Harcourt Butler Technical University

Department Mathematics, School of Basic and Applied Sciences

Vision:

To produce excellent academicians/researchers in Mathematics for teaching/research in interdisciplinary applied thrust areas and to equip budding technocrats/ engineers with sound mathematical/computing skills for social welfare.

Mission:

- To impart mathematical education in order to explore and apply mathematical concepts for technological innovations through activities and experimentation .
- To train students with strong mathematical foundation for conducting research or for serving in industry.
- To inculcate the ability to apply mathematical and computational skills in students for modeling, formulation and solving real-life problems.

About Department of Mathematics

The Department of Mathematics has been striving hard for excellent teaching and research in Mathematical Sciences since its inception in 1961. The undergraduate and postgraduate students of various chemical technology and engineering departments are enriched/equipped with in-depth theoretical background of sophisticated applied mathematics required for modern scientific investigations and technological developments and practical training in numerical computing by following need-based designed curriculum. The Department runs a doctoral research programme for carrying out research in inter-disciplinary areas.

The faculty of the department are actively engaged in research in emerging thrust areas viz. mathematical modeling, ecological and environmental systems, mathematical biology, biomechanics, fluid mechanics of the eye and cerebrospinal fluid, blood flow dynamics etc. Facilities for interdepartmental and interdisciplinary research activities have also been evolved. The Department is well equipped with computing and internet facilities. A number of research projects sponsored by different organizations like CSIR, CST UP, UGC, DST and ICMR have been completed. Also, various conferences, seminars, workshops, summer and winter schools have been organized by the department. Apart from this, the faculty members of the department also regularly visit to deliver lectures in conferences and seminars outside. The experienced and dedicated team of faculty members have presented/ published good numbers of research papers. Nearly 66 students have been awarded Ph.D. degrees under the supervision of departmental faculty members and at present 07 students are registered for Ph.D. Programme.

BMA -101 MATHEMATICS –I
I B.Tech, All Branches
(Effective from Session 2017-18)

L	T	P	C
3	1	0	4

OBJECTIVE: The objective of this course is to educate the students about:

- the convergence of infinite series, improper integrals and differential calculus.
- partial differentiation, multiple integrals and Beta, Gamma functions.
- vector calculus, matrices, linear algebra and optimization techniques.

Course Outcome

On the successful completion of the course, students will be able to

CO1	find nth derivative, determine the expansion of functions and find convergence of series and improper integrals.	Understand, Apply
CO2	find partial differentiation and evaluate area and volume using multiple integrals.	Apply, Evaluate
CO3	convert line integrals to surface integrals and volume integrals, determine potential functions for irrotational force fields.	Apply, Evaluate
CO4	solve linear system of equations and determine the eigen vectors of the matrix.	Apply, Analyse Evaluate,
CO5	learn concept of optimization and optimization techniques.	Apply, Analyse, Evaluate,

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	1	-	1	-	3
CO2	3	3	2	1	2	-	-	1	-	1	-	3
CO3	3	3	2	1	2	-	-	1	-	1	-	3
CO4	3	3	2	1	2	-	-	1	-	1	-	3
CO5	3	3	2	1	2	-	-	1	-	1	-	3
Average	3	3	2	1	2	-	-	1	-	1	-	3

1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High) *If there is no correlation, put "-"*

Detailed Syllabus:

Unit I- Functions of One Real Variable:

Successive differentiation, Leibnitz theorem, Mean value theorems, sequences and series, Expansion of functions, Improper integrals and their convergence.

Unit II- Functions of Several Real Variables:

Limit, Continuity, Partial differentiation, Total differential and approximations, Jacobian, Euler's theorem Expansion of functions, Beta and Gamma Functions, Multiple integral, Change of order, Change of variables, Applications to area, volume, mass, surface area etc. Dirichlet's Integral & applications.

Unit III- Vector Calculus:

Point functions, differentiation, Gradient, Directional derivative, Divergence and Curl of a vector and their physical interpretations, Solenoidal & irrotational fields, Integration, Line, Surface and Volume integrals Green's. Stoke's and Gauss Divergence theorems (without proof) and applications.

Unit IV- Matrices and Linear Algebra:

Vector space and subspace, linear dependence, dimensions and basis, Linear transformation and its matrix representation, Elementary transformations, Echelon form, rank & nullity, Consistency of linear system of equations and their solutions, characteristic equation, Cayley Hamilton theorem, Real and complex eigenvalues and eigenvectors, diagonalisation, quadratic forms, complex, orthogonal, and unitary matrices, Application to Cryptography, discrete, Compartmental models and system stability.

Unit V- Optimization:

Engineering applications of optimization, statement and classification of optimization problems, Optimization techniques, single variable optimization, multi variable optimization with no constraint, with equality and inequality constraints, Linear Programming Problems, Graphical method and Simplex method.

