### SEMESTER – 4

### Sub Code: P16MA41

### FUNCTIONAL ANALYSIS

**Objectives**

1. To study the three structure theorems of Functional Analysis viz., Hahn-Banach theorem, Open mapping theorem and Uniform boundedness principle.
2. To introduce Hilbert spaces and operator theory leading to the spectral theory of operators on a Hilbert space.

### UNIT I

Algebraic Systems: Groups – Rings – The structure of rings – Linear spaces – The dimension of a linear space – Linear transformations – Algebras – Banach Spaces : The definition and some examples – Continuous linear transformations – The Hahn- Banach theorem – The natural imbedding of N in N\*\* - The open mapping theorem – The conjugate of an operator

**UNIT II**

Hilbert Spaces: The definition and some simple properties – Orthogonal complements – Orthonormal sets - The conjugate space H\* - The adjoint of an operator – Self-adjoint operators – Normal and unitary operators – Projections

**UNIT III**

Finite-Dimensional Spectral Theory: Matrices – Determinants and the spectrum of an operator – The spectral theorem – A survey of the situation

**UNIT IV**

General Preliminaries on Banach Algebras: The definition and some examples – Regular and singular elements – Topological divisors of zero – The spectrum – The formula for the spectral radius – The radical and semi-simplicity

**UNIT V**

The Structure of Commutative Banach Algebras : The Gelfand mapping – Applications of the formula r(x) = lim || xn ||1/n - Involutions in Banach Algebras – The Gelfand- Neumark theorem.

### TEXT BOOK

G.F.Simmons,Introduction to Topology and Modern Analysis, McGraw-Hill International Ed. 1963.

UNIT – I Chapters 8 and 9 UNIT – II Chapter 10

UNIT – III Chapter 11

UNIT – IV Chapter 12

UNIT – V Chapter 13

### REFERENCES

1. Walter Rudin, Functional Analysis, TMH Edition, 1974.
2. B.V. Limaye, Functional Analysis, Wiley Eastern Limited, Bombay, Second Print, 1985.
3. K.Yosida, Functional Analysis, Springer-Verlag, 1974.
4. Laurent Schwarz, Functional Analysis, Courant Institute of Mathematical Sciences, New York University, 1964.

### Sub Code: P16MA42

### DIFFERENTIAL GEOMETRY

**Objectives**

1. To introduce the notion of surfaces and their properties.
2. To study geodesics and differential geometry of surfaces.

**UNIT I SPACE CURVES:**

Definition of a space curve - Arc length - tangent - normal and binormal - curvature and torsion - contact between curves and surfaces- tangent surface- involutes and evolutes- Intrinsic equations - Fundamental Existence Theorem for space curves- Helics.

### UNIT II INTRINSIC PROPERTIES OF A SURFACE:

Definition of a surface - curves on a surface - Surface of revolution - Helicoids - Metric- Direction coefficients - families of curves- Isometric correspondence- Intrinsic properties.

### UNIT III GEODESICS:

Geodesics - Canonical geodesic equations - Normal property of geodesics- Existence Theorems - Geodesic parallels - Geodesics curvature- Gauss- Bonnet Theorem - Gaussian curvature- surface of constant curvature.

### UNIT IV NON INTRINSIC PROPERTIES OF A SURFACE:

The second fundamental form- Principal curvature - Lines of curvature - Developable – Developable associated with space curves and with curves on surface - Minimal surfaces - Ruled surfaces.

### UNIT V DIFFERENTIAL GEOMETRY OF SURFACES:

Compact surfaces whose points are umblics- Hilbert's lemma - Compact surface of constant curvature - Complete surface and their characterization - Hilbert's Theorem - Conjugate points on geodesics.

### TEXT BOOK

T.J. Willmore, An Introduction to Differential Geometry, Oxford University Press,(17th Impression) New Delhi 2002. (Indian Print).

UNIT – I Chapter I : Sections 1 to 9. UNIT – II Chapter II: Sections 1 to 9. UNIT – III Chapter II: Sections 10 to 18. UNIT – IV Chapter III: Sections 1 to 8. UNIT – V Chapter IV : Sections 1 to 8

### REFERENCES

1. Struik, D.T. Lectures on Classical Differential Geometry, Addison - Wesley, Mass. 1950.
2. Kobayashi S. and Nomizu. K. Foundations of Differential Geometry, Interscience Publishers, 1963.
3. Wihelm Klingenberg: A course in Differential Geometry, Graduate Texts in Mathematics, Springer Verlag, 1978.
4. J.A. Thorpe Elementary topics in Differential Geometry, Under - graduate Texts in Mathematics, Springer - Verlag 1979.

### Sub Code: P16MA43

**ADVANCED NUMERICAL ANALYSIS**

**Objectives.**

1. To know the theory behind various numerical methods.
2. To apply these methods to solve mathematical problems.

**Unit I**

Transcendental and polynomial equations:Rate of convergence – Secant Method, Regula Falsi Method, Newton Raphson Method, Muller Method and Chebyshev Method. Polynomial equations: Descartes’ Rule of Signs - Iterative Methods: Birge-Vieta method, Bairstow’s method Direct Method: Graeffe’s root squaring method.

