Department of Mathematics

Institute of Basic Science, Khandari Campus

Dr Bhimrao Ambedkar University, Agra

Programme, Programme Specific and Course Outcomes

(PO, PSO & CO)

M.Sc. Mathematics

DEPARTMENT OF MATHEMATICS, INSTITUTE OF BASIC SCIENCE, KHANDARI.
DR BHIMRAO AMBEDKAR UNIVERSITY, AGRA

M.Sc. Mathematics,
Program Outcomes (POs)

PO-1	**Science knowledge**	Apply mathematics knowledge and mathematics expertise to the solution of challenging scientific issues.
PO-2	**Problem Analysis**	Inspect and understand the theoretical and practical data at various workplaces.
PO-3	**Design/ Development of solutions**	Design a system, component, or process to meet the desired needs within realistic constraints such as, safety, economic, environmental health and sustainability.
PO-4	**Conduct investigations of complex problems**	Develop the capacity to analyse complicated issues and offer workable answers by applying applied research knowledge
PO-5	**Modern tool usage**	Identifying, formulating, and resolving scientific issues with contemporary methods and technologies.
PO 6	**Mathematics and Society**	Obtain the wide education required to comprehend how scientific solutions impact the local, national, international, economic, environmental, and societal contexts.
PO-7	**Environment and Sustainability**	Understand the environmental damage and develop environmentally friendly and sustainable scientific practices using the solutions in the societal and environmental context.
PO-8	**Ethics**	Develop an ethical-moral value system and cater to the community needs in a voluntary manner by the judicious use of scientific principles
PO-9	**Multidisciplinary Approach**	Develop a multidisciplinary approach and function on multidisciplinary teams
PO-10	**Communication**	Develop various communication skills such as listening, speaking, writing, etc. which will help in the effective expression of ideas and views.
PO-11	**Project Management and Finance**	Apply scientific knowledge and management skills to manage projects in industries, research and development institutions, public sector units, higher education and in academia.
PO-12	**Life-long Learning**	Demonstrate effective usage of existing resources at workplaces and raise awareness of the importance of life-long learning

DEPARTMENT OF MATHEMATICS, INSTITUTE OF BASIC SCIENCE, KHANDARI.
DR BHIMRAO AMBEDKAR UNIVERSITY, AGRA

M.Sc. Mathematics Programme Specific Outcomes (PSOs)	
PSO-1	Encourage the students to acquire real awareness to modern mathematics and to develop a strong base in pure mathematics field such as real analysis, Abstract Algebra and Topology.
PSO-2	To encourage students to develop the skill of formulation of real-life problems into Mathematical problems and find solutions using mathematical knowledge
PSO-3	To enhance interest and confidence in mathematics to go after higher education in Mathematics and induce a researcher approach mind then by searching the solution of present-day problems of society and solve them using mathematical techniques and helping society locally and globally by their research work.

CURRICULUM

Course Structure : **M. Sc. (Mathematics)**

I Semester

C-1: Advanced Abstract Algebra (5)

C-2: Ordinary Differential Equations and Partial Differential Equations (5)

C-3: Probability and Statistics (5)

C-4: Computational Numerical Methods (5)

C-5: **Minor (4)**

II Semester

C-6: Real Analysis (4)

C-7: Functional Analysis (4)

C-8: Mathematical Modelling (4)

C-9: Inventory Theory and Queuing Theory (4)

C-10: Practical: ‘C’/ ‘C++’/ Python (4)

Research Project (8)

III Semester

C-11: Topology (4)

C-12: Fuzzy Sets and Fuzzy Logics (4)

C-13: Mathematical Programming (4)

C-14: Elective-I (4)

Discrete Mathematics, Financial Mathematics, Reliability Theory, Coding Theory, Summability Theory.
C-15: Practical: MATLAB/Mathematica (4)

IV Semester

C-16: Complex Variables (5)

C-17: Fluid Dynamics (5)

C-18: Elective-II (5)

Course Outcomes (Cos)

C-1: Advance Abstract Algebra

Subject Code:C-1	Advance Abstract Algebra	L.T.P Model	CREDIT-5

Course outcomes (COs)-After the completion of this course students will be able to

CO1: Learning of the basic concepts of Groups, Subgroups, Normal subgroups, Quotients groups and permutation Groups.

CO2: Classify the group homomorphisms, isomorphisms and counting principle, also the concept of direct product and Sylow's theorems and apply them for describing structures of finite groups.

CO3: Understand the basic concept of polynomial rings, ideals of rings and factorization domains.

CO4: Demonstrate the basic concepts of Fields, Field extensions, Galois Fields and apply the Galois field in solving the solvability of Polynomials by Radicals.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	-	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	-	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	-	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	-	-	3	1	2	3	3

Syllabus

Unit-1: Groups, Subgroups, Cyclic Groups, Permutation Groups, Cayley's Theorem, Lagrange's Theorem, Normal subgroups, Quotient Groups,

Unit-2: Homomorphism, Isomorphism Theorems, Direct Products.

Conjugate elements and Class Equation of Finite groups Cauchy's theorem, Sylow's Theorems,

Unit-3: Polynomial Rings, Quotient Rings, Ideals, Maximal Ideals, Prime ideals, integral domains, Unique Factorization domains, Principal Ideal Domains Euclidean Domains. Fields and Field extensions, Galois Fields, Solvability of Polynomials by Radicals.

Unit-4: Vector Spaces, Subspaces, Linear Transformations, eigen values and eigen vectors, Diagonalisation of matrix. Jordan blocks and Jordan forms.

Suggested Reference Books:

1. John Fraleigh, "A First course in Abstract Algebra", Narosa publishing house New Delhi, (3rd edition).

2. Joseph A.Gallian, " Contempory Abstract Algebra", Narosa Publication 4th Edition, 1999.

3. Bhattachary Jain and nagpal, "Basic Abstract Algebra", New Delhi, Narosa Publication House, 2nd Edition.

4. I.N. Herstein, "Topics in Algebra", Vikas Publishing house.

C-2: Ordinary Differential Equations and Partial Differential Equations

Subject Code:C-1	ODEs and PDEs	L.T.P Model	CREDIT-5

Course outcomes (COs)-After the completion of this course students will be able to

CO1: Understand the basic concepts of existence uniqueness of solutions of IVP for first order ODE and also able to find the singular solution first order ODEs and system of First order ODEs.

CO2: Identifying the basic concepts of homogeneous and non-homogeneous ODEs and study the method of variation of parameters and learn to find the eigen values and eigen functions of Sturm Liouville systems and Green's Function

CO3: Find the solution of the PDEs using Lagrange and Charpit Methods and able to learn the concept of Cauchy problem of first order PDEs and Classification of second order PDEs.

CO4: Analyse the general solution of higher order PDEs with constant coefficients, and able to describe the method of separation of variables, Heat and Wave equations.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	3	1	2	2	1	1	-	-	-	3	2	2	3	3
CO2	2	3	1	1	1	1	1	-	-	-	3	2	3	3	3
CO3	2	3	1	1	2	1	1	-	-	-	3	2	3	3	2
CO4	1	2	1	1	1	1	1	-	-	-	3	1	3	3	3

Syllabus

Unit-1: Ordinary Differential Equations (ODEs): Existence and uniqueness of solutions of initial value problems for first-order ordinary differential equations, singular solutions of first-order ODEs, the system of first order ODEs.

Unit-2: General theory of homogenous and non-homogeneous linear ODEs, variation of parameters, Sturm-Liouville boundary value problem, green's function.

Unit-3: Partial Differential Equations (PDEs): Lagrange and Charpit methods for solving first order PDEs, Cauchy problem for first order PDEs. Classification of second order PDEs,

Unit-4: **General solution of higher order PDEs with constant coefficients**, Method of separation of variables for Laplace, Heat and Wave equations.

