COURSE STRUCTURE FOR B. Tech. (All)														
			B. Tech. (All)											
			Teaching Scheme					Examination Scheme						
								Theory			Practical		Total	
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**L**	**T**	**P**	**C**	**Hrs/Wk**	**MS**	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
1.	20MA101T	Mathematics - I	3	1	0	4	4	25	50	25	--	--	100
2.	20MA102T	Mathematics - II	3	1	0	4	4	25	50	25	--	--	100
3.	20MA201T	Mathematics – III: Chemical Engineering	3	1	0	4	4	25	50	25	--	--	100
4.	20MA202T	Mathematics – III: Mechanical Engineering	3	1	0	4	4	25	50	25	--	--	100
5.	20MA203T	Mathematics – III: Electrical Engineering	3	1	0	4	4	25	50	25	--	--	100
6.	20MA204T	Mathematics – III: Civil Engineering	3	1	0	4	4	25	50	25	--	--	100
7.	20MA205T	Mathematics – III: Petroleum Engineering	3	1	0	4	4	25	50	25	--	--	100
8.	20MA206T	Discrete Mathematical Structures: CSE / ICT	3	1	0	4	4	25	50	25	--	--	100
9.	20MA207T	Mathematics - III: Auto Mobile Engineering	3	1	0	4	4	25	50	25	--	--	100
10.	20MA208T	Mathematics - III: Electronics and Communication Engineering	3	1	0	4	4	25	50	25	--	--	100
11.	20MA209E	Probability and Statistics	3	0	0	3	3	25	50	25	--	--	100
12.	20MA210E	Numerical Methods	3	0	0	3	3	25	50	25	--	--	100
13.	20MA211E	Formal Languages and Automata Theory	3	0	0	3	3	25	50	25	--	--	100
14.	20MA301E	Applied Statistics	3	0	0	3	3	25	50	25	--	--	100
15	20MA302E	Optimization for Engineers	3	0	0	3	3	25	50	25	--	--	100
16	20MA303T	Numerical Methods (Theory): Petroleum Engineering	3	1	0	4	4	25	50	25	--	--	100
17	20MA303P	Numerical Methods (Practical): Petroleum Engineering	0	0	2	1	2	--	--	--	50	50	100
Total			**48**	**11**	**2**	**60**	**61**						**1700**

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam, LW – Lab Work, LE – Lab Exam.

Pandit Deendayal Energy University | School of Technology

20MA101T					Mathematics - I					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs. / Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	**1**	**0**	**4**	**4**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES

- To be able to evaluate problems related to differential and integral calculus of complex functions.
- To be able to obtain area, volume using integral calculus.
- To be able to formulate and solve various engineering problems using the calculus.
- To study the properties of Matrix algebra and apply them to solve system of algebraic equations.

UNIT 1 DIFFERENTIAL CALCULUS AND ITS APPLICATIONS — 08 Hrs.

Partial derivative and its application, - Euler's theorem - Total derivatives - Jacobians – Maxima and Minima of two variables using Lagrange's multipliers. Convergence of power series.

UNIT 2 INTEGRAL CALCULUS AND ITS APPLICATIONS — 12 Hrs.

Definition Evaluation of double integral (Cartesian – Polar form) – Change of orders - Change of variables – Evaluation of triple integral, change of variables (Cartesian to spherical – and cylindrical) – Applications, area – volume – center of mass – center of gravity by double and triple integral.

UNIT 3 MATRIX ALGEBRA AND ITS APPLICATIONS — 10 Hrs.

Solution of system of algebraic equation - Rank of a matrix, consistency of system of equation - Characteristic equation of a square matrix-Eigen values and Eigenvectors of a real matrix - Properties of eigen values and eigen vectors - Cayley-Hamilton theorem (without proof) - finding inverse of a matrix - Diagonalization of a matrix using orthogonal transformation.

UNIT 4 VECTOR CALCULUS — 10 Hrs.

Gradient, divergence and curl – Directional derivative – Irrotational and Solenoidal vector fields – Vector Integration – Simple problems on line, surface and volume integrals – Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (without proofs) – Simple application involving cubes and rectangular parallelepipeds.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Identify the use of convergence of infinite series in engineering aspects.
CO2 – Understand the concept of Directional derivative, Irrotational and Solenoidal vector fields.
CO3 – Apply appropriate tool/method to extract the solutions of engineering problems.
CO4 – Analyze the obtained solution in context with theory.
CO5 – Appraise mathematical problems from real to complex domain.
CO6 – Evaluate problems on Green's, Stokes' and Divergence theorems.

TEXT / REFERENCE BOOKS

1. B. S Grewal, Higher Engineering Mathematics, 43rd Edition, Khanna Pub., Delhi, 2014.
2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Alpha Science, 3rd Ed., 2007.
3. Erwin Kreyszig, Advanced Engineering mathematics, John Wiley, 10th Ed., 2015.
4. G. Strang, Linear Algebra and its applications, 4th Edition, Cengage Learning, 2005.
5. K. Hoffman and R. A. Kunze, Linear Algebra, Prentice Hall of India, 2002.

20MA102T					Mathematics - II					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To be able to apply the calculus of complex functions to construct analytic functions.
- To be able to compute residues and apply them to evaluate contour integrals.
- To be able to formulate and solve various engineering problems using the methods of solving ODEs.
- To study the properties of Laplace transforms and apply them to solve ODEs.

UNIT 1 COMPLEX DIFFERENTIATION 10 Hrs.

Limit, Continuity, Differentiability of function of complex variable, Analytic function, Cauchy-Riemann equation (in Cartesian and polar coordinates), Harmonic function and its significance, Singularities, Taylor's series, Mapping (translation, rotation and inversion), bilinear transformation, Conformal mapping, Applications of Conformal mapping.

UNIT 2 COMPLEX INTEGRATION AND APPLICATIONS 10 Hrs.

Definition of a Complex line integral, Contour integrals, Cauchy-Goursat theorem, Cauchy integral theorem, Cauchy Integral formula (CIF), CIF for derivatives, Calculation of residues, Cauchy Residue theorem, Applications of residues to evaluate real definite integrals.

UNIT 3 ORDINARY DIFFERENTIAL EQUATIONS WITH APPLICATIONS 10 Hrs.