Books Recommended:

1. R.K. Jain & S. R. K. lyengar; Advanced Engineering Mathematics, Narosa Publishing House 2002.

2. Erwin Kreyszig: Advanced Engineering Mathematics. John Wiley & Sons 8th Edition.

3. Dennis G. Zill & Michael R Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers, 2nd Edition.

4. S.S. Rao; Optimization: Theory & application Wiley Eastern Limited.

5. T.M. Apostol, calculus, Vol. I, 2nd ed., Wiley 1967.

6. T.M. Apostol, Calculus, Vol. II, 2nd ed**.,** Wiley 1969.

7. Gilbert Strang, Linear Algebra & its applications, Nelson Engineering 2007.

8. Calculus & Analytic Geometry, Thomas and Finny.

BMA -102 MATHEMATICS –II
(I B.Tech, All Branches)
(Effective from Session 2017-18)

L	T	P	C
3	1	0	4

OBJECTIVE: The objective of this course is to educate the students about:

- ordinary differential equations and their applications as mathematical models.
- series solutions of ordinary differential equations and special functions.
- Laplace transform, Fourier series, differential equations and boundary value problems.

Course Outcome

On the successful completion of the course, students will be able to

CO1	solve first and higher order ordinary differential equations.	Apply, Analyse Evaluate,
CO2	find series solutions of ordinary differential equations and learn Bessel's and Legendre's function and its applications.	Apply, Analyse Evaluate,
CO3	solve IVP_S and BVP_S using Laplace Transform.	Apply, Analyse Evaluate,
CO4	find Fourier series expansion of given function and solve partial differential equations.	Apply, Analyse Evaluate,
CO5	solve boundary value problems using variable separable method etc.	Apply, Analyse Evaluate,

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	1	2	-	-	1	-	1	-	3
CO2	3	3	2	1	2	-	-	1	-	1	-	3
CO3	3	3	2	1	2	-	-	1	-	1	-	3
CO4	3	3	2	1	2	-	-	1	-	1	-	3
CO5	3	3	2	1	2	-	-	1	-	1	-	3
Average	3	3	2	1	2	-	-	1	-	1	-	3

1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High) *If there is no correlation, put "-"*

Detailed Syllabus:

Unit- I: <u>Ordinary Differential Equations:</u>

First order ordinary differential equations, Existence and uniqueness of solutions of initial value problems, Solution of higher order linear differential equation with constant coefficients, Solution of second order differential equations by changing dependent and independent variables, Cauchy- Euler equations, Methods of diagonalization, undetermined coefficients and variation of parameters: Nonlinear equations, Linear and nonlinear models, Initial value and boundary value problems, Systems of equations. Application of differential equations as mathematical models, Models from population dynamics, Newton's Law of cooling, electric circuit, Oscillation of spring.

Unit-II: <u>Series Solutions of Ordinary Differential Equations & Special Functions</u>

Ordinary and singular points of an equation, Power series solutions, Frobenius method, Bessel's and Legendre's equations and their series solutions, Properties of Legendre's polynomials and Bessel's functions, Generating

functions, Fourier- Bessel series and Fourier-Legendre series expansions, sturm- Liouville Problem and related theorems.

Unit-III: Laplace Transform:

Laplace transform, Existence conditions and ROC, Inverse Laplace transform, Operational properties, Convolution, Unit step function, Dirac-Delta function, Periodic functions, Applications to solve IVP and BVP: Linear ordinary differential equations, Transfer function and control system analysis.

Unit-IV: Fourier Series and Partial Differential Equations:

Orthogonal functions, Fourier series, existence conditions, Fourier series of even and odd functions, convergence of Fourier series, Fourier half range series, Harmonic analysis, Complex Fourier series and frequency spectrum. Development of partial differential equations and Solutions, Solution of first order partial differential equations, Solutions of linear higher order partial differential equations with constant coefficients.

Unit-V: Boundary-Value Problems:

Classification of second order partial differential equations, Derivation of heat and wave equations, solutions in rectangular coordinates by separation variable method, solution of Laplace equation, D'Alemberts solution of wave equation, Non-homogeneous equations and boundary conditions, Orthogonal series expansions, Fourier series in two dimensions, Boundary value problems in polar, cylindrical and spherical coordinate systems and their solutions.

