Name of the Module: Engineering Mathematics- I
Module Code: MA 101
Semester: 1st
Credit Value: 4[P=0, T=1, L=3]

A. Course Objectives:

The course is designed to meet with the objectives of:

a) providing high quality education in pure and applied mathematics in order to prepare students for graduate studies or professional careers in mathematical sciences and related fields,
b) imparting theoretical knowledge and to develop computing skill to the students in the area of Science and Technology,
c) providing teaching and learning to make the students competent to their calculating ability, logical ability and decision making ability,
d) giving students theoretical knowledge of Calculus, Algebra and their practical applications in the various fields of Science and Engineering,
e) apply their knowledge in modern industry or teaching, or secure acceptance in high-quality graduate programs in Mathematics and other fields such as the field of quantitative/Mathematical finance, Mathematical computing, statistics and actuarial science.

B. Course Content:

Linear Algebra: Basic concept of matrices, Determinant, Jacobi's theorem. Singular and non-Singular matrices, Inverse and its properties, Orthogonal matrix and its properties, Trace of a matrix, Rank of a matrix, System of homogeneous and non homogeneous linear equations, Introduction to vector space (up to basis), Eigen values and Eigen vectors of a square matrix (of order 2 or 3), Cayley-Hamilton theorem and its applications.

Differential Calculus: Limit and Continuity, Higher order derivatives, Leibnitz's theorem and its application, Rolle's theorem and its application, Mean Value theorems – Lagrange & Cauchy and their application, Taylor's theorem and its application, Expansions of functions by Taylor's and Maclaurin's theorem.

Integral Calculus: Single integrals, Double and triple integrals and evaluation of area and Reduction formulae both for indefinite and definite integrals, volume, Change of order of integration.

C. Text Books

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley, 11th edition, 2010.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd edition, 2014.

D. Reference Books

1. Ross L. Finney and George B. Thomas, Calculus and Analytical Geometry (Linear Algebra), Narosa Publishing House, 6th edition 1998.
2. K. M. Hofmann and R. Kunze, Linear Algebra, Prentice hall, 2nd edition, 2015.
3. Bartle and Sherbart, Introduction to Real Analysis, Wiley 4th edition, 2014.
4. T. M. Apostol, Calculus, Vol I and II, John Wiley and Sons Ltd Wiley; 2nd edition, 2007.
5. James Stewart, Transcendental Calculus, Cengage; 2nd edition, 2014.
6. S. K. Mappa, Higher Algebra, Shrat book House, 2014.
7. S. K. Mappa, Real Analysis, Shrat book House, 7th edition, 2013.
8. Clarence Reymond Wylie and Louis C. Barrett, Advanced Engineering Mathematics, McGraw Hill, 1995.

E. Course Outcomes:

The outcomes of course are following:

1. Students will become more confident about their computing skill, logical skill and decision making skill,
2. Students will find various applications of calculus and algebra in the practical fields science and engineering,
3. Students will become more competent to analyze mathematical and statistical problems, precisely define the key terms, and draw clear and reasonable conclusions,
4. Student will be able to use mathematical and statistical techniques to solve well defined problems and present their mathematical work, both in oral and written format, to various audiences (students, mathematicians, and non-mathematicians),
5. Student will be able to understand, and construct correct mathematical and statistical proofs and use the library and electronic data-bases to locate information on mathematical problems,
6. Student will be able to explain the importance of mathematics and its techniques to solve real life problems and provide the limitations of such techniques and the validity of the results,
7. Student will be able to propose new mathematical and statistical question and suggest possible software packages and/or computer programming to find solutions to these questions.

Name of the Module: Engineering Mathematics- II
Module Code: MA 102
Semester: 2nd
Credit Value: 4[P=0, T=1, L=3]

A. Course objectives:

The course is designed to meet the following objectives:

a) imparting theoretical knowledge to the students about three and more dimensional objects in space and to improve their capability of visualizing of objects in space.
b) making student competent enough to construct a differential equation/ mathematical modeling for every real life situation with its solution.
c) giving students theoretical knowledge of vectors with the flavour of Calculus.
d) introduce the concepts of Laplace and Fourier transforms and its application to the solution of differential equations (ODE & PDE) to the students.

B. Course Content:

Vector Calculus: Surfaces, Differentiation and integration of vector functions, scalar and vector fields, Gradient, Tangents, Normal, Curvature, Directional derivative, Divergence, Curl, Line integral, Surface integral and Volume integral, Green's, Gauss' and Stokes' theorems (without proofs) and their simple applications.