Suggested Reference Books:

1)E.A. Coddington, "An introduction to ordinary differential equations", Prentice Hall of IndiaPvt Ltd, New Delhi, 1974.

2) G. Birkoff and G.G. Rota, Ordinary Differential equations, John Willey and Sons.

3) G.F.Simmons, Differential equations with Applications and Historical note, McGraw Hill, Inc. New York. , 1972. 4) E.A. Coddington and Levinson, Theory of Ordinary Differential equations, McGraw Hill, New York (1964).

4). I.N. Sneddon: Elements of Partial Differential Equations, McGraw Hill, New York, 1957.

5). Loannis P Stavroulakis, Stepan A Tersian: Partial Differential Equations: An Introduction with MATHEMATICA and MAPLE, World scientific, Singapore, 2004.

C–3: Probability and Statistics

Subject Code:C-3	Probability and Statistics	L.T.P Model	CREDIT-5

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Define the basic concept of Baye's theorem, probability mass and density function and also Recall the concept of distribution function, moments generating function.

CO2: Understand the concept of Probability distribution, Uniform, Binomial, Hypergeometric, Poisson, Rectangular, Gamma, Beta, Exponential, Normal.

CO3: Apply the previous knowledge to test of significance based on χ^2.

CO4: Analyse the concept of sampling (Large sample), test of significance based on t, F and Z

COs- POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	3	2	2	1	2	1	-	3	2	3	3	3
CO2	2	2	2	3	1	2	1	2	2	-	3	2	3	3	3
CO3	2	2	2	2	2	2	1	1	1	-	3	2	3	3	3
CO4	2	2	2	3	1	2	1	2	1	-	3	1	3	3	3

Syllabus

Unit-1: Probability: Baye's theorem, probability mass and density function, distribution function, moments generating function, characteristic function.

Unit-2: Probability distribution: Uniform, Binomial, Hypergeometric, negative binomial, Poisson, Rectangular, Gamma, Beta, Exponential, Normal.

Unit-3: Sampling distribution, t, F and $\chi^{2.}$ Test of significance: large sample tests, test of significance in binomial

Unit-4: Sampling test for mean and variance in normal population, small sample test based on t, F and χ^2.

Suggested Reference Books:

1. Meyer, P. L., "Introductory Probability and Statistical Applications", 2nd edition, Addison-Wesley Publishing Company, 2017.
2. Gupta, S. C. and Kapoor, V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 2014.
3. Mood, A. M., Graybill, F. A. and Boes, D.C., "Introduction to the Theory of Statistics", Tata McGraw Hill, 2014.
4. Spiegel, M. R., Schiller, J. J. and Srinivasan, "R. A: Probability and Statistics", Tata McGraw-Hill, 2014.
5. Baisnab, A. P. and Jas, M., "Element of Probability and Statistics", Tata McGraw Hill, 1993.

Subject Code:C-4	Computational Numerical Methods	L.T.P Model	CREDIT-5

C-4: Computational Numerical Methods

Course Outcomes (COs): After completion of this course the students will be able to

CO1: Define the concept of Error analysis and also able to find the numerical solution of algebraic and transcendental equations using Newton-Raphson method and fixed-point iteration.

CO2: Understand the concept of various mathematical operations and tasks, such as Interpolation of Polynomials and error analysis of interpolation polynomials and also learn the concept of numerical differentiation and integration.

CO3: Apply the concept of numerical solution of systems of linear equations, direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence and also able to solve the matrix eigenvalue problems using Jacobi and Given's methods.

CO4: Analyse the concept of numerical solution of ODE i.e. Initial value problems, Taylor series method, Runge-Kutta methods, predictor-corrector methods, Numerical solutions of PDE (finite difference method), Schmidt, Lassonnen, Crank-Nicolson, Richardson, Du Fort and Frankel Methods. Convergence and stability.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	2	2	2	3	-	-	1	1	3	1	3	3	3
CO2	2	1	2	2	2	2	-	-	1	1	3	1	3	2	3
CO3	2	2	2	2	2	3	-	-	1	1	3	1	3	3	2
CO4	2	2	2	2	3	2	-	-	1	1	3	1	2	3	3

Syllabus

Computational Numerical Methods

Unit-1: Error analysis, Numerical solution of algebraic and transcendental equations, bisection, secant method, Newton-Raphson method, fixed point iteration.

Unit-2: Interpolation: existence and error of polynomial interpolation, Lagrange, Newton, Hermite (Oscillatory) Interpolations, Numerical differentiation and integration, Trapezoidal and Simpson rule, Gaussian quadrature; (Gauss-Legendre and Gauss-Chebyshev).

Unit-3: Method of undermined parameters, least square and orthonormal polynomial approximation, numerical solution of systems of linear equations: direct and iterative methods, (Jacobi Gauss-Seidel and SOR) with convergence.

Unit-4: Matrix eigen value problems: Jacobi and Given's methods Numerical solution of ODE: initial value problems, Taylor series method,

Runge-Kutta methods, predictor-corrector methods; convergence and stability, Numerical solutions of PDE (finite difference method)

Suggested Reference Books:

1. M. K. Jain, S. R. K. lyengar, R.K. Jain, "Numerical methods for scientific and Engineering computation", New Age international Limited Publishers, 6th edition.

2. J.C. Butcher, "Numerical methods for ordinary differential equations", John Wiley & sons Ltd, 2nd Edition.

3. P. Henrici, "Discrete variable methods in ordinary differential equations, John Wiley & Sons Ltd.

4. S.S. Sastry, "Introductory methods of Numerical analysis", Prentice Hall of India New Delhi.

C–6: Real Analysis

Subject Code:C-6	Real analysis	L.T.P Model	CREDIT-5

Course Outcomes (CO's): After the completion of this corse the students will be able to

CO1: Recall the basic concept of Dedekind's Theory

i.e. rational and irrational numbers, ordering of real numbers, Archimedean property, Trichotomy law, insufficiency of rational numbers.

CO2: Understand the concepts of Riemann Stieltjes Integration

i.e. Riemann integration as a special case of Riemann Stieltjes integration, Darboux's theorem, Algebra of integrable functions, Continuity and differentiability of the integral function, Fundamental theorem of Calculus.

CO3: Demonstrate the concept of uniform convergence and pointwise convergence

i.e. Sequences and series of functions, pointwise and uniform convergence, differentiation, Cauchy criterion for uniform convergence, Weierstrass M – test for uniform convergence

CO4: Analyse the concept of Euclidean spaces and also study the concept of Bolzano Weierstrass Theorem, Heine Borel Theorem

i.e. Algebraic structure of R^n, Geometrical representation of R^n, Triangle inequality, Neighborhood of a point, limit point of a set, Open and closed sets in R^n, Bounded and compact sets in R^n, Bolzano Weierstrass Theorem, Heine Borel Theorem, Sets with Heine Borel Property.

CO5: Learn the concepts of real valued functions of several real variables and also examine the concept of limit and continuity of functions of several variables, Algebra of continuous functions, compactness preserving the character of continuous function, Partial derivatives, Partial Derivatives of higher order, Schwarz's and Young's theorem.

COs- POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	2	-	2	-	2	-	-	1	-	3	-	3	2	2
CO2	1	1	-	1	-	2	-	-	1	-	2	-	3	3	3
CO3	2	1	-	1	-	-	-	-	1	-	2	-	3	3	3
CO4	1	2	-	1	-	1	-	-	1	-	2	-	3	3	3
CO5	2	2	1	1	1	-									

Syllabus

Real Analysis

Unit-1: Dedekind's Theory: Section of Rational Numbers: Real rational and real irrational numbers, ordering of real numbers, Archimedean property, Trichotomy law, Algebra of real numbers, Binary compositions of real numbers and their compatibility with order structure, Real line, insufficiency of rational numbers to be represented by a straight line.

