Name of the Module: Advanced Numerical Methods
Module Code: MA 501
Semester: I
Credit Value: 3 [P=0, T=0, L=3]

A. Course of Objectives:

The course is designed to meet the objectives of:

a) Introducing the basic concepts of round off error, truncation error, numerical stability and condition, Taylor polynomial approximations; to derive and apply some fundamental algorithms for solving scientific and engineering problems: roots of nonlinear equations, systems of linear equations, polynomial and spline interpolation, numerical differentiation and integration, numerical solution of ordinary differential equations.

b) Application of computer oriented numerical methods which has become an integral part of the life of all the modern engineers and scientists. The advent of powerful small computers and workstation tremendously increased the speed, power and flexibility of numerical computing.

c) Injecting future scope and the research directions in the field of numerical methods.

B. Course Content :

Algebraic and Transcendental Equations: Definition and sources of errors, solutions of nonlinear equations, Bisection method, Newton's method, fixed point iterations, Regula-Falsi method, convergence analysis, Newton's method for two variables.

Solution of the system of Linear equations: Gauss elimination method, Gauss Jordan method, Matrix Inversion, Operations Count, LU Factorization method, Gauss-Jacobi and Gauss-Seidel method, Successive Over Relaxation method

Initial value problems: Taylor series method, Euler and modified Euler methods, Runge-Kutta methods, Predictor-Corrector method, multistep methods and its stability analysis.

Finite difference schemes for partial differential equations: Discretization, Explicit and Implicit schemes, Consistency, Stability and Convergence, Stability analysis by matrix and Von Neumann methods, Lax's equivalence theorem, Finite difference schemes for initial and boundary value problems - FTCS, backward Euler and Crank-Nicolson schemes, ADI methods for Parabolic and Hyperbolic PDEs, Central difference schemes Elliptic PDEs

C. Text Books:

1. G. D. Smith, Numerical Solutions to Partial Differential Equations, Oxford University Press, 3rd edition, 1986.
2. K. W. Morton and D. F. Mayers, Numerical Solution of Partial DifferentialEquations, Cambridge University Press, 2nd edition, 2005.

D. Reference Books:

1. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, 3rd edition., AMS, 2002.
2. K. E. Atkinson, An Introduction to Numerical Analysis, Wiley, 1989.
3. S. D. Conte and C. de Boor, Elementary Numerical Analysis - An Algorithmic Approach, McGraw-Hill, 1981.
4. John H. Mathews, Numerical Methods for Mathematics Sciences and Engineering, Prentice Hall of India, New Delhi 2nd edition 2003.
5. 5. M.K.Jain, S.R.K. Iyengar and R.K. Jain, Numerical method for Scientific and Engineering Computation, New Age International Pvt. Ltd. 3rd edition, 1993.
6. 7. J. C. Strikwerda, Finite Difference Schemes and Partial Differential Equations, SIAM, 2004.
7. 8. L. Lapidus and G. F. Pinder, Numerical Solution of Partial DifferentialEquations in Science and Engineering, John Wiley, 1982.
8. S. Saha Roy, Numerical Analysis with Algorithm and Programming, CRC Press, 1 st edition, 2016.

E. Course outcomes:

Upon Completion of the subject:

a) Students will be skilled to do Numerical Analysis, which is the study of algorithms for solving problems of continuous mathematics.

b) Students will know numerical methods, algorithms and their implementation in C++for solving scientific problems.

c) Students will be substantially prepared to take up prospective research assignments.

Name of the Module: **Probability and Random Processes**
Module Code: MA 502
Semester: I
Credit Value:3 [P=0, T=0, L=3]

A. Objectives: The course is designed to meet the objectives of:

a) imparting theoretical knowledge and practical application to the students in the area of probability and random processes,
b) introducing the basic notions of probability theory and develops them to the stage where one can begin to use probabilistic ideas in statistical inference and modeling, and the study of random processes,
c) providing confidence to students in manipulating and drawing conclusions from data and provide them with a critical framework for evaluating study designs and results,
d) injecting future scope and the research directions in the field of random processes.