Ordinary Differential Equations: Formulation of Differential equations, Equation of first order and first degree, Exact ODE, Integrating factor, Equation reducible to first order linear ODE, Fundamental Systems and General Solution of Homogeneous equation of Order Two, Wronskian, Method of Reduction of Order, Higher order linear differential equation with constant coefficients, Operator method, Euler's homogeneous equation and reduction to an equation with constant coefficients, Methods of undermined coefficients, Method of Variation of Parameters, Series solutions (Ordinary point),

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, D'Alembertmethod, heat conduction equation, Laplace's equations and solutions by method of separation of variables (Cartesian coordinates).

Laplace & Fourier transform solution of ODE by Laplace and Fourier transform.

C. Text Books :

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley, 11th edition, 2010.
2. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43rd edition, 2014.

D. Reference Books:

1. Thomas and Finney, Calculus and Geometry (Linear Algebra), 9th edition, 2010.
2. S. L. Ross, Ordinary Differential Equation, Wiley and Sons Ltd., 3rd edition, 2010
3. Boyce and Richard C. Diprima, Elementary Differential Equations and Boundary value Problems, Wiley publications, 9th edition, 2009.
4. I. N. Sneddon, Elements of Partial Differential Equations, Dover Publications Inc. 2nd edition, 2013.
5. S. J. Farlow, Partial Differential Equation for Scientists and Engineers, Dover Publications, 1st edition, 1993.
6. Alan Jeffrey, Advanced Engineering Mathematics,Academic Press, 1st edition, 2001.
7. Dennis G. Zilland and Warren S. Wright, Advanced Engineering Mathematics, 4th edition, 2010.
8. Earl Coddington, Norman Levinson, Introduction to Ordinary Differential Equations McGraw Hill Education; 1st edition, 2017.

E. Course Outcomes:

Upon completion of the subject:

1. Students will have have strong visualizing capability in their mind about any object.
2. Students are so trained that they will recognize various real life situation/ problem and able to solve them by constructing a differential equation/ mathematical model.
3. Students will be able to find the Laplace and Fourier representation as transforms of functions of one variable.

Name of the Module: Probability and Statistics
Module Code: MA 201
Semester: 3rd
Credit Value: 4[P=0, T=1, L=3]

A. Course objectives:

The course is designed to meet the objectives of:

a) imparting theoretical knowledge and practical application to the students in the area of Stochastic Process,
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 stochastic 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 stochastic process.

B. Course Content:

Probability: Random Experiment, Sample space; Events; Probability of events, Frequency Definition of probability; Axiomatic definition of probability; Finite sample spaces, Probability of Non-disjoint events (Theorems). Conditional probability; General Multiplication Theorem; Independent events; Bayes' theorem and related problems.

Random variables: Probability mass function; Probability density function and distribution function. Distributions: Binomial, Poisson, Uniform, Exponential, Normal, t and $\chi 2$. Expectation and Variance (t and $\chi 2$ excluded); Moment generating function; Transformation of random variables (One variable); Central limit theorem (Statement only).

Basic Statistics: Measures of Central tendency: Moments, skewness and Kurtosis - Probability distributions: Binomial, Poisson and Normal - evaluation of statistical parameters for these three distributions, Correlation and regression – Rank correlation.

Statistics: Population; Sample; Statistic; Estimation of parameters (consistent and unbiased); Sampling distribution of sample mean and sample variance (proof not required).

Estimation: Maximum likelihood estimate of statistical parameters (Binomial, Poisson and Normal distribution). Interval estimation (Normal distribution). Testing of Hypothesis and $\chi 2$ goodness of fit.

Curve fitting: Linear and Nonlinear

C. Text Books

1. V. K. Rohatgi and A. K. MdEhsanes Saleh, An Introduction to Probability and Statistics, Willy, 2nd edition, 2008.

2. S. C. Gupta & V. K. Kapoor, Fundamental of Mathematical Statistics, Sultan Chand & Sons, 2014.

D. Reference Books

1. Sheldon M Ross, Introduction to Probability Models , Academic Press; 14th edition, 2014.
2. Harald Cramer, Random Variables and Probability Distributions, Cambridge University Press; Revised ed., 2014.
3. Murray R. Spiegel, Probability and Statistics, McGraw-Hill, McGraw Hill Education; 3rd edition, 2017.
4. P. L. Mayer, Introductory Probability and Statistical Applications, Oxford & IBH, 2nd, 1970.
5. W. Feller, An Introduction to Probability Theory and Its applications, Vol I, Jon Willy and Sons, 3rd edition, 2008.
6. K.L. Chung, A course of Probability Theory, Academic Press, 3rd edition, 2000.

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: Discrete Mathematics

Module Code: MA202
Semester: 3rd
Credit Value: 4[P=0, T=1, L=3]

A. Course Objectives:

The course is designed to meet 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:

Sets and Properties: Finite and Infinite Sets, Combinations of Sets, Countable and uncountable Sets, Mathematical Induction, Principle of Inclusion and Exclusion, Pigeonhole Principles, Propositional logic.