Unit-2: **Riemann Stieltjes Integration**: Definition, Riemann integration as a special case of Riemann Stieltjes integration, Darboux's theorem, Algebra of integrable functions, Properties of Riemann Stieltjes integrals, Functions defined by definite integrals, Continuity and differentiability of the integral function, Fundamental theorem of Calculus.

Unit-3: Uniform Convergence: Sequences and series of functions, pointwise and uniform convergence, Abel and Dirichlet tests for uniform convergence, Uniform convergence and continuity, Uniform Convergence and Riemann integration, Uniform convergence and Differentiation, Cauchy criterion for Uniform convergence, Weierstrass M – test for uniform convergence.

Unit-4: Euclidean Spaces: Definition, Algebraic structure of R^n, Geometrical representation of R^n, Triangle inequality, Neighborhood of a point, limit point of a set, Open and closed sets in R^n, Bounded and compact sets in R^n, Bolzano Weierstrass Theorem, Heine Borel Theorem, Sets with Heine Borel Property.

Unit-5: Real valued functions of several real variable: Limit and continuity of a real valued function of several variables, Algebra of limits, Algebra of continuous functions, compactness preserving character of continuous function, Partial derivatives, Partial Derivatives of higher order, Schwarz's and Young's theorem for the validity of reversal of order of partial derivation.

Suggested Reference Books:

1. Royden, H.L. Fitzpateick P. M, "Real Analysis", New Delhi, Prentice Hall of India, 4th edition, 2009.

2. G. deBarra, "Measure Theory and Integration", McMillan, New York,1981.

3. Jain. P.K. and Gupta V.P, "Lebesgue measure and integration", Wiley Easter Limited, 1986.

4. Rudin W. Principles of Mathematical Analysis", McGraw- Hill Book Co., 1964.

C-7: Functional Analysis

Subject Code:C-6	Functional Analysis	L.T.P Model	CREDIT-5

Course Outcomes (CO's): After the completion of this course the students will be able to

CO1: Remember the basic properties of Vector space, finite dimensional normed spaces, Banach spaces and quotient spaces.

CO2: Understand the elementary properties of bounded linear operator and continuous linear operator.

CO3: Demonstrate the basic properties of inner product space and Hilbert space

i.e. Orthogonal complements, Projections, Orthonormal Basis, Bessel's inequality, Parseval identity, Self-adjoint operators, Normal operators and Unitary operators.

CO4: Deduce the concept of some special theorems such as Hahn-Banach theorem, Open mapping theorem, Closed graph theorem and Spectral theorem for normal operators.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	-	-	-	1	-	2	2	3	2	3
CO2	2	1	-	1	1	2	-	-	1	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	1	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	1	-	3	1	2	3	3

Syllabus

Functional Analysis

Unit-1: Recall: Linear spaces, Linear dependence and independence and Dimension of a linear space. Normed linear spaces, Completeness, Banach Spaces, Spaces and subspaces of Finite Dimension, Convex sets in Normed linear spaces, Quotient spaces.

Unit-2: Linear Operations: Elementary properties of linear operators, Linear operators in finite dimensional space, Spaces of continuous linear operators, Boundedness and continuity of linear operators, Inverse operators.

Unit -3: **Inner product space**-Definition and examples, Simple properties of Inner product spaces, Hilbert space, Orthogonal complements, Orthonormal sets, Projections, Orthonormal Basis, Bessel's inequality, Parseval identity, Definitions, examples and simple properties of Self adjoint operators, Normal operators and unitary operators.

Unit-4: Hahn-Banach theorem, Open mapping theorem and Closed Graph theorem.

Suggested Reference Books:

1. E. Kreyzing, “Introduction to Functional Analysis with Applications”, Wiley, 1989.

2. Bollobas, “Linear Analysis, Cambridge university Press (Indian Edition)1999.

3. A.E. Taylor and D. C. Lay, “Introduction to Functional analysis”, 2nd edition, Wiley, New York, 1980.

4. G. F. Simmons, “Introduction to Topology, Introduction to Topology and Modern Analysis”, International student edition, 1963.

C-8: Mathematical Modelling

Subject Code:C-8	Mathematical Modelling	L.T.P Model	CREDIT-5

Course Outcomes (CO's): After the completion of this course the students will be able to

CO1: Memorise the basic concept of role of mathematics in problem-solving, problem definition and system characterisation.

CO2: Learn the basic concept of mathematical modelling and mathematical formulations.

CO3: Understand the concept of analysis of MF (Dynamic, static, and stochastic formulations and its analysis).

CO4: Analyse the basic concept of the simulations, parameter estimations, design of experiments, validations.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	1	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Mathematical Modelling

Unit-1: Role of mathematics in problem-solving, problem definitions, System Characterizations,

Unit-2 Mathematical modeling, Mathematical formulations,

Unit-3: Analysis of MF (dynamic, static, and stochastic formulations and its analysis),

Unit-4: Simulations, Parameter Estimations, Design of Experiments, Validations.

Suggested Reference Books:

1. Edward A. Bender, "An introduction to mathematical Modeling", CRC Press,2002

2. Walter J. Meyer, "Concepts of Mathematical Modeling", Dover Publ., 2000.

C-9: Inventory and Queueing Theory

Subject Code:C-9	Inventory and Queueing Theory	L.T.P Model	CREDIT-5

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Understand the concept of EOQ and also able to memorise the basic concept of deterministic inventory models with shortage and no shortage, multi-items deterministic problems, Dynamic order Quantity,

CO2: Learn the basic concept inventory problem with uncertain demand and also able to review the concept of one periodic problem without a setup cost and with setup cost.

CO3: Apply the basic concept of queueing system and also able to define the queueing models, Birth-Death models, M/M/1:∞, M/M/1: N.

CO4: Describe the concept of the queuing models M/E_k/1:∞, M/G/1:∞.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	1	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	1	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	1	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	1	1	-	3	1	2	3	3

Syllabus

Inventory and Queueing Theory

Unit-1: Inventory policy: concept of EOQ, Deterministic inventory models with shortage and no shortage, multi-items deterministic problems, Dynamic order Quantity,

Unit-2: Inventory problem with uncertain demand: One Periodic problem without a setup cost and with setup.

Unit-3: Queueing system: Queueing models, Birth-Death models, M/M/1:∞, M/M/1:N,

Unit-4: Queueing models: M/E_k/1:∞, M/G/1:∞.

Suggested Reference Books:

1. D. Gross and C. Harris, "*Fundamentals of Queueing Theory", 3rd Edition,* Wiley, 1998. (WSE Edition, 2004).

2. L. Kleinrock, "*Queueing Systems", Vol. 1: Theory,* Wiley, 1975.

3. J. Medhi, "*Stochastic Models in Queueing Theory", 2nd Edition,* Academic Press, 2003. (Elsevier India Edition, 2006).

4. Jack R. Meredith and Samuel J. Mantel, "Project Management-A Managerial Approach", John Wiley & Sons, 2009.

5 J.W. Prichard and R.H. Eagle. Herold Kerzner, "Project Management-A Systems Approach to Planning, Scheduling and Controlling", John Wiley Inc., 2009.

6. J.W. Prichard and R.H. Eagle, "Modern Inventory Management", John Wiley,

C-10:

Subject Code:C-10	**Practical**	L.T.P Model	CREDIT-4

Practical

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Memorising the concept of solving problems of numerical methods & operations research through using 'C' and 'C++'.

CO2: Understand the Numerical Integration, Solution of ODE,

CO3: Demonstrate the Solution of System of Linear Equations,

CO4: Analyse the Solutions of LPP, solution of inventory problems.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	2	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	2	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	2	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	2	1	-	-	2	-	3	1	2	3	3

Syllabus

Practical

Unit-1 Problems of Numerical Methods & Operations Research through 'C' and 'C++'.

