

UNIVERSITY OF PUNE, PUNE 411007
BOARD OF STUDIES IN MATHEMATICS
S.Y. B. Sc. (MATHEMATICS)
SYLLABUS

S.Y.B.Sc

	Semester-I		Semester-II	
Paper I	Calculus of Several Variables	MT:211	Linear Algebra	MT:221
Paper II	A) : Differential Equations	MT:212(A)	Vector Calculus	MT:222(A))
	B) : Numerical Analysis	MT:212(B)	Discrete Mathematics	MT:222(B))
Paper III	Practicals based on Paper I and II			MT:223

Note :

1. Paper I (MT:211 and MT:221) and Paper III(MT:223) are compulsory.
2. In semester I, students can offer either Paper II(MT:212(A)) or Paper II(MT:212(B)).
3. In semester II, students can offer either Paper II(MT:222(A)) or Paper II (MT:222(B)).

Paper I : Calculus of Several Variables (MT:211)
(Semester-I)

1. **Limits and Continuity :** [6 lectures]
 - (1) Functions of two and three variables.
 - (2) Notions of limits and continuity.
 - (3) Examples.
2. **Partial Derivatives :** [4 lectures]
 - (1) Definition and examples.
 - (2) Chain Rules.
3. **Differentiability :** [14 lectures]
 - (1) Differential and differentiability and necessary and sufficient conditions for differentiability.
 - (2) Higher ordered partial derivatives.
 - (3) Schwartz's theorem, Young's theorem with proof.
 - (4) Euler's theorem for homogeneous functions.
 - (5) Mean Value theorem, Taylor's theorem for functions of two variables
4. **Extreme Values :** [8 lectures]
 - (1) Extreme values of functions of two variables.
 - (2) Necessary conditions for extreme values.
 - (3) Sufficient conditions for extreme values.
 - (4) Lagrange's method of undetermined coefficients.
5. **Multiple Integrals :** [16 lectures]
 - (1) Double integrals, evaluation of double integrals.
 - (2) Change of order of integration for two variables.
 - (3) Double integration in Polar co-ordinates.
 - (4) Triple integrals.
 - (5) Evaluation of triple integrals.
 - (6) Jacobians, Change of variables.(Results without proofs)
 - (7) Applications to Area and Volumes.

Text book:

Shanti Narayan and P.K. Mittal, A Course of Mathematical Analysis
(12th Edition, 1979), S. Chand and Co..

(Art. 12.1 to 12.3, 12.4, 12.5, 13.1, 13.3 to 13.9, 16.6 to 16.8,16..11, 18.5, 18.8).

References:

- (1) M.R. Spiegel, Advanced Calculus: Schaum Series.
- (2) D.V. Widder, Advanced Calculus (IInd Edition), Prentice Hall of India, New Delhi, (1944).
- (3) T.M. Apostol, Calculus Vol. II (IInd Edition), John Willey, New York, (1967).

Paper- I Linear Algebra (MT:221)
(Semester-II)

1. **Vector Spaces :** [14 lectures]
 - (1) Definitions and Examples.
 - (2) Vector Subspaces.
 - (3) Linear Independence.
 - (4) Basis and Dimensions of a Vector Space.
 - (5) Row and Column Spaces of a matrix.
Row rank and Column rank.
2. **Linear Transformations:** [12 lectures]
 - (1) Linear Transformation, representation by a matrix.
 - (2) Kernel and Image of a Linear Transformation.
 - (3) Rank-Nullity theorem.
 - (4) Linear Isomorphism.
 - (5) $L(V, W)$ is a vector space. Dimension of $L(V, W)$ (Statement only)
3. **Inner Product spaces:** [16 lectures]
 - (1) The Euclidean space and dot product.
 - (2) General inner product spaces.
 - (3) Orthogonality, Orthogonal projection onto a line, Orthogonal basis.
 - (4) Gram-Schmidt Orthogonalization.
 - (5) Orthogonal Transformation.
4. **Eigen values and Eigen vectors:** [6 lectures]
 - (1) Rotation of axes of conics.
 - (2) Eigenvalues and eigenvectors.

Text Books:

S. Kumaresan , Linear Algebra: A Geometric Approach, Prentice Hall of India, New Delhi, 1999.

Chapters: 2, 4, 5 (excluding Arts 4.4.10 -4.4.12, 5.3. 5.6, 5.7, 5.9), 7.1, 7.2.