Relations and Functions: Properties of Binary Relations, Equivalence Relations and Partitions, Partial Ordering, Partial order relation, Relations and Lattices.

Group and Rings: Groups, Subgroups, Permutation Groups, Cyclic group, Cosets and Lagrange's Theorem, Rings, Integral Domains and Fields.

Discrete Numeric Functions and Generating Functions: Manipulation of Numeric Functions, Asymptotic Behavior of Numeric Functions, Generating Functions.

Recurrence Relations and Recursive Algorithms: Recurrence Relations, Linear Recurrence Relations with Constant Coefficients.

Boolean Algebra: Lattices and Algebraic Systems, Principle of Duality, Basic Properties of Algebraic System, Distributive and Complemented Lattices, Karnaugh Mapping and Quine Mccluskey Tabular Method.

Graph Theory: Basic concepts, Graph isomorphism, Bipartite graph, Subgraph, Degree, Walk, Path, Cycle, Connectivity. Cut vertices and cut edges, Trees, Binary tree, Spanning trees, Euler graph, Euler tours and Hamiltonian cycles.

C. Text Books:

1. C.L. Liu, "Elements of Discrete Mathematics", McGraw Hill Education; 4th edition, 2017.
2. D.S. Malik and M. K. Sen, Discrete Mathematical Structures: Theory and Applications, Cengage; 1st edition, 2012.

D. Reference Books:

1. K. H. Rosen, Discrete Mathematics and its Applications, McGraw Hill Education; 7th edition, 2017.
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, Print, 3th edition, 2013.
4. Norman L. Biggs, “Discrete Mathematics”, Oxford, 2nd Edition, 2009.
5. Rowan Garnier& John Taylor, “Discrete Mathematics”, CRC Press; 3 edition,2009.
6. R. Johnsonbaugh, “Discrete Mathematics”, Pearson; 8 edition, 2017.
7. N. Deo, with Applications to Engineering and Computer Science, Prentice Hall India Learning Private Limited; 9th edition, 1979.
8. J. P. Tremblay and R. P. Manohar, Discrete Mathematics with Applications to Computer Science, McGraw Hill Education; 1st edition, 2017.
9. T. Koshy, Discrete Mathematics with Applications, Academic Press Inc, 2014.

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 practiced basic concepts of mathematical proof (direct proof, proof by contradiction, mathematical induction).
c) Students will be able to handle the standard logical symbols with some confidence. 4. 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: Numerical Methods
Module Code: MA203

Semester: 4th
Credit Value: 3[P=0, T=0, L=3]

A. Course 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.

A. Course Content:

Errors in computation: Overflow and underflow; Approximate numbers, significant digits, Approximation in numerical computation; Sources of errors (Truncation, chopping round off etc) Propagation and control of round off errors; Pitfalls (hazards) in numerical computations (ill conditioned and well conditioned problems).

Algebraic and Transcendental Equations: Bisection method; Regula-Falsi Method; Fixed point iteration method, Newton-Raphson Method, Secant Method; Order of convergence of Newton Raphson method.

Interpolation: Lagrange's Interpolation, Newton's forward &backward Interpolation Formula,Newton's Divided Difference Formula; Error statement only.

Numerical Differentiation: Use of Newton's forward and backward interpolation formula only.

Numerical Integration: Trapezoidal formula (composite); Simpson's 1/3rd and 3/8th formula (composite); Weddle's method, Error statement.

System of Linear Equations: Gauss elimination method; Gauss-Jordan Method; Matrix Inversion; Operations Count; LU Factorization Methods ; Gauss Jacobi, Gauss-Seidel Method; SOR (Formula only).

First Order Ordinary Differential Equations: Picard Method, Taylor's Series Method; Euler's Method; Modified Euler's Method, Runge-Kutta Method (up to 4th order); Error formula only.

Partial differential equations: Finite difference method for partial derivative, Implicit and explicit methods for one dimensional heat equation (FTCS and Crank-Nicholson methods), Finite difference explicit method for wave equation.

B. Text Books:

1. K. E. Atkinson, “An Introduction to Numerical Analysis”, John Wiley & Sons; 2nd edition, 1989.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, “Numerical method for Scientific and Engineering Computation”, New Age International Pvt Ltd Publishers; 3rd edition edition, 1996.

