DEPARTMENT OF MATHEMATICS
Punjab Engineering College, Chandigarh
(Deemed to be University)

List and syllabi of OPEN ELECTIVE COURSES in Mathematics (including courses for minor specialization in Mathematics) under the new UG scheme 2020.

Sr.No.	Course Code	Course Name	L	T	P	Credits
1	MA 6001	Operation Research	3	1	0	4
2	MA 6002	Optimization Techniques	3	1	0	4
3	MA 6003	Algebra	3	1	0	4
4	MA 6004	Number Theory	3	1	0	4
5	MA 6005	Fourier Series and Integral Transforms	3	1	0	4
6	MA 6006	Calculus of Variations	3	1	0	4
7	MA 6007	Algebraic Coding Theory	3	1	0	4
8	MA 6008	Topology	3	1	0	4
9	MA6009	Numerical Analysis	3	1	0	4
10	MA 6010	Partial Differential Equations and Special Functions	3	1	0	4
11	MA 6011	Matrix Computations	3	0	2	4
12	MA 102/MA103	Linear Algebra, Vector Calculus And Partial Differential Equations/ Probability And Statistics	3	1	0	4

In addition, a student can opt for the courses MA 102 or MA 103 as open elective if he/she has not studied this course in B. Tech. 2nd semester.

Course Name	**OPERATIONS RESEARCH**
Course Code	**MA 6001**
Credits	**4**
L T P	**3 1 0**

Total No. of Lectures : 42

Course Objectives:

At the end of this course, the students should be able to describe the characteristics and scope of Operations Research, identify and solve linear models of Optimization problems, formulate and solve problems of Transportation Model and Assignment Model, understand and apply the theory of Queuing Models in solving problems.

	Lecture wise breakup	No. of Lectures
1	Definition of Operations Research, Characteristics of Operations Research, Scope of Operations Research	2
2	Formulation of Linear Programming problem , Graphical Solution, Simplex Method, Unrestricted variables, Artificial variables, M-Method, Dual Phase method	16
3	Introduction to the Transportation model, Assumption in the Transportation Model, Definition of the Transportation Model, Matrix terminology, Formulation and solution of Transportation Model. Assignment Model.	8
4	Queuing Model, Introduction, Application of Queuing Model, Elements of Queuing System, Operating characteristics of Queuing System, Waiting time and idle time costs.	8
5	Non – Linear Programming, Introduction, Local and Global optimum, necessary and sufficient conditions, Direct search methods- Golden Section and Dichotomous methods, gradient methods.	8

Course Outcomes:

By the end of this course, the students will be able to :

1) describe the characteristics and scope of Operations Research
2) identify and solve linear models of Optimization problems
3) Solve simple problems of The Transportation Model and Assignment Model
4) Solve simple problems of Queuing Models
5) Solve Non – Linear Programming problems

Suggested Books:		
Sr.No.	Name of Book / Authors / Publishers	**Year of Publication/ Edition**
1	“Operations Research”, Taha, H.A, 10th edition, Pearson.	2017
2	“Operations Research”, Ravindran, Phillips, and Solberg, 2nd edition, John Wiley & sons.	2000
3	“Engineering Optimization”, S S Rao, 4nd edition, New Age.	2009
4	“Operations Research”, Kantiswarup, Gupta P.K. & Sultan Chand & Sons.	2007
5	“Operations Research”, Sharma S.D., Kedarnath, Ramnath & Company.	1994
6	“Operations Research”, Bronson R, Shaum’s Outline Series.	1997

CourseName	**OPTIMIZATION TECHNIQUES**
Course Code	**MA 6002**
Credits	**4**
L T P	**3-1-0**

Total No. of Lectures – 42

Course Objectives:

At the end of this course, the student should be able to formulate mathematical model of optimization problems, identify and solve linear models of optimization problems, apply classical methods to solve nonlinear models for optimization problems, apply gradient based and direct iterative methods to solve nonlinear problems.