Reference Books:

- (1) M. Artin, Algebra, Prentice Hall of India , New Delhi, (1994).
- (2) K. Hoffmann and R. Kunze Linear Algebra, Second Ed. Prentice Hall of India New Delhi, (1998).
- (3) S. Lang, Introduction to Linear Algebra, Second Ed. Springer-Verlag, New York, (1986).
- (4) A. Ramchandra Rao and P. Bhimasankaran, Linear Algebra, Tata McGraw Hill, New Delhi (1994).
- (5) G. Schay, Introduction to Linear Algebra, Narosa, New Delhi, (1998).
- (6) L. Smith, Linear Algebra, Springer –Verlag, New York, (1978).
- (7) G. Strang, Linear Algebra and its Applications. Third Ed. Harcourt Brace Jovanovich, Orlando, (1988).
- (8) T. Banchoff and J. Werner, Linear Algebra through Geometry. Springer-Verlag, New York, (1984).
- (9) H. Anton and C. Rorres, Elementary Linear Algebra with Applications, Seventh Ed., Wiley, (1994).

Paper II(A) Differential Equations(MT:212(A))
(Semester I)

1. Differential Equations of first order and first degree: [20 lectures]

- (1) Variables separable form.
- (2) Homogeneous Differential Equations and Exact Differential Equations. Examples of Non- Homogeneous equations.
- (3) Condition for exactness. (Necessary and sufficient condition)
- (4) Integrating factor, Rules of finding integrating factors (Statements only).
- (5) Linear Differential Equations, Bernoulli's equation.

2. Application of Differential Equations : [8 lectures]

- (6) Orthogonal trajectories.
- (7) Growth and decay.

3. Linear Differential Equations with constant coefficients: [20 lectures]

- (8) The auxiliary equations.
- (9) Distinct roots, repeated roots, Complex roots, particular solution.
- (10) The operator $\frac{1}{f(D)}$ and its evaluation for the functions $x^m, e^{ax}, e^{ax}v, xv$ and the operator $1/(D^2+a^2)$ acting on $\sin ax$ and $\cos ax$ with proofs.
- (11) Method of undetermined coefficients, Method of variation of parameters, Method of reduction of order.

Text Book:

- (1) Rainville and Bedient, Elementary Differential Equations, Macmillan Publication .
- (2) Daniel Murray, Introductory Course in Differential Equations, Orient Longman

Reference books:

- (1) Shanti Narayan, Integral Calculus, S. Chand and Company.
- (2) G.F. Simmons and S. Krantz, Differential Equations with Applications and Historical notes, Tata Mc-Graw Hill.

Paper-II(A) Vector Calculus (MT:222(A))
(Semester-II)

- 1. Vector functions of one variable:** [10 lectures]
- 1) Limit and continuity.
 - 2) Derivatives.
 - 3) Derivability in relation to algebraic operations: constant vector functions.
 - 4) Limits, continuity and partial derivatives of vector function of two and three variables.
 - 5) Total differentials
- 2. Curves in three dimensional spaces:** [6 lectures]
- 1) Curves in three dimensional spaces.
 - 2) Tangent vector.
 - 3) Normal plane and osculating plane.
 - 4) Normal plane at a point and fundamental planes.
 - 5) Orthonormal triad of unit vectors
- 3. Differential operators:** [18 lectures]
- 1) The operator del, scalar and vector fields.
Gradient of a scalar point function, properties and its geometrical interpretation.
 - 2) Directional derivatives of a scalar point function.
 - 3) Divergence and curl of a vector point function and its properties.
 - 4) Physical interpretation of Divergence and Curl , Solenoidal and Irrotational vector field.
- 4. Vector Integration :** [14 lectures]
- 1) Line Integral.
 - 2) Surface Integral.
 - 3) Volume Integral.
 - 4) Green's theorem with proof.
 - 5) Gauss's Divergence Theorem(statement only).
 - 6) Stokes's Theorem(Statement only), Examples on sphere, cube, cylinder.

Text book:

- 1) Shanti Narayan, R.K. Mittal, A Text-book of Vector Calculus, S.Chand and Company,(2005).
Articles:1.1 to 1.13, 2.1 to 2.5, 6.1 to 6.17, 7.1 to 7.11.