Unit-2: Numerical Integration, Solution of ODE,

Unit-3: Solution of System of Linear Equations,

Unit-4: Solutions of LPP, Solution of Inventory Problems

C–11: Topology

Subject Code:C-11	Topology	L.T.P Model	CREDIT-4

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Define the basic concept of topological spaces, closed sets, closure of a set, dense subsets, neighbourhood, interior, exterior, frontier, limit point and derived sets, the basis for topology.

CO2: Understand the basic concept order topology, subspace topology, continuous functions and homeomorphism, product topology.

CO3: Demonstrate the basic concept of connected spaces, connected subspaces of real line, components and locally connected spaces, compact spaces, compact subspaces of the real line.

CO4: Analyse the basic concept of countability axioms, separation axioms, normal spaces and appreciate the beauty of deep mathematical results like Urysohn's lemma, Urysohn's metrization theorem, Tychonoff's theorem, Stone-Cech compactification.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	-	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	-	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	-	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	-	-	3	1	2	3	3

Syllabus

Topology

Unit-1: Definitions and examples of topological spaces, closed sets, closure of a set, dense subsets, Kuratowski closure axioms, neighborhood of a point, interior, exterior, frontier (Boundary), accumulation (limit) point and derived sets, basis for topology,

Unit-2: order topology, subspace topology, continuous functions and homeomorphism, product topology.

Unit-3: Connected spaces, connected subspaces of real line, components and locally connected spaces, compact spaces, compact subspaces of the real line.

Unit-4: Countability axioms, separation axioms, normal spaces. Urysohn's lemma, Urysohn's metrization theorem, Tychonoff's theorem, Stone-Cech compactification (Statement only).

Suggested Reference Books:

1. W.J.Pervin, "Foundations of General Topology", Academic Press, New York, 3rd edition, 1970.

2. G.F. Simmons, "Introduction to Topology and Modern Analysis", Mc Graw Hill Book Company, New Delhi, 1963.

3. J.R. Munkers, "Topology a first Course", Prentice Hall of India Pvt.Ltd

DEPARTMENT OF MATHEMATICS, INSTITUTE OF BASIC SCIENCE, KHANDARI.
DR BHIMRAO AMBEDKAR UNIVERSITY, AGRA

C-12: Fuzzy Sets and Fuzzy Logics

Subject Code:C-12	Fuzzy Sets and Fuzzy Logics	L.T.P Model	CREDIT-4

Course Outcomes (CO's): After the completion of this course the students will be able to

CO1: Define the basic concept of fuzzy sets, properties of α-level sets, and also operations on fuzzy sets.

CO2: Understand the basic concept of extended principle, and also the concept of Zadeh's extended principle of fuzzy sets and fuzzy arithmetic.

CO3: Analyse the basic concept of fuzzy relations and fuzzy graphs.

i.e. composition of fuzzy relations, min-max composition, fuzzy equivalence relations, fuzzy compatibility relations, fuzzy graphs, similarity relation.

CO4: Examine the basic concept of possibility theory and also classify the possibility theory versus probability theory.

i.e. fuzzy measure, Fuzzy logic**,** evidence theory, necessity measure, possibility distribution,

CO5: Demonstrate the basic concept of fuzzy logic,

i.e. multi-valued logic, fuzzy propositions, fuzzy quantifiers, linguistic variables and hedges, inference from conditional fuzzy propositions, and the compositional rule of inference.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3
CO5	1	1	1	1	1	1	-	-	2	-	2	2	3	2	3

Syllabus

Unit-1: Fuzzy sets: Basic definitions, $\propto -$level sets, convex fuzzy sets, basic operations on fuzzy set types of fuzzy sets, Cartesian products, algebraic products, bounded sum and difference, norm and t-conorms.

Unit-2: The extension principle. The Zadeh's extension principle of fuzzy sets, image and inverse of fuzzy sets. Fuzzy numbers, elements of fuzzy arithmetic.

Unit-3: Fuzzy relations and Fuzzy Graphs: Fuzzy relations of fuzzy sets, composition of fuzzy relations, min-max composition and its properties, fuzzy equivalence relations, fuzzy compatibility relations, fuzzy relation equivalences, fuzzy graphs, similarity relation.

Unit-4: Possibility Theory: fuzzy measure, evidence theory, necessity measure, possibility measure, possibility distribution, possibility theory and fuzzy sets, possibility theory versus probability theory.

Unit-5: Fuzzy logic: An overview of classical logic, multi-valued logics, fuzzy propositions, fuzzy quantifiers, linguistic variables and hedges, inference from conditional fuzzy propositions, the compositional rule of inference.

Suggested Reference Books:

1. Mohan, C., "An Introduction to Fuzzy Set Theory and Fuzzy Logic", Anshan Publishers, 2015.

2. Lee, K. H., "First Course on Fuzzy Theory and Applications", Springer International Edition, 2005.

3. Yen, J., Langari, "R. Fuzzy Logic - Intelligence, Control and Information", Pearson Education, 1999.

4. Zimmerman H.J., "Fuzzy Set Theory and its Applications", Allied Publishers Ltd., New Delhi, 1991.

C–13: Mathematical Programming

Subject Code:C-13	Mathematical Programming	L.T.P Model	CREDIT-4

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Understand the fundamental properties of solutions for linear programming and revised simplex method, parametric linear programming,

CO2: Demonstrate the basic concept of linear fractional programming, integer programming, and learn to solve the LPP using dual simplex method.

CO3: Define the basic concept of post optimality analysis, non-linear programming, Kuhn-Tucker conditions of optimality,

CO4: Analyse the basic concept of quadratic programming and method due to Beale, Wolfe and duality in Quadratic programming.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Mathematical Programming

Unit-1: simplex method, Dual simplex method,

Unit-2: Integer programming. Sensitivity analysis,

Unit-3: Kuhn-Tucker conditions of optimality, Quadratic programming,

Unit-4: Method due to Beale, Wolfe and duality in Quadratic programming, Self-duality.

Suggested Reference Books:

1. Besaint, W.H. and Ramsey, “A.S. A Treatise on Hydromechanics Part Ihydrostatics”, Andesite Press, 2017.

2. Kundu, P.K., Cohen, I. M. and Dowling: R. D., "Fluid Mechanics", 6th edition, Academic Press, 2015.

3. O'Neil, M. E., and Chorlton: F., "Ideal and Incompressible Fluid Dynamics", Ellis Horwood Ltd, 1986.

4. Yuan, S.W., "Foundations of Fluid Mechanics", Prentice Hall of India Private Limited, New Delhi, 1976.

5. Curle, N. and Davies, "H. J. Modern Fluid Dynamics", Vol1, D Van

C-14: Elective

Discrete Mathematics

Subject Code:C-14	Discrete Mathematics	L.T.P Model	CREDIT-4

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Learn the basic concept of the formal logic and lattices.

i.e. Statements, Symbolic representation and tautologies, Quantifiers, Predicates and Validity, Propositional Logic and lattices as partially ordered sets, their properties, Lattices as algebraic system, Sub-lattices, Direct products, and homomorphisms, some special lattices

CO2: Understand the basic concept of Boolean algebra and the Karnaugh map method.

i.e. Various Boolean identities, sub algebras, direct products and homomorphisms, join – irreducible elements, stems and minterms, Boolean forms and their equivalence, minterm Boolean forms, Sum of products canonical forms, minimization of Boolean functions, application of Boolean algebras to switching theory,

CO3: Demonstrate the basic concept of graphs, path, subgraphs, degree of vertex etc and their properties and also classify the concept of Euler's formula for connected planar graphs, complete and complete bipartite graphs, Kuratowski's theorem and its applications.

