tridiagonal systems Iterative methods: Jacobi and Gauss-Seidel iterative methods Interpolation: Lagrange’s form and Newton’s form Finite difference operators, Gregory Newton forward and backward differences Interpolation

Unit-III


REFERENCES:

Or

Paper VI **Probability and Statistics**
Five Lectures per week + Tutorial as per University rules
Max. Marks 100 (including internal assessment)
Examination 3 hrs

**Unit-I**

**Unit-II**

**Unit-III**
Linear regression for two variables, The rank correlation coefficient. Chebyshev’s inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers. Central Limit Theorem for independent and identically distributed random variables with finite variance.

**REFERENCES:**
Skill Enhancement Course Papers

SEC-1 LaTeX and HTML
2L+ 2Practical per week

Elements of LaTeX; Hands-on-training of LaTex; graphics in LaTeX; PSTricks; Beamer presentation; HTML, creating simple web pages, images and links, design of web pages.

[1] Chapter 9-11, 15

Practical
Six practical should be done by each student. The teacher can assign practical from the exercises from [1].

References:

SEC-2 Computer Algebra Systems and Related Softwares
2L+ 2Practical per week

Use of Mathematica, Maple, and Maxima as calculator, in computing
functions, in making graphs; MATLAB/Octave for exploring linear algebra
and to plot curve and surfaces; the statistical software R: R as a calculator,
explore data and relations, testing hypotheses, generate table values and
simulate data, plotting.

[1] Chapter 12-14

Practical
Six practical should be done by each student. The teacher can assign
practical from the exercises from [1].

References:
[1] Martin J. Erickson and Donald Bindner, A Student's Guide to the Study,
Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL,
2011.
SEC-3 Operating System: Linux
2L+ 2Practical per week


References:
SEC-4 Transportation and Game Theory
2L+ 1 Tutorial per week


References: