BHARATHIDASAN UNIVERSITY TIRUCHIRAPPALLI - 620 024

M.Sc. MATHEMATICS: CHOICE BASED CREDIT SYSTEM – LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2022-2023 onwards)

Sem	Course	Title	Ins. Hrs / Week	Credit	Exam Hrs	Marks		Total
						Int.	Ext.	
I	Core Course – I (CC)	Algebra	6	5	3	25	75	100
	Core Course – II (CC)	Real Analysis	6	5	3	25	75	100
	Core Course – III (CC)	Ordinary Differential Equations	6	5	3	25	75	100
	Core Choice Course – I (CCC) (any one title)	1. Classical Dynamics (or) 2. Automata Theory	6	5	3	25	75	100
	Elective Course – I (EC)	Any one from the list	6	4	3	25	75	100
	TOTAL		**30**	**24**				**500**
II	Core Course – IV (CC)	Complex Analysis	6	5	3	25	75	100
	Core Course – V (CC)	Linear Algebra	6	5	3	25	75	100
	Core Choice Course – II(CCC) (any one title)	1. Partial Differential Equations (or) 2. Nonlinear Differential Equations	6	5	3	25	75	100
	Elective Course – II (EC)	Any one from the list	6	4	3	25	75	100
	Non-Major Elective – I (NME)	Statistics	3	2	3	25	75	100
	Value-Added Course – I (VAC) (any one title)	1. Introduction to LATEX (or) 2. Introduction to MAT LAB	3	2*	3	40	60	100
	TOTAL		**30**	**21**				**500**

***The value added courses credit will not be included in the total CGPA.**
These courses are extra-credit courses.
Instruction hours for these courses is 30 hours.

LIST OF ELECTIVE COURSES

Elective I		Elective II	
1	Graph Theory	1	Optimization Techniques
2	Discrete Mathematics	2	Mathematical Modeling
3	Fuzzy Set Theory	3	Stochastic Processes
Elective III		**Elective IV**	
1	Integral Equations and Calculus of Variations	1	Theory of Probability
2	Financial Mathematics	2	Tensor Analysis and Special Theory of Relativity
3	Combinatorics	3	Algebraic Topology

SUMMARY OF CURRICULUM STRUCTURE OF PG PROGRAMMES

Sl. No.	Types of the Courses	No. of Courses	No. of Credits	Marks
1.	Core Courses	10	50	800
2.	Core Choice Courses	3	15	300
3.	Elective Courses	4	16	300
4.	Entrepreneurship/ Industry Based Course	1	5	100
5.	Project	1	5	100
6.	Non-Major Elective Courses	2	4	200
	Total	**21**	**90**	**2100**
	Value Added Courses *	2*	4*	200*

PROGRAMME OUTCOMES:

- Master Degree Programme in Mathematics will meet the present day needs of academic and Research, Institutions and Industries.
- Students may acquire depth knowledge in Algebra, Analysis, Topology, Functional Analysis, Optimization Techniques and Graph Theory which will motivate the students to go for higher studies/research in Mathematics.
- Inculcate critical thinking to carry out scientific investigation objectively without being biased with preconceived notions.
- Prepare students for pursuing research or careers in mathematical sciences and applied fields.
- Equip the student with skills to analyze problems, formulate a hypothesis, evaluate and validate results, and draw reasonable conclusions thereof.

PROGRAMME SPECIFIC OUTCOMES:

- Mastery of Fundamental Mathematical Concepts (Algebra, Analysis, Geometry)
- Will gain the ability to understand and deal with abstract concepts
- Communicate mathematical concepts effectively
- Ability to think critically and creatively
- Analyze and model real world problems based on mathematical principles
- Ability to solve problems which are modeled
- Communicate the solutions in rigorous mathematical language
- Ability to progress independently and ethically

EMPLOYABILITY OPPORTUNITIES:

After completing M.Sc. Mathematics programme, students can

- Proceed higher studies and become an academician such as professors etc.
- Be a scientific officer on ISRO, DRDO, NAL.
- Play a big role in Information and Communication Technology.
- Be a Datascience modelers.
- Be a Quantitative Risk Analyst.
- Be an interest rate trading strategist.
- Be an operational researchers.
- Become a crypto-engineer.
- Be a professional in investment banking.
- Clear any eligible competitive examination and become a state or central government employee.

*****

First Year	CORE COURSE I ALGEBRA	Semester: I
Code:	(Theory)	Credit: 5

OBJECTIVES:

- To give foundation in Algebraic structures like Groups ,Rings
- To train the students in problem solving in Algebra

UNIT – I:

Set Theory – Mappings – Group – Subgroups – A counting Principle - Normal Subgroups and Quotient groups.

UNIT – II:

Homomorphism – Cayley's theorem – Permutation groups – Another counting principle – Sylow's theorems.