Differential equations of first order and higher degree, Higher order differential equations with constant coefficients, Rules for finding C.F. and P.I., Method of variation of parameters, Cauchy and Legendre's linear equations, Linear differential equations of second order with variable coefficients; Simultaneous linear equations with constant coefficients, Applications of higher order differential equations in solving engineering problems.

UNIT 4 LAPLACE TRANSFORMS 10 Hrs.

Piecewise continuous functions and exponential functions, Definition, Existence and Properties of Laplace transforms, Heaviside function, Inverse Laplace transform, Properties of inverse Laplace transforms, Convolution theorem, Applications of Laplace Transforms in solving differential equations.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Identify the use of various special functions in engineering aspects.
CO2 – Illustrate the ability to handle mathematical models, to describe physical phenomena, using suitable techniques.
CO3 – Apply appropriate tool/method to extract the solutions of engineering problems.
CO4 – Analyze the obtained solution in context with theory.
CO5 – Appraise mathematical problems from real to complex domain.
CO6 – Create a mathematical model of engineering interest.

TEXT / REFERENCE BOOKS

1. R.V. Churchill and J. W. Brown, Complex variables and applications, 7th ed., McGraw-Hill, 2003
2. J. M. Howie, Complex analysis, 1st ed., Springer-Verlag, 2003.
3. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3rd ed., Alpha Science, 2007.
4. Erwin Kreyszig, Advanced Engineering mathematics, 10th ed., John Wiley, 2015.

20MA201T					Mathematics – III: Chemical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To apply Fourier analysis for solving applications in chemical and allied engineering branches.
- To familiarize students with a variety of engineering problems that can be analyzed by using properties of Fourier transform techniques.
- To provide a broad coverage of various mathematical techniques that are widely used for solving and to get analytical solutions to partial differential equations of first and second order.
- To introduce various applications of partial differential equations in many fields of science and engineering.

UNIT 1 FOURIER SERIES **10 Hrs.**

Periodic functions, Odd and even functions, Euler's formulae for Fourier series in an interval of length 2 pi, Change of interval, Dirichlet's conditions, Half range Sine and Cosine series, Complex Fourier series, Parseval's identity and its applications.

UNIT 2 FOURIER TRANSFORM **08 Hrs.**

Fourier integral theorem, Sine and Cosine integrals, Fourier transform, Fourier Sine and Cosine transforms, Properties, Inverse Fourier transform.

UNIT 3 PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER **10 Hrs.**

Formation of Partial Differential Equations (PDEs), Solutions of PDEs of first order, Cauchy problem for first order PDEs, Lagrange's method, Charpit and Jacobi methods for solving first order nonlinear PDEs.

UNIT 4 PARTIAL DIFFERENTIAL EQUATIONS OF SECOND ORDER WITH APPLICATIONS **12 Hrs.**

Classification of second order PDEs, Method of separation of variables, Fourier series solutions of one-dimensional wave equation, One dimensional heat equation, Steady state solution of two-dimensional heat equation, Applications of PDEs to string and rod problems, Finite and infinite plate problems and reaction engineering.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Identify real phenomena as models of partial differential equations.
CO2 – Demonstrate the ability to use mathematical arguments to describe the real-world problems in science and engineering.
CO3 – Apply various analytical methods to obtain solutions to PDEs of first and second order, which occur in science and engineering.
CO4 – Apply the techniques learnt to analyse a comprehensive model related to chemical engineering.
CO5 – Develop the skills to construct boundary value problems arising in chemical engineering.
CO6 – Formulate and solve physical problems involving partial derivatives.

TEXT / REFERENCE BOOKS

1. K. S. Rao, Introduction to Partial Differential Equations, 3rd ed., PHI Learning Pvt Ltd, New Delhi, 2011.
2. T. Amaranth, An Elementary Course in Partial Differential Equations, 2nd ed., Narosa Publishing House, New Delhi, 2003.
3. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, American Mathematical Society, 1998.
4. B.S. Grewal, Higher Engineering Mathematics, 44th ed., Khanna Publishers, 2017
5. E. Kreyszig, Advanced Engineering Mathematics, 10th ed., John Wiley & Sons, 2016.
6. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd ed., Narosa Publishing House, 2002.

20MA202T					Mathematics – III: Mechanical Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To apply Fourier analysis for solving applications in mechanical and other engineering branches.
- To familiarize students with a variety of engineering problems where analytical method fails and special function comes to rescue.
- To get analytical solutions to partial differential equations of first order.
- To use this course as a base for higher studies and for accomplishing the projects at higher semesters.

UNIT 1 FOURIER SERIES AND APPLICATIONS IN MECHANICAL ENGINEERING 10 Hrs.

Periodic functions, odd and even functions, Euler's formulae for Fourier series in an interval of length 2 pi, change of interval, Dirichlet's conditions, half range Sine and Cosine series, complex Fourier series, Parseval's identity and its applications in Mechanical Oscillations, Applications of Fourier Series in Periodic variation of gas pressure in a 4-stroke internal combustion engine Or the study of Crank rotation in respect of Fourier Series.

UNIT 2 SPECIAL FUNCTIONS 10 Hrs.

Power series method to solve the differential equation, Frobenius method for solution near regular-singular points, Legendre's equation, Legendre Polynomials,Rodrigue's formula, Bessel's equation, orthogonality conditions and generating functions for Legendre and Bessel's equations.

UNIT 3 PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER 10 Hrs.

Formation of Partial Differential Equations (PDEs), Solutions of PDEs of first order, Cauchy problem for first order PDEs, Lagrange's method, Charpit and Jacobi methods for solving first order nonlinear PDEs.

UNIT 4 PARTIAL DIFFERENTIAL EQUATIONS OF SECOND ORDER 10 Hrs.

Classification of second order PDEs, method of separation of variables, Fourier series solutions of one-dimensional wave equation, one dimensional heat equation, steady state solution of two-dimensional heat equation, applications of PDEs to string and rod problems pertaining to Mechanical Systems

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Identify the role of periodic functions in real world problems.
CO2 – Understand the various techniques to analyze the behavior of different Mechanical periodic systems such as 4 – stroke engines.
CO3 – Solve the differential equations which are not solvable by analytical methods known so far and thus develop a skill to look for alternatives.
CO4 – Discuss the role of partial derivatives in engineering problems where multiple factors affect the system.
CO5 – Evaluate physical problems involving partial derivatives.
CO6 – Developthe ability to model the physical systems in terms of the methods learnt in this course and then solve accordingly.