Books Recommended:

1. E.A. Coddington, An Introduction to Ordinary Differential Equations, Practice Hall, 1995.

2. I.N. Sneddon, Elements of Partial Differential equations, McGraw-Hill 1957.

3. Dennis G, Zill & Michael R. Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers. 2nd Edition.

4. R.K. Jain & S.R.K. Iyengar; Advanced Engineering Mathematics, Narosa Publishing House, 2002.

5. Erwin Kreyszig; Advaced Engineering Mathematics, John Wiley & Sons 8th Edition.

BMA-203, COMPUTER ORIENTED NUMERICAL AND STATISTICAL TECHNIQUES
(II B.Tech, CSE/IT)
(Effective from Session 2018-19)

L	T	P	C
3	1	2	5

OBJECTIVE: The objective of this course is to provide conceptual understanding of:

- numerical methods for solving nonlinear equations and simultaneous equations.
- numerical techniques for interpolation, differentiation, integration, and solving IVP_S .
- curve fitting, correlation and regression, probability distributions and applied statistical methods.
- developing computer programs of numerical/ statistical methods using C/C^{++} language.

Course Outcome

On the successful completion of the course, students will be able to

CO1	find roots of nonlinear equations and solve systems of algebraic equations.	Apply, Evaluate
CO2	use Interpolations techniques and to find numerical differentiation/ integration of data, function.	Apply, Evaluate
CO3	use numerical methods for finding solutions of ordinary differential equations, simultaneous and higher order equations.	Apply, Evaluate
CO4	use statistical techniques like regression, correlation for finding relation between two or more variables. apply discrete and continuous probability distributions to various problems.	Apply, Evaluate
CO5	use to various parametric and nonparametric tests parameter estimation, hypothesis testing and ANOVA.	Understand, Apply
CO6	developing computer programs of numerical/ statistical methods using C/C^{++} language.	Evaluate, Create

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	1	-	-	-	-	-	3
CO2	3	2	3	3	1	1	-	-	-	-	-	3
CO3	3	2	3	3	1	1	-	-	-	-	-	2
CO4	3	3	3	3	1	1	-	-	-	-	-	2
CO5	3	3	3	3	1	2	3	2	2	1	1	2
CO6	2	1	2	2	3	2	1	-	2	2	2	3
Average	2.83	2.16	2.83	2.83	1.33	.66	.33	.66	.5	.5	.5	2.5

1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High) *If there is no correlation, put "-"*

Detailed Syllabus:

UNIT I: <u>Nonlinear Equations and Simultaneous Linear Equations:</u>

Roots of nonlinear equation, Methods of solution, Order of convergence of iterative methods, Simple roots: Bisection, False position, Secant, Newton-Raphson, Chebyshev, Iteration and multi point iteration methods, Multiple roots: Newton-Raphson and Chebyshev, Complex roots: Newton-Raphson and Muller's method, a system

of nonlinear equations: Newton-Raphson and iteration methods, Polynomial equations: Bairstow's method, convergence analysis of above methods.
Linear systems: Introduction, Direct methods, Operation count, Pivoting, III conditioned linear systems & condition number, Iteration methods: Jacobi, Gauss-Seidel, SOR methods, convergence conditions. Special system of equations: Thomas algorithm. Eigen value problems: Power methods.

UNIT II: Interpolation, Differentiation and Integration:
Curve fitting: Polynomial interpolation, error, Existence and Uniqueness, Truncation error bounds, difference operators, Newton forward and backward difference interpolations, Lagrange, Newton divided difference and Iterated interpolations, Stirling and Bessel's interpolations, Spline interpolation, Least squares and Chebyshev approximations. Numerical Differentiation: Methods based on interpolation, Error analysis.
Numerical Integration: Methods based on interpolations (Trapezoidal, Simpson's 1/3, Simpson's 3/8 rule), Gauss quadrature methods, Romberg integration, Error bounds and estimates.

UNIT-III: Numerical Solution of Ordinary Differential Equations:
Initial-value problems, Single step methods; Taylor's, Picard's, Modified Euler's method and Runge- Kutta method (fouth order), Error estimates, Multi-step methods: Adam's –Bashforth and Milne's methods, convergence and stability analysis, simultaneous and Higher equations: RK Fourth order method.

UNIT-IV: Curve- Fitting, Correlation, Regression and Probability:
Curve-fitting, method of least- squares, fitting of straight lines, polynomials, non-linear and exponential curves etc., correlation analysis, linear, non-linear and multi- regression analysis, probability, random variables and probability distributions, expectation, moments and transform methods, Binomial, Poisson and Normal distributions, overview of t-distribution, F-distribution and χ^2-distribution.

UNIT-V: Statistical Methods:
Sampling theory (small and large), parameter estimation, confidence intervals, tests of hypotheses and significance; z-, t-, F-, and χ^2 tests, goodness of fit test-χ^2 test, analysis of variance, non-parametric tests (Simple application), time series analysis, index numbers, quality control charts.

NST Lab
Develop programs of the following techniques in C/C++ Language:

1. To implement iterative methods to solve nonlinear equations.
2. To implement iterative methods to solve a system of linear equations.
3. To implement Newton's divided difference and Lagrange's interpolation formulae.
4. To implement Numerical differentiation.
5. To implement Numerical integration using Trapezoidal, Simpson 1/3 and Simpson 3/8 rules.
6. To implement single step/multi step methods to solve initial value problems.
7. To implement least squares method for curve fitting.
8. To find correlation coefficient, regression coefficients and lines of regression.
9. To implement tests of hypothesis and significance.
10. To implement non parametric tests.
11. To determine the confidence interval to implement ANOVA.

