

**Department of Mathematics**  
**Faculty of Natural Science, Jamia Millia Islamia, New Delhi-25**

**Structure of B. Sc. (General) (Core Courses)**

**Semester – I**

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BPM-1.1	Calculus	4	4	25	75	100

**Semester – II**

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BPM-2.1	Differential Equations	4	4	25	75	100

**Semester – III**

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BPM-3.1	Analysis-I	4	4	25	75	100
2	BPM-3.2	Numerical Methods	4	4	25	75	100

**Semester – IV**

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BPM-4.1	Analysis-II	4	4	25	75	100
2	BPM-4.2	Groups & Rings	4	4	25	75	100

**Semester – V**

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BPM-5.1	Linear Algebra	4	4	25	75	100
2	BPM-5.2	Probability and Statistics	4	4	25	75	100

**Semester – VI**

S. No.	Code	Title of paper	Unit	Credit	Internal Assessment	Semester Examination	Total Marks
1	BPM-6.1	Functions of Several Variables	4	4	25	75	100

## B. Sc. (G), Semester – I

BPM-1.1	Calculus	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

**Unit-I**  $\varepsilon - \delta$  definition of the limit of a function, Algebra of limits, Continuity, Differentiability, Successive differentiation, Leibnitz Theorem, Rolle's Theorem, Mean Value Theorems, Taylor and Maclaurin's series.

**Unit-II** Indeterminate forms, Curvature, Cartesian, Polar and parametric formulae for radius of curvature, Partial derivatives, Euler's theorem on homogeneous functions.

**Unit-III** Asymptotes, Test of concavity and convexity, Points of Inflexion, Multiple points, Tracing of curves in Cartesian and polar coordinates.

**Unit-IV** Reduction formulae, Quadrature, Rectification, Intrinsic equation, Volumes and surfaces of solids of revolution.

### Books Recommended

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. M. J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P.Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
4. Gorakh Prasad, *Differential Calculus*, Pothishala Pvt Ltd, Allahabad
5. Khalil Ahmad, *Text Book of Calculus*, World Education Publishers, 2012.

## B. Sc. (G), Semester – II

BPM-2.1	Differential Equations	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

**Unit-I** Formation of differential equations, Order and degree of a differential equation, equations of first order and first degree, solutions of equations in which variables are separable, Homogeneous equations, Linear equations and Bernoulli equations, Exact differential equations, integrating factors, Change of variables.

**Unit-II** Equations of the first order and higher degree, Equations solvable for p, y and x, Clairaut equation, Lagrange's equation, Applications. .

**Unit-III** Linear differential equations with constant coefficient, Complementary function and particular integral. Particular integral of the forms  $e^{ax}$ ,  $\sin ax$ ,  $\cos ax$ ,  $x^m$  and  $e^{ax}V$ , Homogeneous linear equations.

**Unit-IV** Linear differential equations of second order, Complete solution in terms of known integral belonging to the complementary function, Normal form, Change of independent variable, Method of undetermined coefficients, Method of variation of parameters, Simultaneous equations with constant coefficients.

### Books Recommended:

1. C. H. Edwards and D. E. Penny, *Differential Equations and Boundary Value Problems: Computing and Modelling*, Pearson education, India 2005.
2. Dennis G. Zill, *A first course in differential equations*,
3. S. L. Ross: *Differential equations*, John Wiley and Sons, 2004.
4. Zafar Ahsan: *Text Book of Differential Equations and their Applications*, Prentice Hall of India.
5. Khalil Ahmad: *Text Book of Differential Equations*, World Education Publishers, 2012.

## B. Sc. (G), Semester – III

BPM-3.1	Analysis-I	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

**Unit-I** Bounded and unbounded sets, Infimum and supremum of a set and their properties, Order completeness property of  $\mathbb{R}$ , Archimedean property of  $\mathbb{R}$ , Density of rational and irrational numbers in  $\mathbb{R}$ , Dedekind form of completeness property, Equivalence between order completeness property of  $\mathbb{R}$  and Dedekind property. Neighbourhood, open set, Interior of a set, Limit point of a set, Closed set and related Theorems/results. Derived set, Closure of a set, Bolzano-Weierstrass theorem for sets. Countable and uncountable sets.