TEXT / REFERENCE BOOKS

1. E. Kreyszig, Advanced Engineering Mathematics, 10th ed., John Wiley & Sons, 2016.
2. B.S. Grewal, Higher Engineering Mathematics, 44th ed., Khanna Publishers, 2017.
3. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd ed., Narosa Publishing House, 2002.
4. Tai-Ran Hsu, Applied Engineering Analysis, 1st ed., John Wiley & Sons, 2018.
5. K. S. Rao, Introduction to Partial Differential Equations, 3rd ed., PHI Learning Pvt Ltd, New Delhi, 2011.
6. T. Amaranth, An Elementary Course in Partial Differential Equations, 2nd ed., Narosa Publishing House, New Delhi, 2003.

20MA203T					Mathematics – III: Electrical Engineering					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs. / Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	**1**	**0**	**4**	**4**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES

- To understand the concept of Fourier series and its application to the solution of partial differential equations.
- To introduce the Fourier transforms and Z-transforms.
- To study the first and second order partial differential equations.
- To use this course as a base for higher studies and for accomplishing the projects at higher semesters.

UNIT 1 FOURIER SERIES **10 Hrs.**

Periodic functions, Euler's formulae, Dirichlet's conditions, expansion of even and odd functions, half range Fourier sine and cosine series, Parseval's formula, complex form of Fourier series.

UNIT 2 FOURIER TRANSFORM AND Z-TRANSFORM **10 Hrs.**

Fourier Transform: Integral transform, Fourier integral theorem, Fourier sine and cosine integrals, Fourier transforms, Fourier sine and cosine transforms, Properties of Fourier transform, Convolution, Parseval's identity, Relationship between Fourier and Laplace transform.

Z-transform: Z - transform, Properties of Z-transforms, Convolution of two sequences, inverse Z-transform, Solution of Difference equations

UNIT 3 PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER **10 Hrs.**

Formation of Partial Differential Equations (PDEs), Solutions of PDEs of first order, Cauchy problem for first order PDEs, Lagrange's method, Charpit and Jacobi methods for solving first order nonlinear PDEs

UNIT 4 PARTIAL DIFFERENTIAL EQUATIONS OF SECOND ORDER **10 Hrs.**

Classification of second order Partial Differential Equations, Method of separation of variables. Fourier Series Solutions of one-dimensional wave equation, One dimensional heat conduction, Steady state two dimensional Laplace equations.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify the partial differential equations of first and second order in order to model or understand the Electrical Engineering applications.

CO2 – Understand the techniques of Fourier transforms and Z-transforms to understand the critical mathematical problems.

CO3 – Apply the methods of Fourier series, Fourier transform and Z-transform in understanding and solving the basic Electrical Engineering problems.

CO4 – Classify the second order partial differential equations and solve using method of separation of variables.

CO5 – Appraise the series representation of periodic functions using Fourier series.

CO6 – Formulate the first order partial differential equations and solve them using various analytical techniques.

TEXT / REFERENCE BOOKS

1. H. K. Dass, Advanced Engineering Mathematics, 21st ed., S. Chand & Company Ltd., 2013.
2. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd ed., Narosa Publishing House, 2002.
3. E. Kreyszig, Advanced Engineering Mathematics, 10th ed., John Wiley & Sons, 2016.
4. Peter V. O'Neil, Advanced Engineering Mathematics, 8th ed., Cengage Learning, 2017.
5. K. Sankara Rao, Introduction to Partial Differential Equations, 3rd ed., PHI Learning, 2011.
6. T. Amaranth, An Elementary Course in Partial Differential Equations, 2nd ed., Narosa Publishing House, New Delhi, 2003.

20MA204T					Mathematics – III: Civil Engineering					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs. / Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	**1**	**0**	**4**	**4**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES

- To provide a broad coverage of various mathematical techniques that are widely used for solving and to get analytical solutions to partial differential equations of first and second order.
- To introduce various applications of partial differential equations in many fields of science and engineering.
- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals in real life situations.

UNIT 1 PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER 10 Hrs.

Formation of Partial Differential Equations (PDEs), Solutions of PDEs of first order, Cauchy problem for first order PDEs, Lagrange's method, Charpit and Jacobi methods for solving first order nonlinear PDEs.

UNIT 2 PARTIAL DIFFERENTIAL EQUATIONS OF SECOND ORDER AND APPLICATIONS 10 Hrs.

Classification of second order PDEs, Method of separation of variables, Fourier series solutions of one-dimensional wave equation, One dimensional equation of heat conduction, Steady state solution of two-dimensional equation of heat conduction.

UNIT 3 NUMERICAL SOLUTION OF SYSTEM OF LINEAR EQUATIONS & NON-LINEAR EQUATIONS 10 Hrs.

Solution of transcendental and non-linear equations by Bisection, Regula-Falsi, Newton-Raphson and Secant method. Concept of Ill conditioned system. Solution of a system of linear simultaneous equations by LU Decomposition, Cholesky Decomposition, Jacobi and Gauss Seidel methods.

UNIT 4 INTERPOLATION AND APPROXIMATION 10 Hrs.

Interpolation with unequal intervals – Lagrange's interpolation, Newton's divided difference interpolation, Cubic Splines, Difference operators and relations, Interpolation with equal intervals – Newton's forward and backward difference formulae.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Identify real phenomena as models of partial differential equations.
CO2 – Understand the formation and solution of PDEs of first, second and higher order.
CO3 – Apply various analytic methods to obtain solutions to PDEs of first and second order, which occur in science and engineering.
CO4 – Solve algebraic and transcendental equations by various numerical methods.
CO5 – Use interpolation methods to estimate the missing data
CO6 – Analyze properties of interpolating polynomials and derive conclusions.

TEXT / REFERENCE BOOKS

1. K. S. Rao: Introduction to Partial Differential Equations, PHI Learning Pvt Ltd, New Delhi, 2010
2. T. Amaranth, An Elementary Course in Partial Differential Equations, Narosa Publishing House, New Delhi.
3. L.C. Evans, Partial Differential Equations, Graduate Studies in Mathematics, Vol. 19, American Mathematical Society, 1998
4. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 5thEd., New Age International, 2007.
5. S.S. Sastry, Introductory Methods for Numerical Analysis, 4th ed., Prentice Hall of India, 2009.
6. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd ed., Narosa, 2002.
7. B.S. Grewal, Numerical Methods in Engineering and Science with Programs in C & C++, Khanna Publishers, 2010.

