Mathematics First Year Course

Mathematics I (1st Semester)
Mathematics II (1st Semester)

Mathematics Electives

MA2010 Complex Variables
MA2020 Differential Equations
MA2040 Probability, Stochastic Process & Statistics
MA2030 Linear Algebra
MA2050 Numerical Analysis
MA2130 Basic Graph Theory

Mathematics I

Course content

Functions of single variable: Sequences in real numbers, limits and continuity of real valued functions on intervals, extreme values of functions on [a, b], Intermediate value property and differentiation, L'Hospital Rule, Taylor's formula, convergence of series, root test, ratio test, Cauchy condensation test, Liebniz's test, power series, radius of convergence, Taylor series, Riemann integration, Riemann Integrable functions, Improper integrals, comparison test, Absolute convergence.

Functions of several variables: Continuity, partial derivatives, differentiability, directional derivatives and gradient, tangent plane and normal line, extreme values, Lagrange Multipliers, double and triple integrals, volume and area, change of variables, surface area, surface integrals, line integrals, Green's theorem, vector fields, divergence and curl of a vector field, Stoke's theorem, Divergence theorem.

Text Book:

1. G.B. Thomas Jr., M.D. Weir and J.R. Hass, Thomas Calculus, Pearson Education, 2009.

References:

1. J. Hefferon, Linear Algebra, http://joshua.smcvt.edu/linearalgebra, 2014.
2. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer-Verlag, 1986.
3. M.T. Nair, Calculus of One Variable, Ane Books, 2014.
4. N. Piskunov, Differential and Integral Calculus Vol. 1-2, Mir Publishers, 1974.
5. G. Strang, Linear Algebra and its Applications.

Mathmatics II

Course content

Matrices: Matrix operations, existence- uniqueness of solutions of a linear system, Gaussian elimination, Gauss-Jordan elimination, special types of matrices, elementary operations, inverse of a matrix , matrices as linear transformations, linear independence, rank of a matrix, nullity of a matrix, orthogonalization, determinant. Eigenvalues, eigenvectors, eigenvalues of special types of matrices, similarity of matrices, diagonalization of matrices.

Ordinary Differential Equations: Separable equations, Exact equations, structure of linear differential equations with constant coefficients, Power Series method, Legendre's equation, Bessel equation, Laplace transform, Sturm-Liouville Problems.

Introduction to Partial Differential Equations.

Text Book:

1. E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., John Willey & Sons, 2010.

References:

1. Hoffman and R. Kunze: Linear Algebra, 2nd Edition, Prentice Hall of India, 2005.
2. Strang, Linear Algebra and its applications, Brooks / Cole 4th Edition, USA, 2006.
3. N. Piskunov, Differential and Integral Calculus Vol. 1-2, Mir Publishers, 1974.

MA2050 Numerical Analysis

Introduction: Round-off Error, Truncation Error, Errors in Scientific and Engineering Computation.

4 lectures

Interpolation: Lagrange's interpolation, forward, backward and divided differences, error of the interpolating polynomial.

4 lectures

Numerical Solutions of Nonlinear Equations: Bisection method, regula-falsi, secant method, Newton's method, fixed-point iteration, convergence acceleration for fixed-point iteration, real roots of polynomials, complex roots of polynomials.

6 lectures

Numerical Differentiation and Integration: Numerical differentiation, basic methods of numerical integration, Gaussian rules, composite rules, adaptive quadrature.

6 lectures

Solution of a System of Linear Equations: Gaussian elimination, pivoting strategy, LU- factorization, Cholesky's method, ill-conditioning, norms, Jacobi and Gauss-seidel methods, partial pivoting.

8 lectures

Numerical Solution of Differential Equations: Taylor series method, Euler method, Runge-Kutta method, predictor-corrector methods for initial value problems, Adams-Moulton method, shooting method and finite difference methods for boundary value problems.

10 lectures

Text: E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., John Wiley & Sons, 2010.

References:

(1). F B Hildebrand, Introduction to Numerical Analysis, Tata McGraw-Hill 1993.
(2) S. D. Conte and C. deBoor, Elementary Numerical Analysis - An Algorithmic Approach, 3rd Ed., McGraw-Hill, 1980.

MA 2030 Linear Algebra

Systems of Linear Equations, Matrices and Elementary Row Operations, Gaussian elimination, Determinant, Inverse of a Matrix, Gauss-Jordan elimination.

Vector Spaces, Subspaces, Linear Independence, Basis, Dimension, Linear Transformation and their representation by matrices.

Inner Product Spaces, Orthonormal Sets, Gram-Schmidt Process.

Special Types of Matrices, Matrices as Linear Transformations, Rank of a Matrix, Nullity of a Matrix, Eigen values, Eigen vectors, Eigen values of Special Types of Matrices, Similarity of Matrices, Basis of Eigenvectors, Diagonalization.

Text:

E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., John Wiley & Sons, 2010.

REFERENCES

1. J B Fraleigh and R A Beauregard, Linear Algebra, Addison- Wesley Publishing Company, 1995.
2. Gilbert Strang, Linear Algebra and its applications, Brooks / Cole 4th Edition, USA, 2006.
3. Hoffman and R. Kunze: Linear Algebra, 2nd Edition, Prentice Hall of India, 2005.
4. M. Artin: Algebra, Prentice Hall of India, 2005.

