INDIAN INSTITUTE OF INFORMATION TECHNOLOGY GUWAHATI

<u>**Department of Mathematics**</u>

MA101	Mathematics I	3-1-0-8

Syllabus

Linear Algebra: Matrices, systems of linear equations and their solutions; vector space(R^n (R)) and its subspaces; spanning set and linear independence; inverse and determinant; range space and rank, null space and nullity, eigenvalues and eigenvectors; diagonalization of matrices; similarity; inner product, Gram-Schmidt process; Generalization of vector spaces over C, linear transformations.

Single Variable Calculus: Convergence of sequences and series of real numbers; continuity of functions; differentiability, Rolle's theorem, mean value theorem, Taylor's theorem; power series; Riemann integration, fundamental theorem of calculus, improper integrals; application to length, area, volume and surface area of revolution.

Texts:

1. D. Poole, *Linear Algebra: A Modern Introduction*, 2nd Edition, Brooks/Cole, 2005.
2. G. B. Thomas, Jr. and R. L. Finney, Calculus and Analytic Geometry, 9th Edn., Pearson Education India, 1996..

References:

1. G. Strang, *Linear Algebra and Its Applications*, 4th Edition (South Asian Edition), Wellesley-Cambridge Press, 2009 (ISBN: 9788175968110).
2. S. R. Ghorpade and B. V. Limaye, *An Introduction to Calculus and Real Analysis*, Springer India, 2006 (ISBN: 9788181284853).
3. K. Hoffman and R. Kunze, *Linear Algebra*, 2nd Edition, Prentice Hall India, 2009 (ISBN: 9788120302709).
4. R. G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Edition, Wiley India, 2007 (ISBN: 9788126511099).

Updated on 21st July 2017

MA102	Mathematics II	3-1-0-8

Syllabus

Multi Variable Calculus: Vector functions of one variable – continuity, differentiation and integration; functions of several variables - continuity, partial derivatives, directional derivatives, gradient, differentiability, chain rule; tangent planes and normals, maxima and minima, Lagrange multiplier method; repeated and multiple integrals with applications to volume, surface area, moments of inertia, change of variables; vector fields, line and surface integrals; Green's, Gauss' and Stokes' theorems and their applications.

Ordinary Differential Equations: First order differential equations - exact differential equations, integrating factors, Bernoulli equations, existence and uniqueness theorem, applications; higher-order linear differential equations - solutions of homogeneous and non-homogeneous equations, method of variation of parameters, series solutions of linear differential equations, Legendre equation and Legendre polynomials, Bessel equation and Bessel functions of first and second kinds. Laplace and inverse Laplace transforms; properties, convolutions; solution of ODE by Laplace transform. Systems of first-order equations, two-dimensional linear autonomous system, phase plane, critical points, stability.

Texts:

1. **G. B. Thomas, Jr.** and **R. L. Finney**, *Calculus and Analytic Geometry*, 9th Edition, Pearson Education India, 1996.
2. **S. L. Ross**, *Differential Equations*, 3rd Edition, Wiley India, 1984.

References:

1. **H. Anton**, **I. C. Bivens** and **S. Davis**, *Calculus*, 10th Edition, Wiley, 2011.
2. **T. M. Apostol**, *Calculus*, Volume 2, 2nd Edition, Wiley India, 2003.
3. **W. E. Boyce** and **R. C. Di Prima**, *Elementary Differential Equations and Boundary Value Problems*, 9th Edition, Wiley India, 2009.
4. **E. A. Coddington**, *An Introduction to Ordinary Differential Equations*, Prentice Hall India, 1995.

