MA 001 Preparatory Mathematics I.

Complex numbers as ordered pairs. Argand's diagram. Triangle inequality. De Moivre's Theorem.

Algebra: Quadratic equations and express-ions. Permutations and Combinations. Binomial theorem for a positive integral index.

Coordinate Geometry: Locus. Straight lines. Equations of circle, parabola, ellipse and hyperbola in standard forms. Parametric representation.

Vectors: Addition of vectors. Multiplication by a scalar. Scalar product, cross product and scalar triple product with geometrical applications.

Matrices and Determinants: Algebra of matrices. Determinants and their properties. Inverse of a matrix. Cramer's rule.

MA 002 Preparatory Mathematics II.

Function. Inverse function. Elementary functions and their graphs. Limit. Continuity. Derivative and its geometrical significance. Differentiability. Derivatives of sum, difference, product and quotient of functions. Derivatives of polynomial, rational, trigonometric, logarithmic, exponential, hyperbolic, inverse trigonometric and inverse hyperbolic functions. Differentiation of composite and implicit functions.

Tangents and Normals. Increasing and decreasing functions. Maxima and Minima.

Integration as the inverse process of differentiation. Integration by parts and by substitution. Definite integral and its appli-cation to the determination of areas (simple cases).

MA 105 Calculus 3 1 0 8

- Review of limits, continuity, differentiability.
- Mean value theorem, Taylors Theorem, Maxima and Minima.
- Riemann integrals, Fundamental theorem of Calculus, Improper integrals, applications to area, volume.
- Convergence of sequences and series, power series.
- Partial Derivatives, gradient and directional derivatives, chain rule, maxima and minima, Lagrange multipliers.
- Double and Triple integration, Jacobians and change of variables formula.
- Parametrization of curves and surfaces, vector Fields, line and surface integrals.
- Divergence and curl, Theorems of Green, Gauss, and Stokes.

Texts/References

1. Hughes-Hallett et al., *Calculus - Single and Multivariable* (3rd Edition), John-Wiley and Sons (2003).
2. James Stewart, *Calculus* (5th Edition), Thomson (2003).
3. T. M. Apostol, *Calculus, Volumes 1 and 2* (2nd Edition), Wiley Eastern 1980.
4. G. B. Thomas and R. L. Finney, *Calculus and Analytic Geometry* (9th Edition), ISE Reprint, Addison-Wesley, 1998.

MA 106 Linear Algebra 3 1 0 4

- Vectors in $\mathbf{R^n}$, notion of linear independence and dependence, linear span of a set of vectors, vector subspaces of $\mathbf{R^n}$, basis of a vector subspace.
- Systems of linear equations, matrices and Gauss elimination, row space, null space, and column space, rank of a matrix.
- Determinants and rank of a matrix in terms of determinants.
- Abstract vector spaces, linear transformations, matrix of a linear transformation, change of basis and similarity, rank-nullity theorem.
- Inner product spaces, Gram-Schmidt process, orthonormal bases, projections and least squares approximation.
- Eigenvalues and eigenvectors, characteristic polynomials, eigenvalues of special matrices (orthogonal, unitary, hermitian, symmetric, skew-symmetric, normal). algebraic and geometric multiplicity, diagonalization by similarity transformations, spectral theorem for real symmetric matrices, application to quadratic forms.

Texts/References

1. H. Anton, *Elementary linear algebra with applications* (8th Edition), John Wiley (1995).
2. G. Strang, *Linear algebra and its applications* (4th Edition), Thomson(2006).
3. S. Kumaresan, *Linear algebra - A Geometric approach*, Prentice Hall of India (2000).
4. E. Kreyszig, *Advanced engineering mathematics* (8th Edition), John Wiley (1999).