C. Reference Books:

1. D. Kincaid and W. Cheney, “Numerical Analysis: Mathematics of Scientific Computing”, 3rd Ed., AMS, 2002.
2. S. D. Conte and C. de Boor, “Elementary Numerical Analysis - An Algorithmic Approach”, SIAM-Society for Industrial and Applied Mathematics, 2017.
3. C.M. Bender and S.A. Orszag, “Advanced Mathematical Methods for Scientists and Engineers”, Springer; Softcover reprint of hardcover 1st edition, 1999.
4. John H. Mathews, “Numerical Methods for Mathematics Sciences and Engineering”, Laxmi Publications, 2011.
5. V Rajaraman, “Computer Oriented Numerical Methods”, PHI Learning Private Limited; 4^{th} edition, 2018
6. Steven C. Chapra, “Numerical Methods for Engineers”, McGraw-Hill Education; 6 edition, 2010.
7. Brian Bradie, “A Friendly Introduction to Numerical Analysis”, Pearson Education; 1 edition, 2007.
8. R. L Burden and J.D. Faires, Numerical Analysis, Brooks/Cole; 3rd edition edition, 2002.
9. Santanu Saha Ray, Numerical Analysis with Algorithm and Programming, Chapman and Hall/CRC; 1 edition, 2018.

F. 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: Numerical Computing Lab
Module Code: MA204
Semester: 4th
Credit Value: 1[P=2, T=0, L=0]

A. Course Objectives:

The course is designed to meet the objectives of:

a) Students will be trained to solve mathematical/engineering problems numerically.
b) Students will acquire practical skills (coding) in the numerical programming.

B. List of Experiments:

I. Assignments on Solution of Algebraic Equations: Bisection, Secant, Regula-Falsi, Newton- Raphson Methods.
II. Assignments on Interpolation: Newton forward & backward, Lagrange.
III. Assignments on Numerical Integration: Trapezoidal Rule, Simpson's 1/3 and 3/8 Rules.
IV. Assignments on Numerical solution of a system of Linear Equations: Gauss elimination, Gauss Jordan, Matrix Inversion, Gauss Jacobiand Gauss Seidel.
V. Assignments on Ordinary Differential Equations: Taylor Series, Euler's Method, Runge-Kutta (4th Order).

C. Reference Books:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, "Numerical method for Scientific and Engineering Computation", New Age International Pvt Ltd Publishers; 3rd edition edition, 1996.

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D. Course Outcomes:

Upon Completion of the subject:

a) Students will be able to do numerical coding for solving problems of different engineering branch.
b) Students will be substantially interested to solve research assignments numerically.

Name of the Module: Optimization Methods
Module Code: MAS 301
Semester: 5th
Credit Value: 4 [P=0, T=1, L=3]

A. Course Objectives:

The course is designed to meet the objectives of:

a) to make the students introduction of the methods of Operations Research,
b) emphasize the mathematical procedures of nonlinear programming search techniques,
c) a scientific approach to decision making, which seeks to determine how best to design and operate a system, usually under conditions requiring the allocation of scarce resources.

B. Course Content:

LPP: Linear programming problems and applications, various components of LP problem formulation, Solving Linear Programming problem using simultaneous equations and Graphical Method, Simplex Method, Duality theory, Transportation and Travelling-Salesman problem, Assignment problems.

Game Theory: Two person Zero-sum game, saddle point, Graphical method, Dominance properties, solution of game by simplex method.

Network Analysis: Shortest Path Algorithms :Dijkstra and Floyd Algorithm, Maximal Flow, Maxflow Mincut theorem, PERT and CPM.

Non-Linear programming Problem: Nonlinear programming, Karush-Kuhn-Tucker necessary and sufficient conditions of optimality, Quadratic programming , Wolfe's method, Beale's method.

C. Text Books:

1. Hamdy A. Taha, “Operations Research”, Ninth edn., Pearson, Pearson Education India; 9 edition, 2014.
2. Hillier & Lieberman—Introduction to Operations Research, McGraw Hill Education; 3 edition, 2017.

D. References Books:

1. S. D. Sharma, Operations Research, KEDAR NATH RAM NATH, 2003.
2. Kanti Swaroop, P. K. Gupta & Man Mohan, “Operations Research”, Sulthan Chand, 2010.
3. Hadley G., “Linear Programming”, Narosa, 2002.

4. Operations Research – Schaum outline series, McGraw Hill Education; 2 edition, 2017.
5. J. G. Chakraborty & P. R. Ghosh, “Linear Programming & Game Theory”, Moulik Library, 2013.

E. Course Outcomes:

Students successfully completing this module will be able to:

a) identify and develop operational research models from the verbal description of the real system & use mathematical software to solve the proposed models,
b) understand the mathematical tools that are needed to solve optimisation problems,
c) develop a report that describes the model and the solving technique, analyse the results and propose recommendations in language understandable to the decision-making processes in Management Engineering.