UNIT – III:

Homomorphisms -Ideals and quotient rings – More ideals and quotient rings – Euclidean Rings-A particular Euclidean Ring.

UNIT – IV:

Polynomial rings – Polynomials over the rational field – polynomials over commutative Rings -Inner Product spaces.

UNIT – V:

FIELDS: Extension fields – Roots of Polynomials – More about roots – The elements of Galois theory– Finite fields.

UNIT – VI CURRENT CONTOUR (For Continuous Internal Assessment Only):

Classification of finite Groups - Commutative rings, Applications of field theory to coding theory.

REFERENCES:

1. I.N. Herstein, Topics in Algebra, Second Edn, Wiley Eastern Limited.
   UNIT – I - Chapter 1: Sec 1.1, 1.2 Chapter 2: Sec 2.1 – 2.6
   UNIT – II - Chapter 2: Sec 2.7, 2.9, 2.10, 2.11, 2.12
   UNIT – III - Chapter 3: Sec 3.3, 3.4, 3.5, 3.7, 3.8.
   UNIT – IV - Chapter 3: 3.9, 3.10, 3.11 Chapter 4: 4.4
   UNIT – V - Chapter 5: Sec 5.1, 5.3, 5.5, 5.6 Chapter 7: Sec 7.1
2. David S. Dummit and Richard M. Foote, Abstract Algebra, Third Edition, Wiley Student Edition, 2015.
3. John, B. Fraleigh, A First Course in Abstract Algebra, Addison-Wesley Publishing Company.

4. Vijay, K. Khanna, and S.K. Bhambri, A Course in Abstract Algebra, Vikas Publishing House Pvt Limited, 1993.
5. Joseph A. Gallian, Contemporary Abstract Algebra, Fourth Edition, Narosa publishing House, 1999.
6. http://www.math.stonybrook.edu/~irwin/algbk.pdf
7. https://www.math.usm.edu/perry/old_classes/mat423fa11/notes_25aug2011.pdf

COURSE OUTCOMES:

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

- Gain expertise in the basic concepts of group theory with the help of numerous examples.
- Discuss in detail about permutation groups and Normal subgroups and discuss on counting tricks in algebra.
- Bring out the key steps involved in proving Sylow theorems and use Sylow's theorems to classify groups of finite order upto 120.
- Learn the fundamental concept in field theory of field extensions and would see the idea of generating new fields.
- Have clear cut idea in the notions of Galois groups, normal extensions and separable extensions and illustrate them with various examples.
- Able to understand the Fundamental theorem of Galois theory.

*****

First Year	**CORE COURSE II**	**Semester: I**
	REAL ANALYSIS	
Code:	**(Theory)**	**Credit: 5**

COURSE OBJECTIVES:

- To enable the students to learn the basic concepts of Real Analysis and techniques in Analysis to prepare for the advanced courses like Functional Analysis and Advanced Analysis.

UNIT – I:

The Real and Complex Number Systems: Introduction – Ordered sets – Fields–The Real Field – Extended Real Number system–The Complex Field – Euclidean Spaces. Basic topology: Finite, countable and uncountable sets – Metric Spaces – Compact sets – Perfect sets – Connected sets.

UNIT – II:

Numerical Sequences: Convergent Sequences – Sub-sequences – Cauchy Sequences – Upper and Lower Limits – Some Special Sequences – Series– Series of Non-Negative Terms. Numerical Series: The Number e – The Root and Ratio Test – Power Series – Summation by Parts – Absolute Convergence- Addition and Multiplication of Series - Rearrangements.

UNIT – III:

Continuity: Limits of Functions - Continuous Functions – Continuity and Compactness – Continuity and Connectedness – Discontinuities – Monotonic Functions – Infinite Limits and Limits at Infinity. Differentiation: The Derivative of a Real Function – Mean Value Theorems – The Continuity of Derivatives – L'Hospital's Rule – Derivatives of Higher Order – Taylor's Theorem – Differentiation of Vector Valued Functions.

UNIT – IV:

The Riemann-Stieltjes Integral: Definition and existence of the integral – Properties of the Integral – Integration and Differentiation – Integration and vector valued functions – Rectifiable curves.

UNIT – V:

Sequence and Series of Functions: Sequence of Functions – Discussion of Main Problem–Uniform Convergence and Continuity –Uniform Convergence and Integration – Uniform Convergence and Differentiation. Families of Functions: Equi continuous Families of Functions – The Stone – Weierstrass Theorem.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Generalizations to topological spaces, Calculus on Manifolds.