B. Course Content :

Probability-Introduction: Axiomatic definition of probability; conditional probability, independence and Baye's, theorem, continuity property of probabilities.

Random Variable: Probability distribution, density and mass functions, functions of a random variable, transformation of random variables, expectation, Variance, Standard Deviation, moment-generating and Characteristicfunctions. Bionomial distribution, Poisson distribution, Uniform distribution, Normal distribution, Exponential distribution.

Two and Higher Dimensional Random variable: Jointly distributed random variables: joint distribution (discrete and continuous), marginal distribution,conditional distributions, expectations, joint moments, transformation of random variables.

Convergences of random variable: Convergence in probability and distribution, laws of large numbers, central limit theorem.

Random process: Random process; mean auto-correlation and auto-covariance functions; stationary process:wide-sense stationary (WSS) processes and strong – sense stationary process, ergodicity; spectral representation of a real WSS process-power spectral density, cross-power spectral density, Poisson and Markov processes.

C. Text books:

1. S. M. Ross, Stochastic processes, John Wiley & Sons, Inc., 1996.
2. J. Medhi, Stochastic process, New Age International Publishers, 3rd edition , 2009.

D. Reference books

1. P.L. Meyer, Introduction to Probability and Statistical Applications, Oxford and IBH Publication, 1970.
2. Amritava Gupta, Ground work of Mathematical Probability & Statistics; Academic Press, 7th edition, 2015.
3. R. N. Bhattacharya and E. C. Waymire, Stochastic processes with applications, A Wiley-Interscience Publication. John Wiley & Sons, Inc., 1990.
4. K. Ito, Stochastic processes, Lecture Notes Series, No. 16 Matematisk Institut, Aarhus Universitet, Aarhus 1969.
5. Miller & Freund, Probability and statistics for engineers, Prentice Hall, India 2002.

E. Course outcomes:

Upon Completion of the subjects:

a) students will add new interactive activities to fill gaps that we have identified by analyzing student log data and by gathering input from other college professors on where students typically have difficulties,

b) students will add new simulation-style activities to the course in Inference and Probability,

c) students will be substantially prepared to take up prospective research assignments.

Name of the Module: **Advanced Discrete Mathematics**
Module Code: MA 503
Semester: I
Credit Value:3 [P=0, T=0, L=3]

A. Course Objectives:

The course is design to meet with the objectives of:

a) to extend student's Logical and Mathematical maturity and ability to deal with abstraction and to introduce most of the basic terminologies used in computer science courses and application of ideas to solve practical problems,
b) apply logical reasoning to solve a variety of problems.

B. Course Content :

Mathematical LogicSets: Introduction- Statements and Notations, Propositions and its type, Connectives, Normal Forms, Theory of Inference for Statement Calculus, Mathematical Induction, Principle of Inclusion and Exclusion, Pigeonhole Principles.

Basic concepts of set theory, Representations of Discrete Structures, Set operations, Relations and ordering, types of relations, Equivalence classes, Partition of a set, Matrix representation of a relation, Representation of relations by graphs, Functions, Types of functions, Composition and inverse of function and their properties, Characteristic function, Hashing function, Recursive function, Recursion in mechanical theorem proving.

Algebraic Structures: Introduction, Algebraic systems: Examples and general properties, Semi groups and monoids, Groups, Normal subgroup, Homomorphism, Isomorphism.

Lattices and Boolean Algebra: Introduction, Lattices as Partially order sets,Properties of lattices,Sub-lattices, lattice Homomorphism, Boolean algebra and its Properties, Boolean Expressions and Boolean Functions, Representation and minimization of circuits, Design examples using Booleanfunction/ Algebra

Graph Theory: Graph isomorphism, Sub graph, Degree, Walk, Path, Cycle, Connectivity,Cut vertices and cut edges, Trees, Spanning trees, Graph algorithms, Shortest path, Minimal spanning tree, Fundamental circuit.