Books Recommended:

1. M.K. Jain, S.R.K. Iyengar & R.K. Jain, Numerical methods for Scientific and Engineering Computation, New age international Publication.
2. S.S. Sastry, Introductory Methods of Numerical Analysis, Eastern Economy Edition.
3. S. Rajasekaran, Numerical Method in Science and Engineering, Wheeler Publishing House.
4. B.S. Grewal, Numerical Method in Engineering & Science, Khanna Publishers.
5. D.L. Harnett, Statistical methods.
6. J.N. Kapur and H.C. Saxena, Mathematical , S.Chand, & Co., 2001.
7. H.C. Saxena, Practical Mathmatical Statistics, S. Chand & Co., 2000.

BMA-204, DISCRETE MATHEMATICAL STRUCTURES
(II B.Tech, CSE/IT)
(Effective from Session 2018-19)

L	T	P	C
3	1	0	4

OBJECTIVE: The objective of this course is

- to develop the logical ability by providing exposure to mathematical logic, proof methods, set theory, relation and functions etc.
- to provide knowledge about coding theory fundamentals, algebraic structures, posets, lattices, boolean algebra for applications in computer science.
- to provide exposure of combinatorics and graph theory for application in computer science.

Course Outcome

On the successful completion of the course, students will be able to

CO1	understand concept of logic and various inference mechanisms using logic.	Understand
CO2	understand set theory, function, relation and the concepts of theorem proving .	Understand
CO3	explain algebraic structures and coding theory .	Understand
CO4	understand and apply concepts of posets, lattices and boolean algebra in computer science.	Understand, Apply
CO5	understand and apply graph theory and concepts of recurrence relations and generating functions in system modeling.	Understand, Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	1	2	-	3	3
CO2	3	3	3	3	3	2	3	1	2	-	3	3
CO3	3	3	3	3	3	2	3	1	3	-	3	3
CO4	3	3	3	3	3	2	3	1	3	-	3	3
CO5	3	3	3	3	3	2	3	-	3	-	3	3
Average	3	3	3	3	3	2	3	.8	2.6	-	3	3

1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High) *If there is no correlation, put* "-"

Detailed Syllabus:

UNIT I: <u>Fundamentals of Logic</u>

Propositional Logic: Propositions, Basic logic operations and truth tables, Tautologies, Contradictions, Contigency, Algebra of propositions, Logical equivalence: the laws of logic, Logical implication: Rules of inference, Logical analysis of argument, Some computing application (Normal forms), Functionally complete set of operations, Formal proofs.

First Order Logic: Predicates & quatifiers, Nested quantifiers, Use of quantifiers, Rules of inference, Validity of arguments, proof methods.

UNIT II: Set Theory, Relations and Functions

Set Theory: Sets & subsets, Venn diagrams, set operations and laws, countable set, Cartesian product, Cardinality, Principle of inclusion- exclusion.
Relations: Relation, Representation & properties, n-ray relations and applications, Composition of relations, Closures of relations, Equivalence relation & partitions, partial orders, compatibility relation.
Functions: Functions and its types, Inverse function, Composition of functions, Special functions, Recursively defined functions, Computational Complexity, Analysis of algorithms.
Theorem Proving Techniques: Mathematical induction (weak, strong, structural) and its applications, Proof by contradiction, Pigeonhole principle.

UNIT III: Algebraic Structures and Coding Theory :

Algebraic Structures: Definition, Properties, Semi group, Monoid, Group, properties of groups, Subgroup, Cyclic group, Cosets and Lagrange's theorem, Permutation groups, Normal subgroup, Homomorphism and isomorphism of groups, Congruence relation, Rings and Fields. Example and standard results.
Coding Theory: Elements of coding theory, Hamming matric, Parity-check and generator matrices, Coding and error detection, Group codes: decoding with coset leaders and error correction, Hamming matrices.

UNIT IV: Partially Ordered Structures

Posets,: Definitions, ordered set, Hasse diagram, isomorphic ordered set, well ordered set, Minimal and Maximal elements, LUB &GLB etc.
Lattices: Definition & Properties, Product Lattices, Isomorphic Lattices, Applications, Types of Lattices.
Boolean Algebras: Definitions & Properties, SOP & POS forms, Logic gates and minimization of circuits, Karnaugh maps, Quine-McClusky method.
Trees: Definition & Examples and Properties, Rooted tree, Binary tree, Tree traversal, application in computer science and engineering.