REFERENCES:

1. Walter Rudin, Principles of Mathematical Analysis, 3rd Edition Tata McGraw-Hill 1985.
   UNIT – I - Chapter 1: Sec 1.1 – 1.38 & Chapter 2: Sec 2.1 – 2.47
   UNIT – II - Chapter 3: Sec 3.1 – 3.55
   UNIT – III - Chapter 4: Sec 4.1 – 4.34Chapter 5: Sec 5.1 – 5.19
   UNIT – IV - Chapter 6: Sec 6.1 – 6.27
   UNIT – V - Chapter 7: Sec 7.1 – 7.33
2. Tom. M. Apostol, Mathematical Analysis, Narosa Publishing House, New Delhi, 1997.
3. R. G. Bartle, D. R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, New York, 1982.
4. Kenneth A. Ross, Elementary Analysis: The Theory of Calculus, Springer NewYork, 2004.
5. N. L.Carothers, Real Analysis, Cambridge University Press, UK, 2000.
6. S. C. Malik, Mathematical Analysis,Willey Eastern Ltd, NewDelhi, 1985.
7. K. R. Stromberg, An Introduction to Classical Real Analysis, Wadsworth, 1981.
8. H. L. Royden, Real Analysis, Third Edition, Macmillan Publishing Company, New Delhi, 1988.
9. https://s2pnd-matematika.fkip.unpatti.ac.id/wp-content/uploads/2019/03/Real-Analysis-4th-Ed-Royden.pdf
10. http://www.freebookcentre.net/maths-books-download/gotoweb.php?id=9633

COURSE OUTCOMES:

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

- Describe fundamental properties of the real numbers that lead to the formal development of real analysis.
- Demonstrate an understanding of limits ad how that are used in sequences.
- Demonstrate an understanding of limits ad how that are used in series.
- Demonstrate an understanding of limits ad how that are used in sequences Examine and recognize the continuity of real functions.
- Demonstrate an intuitive and computational understanding of set theory, Continuity and solving application problems. This will be assessed through homework, class quizzes and tests, and a final exam.

*****

First Year **CORE COURSE III** **Semester: I**

ORDINARY DIFFERENTIAL EQUATIONS

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To give an in-depth knowledge of differential equations and their applications.
- To study the existence, uniqueness, stability behavior of the solutions of the ODE.

UNIT – I:

The general solution of the homogeneous equation– he use of one known solution to find another – The method of variation of parameters – Power Series solutions. A review of power series– Series solutions of first order equations – Second order linear equations; Ordinary points.

UNIT – II:

Regular Singular Points – Gauss's hypergeometric equation – The Point at infinity - Legendre Polynomials – Bessel functions – Properties of Legendre Polynomials and Bessel functions.

UNIT – III:

Linear Systems of First Order Equations – Homogeneous Equations with Constant Coefficients – The Existence and Uniqueness of Solutions of Initial Value Problem for First Order Ordinary Differential Equations – The Method of Solutions of Successive Approximations and Picard's Theorem.

UNIT – IV:

Oscillation Theory and Boundary value problems – Qualitative Properties of Solutions – Sturm Comparison Theorems – Eigen values, Eigen functions and the Vibrating String.

UNIT – V:

Nonlinear equations: Autonomous Systems; the phase plane and its phenomena – Types of critical points; Stability – critical points and stability for linear systems – Stability by Liapunov's direct method – Simple critical points of nonlinear systems.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

System of ode and using Canonical forms to solve.

REFERENCES:

1. G.F. Simmons, Differential Equations with Applications and Historical Notes, TMH, New Delhi, 1984.
   UNIT – I - Chapter 3: Sections 15, 16, 19 and Chapter 5: Sections 25 to 27
   UNIT – II - Chapter 5: Sections 28 to 31 and Chapter 6: Sections 32 to 35
   UNIT – III - Chapter 7: Sections 37, 38 and Chapter 11: Sections 55, 56
   UNIT – IV - Chapter 4: Sections 22 to 24
   UNIT – V - Chapter 8: Sections 42 to 44
2. W.T. Reid, Ordinary Differential Equations, John Wiley & Sons, New York, 1971.
3. E.A. Coddingtonand N. Levinson, Theory of Ordinary Differential Equaitons, McGraw Hill Publishing Company, New York, 1955.
4. http://www.freebookcentre.net/maths-books-download/gotoweb.php?id=8714
5. https://s3.amazonaws.com/open-bookshelf-content/Open+Textbook+Library/URI/urn%3Auuid%3Ae46a68f9-3e84-4999-b9f6-18c3dfb2faca/Ordinary+Differential+Equations.pdf

COURSE OUTCOMES:

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

1. Find the general solution of the first order linear homogeneous equations.
2. Understand the utility of the theory of power series which is studied in Real Analysis course through solving various second order differential equations.
3. Get introduced to the Hypergeometricfunctions which arises in connection with solutions of the second order ordinary differential equations with regular singular points.
4. Solve the problems arises in Mathematical physics using properties of special functions.
5. Understand the importance of studying well-posedness of the problem namely existence, uniqueness and continuous dependence of first order differential equations through Picard's theorem.
6. Understand the utility of the concepts from linear algebra and analysis in the study of system of first order equations.
7. Discuss the Qualitative properties of solutions of first and second order equations. Also they will be able to work on numerous problems using comparison theorem in Sturm Liouville problems.
8. Learn the nature of solutions which involves critical points and phase portrait of nonlinear equations.