Number Theory: Euclidean Algorithm, Fundamental Theorem of Arithmetic, GCD and its Properties, LCM, Congruences and its Properties, Linear Congruence, Chinese Remainder Theorem. Divisibility Theory.

C. Text Books

1. C.L. Liu, "Elements of Discrete Mathematics", Tata McGraw Hill, 2011.
2. J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, Tata McGraw-Hill, 1997.

D. Reference Books

1. K. H. Rosen, Discrete Mathematics and its Applications, 6th Ed., Tata McGraw-Hill, 2007.
2. Kolman B, Busby R. C, Ross S.C, "Discrete Mathematical Structures", PHI Learning, 2011.
3. S. Lipschutz, Marc L. Lipson, "Discrete Mathematics", Schaum's outlines, Tata McGraw Hill, 2010.
4. Norman L. Biggs, "Discrete Mathematics", Oxford, 2nd Edition, 2009.
5. Rowan Garnier& John Taylor, "Discrete Mathematics", CRC Press, 2011.
6. R. Johnsonbaugh, "Discrete Mathematics", Pearson, 2011.
7. N. Deo, Graph Theory, Prentice Hall of India, 1974.
8. T Koshy, Discrete Mathematics with Applications, Elsevier, 1st Edition, 2003.
9. D.S. Malik and M. K. Sen, Discrete Mathematical Structures: Theory and Applications, Thomson Indian Edition, 2004.

E. Course outcomes:

Upon completion of the subject:

a) Students will have acquired greater precision in logical argument and have gained a core mathematical understanding of discrete mathematics.

b) Students will have learned and practised basic concepts of mathematical proof (direct proof, proof by contradiction, mathematical induction). Students will be able to handle the standard logical symbols with some confidence.

c) Students will have learned elementary combinatorial and counting techniques and how to apply them to simple problems.

d) Students will be able to simplify complex mathematical expressions and apply general formulae to specific contexts.

e) Students will have learned how to state precisely and prove elementary mathematical statements and solve problems.

f) Students will have a basic understanding of information technology and its use in mathematical contexts.

Name of the Module: Computing Lab
Module Code: MA 504
Semester: I
Credit Value:1 [P=2, T=0, L=0]

A. Course of Objectives:

The course is designed to meet the objectives of:

a) To increase the Numerical programming skill to solve the various engineering problems,
b) To injecting future scope and the research directions in the field of numerical methods.

B. <u>List of Experiments:</u>

1. Solution of a system of Linear Equations: Gauss elimination, Gauss Jordan, Matrix Inversion, Jacobi, Gauss Seidel.
2. Find the Roots of Algebraic Equations: Bisection, Regula-Falsi, Newton- Raphson Methods.
3. Solution of Ordinary Differential Equations: Taylor Series, Euler's Method, Runge-Kutta (4th Order).
4. Solution of Partial Differential Equations: FTCS scheme, Crank-Nicolson Scheme, ADI scheme.

C. Books:

1. S. Saha Roy, Numerical Analysis with Algorithm and Programming, CRC Press, 2016.
2. C Xavier, C Language and Numerical Methods, New Age Publisher, 1st Edition, 1999.
3. W. H. Press, S. A. Teukolsky, W. T. Vetterling and B. P. Flannery, Numerical Recipes: The Art of scientific Computing, Cambridge University Press, 3rd Edition 2007.

D. Course outcomes:

Upon Completion of the subject:

a) Students will be skilled to do Numerical Analysis, which is the study of algorithms for solving problems of continuous mathematics.
b) Students will know numerical methods, algorithms and their implementation in C++for solving scientific problems.
c) Students will be substantially prepared to take up prospective research assignments.