**Unit-II** Sequence of real numbers, Bounded sequence, limit points of a sequence, Bolzano Weierstrass theorem for sequence, Limit inferior and limit superior, Convergent and non-convergent sequences, Cauchy's sequence, Cauchy's general principal of convergence, Algebra of sequences, Theorems on limits of sequences, Subsequences, Monotone sequences, Monotone convergence Theorem.

**Unit-III** Infinite series and its convergence and divergence, Cauchy's criterion for convergence of series, Test for convergence of positive term series, Comparison tests, Ratio test, Cauchy's  $n^{\text{th}}$  root test, Raabe's test, Logarithmic test, Integral test, Alternating series, Leibnitz test, Absolute and conditional convergence.

**Unit-IV** Continuous functions ( $\varepsilon - \delta$  approach), Discontinuous functions, Types of discontinuities, Sequential criterion for continuity and discontinuity, Theorems on continuity, Uniform continuity, Relation between continuity and uniform continuity, Derivative of a function, Relation between continuity and differentiability, Increasing and decreasing functions, Darboux theorem, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's theorem with Cauchy's and Lagrange's form of remainder.

### Books Recommended:

1. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis (3<sup>rd</sup> Edition)*, John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2003.
2. S. C. Malik and Savita Arora, *Mathematical Analysis*, New Age International (P) Ltd. Publishers, 2009.
3. K. A. Ross, *Elementary Analysis: The Theory of Calculus, Under graduate Texts in Mathematics*, Springer (SIE), Indian reprint, 2004.
4. Sudhir R. Ghorpade and Balmohan V. Limaye, *A course in Calculus and Real Analysis, Undergraduate Text in Maths.*, Springer (SIE), Indian reprint 2006.
5. T. M. Apostol, *Mathematical Analysis*, Addison-Wesley Series in Mathematics, 1974.
6. Gerald G. Bilodeau, Paul R. Thie, G. E. Keough, *An Introduction to Analysis*, 2<sup>nd</sup> Ed., Jones & Bartlett, 2010.

## B. Sc. (G), Semester – III

BPM-3.2	Numerical Methods	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

**Unit-I** Absolute, relative and percentage errors, General error formula. Solution of algebraic and transcendental equations: Bisection method, False position method, Fixed-point iteration method, Newton's method and its convergence, Chebyshev method. Solution of system of non-linear equations by Iteration and Newton-Raphson method.

**Unit-II** Direct methods to solve the system of linear equations: Gauss elimination method, Gauss Jordan method, LU decomposition method. Indirect methods: Gauss-Jacobi and Gauss-Seidal methods. The algebraic Eigen value problems by Householder and Power method.

**Unit-III** Finite difference operators and finite differences, Interpolation and interpolating polynomials: Newton's forward and backward difference formulae. Central differences: Sterling's and Bessel's formula. Lagrange's interpolation formula, Divided Differences, their properties and Newton's general interpolation formula.

**Unit-IV** Numerical differentiation of tabular and non-tabular functions. Numerical integration using Gauss quadrature formulae: Trapezoidal rule, Simpson's rules, Romberg formula and their error estimation. Numerical solution of ordinary differential equations by Picard's method, Taylor series, Euler's method and Runge-Kutta methods.

### Books Recommended:

1. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India, 5th edition, 2007
3. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 7th edition, 2008.
4. S. S. Sastry, Introductory Methods of Numerical Analysis (Fifth Ed.), Prentice Hall of India (Ltd.), 2012.
5. M. Pal, Numerical Analysis for Scientists and Engineers, Narosa Publisher, 2007.
6. N. Ahmad, Fundamental Numerical Analysis with error estimation, Anamaya Publisher.

## B. Sc. (G), Semester – IV

BPM-4.1	Analysis-II	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

**Unit-I** Definition, existence and properties of Riemann integral of a bounded function, Darboux theorem, Condition of integrability, Riemann integrability for continuous functions, monotonic function and theorems on function with finite or infinite number discontinuity (without proof). The Riemann integral through Riemann sums, Equivalence of two definitions, Properties of Riemann integral, Fundamental theorem of calculus, First Mean Value Theorems, Second Mean Value Theorems, Generalized Mean Value Theorems.