CO4: Define and illustrate the concept of spanning trees, cut-sets,

i.e. fundamental cut-sets, and circuits, minimal spanning trees and Kruskal's algorithm, matrix representations of graphs and Euler theorem on the existence of Eulerian paths, circuits and also about the directed graphs, in-degree and out-degree of a vertex, weight undirected graphs, Dijktra's algorithm, strong connectivity and Warshall algorithm, directed trees.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Discrete Mathematics

Unit-1: Formal Logic: Statements, Symbolic representation and tautologies, Quantifiers, Predicates and Validity, Propositional Logic.

Lattices: Lattices as partially ordered sets, their properties, Lattices as algebraic system, Sub-lattices, Direct products, and homomorphisms, some special lattices, e.g. complete, complemented and distributive lattices.

Unit-2: Boolean Algebra: Boolean Algebras, as Lattices, Various Boolean identities, The switching algebra example, subalgebras, direct products and homomorphisms, join – irreducible elements, stoms and minterms, Boolean forms and their equivalence, minterm Boolean forms, Sum of products canonical forms, minimization of Boolean functions, application of Boolean algebras to switching theory, The Karnaugh map method.

Unit-3: Graph Theory: Definition of (undirected) Graphs, Path, Cycles, and subgraphs, induced subgraphs, degree of vertex, connectivity, planar graphs and their properties, trees, Euler's formula for connected planar graphs, complete and complete bipartite graphs Kuratowski's theorem (Statement only) and its use,

Unit-4: spanning trees, cut-sets, fundamental cut-sets, and circuits, minimal spanning trees and Kruskal's algorithm, matrix representations of graphs, Euler theorem on the existence of Eulerian paths and circuits, directed graphs, in-degree and out-degree of a vertex, weight undirected graphs, Dijktra's algorithm, strong connectivity and Warshall algorithm, directed trees, search trees, tree traversals.

Suggested Reference Books:

1. Tremblay, J.P. and Manohar, "R. Discrete Mathematical Structures with Applications to Computer Science", Ist edition McGraw Hill Book Co., 2017.

2. Lepschutz, S. and Lipson M., "Linear Algebra", 5th edition, Tata McGraw Hill 2012.

3. Ram, B. "Discrete Mathematics", Pearson Education, 2012.

4. Kenneth H. R., "Discrete Mathematics and Its Applications", 7th edition, Tata McGraw Hill, 2011. 5. Liu, C. L. Elements of Discrete Mathematics. Tata McGraw Hill, 2000.

Financial Mathematics

Subject Code:C-14	Financial Mathematics	L.T.P Model	CREDIT-4

Course Outcomes (CO's): After the completion of this course the students will be able to

CO1: Understand the basic concept of financial market and derivatives, Binomial Model, CRR model and pricing a European and American contingent claim and also Finite market model and definition, first and second fundamental theorem of Asset pricing, pricing European contingent claims. Incomplete markets, Separating hyperplane theorem.

CO2: Demonstrate the basic concept of black-Scholes model, equivalent martingale measure. European call option-Black-Scholes formula and American call and put option.

CO3: Analyse the basic concept of multi-dimensional Black-Scholes model and First fundamental theorem of asset pricing, form of equivalent local Martingale measures.

CO4: Learn the basic concept of second fundamental theorem of asset pricing and define the concepts of pricing European contingent claims and incomplete markets.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Financial Mathematics

Unit-1: Financial market and derivatives. Binomial Model: Binomial and CRR model, pricing a European and American contingent claim. Finite market model: Definition, First and second fundamental theorem of Asset pricing, pricing European contingent claims. Incomplete markets, Separating hyperplane theorem.

Unit-2: Black-Scholes model, Equivalent martingale measure. European call option-Black-Scholes formula. American call and put option.

Unit-3: Multi-dimensional Balck-Scholes model: First fundamental theorem of asset pricing. Form of equivalent local martingale measures.

Unit-4: Second fundamental theorem of Asset pricing. Pricing European contingent claims. Incomplete markets.

Suggested Reference Books:

1. S. E. Shreve, "Stochastic Calculus for Finance", Vol. I & Vol. II, Springer.

2. Sean Dineen, "Probability Theory in Finance", A Mathematical Guide to the Black-Scholes Formula, American Mathematical Society, Indian edition.

Reliability Theory

Subject Code:C-14	Reliability Theory	L.T.P Model	CREDIT-4

Course Outcomes (CO's): After the completion of this course the students will be able to

CO1: Acknowledge the basic concept of reliability, failure data analysis, Hazard Models, System Reliability, Mixed configuration complex systems and MTBF, Markov models.

CO2: Understand the basic concept of reliability improvement, redundancy optimization, fault Tree Analysis.

CO3: Look over the basic concept of tie set Cut set and reliability using Boolean algebra maintenance and availability.

CO4: Analyse the concept of repairable system and application reliability allocation and reliability theory.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3

CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Reliability Theory

Unit-1: Reliability Definition, Failure data analysis, Hazard Models, System Reliability. Series, Parallel, Mixed configuration complex systems, MTBF,

Unit-2: Markov models. Reliability Improvement, Redundancy optimization, fault Tree Analysis,

Unit-3: Tie set Cutset, Reliability using Boolean Algebra, Maintenance and Availability,

Unit-4: Repairable System. Reliability allocation application. Application of Reliability theory

Suggested Reference Books:

1. R.E. Barlow and F. Proschan, Holt, Rinehart and Winston, "Statistical Theory of Reliability and Life Testing Probability Models", New York.
2. R.E. Barlow and F. Proschan, "Mathematical Theory of Reliability", John Wiley, New York.
3. A. Hoyland, and M. Rausand, "System Reliability Theory Models and Statistical Methods", John Wiley, New York.
4. K.C. Kapur, and L.R. Lamberson, "Reliability in Engineering Design", John Wiley, New York.

Coding Theory

Subject Code:C-14	Coding Theory	L.T.P Model	CREDIT-4

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Understand the concept of coding theory, detection and correction of errors, some basic Algebra, MLD, error correcting coding and detecting coding.

CO2: Acknowledge the concept of linear codes, algebraic definitions, generating and parity check matrices, property of linear codes, MLD for linear codes,

CO3: Demonstrate the basic concept of perfect and related codes, some bounds for codes, Hamming codes, extended codes, extended Golay codes, Golay codes, Reed Muller code and cyclic linear codes.

CO4: Analyse the basic concept of polynomials representation of words, generating parity check matrices for cyclic codes, Dual cyclic codes, BCH codes, Finite fields, Cyclic Hamming codes, Reed Solomon, codes over GF(2^r).

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Coding Theory

Unit-1: Introduction to coding theory: detection and correction of errors, some basic Algebra, MLD, error correcting coding and detecting coding.

Unit-2: Linear codes: algebraic definitions and concepts, generating and parity check matrices, property of linear codes, MLD for linear codes,

Unit-3: Perfect and related codes: Some bounds for codes, Hamming codes, extended codes, extended Golay codes, Golay codes, Reed Muller code, Cyclic linear codes,

Unit-4: polynomials representation of words: generating parity check matrices for cyclic codes, Dual cyclic codes, BCH codes, Finite fields, Cyclic Hamming codes, Reed Solomon, codes over GF(2^r), Transform approach for Reed Solomon Codes, Berlekamp-Massey algorithm, erasures.

Suggested Reference Books:

1. MacWilliams, F. J. and Sloane, N. J. A., "The theory of error-correcting codes", North Holland Mathematical Library, Vol. 16. North-Holland Publishing Co., New York, 1977.

2. van Lint, J. H., "Introduction to coding theory", Third edition, Graduate Texts in Mathematics, 86. Springer-Verlag, Berlin, 1999.