Updated on 1st December 2014

MA203	Mathematics III	3-0-0-6

Syllabus:

Introduction to probability: mathematical background - sets, set operations, sigma and Borel fields; classical, relative-frequency and axiomatic definitions of probability; conditional probability, independence, total probability, Bayes rule; repeated trials;

Random variables: cumulative distribution function, continuous, discrete and mixed random variables, probability mass function, probability density functions; functions of a random variable; expectation - mean, variance and moments; characteristic and moment-generating functions; Chebyshev, Markov and Chernoff bounds; special random variables- Bernoulli, binomial, Poisson, uniform (discrete and continuous), Gaussian, exponential, geometric; joint distribution and density functions; Bayes rule for continuous and mixed random variables; joint moments, conditional expectation; covariance and correlation- independent, uncorrelated and orthogonal random variables; function of two random variables; sum of two independent random variables; random vector- mean vector and covariance matrix, multivariate Gaussian distribution; laws of large numbers, central limit theorem;

Random process: Discrete and continuous time (state) space; probabilistic structure of a random process; mean function, autocorrelation and autocovariance functions; Gaussian, Poisson and Markov processes, White noise, stationarity- strict-sense stationary and wide-sense stationary (WSS) processes, system with stochastic input and its applications in signal and system, cross-correlation functions, Convolution- time and frequency domain analyses, linear time-invariant systems with WSS process as an input, spectral representation of a real WSS process-power spectral density, power spectral density, time averages and ergodicity.

Basics of Queuing Theory, Characteristics of queuing systems.

Texts:

1. Papoulis and S.U. Pillai, *Probability Random Variables and Stochastic Processes, 4/e, McGraw-Hill, 2002.*
2. A. Leon Garcia, *Probability and Random Processes for Electrical Engineering, 2/e, Addison-Wesley, 1993.*

References:

1. H. Stark and J.W. Woods, *Probability and Random Processes with Applications to Signal Processing, Prentice Hall, 2002.*
2. John J. Shynk*, Probability, Random Variables, and Random Processes: Theory and Signal Processing Applications, Wiley publications.*

Updated on 21st July 2017

MA205	Discrete Mathematics	3-0-0-6

Syllabus

Set theory: sets, relations, functions, countability;

Logic - formulae, interpretations, methods of proof, soundness and completeness in propositional and predicate logic;

Number theory: division algorithm, Euclid's algorithm, fundamental theorem of arithmetic, Chinese remainder theorem, special numbers like Catalan, Fibonacci, harmonic and Stirling;

Combinatorics: permutations, combinations, partitions, recurrences, generating functions;

Graph Theory:- paths, connectivity, subgraphs, isomorphism, trees, complete graphs, bipartite graphs, matchings, colourability, planarity, digraphs;

Algebraic Structures: semigroups, groups, subgroups, homomorphisms, rings, integral domains, fields, lattices and Boolean algebras.

Texts:

1. **C. L. Liu**, *Elements of Discrete Mathematics, 2nd Ed., Tata McGraw-Hill, 2000.*
2. **K. H. Rosen**, *Discrete Mathematics and its Applications, 7th Ed., Tata McGraw-Hill, 2009*.

References:

1. **J. P. Tremblay and R. P. Manohar**, *Discrete Mathematical structures with Applications to Computer Scienec, Tata McGraw-Hill, 2001.*
2. **R. C. Penner**, *Discrete Mathematics: Proof Techniques and Mathematical Structures, World Scientific, 1999.*
3. **R. L. Graham, D. E. Knuth, and O. Patashnik**, *Concrete Mathematics, 2nd Ed., Addison-Wesley, 1994.*
4. **J. L. Hein**, *Discrete Structures, Logic, and Computability, 3rd Ed., Jones and Bartlett, 2010*.

Updated on 1st December 2014

MA204	Mathematics-IV	3-0-0-6

Syllabus

Complex Analysis: Complex numbers and elementary properties. Complex functions - limits, continuity and differentiation. Cauchy-Riemann equations. Analytic and harmonic functions. Elementary functions. Anti-derivatives and path (contour) integrals. Cauchy-Goursat Theorem. Cauchy's integral formula, Morera's Theorem. Liouville's Theorem, Fundamental Theorem of Algebra and Maximum Modulus Principle. Taylor series. Power series. Singularities and Laurent series. Cauchy's Residue Theorem and applications. Mobius transformations.

Partial Differential Equations: First order partial differential equations; solutions of linear and nonlinear first order PDEs; classification of second-order PDEs; method of characteristics; boundary and initial value problems (Dirichlet and Neumann type) involving wave equation, heat conduction equation, Laplace's equations and solutions by method of separation of variables (Cartesian coordinates); initial boundary value problems in non-rectangular coordinates.

Solving PDEs by Transforms Methods: Solution of PDE by Fourier Transform method and Laplace Transform method.