Lecture wise breakup		**No. of Lectures**
1	**Linear programming:** Formulation, Graphical solution, Simplex method , Relation between Graphical and Simplex method, Unrestricted variables, Artificial variables, M-Method and Dual Phase method	**(16)**
2	**Optimization Techniques:** **Unconstrained problems -** (Single and multivariable optimization) Necessary and sufficient conditions for extreme points. **Constrained problems - (**multivariable optimization) Equality constraints - Jacobian and Lagrangean methods, Application of Jacobian method to linear problems. Inequality constraints – extension of Lagrangean method, Karush Kuhn tucker Conditions.	**(12)**
3	**Non Linear programming:** **Unconstrained Algorithms –** Direct search methods, Dichotomous and Golden search; Univariate and Hooke and Jeeves search methods; Gradient methods, Cauchy's steepest ascent method and Newton's method. **Constrained Algorithms:** Separable Programming, Quadratic Programming, Geometric Programming	**(14)**

Course Outcomes:

By the end of this course, the student will be able to:
1. Form mathematical model of optimization problems
2. Solve Linear Programming Problems
3. Solve simple Optimization problems using classical / iterative methods.

Suggested Books:		
Sr.No.	Name of Book / Authors / Publishers	**Year of Publication/ Edition**
1	"Operations Research", Hamady Taha, 10th edition, Pearson	2017
2	"Operations Research", Ravindran, Phillips, and Solberg, John Wiley & sons.	2000
3	"Engineering Optimization" , S S Rao, New Age	2000
4	"Operations Research", Kantiswarup, Gupta P.K. & Sultan Chand & Sons.	2007

Course Name	**:**	**ALGEBRA**
Course Code	**:**	**MA 6003**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Total No. of Lectures – 42

Course Objectives:
At the end of this course, the students should be able to understand the concept of a group and give examples of groups. They should know the basic concepts of group theory and be able to apply these concepts. They should be able to understand the concepts of a vector space, a linear transformation of vector spaces. They should be able to apply the theory to solve problems.

Lecture wise breakup		**No. of Lectures**
1	Definition of a group, examples, some preliminary lemmas, Subgroups, Examples, Cosets, Order of a group, Lagrange's Theorem,Euler's Theorem, A counting principle.	10
2	Normal subgroups and quotient groups, Homomorphism, Cauchy's Theorem, Sylows Theorem for Abelian groups, Automorphisms, Cayley's Theorem, Permutation groups, Conjugacy classes, Class Equation.	16
3	Vector Spaces: Vector spaces $R^n(R)$, Linear dependence, Basis, Dimension, Co- ordinates with respect to a basis, Change of basis, Subspace., Linear transformation $R^n \to R^m$, Range space and Rank, Null space and Nullity, Rank and Nullity relation, Matrix representation of a linear transformation, Similar matrices, Invertible linear transformation. Inner product, Norm, Gram-Schmidt orthogonalization process.	16

Course Outcomes:

By the end of the course, the students will be able to

1. Understand the concept of a group and give examples of groups.
2. Know the basic concepts of group theory and be able to apply these concepts.
3. Understand the concepts of a vector space, linear transformation of vector spaces.
4. Understand and apply the theory of vector spaces to solve problems.

Suggested Books:

Sr.No.	Name of Book / Authors / Publishers	**Year of Publication/ Edition**
1	"Topics in Algebra", Herstein, I.N.2nd edition, Wiley Eastern Limited, New Delhi.	1981
2	"Modern Algebra", Singh, S and Zameeruddin, Q ,Vikas Publishing House, New Delhi	2015
3	"Rings and Modules", Musili, C, Narosa Publishing House, (2nd Edition),New Delhi.	1997
4	Introduction to Linear Algebra with Applications, Kolman and Hill, Pearson Education	2003

Course Name	**:**	**NUMBER THEORY**
Course Code	**:**	**MA 6004**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Total No. of Lectures – 42