3. Huffman, W. C. and Pless, V., "Fundamentals of error-correcting codes", Cambridge University Press, Cambridge, 2003.

4. MacKay, D., "Information theory-inference and learning algorithms", Cambridge University Press, New York, 2003.

C-15 Practical

Computer Programming with ‘MATLAB’

Subject Code:C-15	Computer Programming with ‘MATLAB’	L.T.P Model	CREDIT-5

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Understand the concept of problems of Operations Research through ‘MATLAB’.

CO2: Analyse the concept of problems of numerical methods through ‘MATLAB’.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3

Syllabus

C-15 Practical

Computer Programming with ‘MATLAB’

Unit-1: Problems of Operations Research through ‘MATLAB’.

Unit-2: Problems of Numerical Methods through ‘MATLAB’

C–16: Complex Variables

Subject Code:C-16	Complex Variables	L.T.P Model	CREDIT-5

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Understand the concept of analytic Function, power series, bilinear transformation, continuity and differentiability of a complex function, C-R equations and conformal mapping.

CO2: Demonstrate the basic concept of complex integration, Cauchy Goursat theorem, Cauchy integral formula, Poisson's integral formula, Taylor's theorem, Morera's Theorem, Liouville's Theorem, Maximum Modulus Principle.

CO3: Define the basic concept of singular points, Laurent series, Laurent's theorem, Taylor's Series, removable singularity, pole and essential singularity, behaviour of a function near an isolated essential singularity, behaviour at infinity.

CO4: Analyse the basic concept of meromorphic function, principle of argument, Rouche's theorem, fundamental theorem of algebra and calculus of residues.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Unit-1: Analytic Functions: Continuity and Differentiability of a complex function, Cauchy-Riemann Partial Differential Equations as a set of necessary but not sufficient condition for differentiability. Power series, region of convergence, absolute convergence and analyticity of a Power series, Cauchy Hadamard Theorem. Bilinear transformations: Resultant and inverse of Bilinear transformations: Translation, Magnification, Rotation, Inversions with respect to straight line and with respect to circle, A Bilinear Transformation as the resultant of bilinear transformations, angle preserving property of Analytic mappings, Isogonal and Conformal mapping (definitions only).

Unit-2: **Complex integration:** Rectifiable curves, contours, integral along an oriented curve, Sufficient condition for integrability, ML inequality, Cauchy Goursat Theorem for simply connected and multiply connected domains, Cauchy integral formula for simply and multiply connected domains, Poisson's integral formula, analytical character of the derivative of an analytic function, Taylor's theorem, Morera's Theorem, Liouville's Theorem, Theorem of the Arithmetic Mean, Maximum Modulus Principle.

Unit-3: Singular points: Zeros of an analytic function, Isolated character of zeros of an analytic function, Laurent series, region of convergence, absolute convergence and analyticity of Laurent's series, Laurent's theorem, Taylor's part and Principal part of a Laurent series, Removable singularity, Pole and essential singularity, Behaviour of a function near an isolated essential singularity, behaviour at infinity.

Unit-4: Meromorphic Functions: Definition, characterization of Polynomials as Entire functions and Rational functions as Meromorphic functions, Residue at an isolated singularity Residue at infinity, simple computation of residues, Residue Theorem, number of zeros and poles in a domain, Principle of argument, Rouche's theorem, Fundamental theorem of Algebra.Calculus of Residues: Evaluation of real integrals.

Suggested Reference Books:

1. J.B.Conway, "Functions of one complex variable", Narosa publication House, 3rd Edition.

2. Alfors L.V. "Complex Analysis", McGraw 1979.

3. Brown and Churchill, "Complex variable and applications", 9th edition, McGraw

3. Ponnusamy and Silverman, "Complex variables with applications", Birkhauser, 2006.

C–17: Fluid Dynamics

Subject Code:C-**17**	Fluid Dynamics	L.T.P Model	CREDIT-5

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Acknowledge the basic concept of kinematics.

i.e. Lagrangian and Eulerian methods, equation of continuity, Boundary surface, stress lines, path lines and streak lines, velocity potential and irrotational motions, vortex lines.

CO2: Demonstrate the basic concept of equation of motion.

i.e. Lagrange's and Euler's equations of motion, Bernoulli's theorem, irrotational motion in two-dimensions, complex velocity-potential, sources, sinks, doublets, conformal mapping Milne-Thompson circle theorem.

CO3: Understand the concept of two-dimensional irrotational motion produced by motion of circular, co-axial and elliptic cylinders in an infinite mass of liquid, equation of motion of a sphere, Stoke's stream function.

i.e. kinetic energy of liquid, theorem of Blasius motion of a sphere through a liquid at rest at infinity, liquid streaming past a fixed sphere.

CO4: Analyse the concept of stress component in a real fluid, relations between rectangular components of stress,

i.e. connection between stresses and gradients of velocity, Navier-Stoke's equation of motion, plane Poiseuille and through tubes of uniform cross section in form of circle, annulus unsteady flow over a flat plate.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2

CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Unit-1: Kinematics: Lagrangian and Eulerian methods, Equation of continuity, Boundary surface, stress lines, path lines and streak lines, velocity potential and irrotational motions, vortex lines.

Unit-2: Equation of Motion: Lagrange's and Euler's equations of motion, Bernoulli's theorem, equation of motion of flux method, equation referred to moving axes, impulsive actions, stream function, irrotational motion in two-dimensions, complex velocity-potential, sources, sinks, doublets and their images, conformal mapping Milne-Thompson circle theorem.

Unit-3: Two-dimensional irrotational motion produced by motion of circular, co-axial and elliptic cylinders in an infinite mass of liquid, kinetic energy of liquid, theorem of Blasius motion of a sphere through a liquid at rest at infinity, liquid streaming past a fixed sphere, equation of motion of a sphere, Stoke's stream function.

Unit-4: Stress component in a real fluid, relations between rectangular components of stress, connection between stresses and gradients of velocity, Navier-Stoke's equation of motion, plane Poiseuille and through tubes of uniform cross section in form of circle, annulus unsteady flow over a flat plate.

Suggested Reference books:

1. N. Curle and H. J. Davies, “Modern Fluid Dynamics”, Vol. I, 1968.

2. P.K. Kundu and I.M. Cohen, “Fluid Mechanics” (3rd edition) Elsevier Science & Technology, 2002.

3. L.M. Milne Thomson, “Theoretical Hydrodynamics”, Macmillan Company, New York, 1955.

4. G.K. Batchelor, “Introduction to Fluid Dynamics”, Cambridge University Press, 1967.

C-18: Elective-II

C-19: Elective-III

Number Theory and Cryptology

Subject Code:C-18	Number Theory and Cryptology	L.T.P Model	CREDIT-5

Course Outcomes (CO's): After the completion of this course the students will be able to

CO1: Memorise the basic concept Euclidean algorithm, quadratic residues and Reciprocity.

CO2: Understand the concept of some simple cryptosystems, DES and AES systems.

CO3: Define the basic concept of public key cryptosystems, Diffie-Hellman key exchange,

CO4: Analyse the concept of RSA and ElGamal systems and signature schemes, elliptic curve, crypto systems.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Number Theory and Cryptology

Unit-1: Divisibility and the Euclidean algorithm**.** Congruence, Quadratic residues. Reciprocity.

Unit-2: Some simple cryptosystems.

Unit-3: Encryption matrices. Public key cryptosystems. Discrete logarithm, Diffie-Hellman key exchange

Unit-4: RSA signature systems. Some simple protocols.

Suggested Reference Books:

1. Tilborg, H. C. A, "Fundamentals of Cryptology", Springer, 2013.

2. Buchmann, J. A., "Introduction to Cryptology", Springer Science & Business Media, 2012

3. Burton, D. M., "Elementary Number Theory", Tata McGraw Hill Publishing House, 2006.

4. Menezes, A. J., V., Oorschot, P. C. and Vanstone, S. A., "Handbook of Applied Cryptography",CRC Press, 1996.

Calculus of Variations and Integral Equation

Subject Code:C-19	C.O.V. and I.E.	L.T.P Model	CREDIT-5

Course Outcomes (CO's): After the completion of this course the students will be able to

CO1: Acknowledge the concept of variation of a functional, Euler-Lagrange equation and necessary and sufficient conditions for extrema.