UNIT V: Combinatorics and Graph Theory:

Combinatorics: Discrete numeric functions and properties, Recurrence relations and their applications (modeling), various methods of solutions, system of recurrence relations, OGF & EGF, properties, applications: solution of recurrence relations and combinatorial problems.
Graphs: Graphs and graph models, terminology, matrices associated with graphs, Isomorphism, Special types of graphs, connectedness, Euler and Hamilton graphs with their applications, trees with properties, MST, planer graphs and applications, criteria of planarity, Graph coloring and coloring models, directed graphs.

Books Recommended:
1. Trembley, J.P. & R. Manohar, "Discrete Mathematical Structures with applications to Computer Science", McGraw Hill.
2. Kenneth H. Rosen, "Discrete Mathematics and its Applications", McGraw Hill.
3. Ralph, P. Garimaldi, "Discrete& Combinatorial Mathematics" Pearson Publication, Asia.
4. Deo, narsingh, "Graph Theory with applications to Engineering & Computer Science", PHI.
5. Krishnamurthy, V., "Combinatorics Theory & Application", East-West Press Pvt. Ltd., New Delhi.

BMA-201, MATHEMATICS-III
(II B.Tech, CHE, CE, ME, ET, EE, BE, FT, OT, PT, LT, PL,)
(Effective from Session 2018-19)

L	T	P	C
3	1	0	4

OBJECTIVE: The objective of this course is to provide conceptual understanding of:

- various mathematical tools likes Laplace/ Fourier transforms and their applications.
- concepts and principle of complex analysis in solving various real life problems.
- various statistical methods and tests for analyzing experimental data.

Course Outcome

On the successful completion of the course, students will be able to

CO1	solve boundary value problems using Laplace transform and Fourier transform methods and solve difference equations and BVP_S using z transform.	Apply, Evaluate
CO2	construct conformal mapping between many kinds of domains.	Understand, Apply
CO3	evaluate complex integrals, improper real integrals using various formulae/theorems. find Taylor and Laurents series expansion of complex functions.	Apply, Evaluate
CO4	estimate relationship between two variable using curve fitting, regression and its strength using correlation.	Understand, Apply
CO5	various parametric and nonparametric tests parameter estimation, hypothesis testing and ANOVA.	Understand, Apply

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	2	1	2	1	1	-	1	3
CO2	3	3	3	3	2	1	2	1	1	-	1	3
CO3	3	3	3	3	2	1	2	1	1	-	1	3
CO4	3	3	3	3	1	1	-	-	-	-	-	2
CO5	3	3	3	3	1	2	3	2	2	1	1	2
Average	3	3	3	3	1.6	1.2	1.8	1	1	.5	.8	2.6

1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High) *If there is no correlation, put* "-"

Detailed Syllabus:

Unit – I: <u>Transform Methods:</u>

Fourier integral, conditions of convergence, Fourier sine and cosine integrals, complex form, applications, Fourier transform pairs, existence conditions, operational properties. Applications of Laplace transform and Fourier transform to solve boundary value problems, Discrete and Fast Fourier transforms and its applications.

Development of difference equations as models, operator method, method of undetermined coefficients, Z-transform pairs, ROC. Operational properties, limiting- value theorems, its applications to solve difference equations and BVP, systems of difference equations.

Unit- II: Functions of a Complex Variable and Conformal mapping:

Limit, continuity, differentiability and analyticity, Cauchy-Riemann equations, harmonic functions, complex functions as mappings, liner transformation, inverse transformation, bilinear transformations, conformal mapping, applications.

Unit- III: Integration of Complex Functions:

Contour integrals and evaluations, Cauchy- integral theorem, Cauchy's integral formulae, Liouville's theorem, convergence of power series, Taylor series, Laurent series, zeros and singularities of a complex function, residues and residue theorem, Fundamental theorem of algebra Rouche's theorem, Argument Principle and maximum modules theorem, evaluation of definite and improper integrals.

Unit- IV: Curve- Fitting, Correlation, Regression and Probability:

Curve-fitting, method of least- squares, fitting of straight lines, polynomials, non-linear and exponential curves etc., correlation analysis, linear, non-linear and multi-regression analysis, probability, random variables and probability distributions, expectation, moments and transform methods, Binomial, Poisson and Normal distributions.

Unit- V: Statistical Methods:

Sampling theory (small and large), parameter estimation, confidence intervals, tests of hypotheses and significance; Overview of t-distribution, F-distributions and χ^2-distribution. Z-, t-, F-, and χ^2 tests, goodness of fit test- χ^2 test, analysis of variance, non-parametric tests (Simple application). time series analysis, index numbers, quality control charts.