Course Objectives:
At the end of this course, the students should be able to describe the fundamental properties of integers. They should be able to solve congruences by using the various concepts of number theory. They should be able to solve Diophantine equations

Lecture wise breakup		**No. of Lectures**
1	Introduction, Divisibility, Greatest common divisor, The Euclidean algorithm, primes, Fundamental theorem of Arithmetic,	8
2	Congruences, Residue classes and reduced residue classes, Fermat's theorem, Euler's theorem, Wilson Theorem, Solution of congruences , congruences of degree1, Chinese Remainder theorem with applications. Euler's φ-function,	12
3	Congruences of higher degree, prime power modulii, prime modulus, Primitive roots, Indices and their applications, power residues, Quadratic residues, Quadratic reciprocity, Legendre Symbol, Euler's criterion, Gauss's Lemma, Quadratic reciprocity law, Jacobi symbol,	12
4	Greatest integer function, Arithmetic function, Mobius inversion formula, Diophantine equations	10

Course Outcomes:
By the end of the course, the students will be able to 1. Describe the fundamental properties of integers. 2. Solve congruences by using the various concepts of number theory. 3. Solve Diophantine equations

Suggested Books:		
Sr.No.	Name of Book / Authors / Publishers	**Year of Publication/ Edition**
1	"An introduction to theory of numbers", Niven I., Zuckerman S. H. and Montgomary L. H. 5th edition, John Wiley and Sons .	1991
2	"Introduction to Theory of Numbers", Hardy and Wright W. H.Oxford University Press	2008
3	"Higher arithmetic", Davenport H.8th edition,Cambridge University Press .	2008
4	"Elementary Number Theory", David M. Burton, McGraw-Hill Higher Education	2010

Course Name	**:**	**FOURIER SERIES AND INTEGRAL TRANSFORMS**
Course Code	**:**	**MA 6005**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Total No. of Lectures – 42

Course Objectives:

1	At the end of this course, the students should be able to expand functions in Fourier series, Fourier Integrals and learn Fourier sine and cosine Transforms, Harmonic analysis and their applications.
2	The students should be able to evaluate Laplace transforms and Inverse Laplace transform.
3	The students should be able to apply Laplace transforms to solve ordinary differential and integral equations.

Lecture wise breakup		**No. of Lectures**
1	Periodic functions, Trigonometric series, Fourier Series, Euler's formulae, Conditions for existence of Fourier series, Functions of any period p = 2L, Even and odd functions, Half range expansions, Complex Fourier series, Applications of Fourier series, Parseval's identity, Harmonic analysis. Approximation by Trigonometric Polynomials	**(12)**
2	Fourier Integral, Fourier Sine and Cosine Integrals , Evaluation of Integrals, Fourier Transforms, Fourier Cosine and Sine Transforms, Properties of Fourier Transform, Linearity and Symmetry, change of Time Scale, Time Shifting , Frequency Shifting , Fourier Transform of derivatives and integrals, convolution , Properties of Fourier cosine and sine Transforms, Parseval Identity for Fourier Transform , Finite Fourier Cosine and Sine Transform	**(18)**
3	Laplace transform, Inverse transform, Properties of Laplace transform, Transforms of derivatives and integrals, s-Shifting, t-Shifting, Unit step function, Dirac's delta function, Differentiation and integration of transforms, Convolution Theorem Applications to differential and Integral equations.	**(12)**

Course Outcomes:

1	By the end of this course the students will be able to expand a function in terms of its Fourier Series, Fourier Integrals, Fourier Transforms and apply harmonic analysis to numerical data.
2	The students will be able to evaluate Laplace transforms and inverse Laplace transforms.
3	The students will be able to use Laplace transform to solve differential and Integral equations arising in engineering problems.