*****

First Year **CORE CHOICE COURSE I** **Semester: I**

1) CLASSICAL DYNAMICS

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To give a detailed knowledge of the mechanical system of particles.
- To study the applications of Lagrange's and Hamilton's equations.

UNIT – I:

Introductory concepts: The mechanical system - Generalised Coordinates - constraints - virtual work - Energy and momentum.

UNIT – II:

Lagrange's equation: Derivation and examples - Integrals of the Motion - Small oscillations.

UNIT – III:

Special Applications of Lagrange's Equations: Rayleigh's dissipation function - impulsive motion - Gyroscopic systems - velocity dependent potentials.

UNIT – IV:

Hamilton's equations: Hamilton's principle - Hamilton's equations - Other variational principles - phase space.

UNIT – V:

Hamilton - Jacobi Theory: Hamilton's Principal Function – The Hamilton - Jacobi equation - Separability.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Introduction to relativity

REFERENCES:

1. Donald T. Greenwood, Classical Dynamics, PHI Pvt. Ltd., New Delhi-1985.
   UNIT – I - Chapter 1: Sections 1.1-1.5
   UNIT – II - Chapter 2: Sections 2.1-2.4
   UNIT – III - Chapter 3: Sections 3.1-3.4
   UNIT – IV - Chapter 4: Sections 4.1-4.4
   UNIT – V - Chapter 5: Sections 5.1-5.3
2. H. Goldstein, Classical Mechanics, (2nd Edition), Narosa Publishing House, New Delhi.
3. Narayan Chandra Rana&PromodSharad Chandra Joag, Classical Mechanics, Tata Mc Graw Hill, 1991.

4. https://www.pdfdrive.com/download.pdf?id=158582740&h=933106dae8af21f34ec9c7549706b1ed&u=cache&ext=pdf
5. https://www.pdfdrive.com/download.pdf?id=33509812&h=f116b9421b66220f909db64ed8661069&u=cache&ext=pdf

COURSE OUTCOMES:

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

- Understand the important definitions and introductory concepts like the ideas of virtualwork and d'Alembert's principle.
- Derive Lagrange's equations of motion using d'Alembert's principle.
- Understand the nature of equations of motion for holonomic and nonholonomic systems.
- Understand the idea of impulsive constraints.
- Compare dissipative systems and velocity dependent potentials.
- Understand the Hamiltonian view point of dynamics in canonical equations of motion and phase space.
- Understand the concepts of Hamilton - Jacobi theory.
- Obtain some concrete procedure for solving problems using the theory of canonical transformations.

*****

First Year | **CORE CHOICE COURSE I** | **Semester: I**

2) AUTOMATA THEORY

Code: | **(Theory)** | **Credit: 5**

COURSE OBJECTIVES:

- To make the students to understand the nuances of Automata and Grammar.
- To make them to understand the applications of these techniques in computer science.

UNIT – I:

Finite Automata and Regular expressions: Definitions and examples - Deterministic and Nondeterministic finite Automata - Finite Automata with - moves.

UNIT – II:

Context free grammar: Regular expressions and their relationship with automation - Grammar -Ambiguous and unambiguous grammars - Derivation trees – Chomsky Normal form.

UNIT – III:

Pushdown Automaton: Pushdown Automaton - Definition and examples - Relation with Context free languages.

UNIT – IV:

Finite Automata and lexical analysis: Role of a lexical analyzer - Minimizing the number of states of a DFA -Implementation of a lexical analyzer.

UNIT – V:

Basic parsing techniques: Parsers - Bottom up Parsers - Shift reduce - operator precedence - Top down Parsers - Recursive descent - Predictive parsers.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Applications of automata on infinite words to logic and program verification

REFERENCES:

1. John E. Hopcroft and Jeffrey D. Ullman, Introduction to Automata theory, Languages and Computations, Narosa Publishing House, Chennai, 2000.
2. A.V. Aho and Jeffrey D. Ullman, Principles of Compiler Design, Narosa Publishing House, Chennai, 2002.