Books Recommended:

1. Dennis G, Zill & Michael R. Cullen; Advanced Engineering Mathematics, Jones & Bartlett Publishers. 2nd Edition.
2. R.K. Jain & S.R.K. Iyengar; advanced Engineering Mathematics, Narosa Publishing House, 2002.
3 Erwin Kreyszig; Advanced Engineering Mathematics, John Wiley & Sons 8th Edition.
4. R.V. Churchill and J.L. Brown, Complex Variables and Applications, McGraw Hill, 1990.
5. J.N. Kapur and H.C. Saxena, Mathematical Statistics, S.Chand. & Co., 2001.
6. H.C. Saxena, Practical Mathematical Statistics, S. chand & Co., 2000.
7. J.H. Mathews and R.W. Howell, Complex analysis for Mathematics and Engineering, 3rd Ed. Narosa, 1998.

BMA-206, COMPUTER ORIENTED NUMERICAL METHODS
(II B.Tech, CE, ME, ET, EE)
(Effective from Session 2018-19)

L	T	P	C
3	1	0	4

OBJECTIVE: The objective of this course is to provide conceptual understanding of:

- various numerical methods for solving linear and non linear equations.
- various numerical techniques of interpolation, integration and differentiation with their applications.
- various numerical methods to solve IVP_S and BVP_S.

Course Outcome

On the successful completion of the course, students will be able to

CO1	find roots of nonlinear equations and solve systems of algebraic equations.	Apply, Evaluate
CO2	use interpolation techniques and to find numerical differentiation/ integration of data, function.	Apply, Evaluate
CO3	use numerical methods for finding solutions of ordinary differential equations, simultaneous and higher order equations.	Apply, Evaluate
CO4	learn numerical methods for finding solution of initial and boundary value problems, partial differential equations.	Apply, Evaluate
CO5	learn basic concepts of some Finite element methods.	Apply, Evaluate

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	1	1	-	-	-	-	3
CO2	3	2	3	3	1	1	1	-	-	-	-	3
CO3	3	2	3	3	1	1	1	-	-	-	-	2
CO4	3	2	3	3	1	1	1	-	-	-	-	3
CO5	3	2	3	3	1	1	1	-	-	-	-	3
Average	3	2	3	3	1	1	1	-	-	-	-	3

1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High) *If there is no correlation, put* "-"

Detailed Syllabus:

UNIT I: <u>Nonlinear Equations and Simultaneous Linear Equations:</u>

Roots of nonlinear equation, Methods of solution, Order of convergence of iterative methods, Simple roots: Bisection, False position, secant, Newton-Raphson, Chebyshev, Iteration and multi point iteration methods, Multiple roots: Newton-Raphson and Chebyshev, Complex roots: Newton-Raphson and Muller's method, a system of nonlinear equations: Newton-Raphson and Iteration methods, Polynomial equations: Bairstow's method, convergence analysis of above methods.

Linear systems: Introduction, Direct methods, Operation count, Pivoting, III conditioned linear systems & condition number, Iteration methods: Jacobi, Gauss-Seidel, SOR methods, convergence conditions. Special system of equations: Thomas algorithm. Eigen value problems: Given's and Power methods.

UNIT II: Interpolation, Differentiation and Integration:

Curve fitting: Polynomial interpolation, error, Existence and Uniqueness, Truncation error bounds, difference operators, Newton forward and backward difference interpolations, Lagrange, Newton divided difference and Iterated interpolations, stirling and Bessel's interpolations, Spline interpolation, Least squares and Chebyshev approximations. Numerical Differentiation: Methods based on interpolation, Error analysis. Numerical Integration: Methods based on interpolations (Trapezoidal, Simpson's 1/3, simpson's 3/8 rule), Gauss quadrature methods, Romberg integration, Error bounds and estimates.

UNIT III: Numerical Solution of Ordinary Differential Equations:

Initial-value problems, Single step methods: Taylor's, Picard's, Euler's, Modified Euler's method and Runge-Kutta method (fourth Order), Error estimates, Multi-step methods: Adam's-Bashforth and Milne's methods, convergence and stability analysis, Simultaneous and Higher order equations: RK Fourth order method.

UNIT IV: Initial & Boundary Value Problems and Iterative Solvers:

BVP: Shooting method and Finite difference methods for Ordinary Differential Equations, Solution of Partial differential equation; solution of Laplace, Poisson equations: Standard 5- point and diagonal 5- point formulae, Jacobi method, Gauss Seidel method (Liebmann's iterative method) Relaxation method. Solution of heat equation: Crank – Nicolson method, Solution of wave equation.

UNIT V: Finite Element Method:

Basic concepts, variational formulation and functional, base functions, approximations weighted residual methods: Ritz method, Galerkin method, Least squares method, collocation method, Finite element and solution of simple problems and time dependent problems.

Books Recommended:

1. M.K.Jain, S.R.K. Iyengar & R.K.Jain, Numerical methods for Scientific and Engineering Computation, N age International Publication.
2. S.S Sastry, Intoductory Methods of Numerical Analysis, Eastern Economy Edition.
3. S. Rajasekaran, Numerical Method in Science and Engineering, Wheeler Publishing House.
4. B.S. Grewal, Numerical Method in Engineering & Science, Khanna Publishers.