20MA205T					Mathematics – III: Petroleum Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	0	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the concept of partial differential equations and their solution.
- To conceptualize the heat, wave, and Laplace equations and their solution.
- Expansion of periodic functions/waveforms in terms of sine and cosine functions.
- To acquaint the concept of Fourier transform and their applications in physics
- To become familiar about applications of Fourier series to PDEs.

UNIT 1 FOURIER SERIES AND FOURIER TRANSFROM ALONG WITH ITS APPLICATIONS **11 Hrs.**

Periodic function, definition and its properties, definition of a Fourier series of function, need of Fourier series, Dirichlet's condition, Finding the coefficients, Fourier series of even and odd function, Extending the scope of Fourier series, Fourier series of arbitrary interval, convergence of Fourier series, Harmonic analysis, applications of Fourier series.
Introduction, definition, existence, Fourier transform of simple functions, properties of Fourier transform, Fourier Sine and Cosine transforms, Fourier transform in science and engineering, Solving differential equations through Fourier transforms.

UNIT 2 PARTIAL DIFFERENTIAL EQUATION **09 Hrs.**

Partial Differential Equations: Formation PDEs, Solution of Partial Differential equations f(x,y,z,p,q) = 0, Nonlinear PDEs first order, Some standard forms of nonlinear PDE, Linear PDEs with constant coefficients, Equations reducible to Homogeneous linear form, Classification of second order linear PDEs.

UNIT 3 APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS **10 Hrs.**

Importance of second order partial differential equations and their classification, method of variable separable, physical significance of elliptic, parabolic and hyperbolic equations, One and two dimension heat, Laplace and wave equations in Cartesian and polar coordinates and their solution by variable separable, Laplace and Fourier transform

UNIT 4 GEOSTATISTICS AND ITS APPLICATIONS **10 Hrs.**

Introduction to Geostatics, Probability Theory review, Spatial Analysis, Variogram Modelling, Estimation (Global and Local). Cross validation, Estimators (Simple kriging, Indicator kirging, Block kriging); Geostatistical simulation (Cholesky decomposition, conditional simulation, sequential gaussian simulation- SGS)

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Apply the appropriate analytical methods to handle engineering problems whose governing equations are differential equation.
CO2 – Analyze the analytical solution in terms of physics.
CO3 – Analyze mathematical model of real-world problems with mastery of the core concepts.
CO4 – Evaluate the solution of partial differential equations.
CO5 – Evaluate linear second order PDEs using separation of variables and Fourier series for boundary value problems.
CO6 – Formulate physical problems in terms of partial differential equations.

TEXT/REFERENCE BOOKS

1. R. K. Jain & S. R. K. Iyengar, Higher Engineering Mathematics, 3rded., Narosa, 2007.
2. E. Kreyszig, Advanced Engineering Mathematics, 8thed., John Wiley, 1999.
3. M. D. Raisinghania, Ordinary and Partial Differential Equations, 8th ed., S. Chand Publication, 2010.
4. L. Debnath and D. Bhatta, Integral transform and their applications, 3rd ed., Chapman and Hall/CRC, 2014
5. M. R. Spiegel, Fourier Analysis with applications to boundary value problems, Schaum's Outlines, McGraw-Hill education.
6. Paras Ram, Engineering Mathematics through Applications, 2nd ed., CBS Publishers, 2011.

20MA206T					Discrete Mathematical Structures: CSE / ICT					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the concept of sets, relations, functions and logic.
- To understand Combinatorics as an analytical method for problem solving.
- To apply graph theory-based modeling to solve real life problems.
- To explain the basics of algebraic structures.

UNIT 1 SETS, RELATIONS, FUNCTIONS AND LOGIC **10 Hrs.**

Finite and Infinite sets, Countable and Uncountable sets, Mathematical Induction, Functions and Relations, Types of Relation, Partial Ordered Relations, Hasse diagram and Lattice. Propositions - Simple and Compound. Basic logical operators. Implication. Truth tables. Tautologies, Contradictions and Contingency. Valid arguments and Fallacy.

UNIT 2 COMBINATORICS **10 Hrs.**

Recursive functions, Recurrence relations, Solutions of recurrence relations (Direct Method and by using Generating Function), Counting principles, Permutation, Combination, Derangement, inclusion-exclusion principle, Pigeon hole principle, Extended Pigeon hole principle.

UNIT 3 GRAPH THEORY AND ITS APPLICATIONS **12 Hrs.**

Binary Operation, Graphs and related definitions, Sub graphs, Homomorphism and Isomorphism, Paths and Connectivity. Bipartite graph. Eulerian graph and Konigsberg Bridge problem. Hamiltonian graph. Labeled and weighted graphs. Graph coloring. Four color problem. Planar Graphs. Digraphs and related definitions. Trees. Algebraic expressions and Polish notation. Sequential representation. Adjacency matrix. Shortest path Algorithms (Dijkstra), Binary trees, Strongly and weakly connected graphs, Powers of the adjacency matrix, Floyd-Warshall algorithm, Application of Graph theory in real-life applications.

UNIT 4 ALGEBRAIC STRUCTURES **08 Hrs.**

Group, Semi group, Monoids, Properties of a Group, Composition table for finite Group, Order of a group, Order of its elements, Cyclic Group, Generator, Lagrange’s Theorem. Ring, Properties of Rings, Integral Domain, Field.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify structures of algebraic nature, prove and use their properties.
CO2 – Understand the basic concepts of sets, relations, functions, logic and be able to determine their properties.
CO3 – Apply the basic techniques of Combinatorics and Counting.
CO4 – Apply Graph theory in related areas such as minimal-path problems and network flow problems.
CO5 – Defend and point out fallacious reasoning and propositions.
CO6 – Construct and solve recurrence relations that arise in counting problems including problems of determining the time complexity of recursively defined algorithms.

TEXT / REFERENCE BOOKS

1. Seymour Lipschutz and Marc Lipson, Discrete Mathematics, Schaum’s Series, 3rd ed., McGraw-Hill Education, 2009.
2. Kenneth Rosen, Discrete Mathematics and Its Applications, 7th ed., McGraw Hill Education, 2017.
3. Bernard Kolman, Robert Busyb and Sharon C. Ross, Discrete Mathematical Structures, 6th ed., Pearson, 1998.
4. Thomas Koshy, Discrete Mathematics with Applications, Academic Press Inc., 2004.
5. Ralph P. Gramaldi, Discrete and Combinatorial Mathematics, 5th ed., Pearson, 2006.
6. C.L. Liu, D.P. Mohapatra, Elements of Discrete Mathematics: A Computer Oriented Approach, 4th ed., McGraw Hill Education, 2017.