CO2: Look over the concept of variational methods for boundary value problems in ordinary and partial differential equations.

CO3: Understand the concept of linear integral equation of the first and second kind of Fredholm and Volterra type.

CO4: Analyse the concept of solutions with separable kernels and characteristic numbers and eigen functions, resolvent kernel.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Calculus of Variations and Integral Equation

Unit-1: Calculus of Variations: Variation of a functional, Euler-Lagrange equation, Necessary and sufficient conditions for extrema.

Unit-2: Variational methods for boundary value problems in ordinary and partial differential equations.

Unit-3: Linear Integral Equations: Linear integral equation of the first and second kind of Fredholm and Volterra type,

Unit-4: Solutions with separable kernels. Characteristic numbers and eigen functions, resolvent kernel.

Suggested Reference Book:

1.Wazwaz, A. M. A., "First Course in Integral Equations", 2nd edition World Scientific Publishing Co. 2015.

2.Kanwal, R. P. Linear Integral Equation, "Theory and Techniques", Academic Press, 2014.

3. Gelfand, I. M. and Fomin, S. V., "Calculus of Variations", Courier Corporation, 2012.

4.Hildebrand, F. B., "Method of Applied Mathematics", Courier Corporation, 2012.

5.Raisinghania M. D., "Integral Equation & Boundary Value Problem", S. Chand Publishing, 2007.

Wavelet Analysis

Subject Code:C-**18**	Wavelet Analysis	L.T.P Model	CREDIT-5

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Recall the basic concepts of the scalable structure of information, the new mathematical engineering, good approximations and wavelets.

CO2: Understand the basics of linear algebra.

i.e. Vector spaces, basis, dimension, linear transformations, matrices and digitalization, inner products and orthonormal bases.

CO3: Look Over the wavelet theory, algebra and geometry of wavelet, Matrices and define and illustrate the one-dimensional wavelet Systems

CO4: Analyse the concept of higher dimensional wavelet systems, wavelets on Z, Fourier series, transform, convolution and wavelet approximation and Algorithms.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3

CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Wavelet Analysis

Unit-1: The Scalable Structure of Information: The New Mathematical Engineering, Good Approximations, Wavelets:

Unit-2: A Positional Notation for Functions, Review of linear algebra: Vector spaces, basis, dimension, linear transformations, matrices and digitalization, inner products and orthonormal bases.

Unit-3: Wavelet Theory: Algebra and Geometry of Wavelet: Matrices, One-Dimensional Wavelet Systems, Examples of One-Dimensional Wavelet Systems,

Unit-4: Higher Dimensional, Wavelet Systems. Wave lets on Z, Z_n ,Fourier series, transform and convolution on l*2.

Wavelet Approximation and Algorithms: The Mallat Algorithm

Suggested Reference Books:

1. Boggess, A. and Narcowich, F.J., "A First Course in Wavelets and Fourier Analysis", John Wiley & amp; Sons, 2010.

2. Mallat, S. A., "Wavelet Tour of Signal Processing", Academic Press, 2009.

3. Han, D., Kornelson, K., Larson, D. and Weber, E., "Frames for Undergraduates, Student Math", Lib., (AMS) Vol. 40, 2007.

4. Christensen O., "An Introduction to Frames and Riesz Bases", Birkhauser, 2003.

5. Harnendez, E. and Weiss, "G. A First Course on Wavelets", CRC Press, 1996.

Control Theory

Subject Code:C-19	Control Theory	L.T.P Model	CREDIT-5

Course Outcomes (CO's): After the completion of this course the students will be able to

CO1: Memorise the basic the concept of mathematical models of control systems, State space representation, Autonomous and non-autonomous systems, State transition matrix, Peano series Solution of linear dynamical system.

CO2: Understand the concept of block diagram, transfer function, realization, Controllability, Kalman theorem, Controllability Grammian, Control computation using Grammian matrix, Observability, Duality theorems. Discrete control systems, Controllability and Observability results for discrete systems. Companion form.

CO3: Study the concept of feedback control, State observer, realization.

Lyapunov stability, Stability analysis for linear systems, Lyapunov theorems for stability and instability for nonlinear systems, Stability analysis through Linearization, Routh criterion, Nyquist criterion.

CO4: Analyse the concept of stabilizability and detachability, state feedback of multivariable system, Riccatti equation, Calculus of variation, Euler- Hamiltonian equations, Optimal control for nonlinear control systems, Computation of optimal control for linear systems. Control systems on Hilbert spaces, Semi group theory, Mild solution, Control of a linear system.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Control Theory

Unit-1: Mathematical models of control systems, State space representation, Autonomous and non- autonomous systems, State, transition matrix, Peano series Solution of linear dynamical system.

Unit-2: Block diagram, Transfer function, Realization, Controllability, Kalman theorem, Controllability Grammian, Control computation using Grammian matrix, Observability, Duality theorems. Discrete control systems, Controllability and Observability results for discrete systems. Companion form,

Unit-3: Feedback control, State observer, Realization. Liapunov stability, Stability analysis for linear systems, Liapunov theorems for stability and instability for nonlinear systems, Stability analysis through Linearization, Routh criterion, Nyquist criterion,

Unit-4: Stabilizability and detachability, State feedback of multivariable system, Riccatti equation, Calculus of variation, Euler- Hamiltonian equations, Optimal control for nonlinear control systems, Computation of optimal control for linear systems. Control systems on Hilbert spaces, Semi group theory, Mild solution, Control of a linear system

Suggested Reference Books:

1) M. Gopal, "Control Systems-Principles and Design", McGraw Hill Education.

2) B. C. Kuo, "Automatic Control System", Prentice Hall

3) K. Ogata, "Modern Control Engineering", Prentice Hall, 1991.

4) J. Nagrath and M. Gopal, "Control Systems Engineering", New Age International, 2009.

5) A. Anand kumar, "Control Systems" PHI Pvt. Ltd, 2014.

Bio-Mathematics

Subject Code:C-**19**	Bio-mathematics	L.T.P Model	CREDIT-5

(CO's): After the completion of this course the students will be able to

CO1: Understand the basic concept of epidemic models, deterministic models without removal, general deterministic model with removal, a general deterministic model with removal and immigration, and control of an epidemic.

CO2: Classify the basic concepts of mathematical models in pharmacokinetics, **i.e**. determination of transfer coefficients and compartment volumes, mathematical techniques used in compartment analysis, stochastic compartment models.

CO3: Examine the basic concept of models for blood flow. **i.e.** Tardiovascular system and blood flows, steady non-Newtonian fluid flow in circular Tubes, Newtonian pulsatile flows in rigid and elastic tubes, blood flow through the Artery with mild stenosis, peristaltic flow in tubes and channels, models for air flow in lungs,

CO4: Analyse the concept of diffusion and diffusion-reaction models.

i.e. The diffusion equations, oxygen diffusion living tissues. Non-linear populations growth Models, models in genetics, the basic model for an inheritance, models for genetic Improvement, selection and mutation, applications in ecology.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Bio-mathematics

Unit-1: Epidemic models: Deterministic models without removal, a general deterministic model with removal, a general deterministic model with removal and immigration, and control of an epidemic.

Unit-2: Mathematical models in Pharmacokinetics: basic equations and their solutions, solutions for special cases, determination of transfer coefficients and compartment volumes, mathematical techniques used in compartment analysis, stochastic compartment models.