BMA-202, COMPUTER ORIENTED NUMERICAL METHODS
(II B.Tech, CHE, BE, FT, OT, PT, PL, LT)
(Effective from Session 2018-19)

L	T	P	C
3	0	2	4

OBJECTIVE: The objective of this course is to provide conceptual understanding of:

- various numerical methods for solving linear and non linear equations.
- various numerical techniques of interpolation, integration and differentiation with their applications.
- various numerical methods to solve IVP_S and BVP_S.
- developing computer programs of numerical methods using C/C^{++} language.

Course Outcome

On the successful completion of the course, students will be able to

CO1	find roots of nonlinear equations and solve systems of algebraic equations.	Apply, Evaluate
CO2	use interpolation techniques and to find numerical differentiation/ integration of data function.	Apply, Evaluate
CO3	use numerical methods for finding solutions of ordinary differential equations, simultaneous and higher order equations.	Apply, Evaluate
CO4	learn numerical methods for finding solution of initial and boundary value problems, partial differential equations.	Apply, Evaluate
CO5	learn basic concepts of some Finite element methods.	Apply, Evaluate
CO6	developing computer programs of numerical methods using C/C^{++} language.	Apply, Evaluate, Create

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	3	3	1	1	1	-	-	-	-	3
CO2	3	2	3	3	1	1	1	-	-	-	-	3
CO3	3	2	3	3	1	1	1	-	-	-	-	3
CO4	3	2	3	3	1	1	1	-	-	-	-	3
CO5	3	2	3	3	1	1	1	-	-	-	-	3
CO6	3	2	2	2	3	2	1	2	2	2	2	3
Average	3	2	2.83	2.83	1.33	1.16	1	.33	.33	.33	.33	3

1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High) *If there is no correlation, put "-"*

Detailed Syllabus:

UNIT I: <u>Nonlinear Equations and Simultaneous Linear Equations:</u>

Roots of nonlinear equation, Methods of solution, Order of convergence of iterative methods, Simple roots: Bisection, False position, secant, Newton-Raphson, Chebyshev, Iteration and multi point iteration methods, Multiple roots: Newton-Raphson and Chebyshev, Complex roots: Newton-Raphson and Muller's method, a system of nonlinear equations: Newton-Raphson and Iteration methods, Polynomial equations: Bairstow's method, convergence analysis of above methods.

Linear systems: Introduction, Direct methods, Operation count, Pivoting, III conditioned linear systems & condition number, Iteration methods: Jacobi, Gauss-Seidel, SOR methods, convergence conditions. Special system of equations: Thomas algorithm. Eigen value problems: Given's and Power methods.

UNIT II: Interpolation, Differentiation and Integration:

Curve fitting: Polynomial interpolation, error, Existence and Uniqueness, Truncation error bounds, difference operators, Newton forward and backward difference interpolations, Lagrange, Newton divided difference and Iterated interpolations, stirling and Bessel's interpolations, Spline interpolation, Least squares and Chebyshev approximations. Numerical Differentiation: Methods based on interpolation, Error analysis. Numerical Integration: Methods based on interpolations (Trapezoidal, Simpson's 1/3, simpson's 3/8 rule), Gauss quadrature methods, Romberg integration, Error bounds and estimates.

UNIT III: Numerical Solution of Ordinary Differential Equations:

Initial-value problems, Single step methods: Taylor's, Picard's, Euler's, Modified Euler's method and Runge-Kutta method (fourth Order), Error estimates, Multi-step methods: Adam's-Bashforth and Milne's methods, convergence and stability analysis, Simultaneous and Higher order equations: RK Fourth order method.

UNIT IV: Initial & Boundary Value Problems and Iterative Solvers:

BVP: Shooting method and Finite difference methods for Ordinary Differential Equations, Solution of Partial differential equation; solution of Laplace, Poisson equations: Standard 5- point and diagonal 5- point formulae, Jacobi method, Gauss Seidel method (Liebmann's iterative method) Relaxation method. Solution of heat equation: Crank – Nicolson method, Solution of wave equation.

UNIT V: Finite Element Method:

Basic concepts, variational formulation and functional, base functions, approximations weighted residual methods: Ritz method, Galerkin method, Least squares method, collocation method, Finite element and solution of simple problems and time dependent problems.