Suggested Books:		
Sr. No.	Name of Book / Authors / Publishers	**Year of Publication/ Edition**
1	“Higher Engineering Mathematics“, B V Ramana, Tata McGraw -Hill	2008
2	“Advanced Engineering Mathematics”, E. Kreyszig, 10^{th} edition, John Wiley.	2010
3	“Advanced Engineering Mathematics”, Wylie and Barrett, McGraw Hill.	2003

Course Name	**:**	**CALCULUS OF VARIATIONS**
Course Code	**:**	**MA 6006**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Total No. of Lectures- 42

Course Objectives: At the end of the course the students should be able to understand the concepts of functional, extremum and a variational problem. They should be able to learn the concepts of transversality conditions and canonical transformation. They should be able to learn the concept and formulae for the second variation of a functional. They should be able to apply direct methods in calculus of variations Euler's finite difference methods, use Rayleigh Ritz method and Sturm-Liouville to solve differential equations.

	Lecture wise breakup	**No. of Lectures**
1	Variation of a functional. A necessary condition for an extremum, Euler's equation. Some classical problems. Fixed end point problems for unknown functions. Variational problems with subsidiary conditions.	**(12)**
2	General variation of a functional. Variable end point problems, transversality conditions. Transversal theorem. Weirstress-Erdmann corner condition. Canonical form of Euler equations and their first integrals. Canonical transformations. Noether's theorem. Hamilton-Jacobi equations. Jacobi's theorem.	**(12)**
3	The second variation of a functional and the formula for second variation. Legendre's necessary condition. Jacobi's necessary condition. Conjugate points, Sufficient condition for a weak extremum. General definition of a field and field of a functional. Hilberts invariant integral. Weierstrass E-functional. Sufficient conditions for a strong minimum.	**(12)**
4	Direct methods in calculus of variations, Euler's finite difference method and the Rayleigh Ritz method. Applications to sturm-Liouville problem.	**(6)**

Course Outcomes:

At the end of the course the students will be able to

1	Understand the concept of functional, extremum and a variational problem.
2	Learn the concepts of transversality conditions and canonical transformation.
3	Learn the concept and formulae for the second variation of a functional.
4	They will be able to apply direct methods in calculus of variations, Euler's finite difference methods, Rayleigh Ritz method and Sturm-Liouville Theorem.

Suggested Books:		
Sr.No.	Name of Book / Authors / Publishers	**Year of Publication/ Edition**
1	"Calculus of variations", I M. Gelfand and S. V. Fomin	2000
2	"Calculus of variations", L.E. Elsgolc.	2007

Course Name	**:**	**ALGEBRAIC CODING THEORY**
Course Code	**:**	**MA 6007**
Credits	**:**	**4**
L T P	**:**	**3-1-0**

Total No. of Lectures – 42

Course Objectives:

At the end of this course, the students should be able to translate fundamental problems of coding theory into mathematical problems and then solve them by using the theory of finite fields, polynomial rings and finite groups. They should be able to understand and apply the theory of linear codes. They should be able to understand and apply the theory of Cyclic codes.

Lecture wise breakup		**No. of Lectures**
1	INTRODUCTION TO CODING THEORY Source and Channel coding, Error detecting and error correcting codes	2
2	ERROR DETECTION, ERROR CORRECTION AND DECODING Communication Channels, Maximum likelihood decoding, Hamming distance, Nearest neighbour/ minimum distance decoding, Distance of a code	6
3	FINITE FIELDS Fields, Polynomial rings, Structure of finite fields, Minimal polynomials	10
	LINEAR CODES Vector spaces over finite fields, Linear Codes, Hamming weight, Bases for linear codes Generator matrix and parity check matrix, Equivalence of linear codes, Encoding with a linear code, Decoding of linear codes, Cosets, Nearest neighbor decoding for linear codes, Syndrome Decoding, Weight Enumerator of a Code, Macwilliam's Identity,	16
5	CYCLIC CODES Definition, Generator polynomials, Generator matrix and parity check matrix, Decoding of linear codes.	8

Course Outcomes:

By the end of the course, the students will be able to

1. Translate fundamental problems of coding theory into mathematical problems and then solve them by using the theory of finite fields, polynomial rings and finite groups.
2. Understand and apply the theory of linear codes.
3. Understand and apply the theory of cyclic codes.