20MA207T					Mathematics – III: Automobile Engineering					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To apply Fourier analysis for solving applications in mechanical and other engineering branches.
- To familiarize students with a variety of engineering problems where analytical method fails and special function comes to rescue.
- To get analytical solutions to partial differential equations of first order.
- To use this course as a base for higher studies and for accomplishing the projects at higher semesters.

UNIT 1 FOURIER SERIES AND APPLICATIONS IN AUTOMOBILE ENGINEERING 10 Hrs.

Periodic functions, odd and even functions, Euler's formulae for Fourier series in an interval of length 2 pi, change of interval, Dirichlet's conditions, half range Sine and Cosine series, complex Fourier series, Parseval's identity and its applications in Mechanical Oscillations, Applications of Fourier Series in Periodic variation of gas pressure in a 4-stroke internal combustion engine Or the study of Crank rotation in respect of Fourier Series.

UNIT 2 NUMERICAL SOLUTION OF SYSTEM OF LINEAR EQUATIONS & NON-LINEAR EQUATIONS 10 Hrs.

Solution of transcendental and non-linear equations by Bisection, Regula-Falsi, Newton-Raphson and Secant method. Concept of Ill conditioned system. Solution of a system of linear simultaneous equations by LU Decomposition, Cholesky Decomposition, Jacobi and Gauss Seidel methods

UNIT 3 PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER 10 Hrs.

Formation of Partial Differential Equations (PDEs), Solutions of PDEs of first order, Cauchy problem for first order PDEs, Lagrange's method, Charpit and Jacobi methods for solving first order nonlinear PDEs.

UNIT 4 PARTIAL DIFFERENTIAL EQUATIONS OF SECOND ORDER 10 Hrs.

Classification of second order PDEs, method of separation of variables, Fourier series solutions of one-dimensional wave equation, one dimensional heat equation, steady state solution of two-dimensional heat equation, applications of PDEs to string and rod problems pertaining to Mechanical Systems

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Identify the role of periodic functions in real world problems.
CO2 – Understand the various techniques to analyze the behavior of different Mechanical periodic systems such as 4 – stroke engines.
CO3 – Solve the differential equations which are not solvable by analytical methods known so far and thus develop a skill to look for alternatives.
CO4 – Discuss the role of partial derivatives in engineering problems where multiple factors affect the system.
CO5 – Evaluate physical problems involving partial derivatives.
CO6 – Developthe ability to model the physical systems in terms of the methods learnt in this course and then solve accordingly.

TEXT / REFERENCE BOOKS

1. E. Kreyszig, Advanced Engineering Mathematics, 10th ed., John Wiley & Sons, 2016.
2. B.S. Grewal, Higher Engineering Mathematics, 44th ed., Khanna Publishers, 2017.
3. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd ed., Narosa Publishing House, 2002.
4. Tai-Ran Hsu, Applied Engineering Analysis, 1st ed., John Wiley & Sons, 2018.
5. K. S. Rao, Introduction to Partial Differential Equations, 3rd ed., PHI Learning Pvt Ltd, New Delhi, 2011.
6. T. Amaranth, An Elementary Course in Partial Differential Equations, 2nd ed., Narosa Publishing House, New Delhi, 2003.

20MA208T					Mathematics – III: Electronics and Communication Engineering					
					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand the concept of Fourier series and its application to the solution of partial differential equations.
- To introduce the Fourier transforms and Z-transforms.
- To study the first and second order partial differential equations.
- To use this course as a base for higher studies and for accomplishing the projects at higher semesters.

UNIT 1 FOURIER SERIES **10 Hrs.**

Periodic functions, Euler's formulae, Dirichlet's conditions, expansion of even and odd functions, half range Fourier sine and cosine series, Parseval's formula, complex form of Fourier series.

UNIT 2 FOURIER TRANSFORM AND Z-TRANSFORM **10 Hrs.**

Fourier Transform: Integral transform, Fourier integral theorem, Fourier sine and cosine integrals, Fourier transforms, Fourier sine and cosine transforms, Properties of Fourier transform, Convolution, Parseval's identity, Relationship between Fourier and Laplace transform.

Z-transform: Z - transform, Properties of Z-transforms, Convolution of two sequences, inverse Z-transform, Solution of Difference equations

UNIT 3 PARTIAL DIFFERENTIAL EQUATIONS OF FIRST ORDER **10Hrs**

Formation of Partial Differential Equations (PDEs), Solutions of PDEs of first order, Cauchy problem for first order PDEs, Lagrange's method, Charpit and Jacobi methods for solving first order nonlinear PDEs.

UNIT 4 PARTTIAL DIFFERENTIAL EQUATIONS OF SECOND ORDER WITH APPLICATIONS **10Hrs**

Classification of second order PDEs, method of separation of variables, Fourier series solutions of one-dimensional wave equation, One dimensional, two dimensional and three dimensional PDEs, Applications of to wave analysis.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify the partial differential equations of first and second order in order to model or understand the Electrical Engineering applications.
CO2 – Understand the techniques of Fourier transforms and Z-transforms to understand the critical mathematical problems.
CO3 – Apply the methods of Fourier series, Fourier transform and Z-transform in understanding and solving the basic Electrical Engineering problems.
CO4 – Classify the second order partial differential equations and solve using method of separation of variables.
CO5 – Appraise the series representation of periodic functions using Fourier series.
CO6 – Formulate the first order partial differential equations and solve them using various analytical techniques.

TEXT / REFERENCE BOOKS

1. H. K. Dass, Advanced Engineering Mathematics, 21st ed., S. Chand & Company Ltd., 2013.
2. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd ed., Narosa Publishing House, 2002.
3. E. Kreyszig, Advanced Engineering Mathematics, 10th ed., John Wiley & Sons, 2016.
4. Peter V. O'Neil, Advanced Engineering Mathematics, 8th ed., Cengage Learning, 2017.
5. K. Sankara Rao, Introduction to Partial Differential Equations, 3rd ed., PHI Learning, 2011.
6. T. Amaranth, An Elementary Course in Partial Differential Equations, 2nd ed., Narosa Publishing House, New Delhi, 2003.