MA 108 Differential Equations-I 3 1 0 4

- Exact equations, integrating factors and Bernoulli equations.
- Orthogonal trajectories.
- Lipschitz condition, Picard's theorem, examples on nonuniqueness.
- Linear differential equations generalities.
- Linear dependence and Wronskians.
- Dimensionality of space of solutions, Abel-Liouville formula.
- Linear ODE's with constant coefficients, the characteristic equations.
- Cauchy-Euler equations.
- Method of undetermined coefficients.
- Method of variation of parameters.
- Laplace transform generalities.
- Shifting theorems.
- Convolution theorem.

Texts/References

1. E. Kreyszig, *Advanced engineering mathematics* (8th Edition), John Wiley (1999).
2. W. E. Boyce and R. DiPrima, *Elementary Differential Equations* (8th Edition), John Wiley (2005).
3. T. M. Apostol, *Calculus, Volume 2* (2nd Edition), Wiley Eastern, 1980.

MA 205 Complex Analysis 3 1 0 4

- Definition and properties of analytic functions.
- Cauchy-Riemann equations, harmonic functions.
- Power series and their properties.
- Elementary functions.
- Cauchy's theorem and its applications.
- Taylor series ans Laurent expansions.
- Residues and the Cauchy residue formula.
- Evaluation of improper integrals.
- Conformal mappings.
- Inversion of Laplace transforms.

Texts/References

1. R. V. Churchill and J. W. Brown, *Complex variables and applications* (7th Edition), McGraw-Hill (2003).
2. J. M. Howie, *Complex analysis*, Springer-Verlag (2004).
3. M. J. Ablowitz and A. S. Fokas, *Complex Variables- Introduction and Applications*, Cambridge University Press, 1998 (Indian Edition).
4. E. Kreyszig, *Advanced engineering mathematics* (8th Edition), John Wiley (1999).

MA 207 Differential Equations-II 3 1 0 4

- Review of power series and series solutions of ODE's.
- Legendre's equation and Legendre polynomials.
- Regular and irregular singular points, method of Frobenius.
- Bessel's equation and Bessel's functions.
- Strum-Liouville problems.
- Fourier series.
- D'Alembert solution to the Wave equation.
- Classification of linear second order PDE in two variables.
- Laplace, Wave, and Heat equations using separetion of variables.
- Vibration of a circular membrane.
- Heat equation in the half space.

Texts/References

1. E. Kreyszig, *Advanced engineering mathematics* (8th Edition), John Wiley (1999).
2. W. E. Boyce and R. DiPrima, *Elementary Differential Equations* (8th Edition), John Wiley (2005).
3. R. V. Churchill and J. W. Brown, *Fourier series and boundary value problems* (7th Edition), McGraw-Hill (2006).

MA 214 Introduction to Numerical Analysis 3 1 0 8

- Interpolation by polynomials, divided differences, error of the interpolating polynomial, piecewise linear and cubic spline interpolation.
- Numerical integration, composite rules, error formulae.
- Solution of a system of linear equations, implementation of Gaussian elimination and Gauss-seidel methods, partial pivoting, row echelon form, LU factorization Cholesky's method, ill-conditioning, norms.
- solution of a nonlinear equation, bisection and secant methods.
- Newton's method, rate of convergence, solution of a system of nonlinear equations, numerical solution of ordinary differential equations, Euler and Runge-Kutta methods, multi-step methods, predictor-corrector methods, order of convergence, finite difference methods, numerical solutions of elliptic, parabolic, and hyperbolic partial differential equations.
- Eigenvalue problem, power method, QR method, Gershgorin's theorem.
- Exposure to software packages like IMSL subroutines, MATLAB.

Texts/References

1. S. D. Conte and Carl de Boor, *Elementary Numerical Analysis- An Algorithmic Approach* (3rd Edition), McGraw-Hill, 1980.
2. C. E. Froberg, *Introduction to Numerical Analysis* (2nd Edition), Addison-Wesley, 1981.
3. E. Kreyszig, *Advanced engineering mathematics* (8th Edition), John Wiley (1999).