Suggested Books:

Sr.No.	Name of Book / Authors / Publishers	**Year of Publication/ Edition**
1	"Coding Theory", San Ling & Chaoping Xing , Cambridge University Press	2010
2	"Introduction to the 'Theory of Error Correcting Codes", Vera Pless, Cambridge University Press	2003
3	"Introduction to Error Correcting Codes", Raymond Hill, Clarendon Press, Oxford	1986
4	"Theory of Error Correcting Codes Part I & II", F.J.Macwilliams & NJA Sloane	1977

Course Name	**:**	**TOPOLOGY**
Course Code	**:**	**MA 6008**
Credits	**:**	**4**
L T P	**:**	**3:1:0**

Course Objectives:
At the end of this course, the students should be able to understand the concept of a metric space and give examples of metric space. They should know the basic concepts of topological space and be able to apply these concepts. They should be able to apply the theory to solve problems and understand the application of these concepts .

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
1.	**Introduction To Metric Space**: Metric spaces: definition and examples, balls and bounded sets, sequences in metric spaces, convergent and Cauchy sequences, open sets, closed sets, limit points, Complete Metric Spaces, totally bounded sets. Compact sets, Heine Borel theorem, sequential compactness, finite intersection property, continuity and compactness, uniform continuity, Dense sets, separable sets.	14
2.	**Introduction To Topological Concepts**: Topological spaces, basis, subbasis, open sets,closed sets, limit point, closure of a set and its properties Neighbourhood of a point, Neighbourhood axioms, Separation axioms, T_1,T_2, regular , normal ,completely regular, Compactness, countable compactness, Lindelof spaces, Sequences, nets , compactness in terms of sequences, nets. Connectedness, connected components, continuity and connectedness, path connectedness Continuous maps, closed maps and their characterizations, homeomorphisms, Continuity, closedness and openness of maps in terms of sequences and nets. Semi-open sets, semi-closed sets, semi-closure, Semi interior, Semi continuity in terms of semi_open and semi closed sets	28

Course Outcomes: By the end of the course, the students will be able to

1. The students should be able to understand the concept of a metric space and give examples of metric space.
2. the basic concepts of topological space and be able to apply these concepts.
3. able to apply the theory to solve problems and
4. able to understand the application of these concepts .

Text Books:		
S.No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1.	General Topology, S.Willard, Dover publications.	2012
2	Foundations of General Topology, William J. Pervin and Ralph P. Boas (Auth.), Elsevier Inc	1964

Reference Books:		
S.No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/Reprint**
1.	General Topology,J.L.Kelly, Springer	1975
2.	Counter Examples in Topology,L.A.Steen & J.A. Seebach, (2^{nd} ed.) Dover Publications	1995
3	Topology For Analysis,A.Wilansky:Toronto:Xerox College Publishing.	1970

Course Name	**:**	**NUMERICAL ANALYSIS**
Course Code	**:**	**MA 6009**
Credits	**:**	**4**
L T P	**:**	**3:0:2**

Course Objectives:
At the end of this course, the students should be able to describe errors involved in computations and to estimate these errors. The students should be able to solve equations, apply numerical methods to interpolate, extrapolate, differentiate and integrate functions. They should be able to solve differential equation using numerical methods and solve systems of equations.