20MA211E					Formal Languages and Automata Theory					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs. /Week**	**Theory**			**Practical**		**Total Marks**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	
3	**0**	**0**	**3**	**3**	**25**	**50**	**25**	**--**	**--**	**100**

COURSE OBJECTIVES

- To identify the hierarchy of formal languages, grammars and machines.
- To understand equivalence of languages accepted by Push Down Automata and languages generated by context free grammars.
- To design finite automata and to accept a set of strings of a language.
- To design context free grammars to generate strings from a context free language.
- To develop a formal notation for strings, languages and machines.

UNIT 1 REGULAR LANGUAGES AND ITS APPLICATIONS **12 Hrs.**

Alphabets, Language, Operations on Languages. Regular Expression, Regular Languages. Finite State Machine, Deterministic and Non-deterministic Finite State machines, Regular Grammar, Finite State Machine with output - Moore machine and Melay Machine, Conversion of Moore machine to Melay Machine and Vice-Versa. Conversion of DFA to Regular Expression, Pumping Lemma, Properties and Limitations of Finite state machine, Decision properties of Regular Languages, Application of Finite Automata.

UNIT 2 CONTEXT FREE GRAMMAR (CFGs) **10 Hrs.**

Context Free Grammar, Derivation tree and Ambiguity, Application of Context free Grammars, Chomsky and Greibach Normal form, Properties of Context Free Grammar, CKY Algorithm, Decidable properties of Context free Grammar, Pumping Lemma for Context free grammar.

UNIT 3 PUSH DOWN AUTOMATA (PDAs) **10 Hrs.**

Definition of Push down automation, The languages of a PDA, Equivalence of PDAs and CFGs, Stack Machine, Design of Deterministic and Non -deterministic Push-down stack.

UNIT 4 TURING MACHINE **08 Hrs.**

Turing machine, Definition and design of Turing Machine, Church-Turing Thesis, Variations of Turing Machines, Universal Turing Machine, Post Machine, Chomsky Hierarchy, Post correspondence problem.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the equivalence between Context-Free Grammars and Pushdown automata.
CO2 – Explain the theory of finite automata, as the first step towards learning advanced topics, such as compiler design.
CO3 – Design context free grammars to generate strings of context free language.
CO4 – Design finite automata to accept a set of strings of a language.
CO5 – Develop an understanding of computation through Turing Machines.
CO6 – Develop a clear understanding of the Chomsky hierarchy for language classes.

TEXT/REFERENCE BOOKS

1. E. J. Hopcroft, D. J. Ullman and R. Motwani, Introduction to Automata Theory, Languages and Computation, 3rd ed., Pearson Education, 2007.
2. C.J. Martin, Introduction to Languages and the Theory of Computation, 4th ed., McGraw-Hill Higher Education, 2011.
3. R.H. Lewis and H.C. Papadimitriou, Elements of the Theory of Computation, 2nd ed., Prentice Hall, 1998.
4. A. I. D. Cohen, Introduction to Computer Theory, 2nd ed., Wiley, 1997.
5. M. Sipser, Introduction to the Theory of Computation, 3rd ed., Cengage Learning, 2013.

20MA209E					Probability and Statistics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To be able to understand the concept of probability and probability distribution function.
- To be able to obtain the statistical measure of various real-world problem.
- To be able to analyze the probability distribution in view of various problems of engineering.
- To be able study various central tendency, curve fitting and correlation.

Prerequisite – Basics of Probability, Conditional Probability, Total Probability, Baye's Theorem.

UNIT 1 RANDOM VARIABLES 10 Hrs.

Random variables. Discrete random variable, Continuous random variable, Expectation, Variance, Moment generating function.

UNIT 2 DISTRIBUTION FUNCTIONS 10 Hrs.

Discrete probability distribution functions, Binomial distribution, Negative binomial distribution, Poisson distribution, Continuous probability density function, Normal distribution.

UNIT 3 CURVE FITTING AND REGRESSION 10 Hrs.

Measure of central tendency, Curve fitting, Correlation, simple correlation, partial correlation, regression analysis.

UNIT 4 BASICS Of R PROGRAMMING 10 Hrs.

Introduction, Operators: Arithmetic, logical and relational, Control structures: loops and if-else statements, Descriptive Statistics, Correlation and Regression.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Identify the use of probability in engineering aspects.
CO2 – Understand the concept of probability and statistics.
CO3 – Develop the ability to apply appropriate probability distribution in context with engineering problems.
CO4 – Analyze the obtained statistical solution in context with theory.
CO5 – Appraise mathematical problems in term of statistics from real to complex domain.
CO6 – Evaluate problems on various central tendency, fitting of curve, and regression and correlation.

TEXT/REFERENCE BOOKS

1. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Cengage Learning, 2012.
2. Ronald E. Walpole, Sharon L. Myers and Keying Ye, Probability & Statistics for Engineers & Scientists, 8th ed., Pearson Education, 2006.
3. Sheldon M. Ross, "Introduction to Probability Models" Academic Press, 10th edition, 2019.
4. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, Academic Press, 4th edition, 2014.
5. S.C. Gupta & V.K. Kapoor, "Fundamentals of Mathematical Statistics" Sultan Chand & Sons, 11th Edition, 2014.

20MA210E					Numerical Methods					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. /Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand and acquaint the concept of various numerical methods.
- To develop numerical skills in solving problem of engineering interest.
- To lay foundation of computational techniques for post graduate/specialized studies and research.
- To make familiar the numerical solution techniques for linear/nonlinear ODEs/PDEs.

UNIT 1 SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS AND INTERPOLATION 10 Hrs.

Iterative methods: Gauss-Jacobi's method, Gauss-Seidel method, Numerical evaluation of largest as well as smallest (numerically) Eigen values and corresponding Eigen vectors.
Introduction to interpolation, Newton Gregory Forward Interpolation Formula, Newton Gregory Backward Interpolation Formula, Central difference interpolation formula, Lagrange's Interpolation Formula for unevenly spaced Formula, Error in interpolation, Newton's Divided Difference Formula, cubic spline interpolation.

UNIT 2 NUMERICAL DIFFERENTIATION AND INTEGRATION 10 Hrs.