**Unit II**

System of Linear Algebraic equations and Eigen Value Problems: Error Analysis of Direct methods – Operational count of Gauss elimination, Vector norm, Matrix norm, Error Estimate. Iteration methods - Jacobi iteration method, Gauss Seidel Iteration method, Successive Over Relaxation method - Convergence analysis of iterative methods, Optimal Relaxation parameter for the SOR method. Finding eigen values and eigen vectors – Jacobi method for symmetric matrices and Power methods only.

**Unit III**

Interpolation and Approximation:- Hermite Interpolations, Piecewise and Spline Interpolation – piecewise linear interpolation, piecewise quadratic interpolation, piecewise cubic interpolation, spline interpolation-cubic Spline interpolation. Bivariate Interpolation- Lagrange Bivariate interpolation. Least square approximation.

**Unit IV**

Differentiation and Integration: Numerical Differentiation – Optimum choice of Step length – Extrapolation methods – Partial Differentiation. Numerical Integration: Methods based on undetermined coefficients - Gauss Legendre Integration method and Lobatto Integration Methods only.

**Unit V**

Ordinary differential equations – Singlestep Methods: Local truncation error or Discretization Error, Order of a method, Taylor Series method, Runge-Kutta methods: Explicit Runge–Kutta methods– Minimization of Local Truncation Error, System of Equations, Implicit Runge-Kutta methods. Stability analysis of single step methods (RK methods only).

**TEXT BOOKS**

M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International (p) Limited Publishers, New Delhi, Sixth Edition 2012.

Unit I Chapter 2 § 2.5 (Pages 41-52), 2.9 ( Pages 83-99)

Unit II Chapter 3 § 3.3( Pages 134-140), 3.4( Pages 146-164), 3.5(Pages 170-173),

3.7 ( Pages179-185) and 3.11 (Pages 196-198)

Unit III Chapter 4 § 4.5 - 4.7 & 4.9 (Pages 284-290)

Unit IV Chapter 5 § 5.2 - 5.5(Pages 320-345) and 5.8(pages 361 – 365 and 380-386)

Unit V Chapter 6 §6.4(Pages 434-459) and 6.5(Pages 468-475)

**REFERENCES**

1. Kendall E. Atkinson, An Introduction to Numerical Analysis, II Edn., John Wiley & Sons, 1988.
2. M.K. Jain, Numerical Solution of Differential Equations, II Edn., New Age International Pvt Ltd., 1983.
3. Samuel. D. Conte, Carl. De Boor, Elementary Numerical Analysis, Mc Graw-Hill International Edn., 1983.

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# ELECTIVE V

### Sub Code: P16MAE5P

**FLUID DYNAMICS**

**Objectives**

## To give the students an introduction to the behaviour of fluids in motion.

1. To give the students a feel of the applications of Complex Analysis in the analysis of the flow of liquids.

**UNIT I**

Real Fluids and Ideal Fluids - Velocity of a Fluid at a point – Streamlines and Path lines: Steady and Unsteady Flows – The Velocity potential – The Vorticity vector – Local and Particle Rates of Change – The Equation of continuity – Worked examples – Acceleration of a Fluid – Conditions at a rigid boundary – General analysis of fluid motion – Pressure at a point in a Fluid at Rest – Pressure at a point in Moving Fluid – Conditions at a Boundary of Two Inviscid Immiscible Fluids – Euler's equation of motion – Bernoulli's equation – Worked examples.

**UNIT II**

Discussions of a case of steady motion under conservative body forces – Some potential theorems – Some Flows Involving Axial Symmetry – Some special two- Dimensional Flows-Impulsive Motion.Some three- dimensional Flows: Introduction – Sources, Sinks and Doublets – Images in a Rigid infinite Plane

– Axi-Symmetric Flows; Stokes stream function.

**UNIT III**

Some Two- Dimensional Flows: Meaning of a Two- Dimensional Flow – Use of cylindrical polar co-ordinates – The stream function – The Complex Potential for Two- Dimensional, Irrotational , Incompressible Flow – complex velocity potentials for Standard Two Dimensional Flows – Some worked examples – The Milne- Thomson circle theorem and applications – The theorem of Blasius.

**UNIT IV**

The use of conformal Transformation and Hydrodynamical Aspects – Vortex rows. Viscous flow Stress components in a real fluid - relations between cartesian components of stress - Translational Motion of Fluid element – The Rate of Strain Quadraic and Principle Stresses – Some further properties of the rate of strain quardric - Stress analysis in fluid motion – Relations between stress and rate of strain - The coefficient of viscosity and laminar flow – The Navier- Stokes equations of motion of a viscous fluid.

**UNIT V**

Some solvable problems in viscous flow – Steady viscous flow in tubes of uniform cross section – Diffusion of vorticity – Energy Dissipation due to viscosity – Steady flow past a Fixed Sphere – Dimensional Analysis; Reynolds Number – Prandtl’s Boundary Layer.

**TEXT BOOK**

Text Book of Fluid Dynamics by F. Chorlton , CBS Publishers & Distributors, New Delhi , 1985.

UNIT I Chapter 2 and Chapter 3 : Sections 3.1 to 3.6

UNIT II Chapter 3: Sections 3.7 to 3.11 and Chapter 4 : Sections 4.1 to 4.3 and 4.5

UNIT III Chapter 5: Sections : 5.1 to 5.9 except 5.7

UNIT IV Chapter 5: Sections 5.10, 5.12 and Chapter 8 : Sections 8.1 to 8.9

UNIT V Chapter 8: Sections : 8.10 to 8.16.