**Unit-II** Definition of improper integrals, Convergence of improper integrals, Test for convergence of improper integrals, Comparison test, Cauchy's test for convergence, Absolute convergence, Abel's Test, Dirichlet's Test, Beta and Gamma functions and their properties and relations.

**Unit-III** Pointwise and uniform convergence of sequences and series of functions, Cauchy's criterion for uniform convergence of sequence and series, Weierstrass M-test, Uniform convergence and continuity, Uniform convergence and differentiation, Uniform convergence and integration, Weierstrass Approximation Theorem.

**Unit-IV** Fourier Series, Fourier Series for even and odd functions, Half Range Series, Fourier Series on intervals other than  $[-\pi, \pi]$ .  
Power Series, Radius of Convergence, Cauchy's Hadamard Theorem, Uniform and Absolute convergence, Abel's Theorem (without proof), exponential and logarithmic functions.

### Books Recommended:

1. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis (3<sup>rd</sup> Edition)*, John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2003.
2. S. C. Malik and Savita Arora, *Mathematical Analysis*, New Age International (P) Ltd. Publishers, 2009.
3. K. A. Ross, *Elementary Analysis: The Theory of Calculus, Under graduate Texts in Mathematics*, Springer (SIE), Indian reprint, 2004.
4. Sudhir R. Ghorpade and Balmohan V. Limaye, *A course in Calculus and Real Analysis, Undergraduate Text in Maths.*, Springer (SIE), Indian reprint 2006.
5. T. M. Apostol, *Mathematical Analysis*, Addison-Wesley Series in Mathematics, 1974.
6. Gerald G. Bilodeau, Paul R. Thie, G. E. Keough, *An Introduction to Analysis*, 2<sup>nd</sup> Ed., Jones & Bartlett, 2010.
7. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1990.
8. Charles G. Denlinger, *Elements of Real Analysis*, Jones & Bartlett (Student Edition), 2011.

## B. Sc. (G), Semester – IV

<b>BPM-4.2</b>	<b>Groups and Rings</b>	<b>Unit</b>	<b>Credit</b>	<b>Lecture/ week</b>
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

**Unit-I** Sets, Relations, Types of relations, Equivalence relation, Group and their properties, Subgroups and their characterizations, Cosets, Normal subgroups, Lagrange's theorem and its consequences, Factor groups.

**Unit-II** Group Homomorphisms, Kernel of a homomorphism, Isomorphisms, The homomorphism theorems, The Isomorphism theorems, Permutation groups, Even and odd permutations, Alternating groups, Cayley's theorem.

**Unit-III** Rings and their properties, Integral domain, Division ring and Field, Subrings, Ideals and their properties, Operations on ideals, Quotient rings.

**Unit-IV** Ring homomorphism and its properties, Kernel of a homomorphism, The homomorphism Theorems, Isomorphism, Euclidean domain and their properties, Unique factorization domains.

### Books Recommended:

1. N. Herstein, Topics in Algebra, Wiley Eastern Ltd., New Delhi.
2. Surjeet Singh and Qazi Zameeruddin, Modern Algebra, Vikas Publishing House Pvt. Ltd., New Delhi.
3. J.A. Gallian, Contemporary Abstract Algebra, Narosa Publication.
4. David C. Lay: Linear algebra and its applications (3rd Edition), Pearson Education Asia, Indian Reprint, 2007.

## B. Sc. (G), Semester – V

BPM-5.1	Linear Algebra	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

**Unit-I** Definition examples and basic properties of a vector space, Subspaces, Linear Dependence Independence, Linear combinations and span, Basis and dimension, Sum and intersection of subspaces, Direct sum of subspaces.

**Unit-II** Definition and examples of linear transformations, Properties of linear transformations, Range and kernel, The rank and nullity of a linear transformation, Rank-Nullity Theorem and its consequence, The matrix representation of a linear transformation, Change of basis.

**Unit-III** Scalar product in an Inner product spaces, Orthogonality in inner product spaces, Normed linear spaces, Inner product on complex vector spaces, Orthogonal Complements, orthogonal sets, Gram-Schmidt Orthogonalization process.

**Unit-IV** Eigenvalues and eigen vectors, Characteristic equation and polynomial, Eigenvectors and eigenvalues of linear transformations and matrices, The Cayley-Hamilton Theorem, Similar matrices and Diagonalization, Orthogonal Diagonalization.