NT Lab

Develop Programs of the following techniques in C/C++ Language:

1. To implement iterative methods to solve a nonlinear equation.
2. To implement iterative methods to solve a system of linear equations.
3. To implement Forward, Backward and Central difference interpolation formulae.
4. To implement Newton's divided difference and Lagrange's interpolation formulae.
5. To implement Numerical differentiation.
6. To implement Numerical integration using Trapezoidal, Simpson 1/3 and Simpson 3/8 rules.
7. To implement single step methods to solve initial value problems.
8. To implement multi step methods to solve initial value problems.
9. Solution of Heat equations (Parabolic equations) by finite difference method.
10. Solution of Laplace equations (elliptic equations) by finite difference method.
11. Solution of wave equations (Hyperbolic equations) by finite difference method.

Books Recommended:

1. M.K.Jain, S.R.K. Iyengar & R.K.Jain, Numerical methods for Scientific and Engineering Computation, N age International Publication.
2. S.S Sastry, Intoductory Methods of Numerical Analysis, Eastern Economy Edition.
3. S. Rajasekaran, Numerical Method in Science and Engineering, Wheeler Publishing House.
4. B.S. Grewal, Numerical Method in Engineering & Science, Khanna Publishers.

BMA-341/342, OPERATIONS RESEARCH
(III B.Tech, All Branches)
(Effective from Session 2018-19)

L	T	P	C
3	0	0	3

OBJECTIVE: The objective of this course is to educate the students about:

- mathematical formulation and solution of Linear programming problems by various method.
- transportation problems and assignment problems and their solutions.
- advanced LPP and Travelling salesman Problem and their solutions.
- fundamentals of Network problems and their solutions by CPM and PERT Methods.
- dynamic programming problem and genetic algorithm.

Course Outcome

On the successful completion of the course, students will be able to

CO1	understand and solve linear programming problems.	Apply, Evaluate
CO2	formulate and solve Transportations models, Assignment models and integer linear programming problems.	Apply, Evaluate, Create
CO3	formulate and solve sequencing and scheduling models.	Apply, Evaluate, Create
CO4	formulate and solve Replacement and inventory models.	Apply, Evaluate, Create
CO5	learn and use Dynamic programming and Genetic Algorithms.	Apply, Evaluate

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	2	3	1	2	-	3	3
CO2	3	3	3	3	3	2	3	1	2	-	3	3
CO3	3	3	3	3	3	2	3	1	3	-	3	3
CO4	3	3	3	3	3	2	3	1	3	-	3	3
CO5	3	3	3	3	3	2	3	-	3	-	3	3
Average	3	3	3	3	3	2	3	.8	2.6	-	3	3

1: Slight (Low) 2: Moderate (Medium) 3:Substantial (High) *If there is no correlation, put "-"*

Detailed Syllabus:

UNIT I: Linear Programming Problems (LPP)

OR model, Formulation of LPP. model, Graphical LPP solution and sensitivity analysis, simplex method, M-method, Two-phase method, Special cases in simplex method application, Duality theory, Dual simplex method, Revised simplex method, Degeneracy, Sensitivity analysis, Various industrial application of LP.

UNIT II: Transportation Models, Assignment Models and Integer Programming:

Formulation and Optimal solution of transportation models, Assignment models, Transshipment models, Degeneracy in TP model, Industrial application, Formulation and Solution of integer linear programming problems; Cutting-plane algorithm, Branch and Bound algorithm, 0-1 ILPP, applications, Knapsack problem, facility-location problem.

UNIT III: Sequencing and Scheduling Model:

Sequencing problems- Travelling salesman problem, Machine-scheduling problem (Job shop), Network based planning models, Objectives of CPM and PERT, Characteristics of CPM/PERT projects, Network diagram, Terminology, Critical path, Project duration, PERT Network, Activity time, Probabilities of project completion, Optimal crashing of project activities.

UNIT IV: Replacement and Inventory models:

Replacement Problems: Optimal age of equipment replacement, capital equipment discounting cost, Replacement of items that fail, Individual and group replacement policies.

Inventory Models: Deterministic inventory models, Classic EOQ model, EOQ with price breaks, Multiterm, stochastic inventory models under probabilistic demand and lead times.

UNIT V: Dynamic Programming and Genetic Algorithms:

Dynamic programming: Bellman's principle of optimality, computations in DP, Forward and Backward recursions, Dynamic Programming formulations, Investment problem, General allocation problem, Storage coach problem, Production scheduling.

Genetic Algorithms: Working principles, similarities and differences between Gas and Traditional methods, Gas for constrained optimization, Applications of Gas to solve simple problems.

Text Books Recommended:

1. S.S. Rao, "Optimization: Theory and Applications" Willey Eastern Limited.
2. H.A. Taha, " Operations Research- AN Introduction", Macmillan.
3. Hiller, F.S., G.J. Lieberman, "Introduction to Operations Research", Hoiden-Day.
4. Kalyanmoy Deb, "Optimizaton for Engineering Design: Algorithms & Examples " Prentice- Hall of India.
5. B.E. Gillet, Introduction Operations Research- A Computer Oriented Algorithmic Approach, McGraw Hill 1989.