UNIT – I - Chapter 2: Sections2.1-2.4 of (1)
UNIT – II - Chapter 2: Section 2.5, Chapter 4: Sections 4.1-4.3, 4.5,4.6 of (1)
UNIT – III - Chapter 5: Section 5.2, 5.3 of (1)

UNIT – IV - Chapter 3: Section 3.1-3.8 of (2)
UNIT – V - Chapter 5: Sections 5.1-5.5 of (2)

3. Harry R. Lewis and Christos H. Papadimitriou, Elements of the Theoryof Computation, Second Edition, Prentice Hall, 1997.
4. A.V. Aho, Monica S. Lam, R. Sethi, J.D. Ullman, Compilers: Principles,Techniques and Tools, Second Edition, Addison-Wesley, 2007.
5. https://www.pdfdrive.com/download.pdf?id=43053701&h=c8a1bf37c9665471f52f8dbbb722fcad&u=cache&ext=pdf
6. https://www.pdfdrive.com/download.pdf?id=165866660&h=fd2fb0e39a54f5571a50d79af60958df&u=cache&ext=epub

COURSE OUTCOMES:

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

- Relate practical problems to languages, automata, and computability
- Demonstrate an increased level of mathematical sophistication
- Apply mathematical and formal techniques for solving problems

*****

First Year **ELECTIVE COURSE I** **Semester: I**

1) GRAPH THEORY

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To give a rigorous study of the basic concepts of Graph Theory.
- To study the applications of Graph Theory in other disciplines.

Note: Theorems, Propositions and results which are starred are to be omitted.

UNIT – I:

Basic Results: Basic Concepts - Subgraphs - Degrees of Vertices - Paths and Connectedness- Operations on Graphs - Directed Graphs: Basic Concepts – Tournaments.

UNIT – II:

Connectivity: Vertex Cuts and Edge Cuts - Connectivity and Edge - Connectivity, Trees: Definitions, Characterization and Simple Properties - Counting the Number of Spanning Trees - Cayley's Formula.

UNIT – III:

Independent Sets and Matchings: Vertex Independent Sets and Vertex Coverings - Edge Independent Sets -Matchings and Factors - Eulerian Graphs - Hamiltonian Graphs.

UNIT – IV:

Graph Colourings: Vertex Colouring - Critical Graphs - Triangle - Free Graphs - Edge Colouringsof Graphs - Chromatic Polynomials.

UNIT – V:

Planarity: Planar and Nonplanar Graphs - Euler Formula and its Consequences - K5 and K3,3 are Nonplanar Graphs - Dual of a Plane Graph - The Four-Colour Theorem and the Heawood Five-Colour Theorem-Kuratowski's Theorem.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

The Four Color Conjecture

TEXT BOOK(S):

1. R. Balakrishnan, K. Ranganathan, A Textbook of Graph Theory, Springer International Edition, New Delhi, 2008.
   UNIT I - Chapter I & II: 1.1 to 1.4, 1.7, 2.1, 2.2
   UNIT II - Chapter III & IV: 3.1, 3.2, 4.1, 4.3 to 4.4
   UNIT III - Chapter V & VI: 5.1 to 5.4, 6.1, 6.2

UNIT IV - Chapter VII: 7.1 to 7.4, 7.7
UNIT V - Chapter VIII: 8.1 to 8.6

2. J.A. Bondy, U.S.R. Murty, Graph Theory with Applications, Mac MilanPress Ltd., 1976.
3. Gary Chartrand, Linda Lesniak, Ping Zhang, Graphs and Digraph,CRC press,2010.
4. F.Harary, Graph Theory, Addison - Wesley, Reading, Mass., 1969.
5. https://www.whitman.edu/mathematics/cgt_online/cgt.pdf
6. https://www.pdfdrive.com/download.pdf?id=188461519&h=0e27445c1a90d11918eeab7108536b09&u=cache&ext=pdf

COURSE OUTCOMES:

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

- Understand and work on the fundamental concepts of graphs.
- Apply graph theory based tools in solving practical problems.
- Understand basic concepts in Trees and discuss matching problems and its applications elsewhere.
- Comprehend and work on the concepts of planarity and discuss the dual of a plane graph.

*****

First Year **ELECTIVE COURSE I** **Semester: I**

2) DISCRETE MATHEMATICS

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To study the concepts like Boolean algebra, coding theory.
- To introduce the different notions grammar.

UNIT – I:

Relations and Functions: Binary relations, equivalence relations and partitions, partial order relations, inclusion and exclusion principle, Hasse diagram, Pigeon hole principle. Functions, inverse functions, compositions of functions, recursive functions.

UNIT – II:

Mathematical Logic: Logic operators, Truth tables, Theory of inference and deduction, mathematical calculus, predicate calculus, predicates and qualifiers.

UNIT – III:

Lattices: Lattices as Partially Ordered Sets. Their Properties, Lattices as algebraic Systems, Sub lattices, Direct Product and homomorphism. Some Special Lattices - Complete, Complemented and Distributive Lattices, Isomorphic Lattices.