Texts:

1. **J. W. Brown and R. V. Churchill**, Complex Variables and Applications, 7th Edition, Mc-Graw Hill, 2003. (or 8th Edition-2008).
2. **K. Sankara Rao**, Introduction to Partial Differential Equations, 3rd Edition, 2011.

References:

1. **J. H. Mathews and R. W. Howell**, Complex Analysis for Mathematics and Engineering, 3rd Edition, Narosa, 1998.
2. **I. N. Sneddon**, Elements of Partial Differential Equations, McGraw Hill, 1957.

Updated on 1st December 2014

MA305	Optimization Techniques	3-0-0-6

Syllabus:

Linear programming problem: formulation and geometric ideas, simplex algorithm, duality, transportation and assignment problem, Integer programming problems; Nonlinear optimization: method of Lagrange multipliers, Karush-Kuhn-Tucker theory, numerical methods for nonlinear optimization; Convex optimization and quadratic programming; Applications of linear, integer and quadratic programming to various areas of science and engineering.

Texts:

1. S. Chandra, Jayadeva, A. Mehra, Numerical Optimization with Applications, 1st Edition, Narosa Publishing House, 2009.

References:

1. John J. Jarvis, Mokhtar S. Bazaraa, Hanif D. Sherali, Linear Programming and Network Flows, 4th Edition, John Wiley & Sons, 2010.
2. Hamdy A. Taha. Operation Research: An Introduction, 9th Edition, Prentice Hall, 2011.
3. D. G. Luenberger and Y. Ye, Linear and Nonlinear Programming, 3rd Edition, Springer, 2008.

Updated on 20th November,2015

MA401/MA601	Numerical Analysis	3-0-0-6

Errors in computation: Floating point representation of numbers and round off errors, Error propagation and amplification.

Solution of linear systems: Gauss elimination, pivoting, matrix factorization, Iterative methods- Jacobi and Gauss-Seidel methods. Conjugate gradient method. Ill- conditioning, norms.

Solution of nonlinear systems: Bisection method, Secant method, Newton-Raphson method, Fixed point methods, Muller's method. Rate of convergence

Interpolation: Lagrange, Newton's divided differences, Hermite and piecewise polynomial interpolation.

Approximation of functions- Weierstrass and Taylor's expansion, least square approximation.

Numerical integration: Trapezoidal, Simpson's, Newton-Cotes rule, Gaussian quadrature.

Numerical solution of ordinary differential equations: Euler's, Multistep, Runge-Kutta and predictor-corrector methods. Order of convergence.

Matrix eigenvalue problems: Power method, QR method.

Text:

1. K. E. Atkinson, "An introduction to numerical analysis", Wiley-India Edition, 2013.

Reference:

1. S. D. Conte and Carl de Boor, Elementary Numerical Analysis - An Algorithmic Approach, Society for Industrial & Applied Mathematics, U.S. (30 March 2018).
2. E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley.

Updated on 9th January,2020

MA401/MA601	Numerical Analysis	3-0-0-6

Errors in computation: Floating point representation of numbers and round off errors, Error propagation and amplification.

Solution of linear systems: Gauss elimination, pivoting, matrix factorization, Iterative methods- Jacobi and Gauss-Seidel methods. Conjugate gradient method. Ill- conditioning, norms.

Solution of nonlinear systems: Bisection method, Secant method, Newton-Raphson method, Fixed point methods, Muller's method. Rate of convergence

Interpolation: Lagrange, Newton's divided differences, Hermite and piecewise polynomial interpolation.

Approximation of functions- Weierstrass and Taylor's expansion, least square approximation.

Numerical integration: Trapezoidal, Simpson's, Newton-Cotes rule, Gaussian quadrature.

Numerical solution of ordinary differential equations: Euler's, Multistep, Runge-Kutta and predictor-corrector methods. Order of convergence.

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Reference:

3. S. D. Conte and Carl de Boor, Elementary Numerical Analysis - An Algorithmic Approach, Society for Industrial & Applied Mathematics, U.S. (30 March 2018).
4. E. Kreyszig, Advanced engineering mathematics (10th Edition), John Wiley.

Updated on 9th January,2020