Unit-3: Models for blood flow some basic concepts for fluid dynamics, basic concepts about blood, cardiovascular system and blood flows, steady non-Newtonian fluid flow in circular tubes, Newtonian pulsatile flows in rigid and elastic tubes, blood flow through the artery with mild stenosis, peristaltic flow in tubes and channels, models for air flow in lungs,

Unit-4: Diffusion and Diffusion-reaction models, the diffusion equations, oxygen diffusion living tissues. Non-linear populations growth models, models in genetics, the basic model for an inheritance, models for genetic improvement, selection and mutation, applications in ecology

Suggested Reference Books:

1. C.G. Caro, T.J. Pedley, R. Schroter, "Mechanics of circulation" Oxford University Press., 1978.

2. Susan J Hall, "Basic Biomechanics Boston", McGraw-Hill Companies, Inc., 1999.

Soft Computing

Subject Code:C-**18**	Soft Computing	L.T.P Model	CREDIT-5

Course Outcomes (CO's): After the completion of this course the students will be able to

CO1: Recall the basics of neural Networks

i.e. Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory.

CO2: Acknowledge the concept of backpropagation networks architecture

i.e. perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, the effect of learning rule co-efficient; backpropagation algorithm, factors affecting backpropagation training, applications.

CO3: Understand the concept of fuzzy Logic

i.e. Basic Concepts of fuzzy sets and logic, membership functions, interference in fuzzy logic, fuzzy if-then rules, fuzzy implications and fuzzy algorithms, fuzzyfications & defuzzificataions, fuzzy controller, industrial applications.

CO4: Analyse the basic concept of genetic algorithm (GA)

i.e. working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, and applications.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Soft Computing

Unit-1: Neural Networks-1(Introduction & Architecture) Neuron, Nerve structure and synapse, Artificial Neuron and its model, activation functions, Neural network architecture: single layer and multilayer feed forward networks, recurrent networks. Various learning techniques; perception and convergence rule, Auto-associative and hetro-associative memory.

Unit-2: Neural Networks-II (Backpropagation networks) Architecture: perceptron model, solution, single layer artificial neural network, multilayer perception model; back propagation learning methods, the effect of learning rule co-efficient; backpropagation algorithm, factors affecting backpropagation training, applications.

Unit-3: Fuzzy Logic –Basic Concepts of fuzzy sets and logic, Membership functions, interference in fuzzy logic, fuzzy if-then rules, Fuzzy implications and Fuzzy algorithms, Fuzzyfications & Defuzzificataions, Fuzzy Controller, Industrial applications.

Unit-4: Genetic Algorithm (GA) Basic concepts, working principle, procedures of GA, flow chart of GA, Genetic representations, (encoding) Initialization and selection, Genetic operators, Mutation, Generational Cycle, and applications.

Suggested Reference Books:

1. S. N. Sivanandam & S. N. Deepa, “Principles of Soft Computing”, 2nd edition, Wiley India, 2008.

2. David E. Goldberg, “Genetic Algorithms-In Search, optimization and Machine learning”, Pearson Education.

3. J. S. R. Jang, C.T. Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, Pearson Education, 2004. 4. G.J. Klir & B. Yuan, “Fuzzy Sets & Fuzzy Logic”, PHI, 1995.

4. Melanie Mitchell, “An Introduction to Genetic Algorithm”, PHI, 1998.

5. Timothy J. Ross, “Fuzzy Logic with Engineering Applications”, McGraw- Hill International editions, 1995

Special Function

Subject Code:C-**19**	Special Function	L.T.P Model	CREDIT-5

Course Outcomes (COs): After the completion of this course the students will be able to

CO1: Understand the concept of series solution of second order linear differential equations.

CO2: define the concept of the Gamma and Beta functions and study the basic properties.

CO3: study the concept of hypergeometric functions.

CO4: Analyse the basic concept of Legendre Functions.

CO5: Demonstrate the concept of Bessel Functions and Hermite functions.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3
CO5	1	1	1	2	1	1	-	-	1	-	2	1	2	3	3

Syllabus

Special Function

Unit-1: Series solution of second order linear differential equations: Ordinary and singular points of a linear differential equation, The point at infinity, Series solution near regular singular point.

Unit-2: The Gamma and Beta functions: Definitions and basic properties.

Unit-3: Hypergeometric Functions: The hypergeometric series, An integral formula for the hypergeometric series, The hypergeometric equation, Linear relations between the solutions of the hypergeometric equation, Relations of contiguity, and the confluent hypergeometric function.

Unit-4: Legendre Functions: Legendre polynomials, Recurrence relations for the Legendre polynomials, The formulae of Murphy and Rodrigues, Series of Legendre polynomials, Legendre's differential equation.

Unit-5: Bessel Functions: The origin of Bessel functions, Recurrence relations for the Bessel coefficients, Series expansion for the Bessel coefficients, Integral expressions for the Bessel coefficients, The additional formula for the Bessel coefficients, Bessel's differential equation.

Hermite Functions: The Hermite polynomials, Hermite differential equation, Hermite functions.

Suggested Reference Books:

George E.A., Richard A. and Ranjan R., "Special Functions" Cambridge University Press,1st edition,2000.

Measure Theory

Subject Code:C-18	Measure Theory	L.T.P Model	CREDIT-5

Course Outcomes (CO's): After the completion of this course the students will be able to

CO1: Understand the basic concept of introduction and motivation of Measure theory,

i.e. Motivation and definition of Lebesgue outer measure on R^n. Properties of Lebesgue outer measure on R^n, Caratheodory extension theorem.

CO2: Study the basic concept of Lebesgue measurability, Vitali and Cantor sets, Boolean and sigma algebras

i.e. Abstract measure spaces with examples: Borel and Radon measures, Metric outer measures, Lebesgue-Stieljes measures, Hausdorff measures and dimension.

CO3: Examine the basic concept of measurable functions and abstract Lebesgue integration, Monotone convergence theorem, Fatou's lemma, Tonnelli's theorem, Dominated convergence theorem, the space L^1. Various modes of convergence and their interdependence.

CO4: Analyse the concept of Riesz representation theorem, illustrate the measures constructed via RRT. Product measures and Fubini-Tonnelli theorem. Hardy-Littlewood Maximal inequality and Lebesgue's differentiation theorem.

COs-POs & PSOs MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	2	1	1	2	1	1	-	-	2	-	3	1	3	3	3
CO2	2	1	-	1	1	2	-	-	2	-	3	2	3	2	3
CO3	2	1	1	1	-	-	-	-	2	-	3	2	3	3	2
CO4	1	2	1	1	1	1	-	-	2	-	3	1	2	3	3

Syllabus

Measure Theory

Unit-1: Introduction and Motivation of Measure theory, Motivation and definition of Lebesgue outer measure on R^n. Properties of Lebesgue outer measure on R^n, Caratheodory extension theorem.

Unit-2: Lebesgue measurability, Vitali and Cantor sets, Boolean and sigma algebrasAbstract measure spaces with examples: Borel and Radon measures, Metric outer measures, Lebesgue-Stieljes measures, Hausdorff measures and dimension.

Unit-3: Measurable functions and abstract Lebesgue integration, Monotone convergence theorem, Fatou's lemma, Tonnelli's theorem Borel-Cantelli Lemma, Dominated convergence theorem, the space L^1, Various modes of convergence and their interdependence.

Unit-4: Riesz representation theorem, examples of measures constructed via RRT. Product measures and Fubini-Tonnelli theorem. Hardy-Littlewood Maximal inequality and Lebesgue's differentiation theorem.

***Suggested Reference Books**:*

1. I.K. Rana, “An Introduction to Measure and Integration”, Second Edition, Narosa, 2005.

2. D.L. Cohn, “Measure Theory”, Birkhauser, 1997.

3. P.K. Jain and V.P. Gupta, “Lebesgue Measure and Integration”, New Age International, 2006