UNIT – IV:

Boolean algebra: Various Boolean identities, the switching Algebra Example, Sub Algebras, Direct Production and Homomorphism. Boolean Forms and their Equivalence, Midterm Boolean forms, Sum of Products, Canonical Forms. Minimization of Boolean Functions.The Karnuagh Map Method.**Coding Theory:** Coding of binary information and error detection, Group codes, decoding and error correction.

UNIT – V:

Grammar and Languages: Phrase structure grammars, rewriting rules, derivation sentential forms, language generated by grammar, regular, context free and context sensitive grammar and languages.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Perron -Frobenius theorem and Google's Page rank.

REFERENCES:

1. Trembly. J.P &Manohar. P., “Discrete Mathematical Structures with Applications to Computer Science” McGraw- Hill.
2. Liu, C.L., “Elements of Discrete Mathematics”, McGraw-Hill Book co.

3. K.D Joshi, "Foundations of Discrete Mathematics", Wiley Eastern Limited.
4. Kolman, Busy & Ross, "Discrete Mathematical Structures", PHI.
5. Alan Doer: "Applied Discrete Structure for Computer Science", Galgotia Publications Pvt. Ltd.
6. Seymour Lipschutz, M. Lipson: "Discrete Mathematics", McGraw-Hill Edition.
7. Kenneth G. Roden: "Discrete Mathematics and its Applications", McGraw-Hill international editions, Mathematics Series.
8. http://discrete.openmathbooks.org/pdfs/dmoi-tablet.pdf
9. https://www.pdfdrive.com/download.pdf?id=6841453&h=4e81fe396ba8fe28e9fddc1f328c6fc3&u=cache&ext=pdf

COURSE OUTCOMES:

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

- Understand relations and functions and work with them.
- Understand functions of logic gates and use it to carry out logical operations on single or multiple binary inputs and give one binary output.
- Work with fundamental concepts and basic laws of Boolean algebra.

*****

First Year **ELECTIVE COURSE I** **Semester: I**

3) FUZZY SET THEORY

Code: **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

- To introduce the concept of fuzzy theory and study its application in real problems
- To study the uncertainty environment through the fuzzy sets that incorporates imprecision and subjectivity into the model formulation and solution process.

UNIT – I:

From Classical Sets To Fuzzy Sets, Fuzzy Sets Verses Crisp Sets: Fuzzy sets: Basic types – Fuzzy sets: Basic Concepts –Additional Properties of α – cuts- Extension Principle for fuzzy sets.

UNIT – II:

Operations On Fuzzy Sets: Types of operations– Fuzzy complements- Fuzzy Intersections: t-Norms – Fuzzy Unions: t-Conorms - Combinations of Operations.

UNIT – III:

Fuzzy Arithmetic: Fuzzy numbers - Linguistic variables - Arithmetic operations on intervals – Arithmetic operations on Fuzzy numbers.

UNIT – IV:

Fuzzy Relations: Binary Fuzzy Relations – Binary Relations on a Single Set – Fuzzy Equivalence Relations – Fuzzy Compatibility Relations –Fuzzy Ordering Relations – Fuzzy Morphisms.

UNIT – V:

Fuzzy Decision Making: Individual decision making – Multiperson Decision Making-Ranking methods – Fuzzy Linear programming.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Bipolar fuzzy sets

REFERENCES:

1. George J. Klir and Bo Yuan, Fuzzy sets and Fuzzy Logic Theory and Applications, Prentice Hall of India, (2005).
   UNIT I - Chapter 1 Sec1.3, 1.4, Chapter :2 Sec 2.1, 2.3
   UNIT II - Chapter 3 Sec 3.1, 3.2, 3.3, 3.4, 3.5.
   UNIT III - Chapter 4 Sec4.1,4.2, 4.3, 4.4.

UNIT IV- Chapter 5 Sec 5.3 ,5.4, 5.5, 5.6, 5.7, 5.8.
UNIT V - Chapter 15 Sec 15.2,15.3, 15.6, 15.7

2. H.J. Zimmermann, Fuzzy Set Theory and its Applications, Allied Publishers Limited (1991).
3. M. Ganesh, Introduction to Fuzzy sets and Fuzzy logic, Prentice Hall of India, New Delhi (2006).
4. https://cours.etsmtl.ca/sys843/REFS/Books/ZimmermannFuzzySetTheory2001.pdf
5. https://www.mdpi.com/books/pdfdownload/book/4344

COURSE OUTCOMES:

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

- Interpret fuzzy set theory and uncertainty concepts.
- Identify the similarities and differences between probability theory and fuzzy set theoryand their application conditions.
- Apply fuzzy set theory in modeling and analyzing uncertainty in a decision problem.
- Apply fuzzy control by examining simple control problem examples.

*****

First Year **CORE COURSE IV** **Semester: II**

COMPLEX ANALYSIS

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To learn the various intrinsic concepts and the theory of Complex Analysis.
- To study the concept of Analyticity, Complex Integration and Infinite Products in depth.