Introduction, Formulae for Derivatives, Newton-Cotes' Quadrature Formula, Trapezoidal rule, Simpson's rule, Weddle's rule, Romberg's method, error in integration, Double Integration with constant and variable limits, Gaussian integration.

UNIT 3 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS AND TRANSCENDENTAL EQUATIONS 10 Hrs.

Runge-Kutta methods of various order, Modified Euler's method, Predictor corrector method: Adam's method, Milne's method, Solution of Boundary value problems using finite differences, Fixed Point Iteration Method, Newton's Method.

UNIT 4 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATION 10 Hrs.

Finite difference approximation of partial derivatives, Classification of 2nd order PDEs, different type of boundary conditions, solutions of Elliptic, parabolic and hyperbolic equations of one and two dimensions, Crank- Nicholson method, ADI method.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Apply a suitable numerical technique to extract approximate solution to the problem whose solution cannot be obtained by routine methods.
CO2 – Analyze the accuracy of numerical methods by estimating error.
CO3 – Analyze / interpret the achieved numerical solution of problems by reproducing it in graphical or tabular form.
CO4 – Evaluate a polynomial on which operations like division, differentiation and integration can be done smoothly from the data generated by performing an experiment or by an empirical formula with.
CO5 – Evaluate a sufficiently accurate solution of various physical models of science as well as engineering interest whose governing equations can be approximated by nonlinear ODEs or PDEs or system of ODEs or PDEs.
CO6 – Design / create an appropriate numerical algorithm for various problems of science and engineering.

TEXT/REFERENCE BOOKS

1. B.S. Grewal, Numerical Methods in Engineering and Science with Programs in C & C++, Khanna Publishers, 2010.
2. S.S. Sastry, Introductory Methods for Numerical Analysis,4th ed., Prentice Hall of India, 2009.
3. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, 2007.
4. C. F. Gerald and P. O. Wheatley, Applied Numerical analysis, 7th ed., Pearson education, 2003.
5. Erwin Kreyszig, Advanced Engineering Mathematics, 9th ed., Wiley publication, 2005
6. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd ed., Narosa, 2002.

20MA301E					Applied Statistics					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. / Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

- ➢ To be able to evaluate problems related to probability and distribution.
- ➢ To be able to obtain the central measure of various data related to real world problem.
- ➢ To be able to Understanding of data collection, its distribution and testing.
- ➢ To be able to analyze the data related to various field of science and engineering.

Prerequisite – Course on Probability and Statistics **10 Hrs.**

UNIT 1 PROBABILITY AND DISTRIBUTION

Sample Space and Events; Axioms, Interpretations and Properties of Probability; Expectation; conditional Probability; Total probability, Bayes' Rule, Random variables; Measures of central tendency and dispersion. Joint distributions and their Mean, Variance and Covariance. Discrete Distributions – Binomial, Poisson Hypergeometric; Continuous Distribution – Normal, t, Exponential, χ^2 and F distributions.

UNIT 2 PARAMETER ESTIMATION **08 Hrs.**

The central limit theorem. General concepts of estimation, point estimation. Interval estimation, sampling distributions and the concept of standard error, confidence levels, confidence intervals based on a single sample and two samples. Concepts of maximum likelihood estimators.

UNIT 3 SAMPLING DISTRIBUTION **12 Hrs.**

Hypothesis testing: Introduction, Type I and Type II errors, tests concerning the mean and variance based on a single sample and two samples. Use of p-values. Analysis of Variance and the F-test. One way and Two way Models. Covariance and correlation, hypothesis tests for the correlation coefficient. Contingency tables, two-way tables.

UNIT 4 ANALYSIS OF VARIANCE **10 Hrs.**

Simple linear regression, estimating model parameters – the method of least squares; inferences about slope parameters, coefficient of determination, predicting Y values, prediction intervals. Introduction to multiple regression and its assumptions, estimating parameters, hypothesis testing for coefficients, ANOVA in regression. Data analysis using computer software.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Identify the use of probability in engineering aspects.
CO2 – Understand the concept of probability distribution and hypothesis test.
CO3 – Develop the ability to apply appropriate tool/method to extract the solutions of engineering problems.
CO4 – Analyze the obtained solution of data analysis in context with theory.
CO5 – Appraise mathematical/statistical problems from real to complex domain.
CO6 – Evaluate problems on analysis of variance.

TEXT/REFERENCE BOOKS

1. Jay L. Devore, Probability and Statistics for Engineering and the Sciences, Cengage Learning, 2012.
2. Ronald E. Walpole, Sharon L. Myers and Keying Ye, Probability & Statistics for Engineers & Scientists, 8th ed., Pearson Education, 2006.
3. Sheldon M. Ross, "Introduction to Probability Models", 10th ed., Academic Press, 2019.
4. Sheldon M. Ross, Introduction to Probability and Statistics for Engineers and Scientists, 4th ed., Academic Press, 2014.
5. S.C. Gupta & V.K. Kapoor, "Fundamentals of Mathematical Statistics" 11th ed., Sultan Chand & Sons, 2014.

<table>
<tr><th colspan="5">20MA302E</th><th colspan="6">Optimization for Engineers</th></tr>
<tr><th colspan="5">Teaching Scheme</th><th colspan="6">Examination Scheme</th></tr>
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COURSE OBJECTIVES

- To understand the concept of optimization
- To make students acquaint with basic terminology of mathematical model as design vectors, objective functions, constraints and bounds.
- To understand formulation and various methods available for solving linear programming problem.
- To understand formulation and various methods available for solving non- linear programming problem.
- To introduce stochastic approach of optimization

UNIT 1 INTRODUCTION TO OPTIMIZATION — 09 Hrs.

Origin and development of optimization methods, Mathematical models, Characteristics and limitations of mathematical model, design vectors (decision variable), objective functions, types of constraints and boundary conditions, mathematical formulation of engineering problems.

UNIT 2 LINEAR PROGRAMMING (CONSTRAINED) — 12 Hrs.

Structure of Linear Programming Problem, feasible solution and optimal solution, solution of LPP by graphical method, solution of LPP by simplex method and Big M- method, types of solutions and their interpretations.

UNIT 3 NON-LINEAR PROGRAMMING — 09 Hrs.

Unconstrained optimization for single and multivariable functions, (conventional and search algorithms), Constrained multivariable optimization with equality constraints – Lagrange multiplier method, Constrained multivariable optimization with inequality constraints – Kuhn Tucker necessary and sufficient conditions.