MA2130 Basic Graph Theory

Fundamentals: Graphs, subgraphs, isomorphism, representation of graphs, degrees and graphical sequences, walks, trails, paths, cycles, Connectivity, bipartite graphs

Trees: Characterisations of trees, minimum-spanning-trees, number of trees, Cayley's formula

Connectivity: cut-sets, Characterization of blocks.

Search algorithms: DS, BFS, Shortest path algorithms, identification of cut-vertices and cut-edges.

Eulerian and Hamilton graph; Characterizations, Necessary/sufficient conditions, Fleury's algorithms.

Coverings, independent sets: Basic relations, matchings in bipartite graphs, Tutte's Perfect matching theorem and consequences.

Colorings, Edge-colorings of bipartite graphs, Gupta Vizing's theorem(without proof), greedy algorithm for vertex-colorings, Brook's theorem, clique-number and vertex chromatic number.

Planar graphs: Euler's formula V-E+F=2 and its consequences, Kuratowski's Characterization (without Proof), DMP planarity algorithm.

Directed graphs: Basics, Various Connectivities and tournaments.

Logic: Conjunctions and Truth Tables, Atomic Statements, Negation, Complement, Tautologies, Implications, If..., then Statements, Bi-Implications, Compound Statements, Binary graph representation of statements, Verification of Statements by Bottom of methods (using binary graphs).

REFERENCES:

1. J.A Bondy and U.S.R Murthy, Graph Theory with Applications, Macmillan, 1976 D.B. West, Introduction to Graph Theory, P.H.I 1999.
2. P. Suppes, Introduction to Logic, Dover Publication Inc., 2003.

MA2010 COMPLEX VARIABLES

Analytic functions: Limits and continuity, differentiability and analyticity, analytic branches of inverse of functions, branches of logarithm, Cauchy-Riemann equations, harmonic conjugates. Complex integral: Cauchy's theorem and integral formula, series of complex functions and the Weierstrass M-test, Taylor series, identity theorem, isolation of zeros of an analytic function, statements of open mapping, inverse function, Liouville theorem, fundamental theorem of Algebra.

Residue Calculus: Singularities and their classification, Laurent series, residue theorem and argument principle, computing real integrals using residues. Bilinear transformation, conformal mapping, elementary properties of the mapping of exponential, sine and cosine functions.

TEXT:

E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., John Willey & Sons, 2010.

REFERENCES:

1. R.V Churchill & J.W. Brown: Complex Variables and Applications, Mc-Graw Hill, 1990.

2. S. Ponnusamy and H. Silverman, Complex Variables with Applications, Birkhauser, 2006.

MA2020 Differential Equations

First order ODE: Geometrical meaning of a first order ODE, variable separable equations, exact equations, integrating factors, linear equations of first order, solution of homogeneous linear equations with constant coefficients of higher order, linear independence of solutions and Wronskian, complex roots and repeated roots of characteristic equation, solution of non- homogeneous equations.

Series solution of ODE: Power series method, Legendre's equation, Legendre polynomials, Frobenius method, Bessel's equation, Sturm-Liouville problem.

Partial differential equations: First order equations, characterization of second order equations, wave equation, D'Alembert's solution of wave equation, separation of variables, use of Fourier series, heat equation and solution by Fourier series, Laplacian in polar coordinates, Laplacian in cylindrical and spherical coordinates, solution of Laplace equation.

Text:

E. Kreyszig, Advanced Engineering Mathematics, 10th Ed., John Willey & Sons, 2010.

REFERENCES:

1. W.E. Boyce and R.C. DiPrima, Elementary Differential Equations, 7th Ed., John Wiely& Sons, 2002.

2. S.J. Farlow, Partial Differential Equations for scientists and Engineers, Dover, 2006.

3. N. Piskunov, Differential and Integral Calculus Vol. 1-2, Mir Publishers, 1974.

MA2040 Probability, Stochastic Process and Statistics

Probability: Probability models and axioms, conditioning and Bayes' rule, independence discrete random variables; probability mass functions; expectations, examples, multiple discrete random variables: joint PMFs, expectations, conditioning, independence, continuous random variables, probability density functions, expectations, examples, multiple continuous random variables, continuous Bayes rule, derived distributions; convolution; covariance and correlation, iterated expectations, sum of a random number of random variables.

Stochastic process: Bernoulli process, Poisson process, Markov chains. Weak law of large numbers, central limit theorem.

Statistics: Bayesian statistical inference, point estimators, parameter estimators, test of hypotheses, tests of significance.

TEXT:

D. Bertsekas and J. Tsitsiklis, Introduction to Probability, 2nd ed, Athena Scientific, 2008.

REFERENCES:

1. K.L. Chung, Elementary Probability Theory with Stochastic Process, Springer Verlag, 1974.

2. A. Drake, Fundamentals of Applied Probability Theory. McGraw-Hill, 1967.

3. O. Ibe, Fundamentals of Applied Probability and Random Processes.Academic Press, 2005.

4. S. Ross, A First Course in Probability. 8th ed. Prentice Hall, 2009.