UNIT – I:

Elementary Point Set Topology: Sets and Elements – Metric Spaces – Connectedness – Compactness – Continuous Functions – Topological Spaces; Conformality: Arcs and Closed Curves – Analytic Functions in Regions – Conformal Mapping – Length and Area; Linear Transformations: The Linear Group – The Cross Ratio – Symmetry.

UNIT – II:

Fundamental theorems in complex integration: Line Integrals – Rectifiable Arcs – Line Integrals as Functions of Arcs – Cauchy's Theorem for a Rectangle – Cauchy's Theorem in a Disk; Cauchy's Integral Formula: The Index of a Point with Respect to a Closed Curve – The Integral Formula – Higher Derivatives.

UNIT – III:

Local Properties of Analytic Functions - Removable Singularities - Taylor's Theorem – Integral representation of the nth term - Zeros and Poles – Algebraic order of f(z) – Essential Singularity - The Local Mapping – The Open Mapping Theorem - The Maximum Principle.

UNIT – IV:

The General Form of Cauchy's Theorem: Chains and Cycles – Simple Connectivity – Homology – The General Statement of Cauchy's Theorem – Proof of Cauchy's Theorem – Locally Exact Differentials – Multiply Connected Regions; The Calculus of Residues: The Residue Theorem – The Argument Principle – Evaluation of Definite Integrals.

UNIT – V:

Harmonic Functions: Definition and Basic Properties – The Mean-value Property – Poisson's Formula – Schwarz's Theorem – The Reflection Principle; Power series expansions-Weierstrass's Theorem – The Taylor Series – The Laurent Series.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Analytic Continuation - Global version of Cauchy's theorem

REFERENCES:

1. Lars V. Ahlfors, Complex Analysis, Third Ed. McGraw-Hill Book Company, Tokyo, 1979.
   UNIT – I - Chapter 3: 1.1-1.6, 2.1-2.4,3.1-3.3
   UNIT – II - Chapter 4: 1.1-1.5, 2.1-2.3
   UNIT – III - Chapter 4: 3.1, 3.2, 3.3,3.4
   UNIT – IV - Chapter 4: 4.1-4.7, 5.1-5.3
   UNIT – V - Chapter 4: 6.1-6.5 and Chapter 5: 1.1-1.3
2. Serge Lang, Complex Analysis, Addison Wesley, 1977.
3. S. Ponnusamy, Foundations of Complex Analysis, Narosa Publishing House, NewDelhi, 1997.
4. Karunakaran, Complex Analysis, Alpha Science international Ltd,Second edition, 2005.
5. https://s2pnd-matematika.fkip.unpatti.ac.id/wp-content/uploads/2019/03/John-M.-Howie-Complex-Analysis-Springer-Undergraduate-Mathematics-Series-Springer-2007.pdf
6. https://mccuan.math.gatech.edu/courses/6321/lars-ahlfors-complex-analysis-third-edition-mcgraw-hill-science_engineering_math-1979.pdf

COURSE OUTCOMES:

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

- Understand the complex number system from geometric view point. Will gain mastery in arguments on C* and logarithms.
- Get expertise in the concept of convergence of sequences and series of complex numbers, continuity and differentiability of function on complex numbers. Also the students will be able to thoroughly understand and know the importance of power series in complex analysis.
- Workout the path integrals on the complex plane.
- Understand the central theme of Cauchy theory, viz., existence of local primitives and local power series expansion.
- Get acquainted with various techniques of proving fundamental theorem of algebra, open mapping theorem, maximum modulus theorem and Liouville's theorem.
- Classify singularities, compute poles and residues and understand the Laurent series expansion.
- Appreciate and work on the topology of extended complex plane.

*****

First Year | **CORE COURSE V** | **Semester: II**

LINEAR ALGEBRA

Code: | **(Theory)** | **Credit: 5**

COURSE OBJECTIVES:

- To give the students a thorough knowledge of the various aspects of Linear Algebra
- To train the students in problem-solving as a preparatory for competitive exam.

UNIT – I:

Matrices: Systems of linear Equations - Matrices and Elementary Row operations -Row-reduced echelon Matrices - Matrix Multiplication - Invertible Matrices-Bases and Dimension. (Only revision of Vector spaces and subspaces).

UNIT – II:

Linear transformations: The algebra of linear transformations - Isomorphism of Vector Spaces -Representations of Linear Transformations by Matrices - Linear Functionals - The Double Dual - The Transpose of a Linear Transformation.

UNIT – III:

Algebra of polynomials: The algebra of polynomials - Lagrange Interpolation - Polynomial Ideals -The prime factorization of a polynomial - Commutative rings – Determinant functions.