UNIT 4 STOCHASTIC PROGRAMMING — 10 Hrs.

Introduction to stochastic programming, basic concepts of probability: random variable, probability mass function and density function, stochastic linear programming, stochastic non – linear programming.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand importance and physical interpretation of decision variables, objective functions, bounds and constraints.
CO2 – Apply simplex algorithm to solve a wide range of linear programming problems.
CO3 – Apply concepts of probability distribution to solve stochastic linear programming problem.
CO4 – Differentiate different approaches available to solve a non – linear Programming Problem.
CO5 – Formulate mathematical structure of linear and non – linear problems from various engineering problems.
CO6 – Produce optimal solutions for stochastic non – linear programming with appropriate interpretations.

TEXT / REFERENCE BOOKS

1. H. A. Taha, Operations research: an introduction, , 8th ed., PHI Publications, New Delhi, 2006.
2. F. S. Hiller and G. J. Liberman, Introduction to operations research, 9th ed., McGraw-Hills Publication, 2012
3. Singiresu S. Rao, Engineering Optimization: Theory and Practices, 4th ed., WILEY, 2009
4. K. V. Mittal and C. Mohan, Optimization methods in Operations Research and System Analysis, 5th ed., New Age International Publications,1996

20MA303T					Numerical Methods (SPT)					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs. /Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	1	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

- To understand and acquaint the concept of various numerical methods.
- To develop numerical skills in solving problem of engineering interest.
- To lay foundation of computational techniques for post graduate/specialized studies and research.
- To make familiar the numerical solution techniques for linear/nonlinear ODEs/PDEs.

UNIT 1 SOLUTION OF SIMULTANEOUS LINEAR EQUATIONS AND INTERPOLATION **10 Hrs.**

Iterative methods: Gauss-Jacobi's method, Gauss-Seidel method, Numerical evaluation of largest as well as smallest (numerically) Eigen values and corresponding Eigen vectors.
Introduction to interpolation, Newton Gregory Forward Interpolation Formula, Newton Gregory Backward Interpolation Formula, Central difference interpolation formula, Lagrange's Interpolation Formula for unevenly spaced Formula, Error in interpolation, Newton's Divided Difference Formula, cubic spline interpolation.

UNIT 2 NUMERICAL DIFFERENTIATION AND INTEGRATION **10 Hrs.**

Numerical Differentiation: Introduction, Formulae for Derivatives.Numerical Integration: Introduction, Newton-Cotes's Quadrature Formula, Trapezoidal rule, Simpson'sone-third rule, Simpson's Three-Eighth rule, Weddle's rule, Romberg's method, Double Integration.

UNIT 3 NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS AND TRANSCENDENTAL EQUATIONS **10 Hrs.**

Runge-Kutta methods of various order, Modified Euler's method, Predictor corrector method: Adam's method, Milne's method, Solution of Boundary value problems using finite differences, Fixed Point Iteration Method, Newton's Method.
Introduction, Descarte's Sign rule, Bisection Method, Method of false position, Secant method, Iteration method, Extended method of iteration, Newton-Raphson method, It's applications, Solution of nonlinear simultaneous equations, Newton-Raphson method for multiple roots.

UNIT 4 NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATION AND FINITE LELEMNTS METHODS **10 Hrs.**

Finite difference approximation of partial derivatives, Classification of 2nd order PDEs, different type of boundary conditions, solutions of Elliptic, parabolic and hyperbolic equations of one and two dimensions, Crank- Nicholson method, ADI method. Introduction to Finite Elements Methods: Introduction to Finite Element Methods, Functionals, Base Functions. Methods of Approximation: The Rayleigh-Ritz Method, The Galerkin Method. The FEM for one dimensional Problems and applications to two dimensional problems.

40 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to
CO1 – Apply a suitable numerical technique to extract approximate solution to the problem whose solution cannot be obtained by routine methods.
CO2 – Analyze the accuracy of numerical methods by estimating error.
CO3 – Analyze / interpret the achieved numerical solution of problems by reproducing it in graphical or tabular form.
CO4 – Evaluate a polynomial on which operations like division, differentiation and integration can be done smoothly from the data generated by performing an experiment or by an empirical formula with.
CO5 – Evaluate a sufficiently accurate solution of various physical models of science as well as engineering interest whose governing equations can be approximated by nonlinear ODEs or PDEs or system of ODEs or PDEs.
CO6 – Design / create an appropriate numerical algorithm for various problems of science and engineering.

TEXT/REFERENCE BOOKS

1. B.S. Grewal, Numerical Methods in Engineering and Science with Programs in C & C++, Khanna Publishers, 2010.
2. S.S. Sastry, Introductory Methods for Numerical Analysis, 4th ed., Prentice Hall of India, 2009.
3. M.K. Jain, S.R.K. Iyengar, R.K. Jain, Numerical Methods for Scientific and Engineering Computation, New Age International, 2007.
4. Erwin Kreyszig, Advanced Engineering Mathematics, 9th ed., Wiley publication, 2005
5. R.K. Jain & S.R.K. Iyengar, Advanced Engineering Mathematics, 3rd ed., Narosa, 2002.

20MA303P					Numerical Methods (Practical)					
Teaching Scheme					**Examination Scheme**					
L	**T**	**P**	**C**	**Hrs. / Week**	**Theory**			**Practical**		**Total**
					MS	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
0	**0**	**2**	**1**	**2**	**---**	**---**	**---**	**50**	**50**	**100**

Computer program (in MATLAB) of following topics/methods will be discussed and executed in the lab.

1. Evaluation of largest as well as smallest (numerically) Eigen values and corresponding Eigen vectors.
2. Curve fitting,
3. Newton Gregory Forward Interpolation Formula,
4. Newton Gregory Backward Interpolation Formula,
5. Lagrange's Interpolation Formula for unevenly spaced Formula,
6. Newton's Divided Difference Formula, cubic spline interpolation.
7. Graeffe's root squaring method,
8. Euler's method,
9. Runge-Kutta methods,
10. Modified Euler's method,
11. Predictor corrector method: Adam's method, Milne's method.
12. Solution of Boundary value problems using finite differences.
13. Solution of tridiagonal system,
14. Solution of elliptic, parabolic and hyperbolic equations of one and two dimensions,
15. Crank- Nicholson method.