No. of Lectures: 42
No. of Lab Hours: 28

Lecture wise breakup		**No. of Lectures**
1.	**ERRORS** Errors in numerical calculations, Absolute, relative and percentage errors, Round off and truncation errors, Error propagation, Loss of significant digits, Errors in series approximation, Speed of convergence.	5
2.	**SOLUTION OF EQUATIONS** Bisection method, Fixed point iteration and its convergence, Acceleration of convergence using Aitken's method; Regula-Falsi, Newton-Raphson, Generalized Newton's, Chebyshev's and Halley's methods.	7
3.	**INTERPOLATION** Lagrange Interpolation, Newton's divided difference interpolation, Finite differences, Newton's, Bessel's, Stirling's and Guass' difference formulae.	10
4.	**NUMERICAL DIFFERENTIATION & INTEGRATION** Differentiation using differences, Integration using Newton-cote's formulas with errors, Gaussian Quadrature.	8
5.	**SOLUTION OF LINEAR SYSTEM OF EQUATIONS** Direct methods - Gauss elimination, Partial pivoting, Complete pivoting, Gauss-Jordan and factorization methods, Iterative methods-Gauss Siedal and Jacobi's methods.	6
6.	**NUMERICAL METHODS FOR DIFFERENTIAL EQUATIONS** Solution of first order differential equations using Taylor's series, Euler's, Picard's and Runge-Kutta method upto 4^{th} order, Predictor-Corrector methods (Adam's and Milne's method),	6

Lab Work:

Lab Contents	No. of Hours
Implement all the numerical methods developed in theory lectures in MATLAB/Mathematica.	28

Course Outcomes:
1. Describe errors involved in computations and to estimate the errors. 2. Solve algebraic and transcendental equations. 3. Apply numerical methods to interpolate, extrapolate differentiate and integrate functions. 4. Solve systems of linear equations. 5. Solve differential equation using numerical methods. 6. Implement all the numerical methods in MATLAB/Mathematica.

Text Books:

S.No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1.	Numerical Methods for Mathematics, Science and Engineering, John H. Mathews, Prentice Hall.	1992
2.	Numerical Methods for Engineers, Steven C. Chapra, Raymond P. Canale, McGraw-Hill.	2014

Reference Books:

S.No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1.	Advanced Engineering Mathematics, E. Kreyszig, John Wiley.	2006
2.	An Introduction to Numerical Analysis, Atkinson, John Wiley.	2012

Course Name	**:**	**PARTIAL DIFFERENTIAL EQUATIONS AND SPECIAL FUNCTIONS**
Course Code	**:**	**MA 6010**
Credits	**:**	**4**
L T P	**:**	**3:1:0**

Total No. of Lectures – 42

Lecture wise breakup		**No. of Lectures**
1.	**PARTIAL DIFFERENTIAL EQUATIONS** Formation and solution of first order partial differential equations, Linear equations of higher order with constant coefficients, Applications to Engineering problems.	17
2.	**SPECIAL FUNCTIONS** Series solution of differential equations, Power series methods, Series solution of Legendre's differential equation Legendre's polynomial, generating functions, Recurrence relations, Frobenius method, Series solution of Bessel's differential equation, Bessel's functions, Modified Bessel's functions, generating functions, Recurrence relations, Equations reducible to Bessel's equation, Sturm Liouville's problem, Eigen function expansions.	25

Course Outcomes: By the end of the course, the students will be able to
1. Formulate and solve linear and nonlinear partial differential equations
2. Apply partial differential equations to engineering problems.
3. Solve differential equations using series solutions.
4. Describe special functions as solutions to differential equations.
5. Expand functions in terms of eigenfunctions and to solve Sturm Liouville's problems.

Text Books:

S.No.	**Name of Book/ Authors/ Publisher**	**Year of Publication**
1.	Advanced Engineering Mathematics, E. Kreyszig, John Wiley.	2006
2.	Elements of Partial differential equations, Sneddon, McGraw Hill.	2006

Reference Books:

S.No.	**Name of Book/ Authors/ Publisher**	**Year of Publication/Reprint**
1.	Higher Engineering Mathematics, B. V. Ramana, McGraw Hill.	2008
2.	Advanced Engineering Mathematics, Wylie and Barrett, McGraw	2003

	Hill.	