Reference books:

- (1) M.R. Spiegel, Advanced Calculus : Schaum Series.
- (2) D.V. Widder, Advanced Calculus (IInd Edition), Prentice Hall of India , New Delhi,(1944).
- (3) John M. H. Olmsted, Advanced Calculus, Eurasia Publishing House, New Delhi(1970)
- (4) T.M. Apostol , Calculus Vol. II (IInd Edition), John Wiley, New York, (1967).

Paper – II (B) Numerical Analysis(MT:212(B))
(Semester- I)

- 1. Errors:** [4 lectures]
(1) Rounding off numbers to n significant digits, to n decimal places.
(2) Absolute, relative and percentage errors.
- 2. Solution of Equations:** [12 lectures]
(1) Location of roots.
(2) Descartes' Rules.
(3) Sturm's theorem (without proof).
(4) Regula Falsi theorem.
(5) Newton- Raphson Method.
(6) Gauss-Seidel Method.
- 3. Fitting of Polynomials:** [6 lectures]
(1) Least Square Method.
(2) Fitting of
(i) Straight Line.
(ii) Second Degree Curve.
(iii) Power Function ax^b
(iv) Exponential Function ae^{bx}
- 4. Interpolation:** [12 lectures]
(1) Operators Δ, ∇, E and their relations.
(2) Fundamental theorem of difference calculus.
(3) Newton's Interpolation Formulae (Forward and Backward with proofs).
(4) Lagrange's Interpolation Formula with proof.
(5) Divided difference formula and Newton's divided difference formula.
- 5. Numerical Integration:** [8 lectures]
(1) General quadrature formula.
(2) Trapezoidal rule.
(3) Simpsons's $\frac{1^{rd}}{3}$ rule.
(4) Simpsons's $\frac{3^{th}}{8}$ rule.
- 6. Numerical solution of first order ordinary differential equations:** [6 lectures]
(1) Euler's method.
(2) Modified Euler's methods.
(3) Runge - Kutta Methods 1st and 2nd order.

Text Books :

- (1) H.C. Saxena; Finite differences and Numerical Analysis, S. Chand and Company.
(2) S.S. Sastry; Introductory Methods of Numerical Analysis, 3rd edition, Prentice Hall of India, 1999.

Note: Refer to S.S. Sastry for Chapter 1. Remaining Chapters from H.C.Saxena.

Reference Book:

- (1) K.E. Atkinson; An Introduction to Numerical Analysis, Wiley Publications.

Paper –II (B) Discrete Mathematics (MT:222(B))P
(Semester-II)

- 1. Mathematical Induction:** [4 lectures]
1) Introduction.
2) Strong Induction.
(Section 2.4 of [1])
- 2. Counting:** [14 lectures]
1) Permutations.
2) Combinations.
3) The Pigeonhole principle excluding Extended Pigeonhole principle
4) Recurrence relations.
(Section 3.1, 3.2, 3.3 and 3.5 of [1])
- 3. Order Relations and Structures:** [12 lectures]
1) Relations and Digraphs.
2) Partially Ordered Sets.
3) External elements of Partially Ordered Sets.
4) Lattices.
5) Finite Boolean Algebras.
6) Functions on Boolean Algebras.
7) Circuit Design
(Sections 4.2, 6.1, 6.2, 6.3, 6.4, 6.5 and 6.6 of [1])
- 4. Topics in Graph Theory:** [10 lectures]
1) Graphs (including Subgraphs)
2) Euler Paths and Circuits.
3) Hamiltonian Paths and Circuits.
4) Transport networks.
5) Matching problems.
(Sections 8.1, 8.2, 8.3, 8.4, 8.5 and 8.6 of [1])
- 6. Trees:** [4 lectures]
1) Definitions.
2) Spanning Trees
3) Minimal Spanning Trees.
4) Kruskal's Algorithm.
(Relevant Sections from [2].)

Text Books:

- (1) Bernard Kolman, Robert C. Busby, Sharon Cutler Ross and Nadeem-ur-Rehman: Discrete Mathematical Structures, Fifth Edition, Pearson Education, Inc., 2004.
- (2) Narsingh Deo, Graph Theory with Applications to Engineering and Computer Science, Prentice-Hall of India Pvt Ltd, 1974.

Reference Book:

- (1). Kenneth H. Rosen, Discrete Mathematics and its Applications, Fifth Edition, Tata McGraw-Hill Publishing Company Ltd., 2003.

Paper III (MT:223)

Practicals based on paper I and Paper II