### Books Recommended:

1. David C. Lay: *Linear algebra and its applications (3rd Edition)*, Pearson Education Asia, Indian Reprint, 2007.
2. Geory Nakos and David Joyner: *Linear algebra with Applications*, Brooks/ Cole Publishing Company, International Thomson Publishing, Asia, Singapore, 1998.
3. Stephen H. Friedberg, Arnold J. Insel and L. E. Space- *Linear Algebra*, 4th dition, PHI Pvt Ltd., New Delhi, 2004.
4. I. V. Krishnamurty, V.P. Mainra, J.L. Arora- *An introduction to Linear Algebra*, East West Press , New Delhi, 2002.



## B. Sc. (G), Semester – V

BPM-5.2	Probability and Statistics	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

**Unit-I** Sample space and events, algebra of events, axiomatic approaches, conditional probability, basic laws of total probability and compound probability, Bayes' theorem, Prior probabilities (priors) and posterior probabilities.

**Unit-II** Discrete and continuous random variables, mathematical expectation, variance, moment about a point, central moment, moment generating function, Binomial, Poisson, Normal and Rectangular distributions.

**Unit-III** Two-dimensional random variables, joint distribution functions, marginal distributions, covariance, linear regression and correlation, rank correlation, least square method of fitting regression lines.

**Unit-IV** Sampling, random sampling, large sample tests of means and proportion.  $t$ -student,  $\chi^2$  (chi square) and  $F$  distributions (without derivation) and testing of hypothesis based on them.

### Books Recommended:

1. Irwin Miller and Marylees Miller, *John E. Freund's Mathematical Statistics with Applications*, Pearson Education.
2. Robert V. Hogg, Allen Craig Deceased and Joseph W. McKean, *Introduction to Mathematical Statistics*, Pearson Education
3. Sheldon M. Ross, *Introduction to probability and statistics for engineers and scientists*, Elsevier Academic Press.
4. J.N. Kapur and H.C. Saxena, *Mathematical Statistics*, S. Chand.
5. P.N.Arora, *Comprehensive Statistical Methods*, S.Chand.

## B. Sc. (G), Semester – VI

BPM-6.1	Functions of Several Variables	Unit	Credit	Lecture/ week
Internal Assessment: 25 Marks End Semester Examination: 75 Marks Duration of Examination: 2 Hrs.		4	4	4

- Unit-I** Functions of several variables. Domains and Range. Functional notation, Level curves and level surfaces. Limits and continuity. Partial derivatives. Total differential. Fundamental lemmas. Differential of functions of  $n$  variables and of vector functions. The Jacobian matrix. Derivatives and differentials of composite functions, The general chain rule.
- Unit-II** Implicit functions. Inverse functions. Curvilinear co-ordinates. Geometrical Applications. The directional derivatives. Partial derivatives of higher order. Higher derivatives of composite functions. The Laplacian in polar, cylindrical and spherical co-ordinates. Higher derivatives of implicit functions. Maxima and minima of functions of several variables.
- Unit-III** Vector fields and scalar fields. The gradient field. The divergence of a vector field. The curl of a vector field. Combined operations. Irrotational fields and Solenoidal fields. Double integrals, triple integrals and multiple integrals in general. Change of variables in integrals. Arc length and surface area.
- Unit-IV** Line integrals in the plane. Integrals with respect to arc length. Basic properties of line integrals. Line integrals as integrals of vectors. Green's Theorem. Independence of path, Simply connected domains, Extension of results to multiply connected domains. Line Integrals in space. Surfaces in space, orientability. Surface integrals. The divergence theorem. Stokes's theorem. Integrals independent of path.

### Books Recommended:

1. Wilfred Kaplan: Advanced Calculus, Adisson-Wasley Publishing Company, 1973.
2. E. Swokowski: Calculus with Analytical Geometry, Prindle, Weber & Schmidt, 1994.
3. E. Kreyzig: Advanced Engineering Mathematics, John Wiley and Sons, 1999.
4. David Widder: Advanced Calculus, Prentice Hall of India, 1999.
5. S. C Malik and Savita Arora: Mathematical Analysis, New Age International (P), 1996.