Course Name	**MATRIX COMPUTATIONS**
Course Code	**MA 6011**
Credits	**04**
L T P	**3:0:2**

Total No. of Lectures: 42
Total No. of Lab hours: 28

Course Objectives:

The main objectives of this course are:

1. To provide in-depth knowledge about matrix computations that is very useful in applications of science and engineering.
2. To apply direct and iterative methods to solve the general and special linear systems of equations.
3. To explain the effects of errors in computation and how such errors affect solutions?
4. To develop tools and study methods to solve the least squares problem and the eigenvalue problem.

Course Content:

S. No.	Course Contents	No. of Lectures
1.	**Direct solution of linear systems**: Gaussian elimination, LU decomposition, the condition of LU decomposability, Gaussian elimination with pivoting. **Sensitivity and round-off errors:** Vector norms, matrix norms, condition number, perturbation, residual, round-off errors, backward stability, error propagation and round-off errors in Gaussian elimination, accuracy of solution of linear systems.	10
2.	**Special linear systems:** Positive definite systems, symmetric positive definite systems, Cholesky factorization. Banded systems, tridiagonal systems. A brief discussion on toeplitz matrices.	6
3.	**Orthogonalization and least squares:** Orthogonal triangularization, Householder reflection, Givens rotation, the QR factorization, full rank least squares problem. Gram-Schmidt process.	8
4.	**Singular value decomposition:** Introduction**,** basic applications of singular values, the SVD and least squares problem, sensitivity of least squares problem.	4
5.	**Eigenvalues and eigenvectors**: Power methods, similarity transforms, Hessenberg and real Schur forms. Sensitivity of eigenvalues and eigenvectors, the QR algorithm, computing singular values and vectors. A brief discussion on Sparse systems.	10
6.	**Iterative methods for linear systems:** Classical iterative methods: Jacobi's, Gauss-Seidel, Successive Over-relaxation methods, block iterative methods, convergence of iterative methods.	4

Lab Work:

Lab Contents	**No. of Hours**
1. Introduction to MATLAB: Array operations, loop and execution control, MATLAB files: scripts and functions, plotting and output, symbolic computation, interactive computation, importing and exporting data. 2. Implement all the methods developed in theory lectures in MATLAB.	28

Course Outcomes:

Upon successful completion, students will have the knowledge and skills to:
1. Find the solution of general and special linear systems using direct and iterative methods. 2. Explain the affect of perturbations on the sensitivity of solution of linear system and the effect of roundoff errors on the accuracy of the computed solution. 3. Solve the least squares problems and the eigenvalue problems.

Text Books

S. No.	**Name of Book/Author/Publishers**	**Year of Publication**
1.	*Matrix Computations,* Gene H. Golub and Charles F. Van Loan, 4th Edition, The Johns Hopkins University Press.	2013
2.	*Fundamentals of Matrix Computations,* David S. Watkins, 3rd Edition, Wiley-Interscience.	2010

Reference Books

S. No.	**Name of Book/Author/Publishers**	**Year of Publication**
1.	*Numerical Linear Algebra,* Lloyd N. Trefethen and David Bau, SIAM Press, Philadelphia, USA.	1997
2.	*Matrix algorithms, Volume 1: Basic Decompositions,* Gilbert W. Stewart, SIAM Press, Philadelphia, USA.	1998
3.	*Linear Algebra and Matrix Computations with MATLAB,* Xue Dingyu, , 1st Edition, De Gruyter STEM, Tsinghua University Press.	2020

Course Name	**:**	**LINEAR ALGEBRA, VECTOR CALCULUS AND PARTIAL DIFFERENTIAL EQUATIONS**
Course Code	**:**	**MA 1201**
Credits	**:**	**4**
L T P	**:**	**3-1-0**
Total No. of Lectures	**:**	**42**

Course Objectives:
At the end of the semester, the students should be able to

1	learn the various concepts associated with real vector spaces and theory of matrices
2	learn the various concepts of vector calculus and their applications to problems.
3	formulate and solve linear and nonlinear partial differential equations and apply to engineering problems.

	Lecture wise breakup	**No. of Lectures**
1	**ALGEBRA** Vector spaces over reals, Linear dependence, Basis, Dimension, Co-ordinates with respect to a basis, Change of basis, Subspace, Linear transformation $R^n \rightarrow R^m$, Range space and Rank, Null space and Nullity, Rank and Nullity relation, Matrix representation of a linear transformation, Similar matrices, Invertible linear transformation, Eigenvalues and eigenvectors, Cayley Hamilton theorem, Diagonalization of a matrix.	16
2	VECTOR CALCULUS Gradient, Divergence and Curl – their physical interpretation, Line, Surface and Volume integrals, Green's theorem in the plane, Stoke's theorem, Divergence theorem, Applications to Science and Engineering.	14
3	**PARTIAL DIFFERENTIAL EQUATIONS** Formation and solution of first order partial differential equations, Linear equations of higher order with constant coefficients, Applications to Engineering problems.	12

Course Outcomes:

At the end of the semester, the students are able to

1	solve the various problems related to real vector spaces and theory of matrices
2	apply various concepts of vector calculus to problems.
3	formulate and solve linear and nonlinear partial differential equations and apply to engineering problems.

Text Books:

1	Introductory Linear Algebra with Applications, Kolman, B. and Hill,D.R., 7th editiom, Pearson Education	2001
2	E. Kreyszig, Advanced Engineering Mathematics, Eighth Edition, John Wiley.	2005

Reference Books:

1	Elements of Partial differential equations, Sneddon, Mc Graw Hill.	1957
2	Advanced Engineering Mathematics, Wylie and Barrett, 6th edition, Mc Graw Hill.	2003

Course Name	**:**	**PROBABILITY AND STATISTICS**
Course Code	**:**	**MA 1301**
Credits	**:**	**4**
L T P	**:**	**3-1-0**
Total No. of Lectures	**:**	**42**

Course Objectives:
At the end of the semester, the students should be able to

1	understand the concepts of random variable and probability distribution.
2	learn the concepts of some theoretical probability distributions .
3	understand the concept of sampling distribution and be able to construct and interpret confidence interval estimates for the mean , proportion , difference of mean and proportion
4	learn to use various tests of hypotheses

	Lecture wise breakup	**No. of Lectures**
1	**RANDOM VARIABLES** Random variables, Discrete, Continuous and Joint Probability distributions, Marginal and Conditional distributions, Independent random variables, Expectation, Variance and Covariance, Means and variances of linear combinations of random variables, Chebyshev's inequality	10
2	**PROBABILITY DISTRIBUTIONS** Binomial, Poisson, Uniform and Normal distributions, Normal and Poisson approximations to Binomial, Moments, Moment generating function.	10

3	**SAMPLING DISTRIBUTIONS** Population, Sample, Sampling distributions, Central limit theorem, Distribution of sample mean, Difference of means, Proportions and difference of proportions, Chi-square distribution, Student's t-distribution.	7
4	**ESTIMATION** Estimation of parameters, Point estimate, Confidence interval for mean, difference of means and proportions.	6
5	**TESTS OF HYPOTHESES** Hypothesis, Test statistic, Critical region, Significance level, Single Sample and Two Samples Tests for mean and proportion.	9

Course Outcomes:

At the end of the semester, the students are able to

1	understand the concepts of random variable and probability distribution.
2	apply the concepts of some theoretical probability distributions .
3	use the concept of sampling distribution and apply tests of significance to practical problems of engineering
4	apply various tests of hypotheses

Text Books:

1	Probability and statistics for Engineers and Scientists, Walpole, Myers, Myers and Ye, 7^{th} edition, Pearson Education	2006

Reference Books:

1	Miller and Freund's: Prabability and Statistics for Engineers, Richard A. Johnson, C.B. Gupta, Pearson Education.	2006
2	John E. Freund's: Mathematical statistics with Application, Miller and Miller, Pearson Education.	2004