UNIT – IV:

Determinants: Permutations and the uniqueness of determinants - Classical Adjoint of a (square) matrix - Inverse of an invertible matrix using determinants - Characteristic values - Annihilating polynomials.

UNIT – V:

Diagonalization: Invariant subspaces - Simultaneous triangulation and simultaneous Diagonalization Direct-sum Decompositions - Invariant Direct sums – Primary Decomposition theorem.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Introduction to Module theory

REFERENCES:

1. Kenneth Hoffman and Ray Alden Kunze, Linear Algebra, Second Edition, Prentice Hall of India Private Limited, New Delhi, 1975.
   UNIT – I - Chapter 1 & 2 1.2-1.6 and 2.3
   UNIT – II - Chapter 3
   UNIT – III - Chapter 4 & 5 4.1 - 4.5 and 5.1 - 5.2
   UNIT – IV - Chapter 5 & 6 5.3, 5.4 and 6.1 - 6.3

UNIT – V - Chapter 6 6.4 - 6.8

2. S. Kumaresan, Linear Algebra: A Geometric Approach, Prentice-Hall of India Ltd, 2004.
3. V. Krishnamurthy, V.P. Mainra, J.L. Arora, Introduction to Linear Algebra,East West Press Ltd, 1985.
4. A.R. Rao, P. Bhimashankaram, Linear Algebra, Second Edition, Tata McGraw Hill, 2000.
5. Edgar G.Goodaire,Linear Algebra-Pure & Applied World Scientific,Cambridge University Press India Ltd, 2014.
6. https://joshua.smcvt.edu/linearalgebra/book.pdf
7. https://resources.saylor.org/wwwresources/archived/site/wp-content/uploads/2012/02/Linear-Algebra-Kuttler-1-30-11-OTC.pdf

COURSE OUTCOMES:

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

- Realise that the subject evolves as a generalization of solving a system of linear equations.
- Discuss in detail the basic concepts of Linear dependence, basis and dimension of a vector space. The students will be able to demonstrate how the geometric ideas turn into rigorous proofs.
- Master the dimension formula and rank and nullity theorem which are often exploited.
- Capture the idea of producing lot of structure preserving maps (Linear transformations). Further the study of algebras of linear maps would be accomplished.
- Having got trained in numerous examples the student realizes the isomorphic theory of linear transformations and matrices.
- Learn the theory of determinants and put them in practice.
- Understand that the central theme of structure theory of linear maps is to decompose the given vector space as a direct sum of generalized the Eigen spaces using the given map on it.
- Understand that linear Algebra plays a fundamental role in many areas of mathematics including Algebra, Geometry, Functional analysis and which finds widest application in Physics, Chemistry and elsewhere.

*****

First Year **CORE CHOICE COURSE II** **Semester: II**

1) PARTIAL DIFFERENTIAL EQUATIONS

Code: **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

- To give an in-depth knowledge of solving partial differential equations and apply them in scientific and engineering problems.
- To study the other aspects of PDE.

UNIT – I:

Partial differential equations- origins of first order Partial differential equations- Cauchy's problem for first order equations- Linear equations of the first order- Integral surfaces Passing through a Given curve- surfaces Orthogonal to a given system of surfaces -Nonlinear Partial differential equations of the first order.

UNIT – II:

Cauchy's method of characteristics- compatible systems of first order equations- Charpits method- Special types of first order equations- Solutions satisfying given conditions- Jacobi's method.

UNIT – III:

Partial differential equations of the second order: The origin of second order equations –second order equations in Physics – Higher order equations in Physics - Linear partial differential equations with constant co-efficient- Equations with variable coefficients-Characteristic curves of second order equations.

UNIT – IV:

Characteristics of equations in three variables- The solution of Linear Hyperbolic equations-Separation of variables.The method of Integral Transforms – Non Linear equations of the second order.

UNIT – V:

Laplace equation: Elementary solutions of Laplace's equations-Families of equipotential Surfaces- Boundary value problems-Separation of variables – Problems with Axial Symmetry.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Greens function - Theory of distributions.

REFERENCES:

1. Ian N. Sneddon,Elements of Partial differential equations, Dover Publication – INC, New York, 2006.
   UNIT – I - Chapter II Sections 1 to 7

UNIT – II - Chapter II Sections 8 to 13
UNIT – III - Chapter III Sections 1 to 6
UNIT – IV - Chapter III Sections 7 to 11
UNIT – V - Chapter IV Sections 2 to 6

2. M.D. Raisinghania, Advanced Differential Equations, S. Chand and company Ltd., New Delhi,2001.
3. E.T. Copson, Partial Differential Equations, Cambridge University Press.
4. https://s2pnd-matematika.fkip.unpatti.ac.id/wp-content/uploads/2019/03/Walter-A-Strauss-Partial-differential-equations-_-an-introduction-Wiley-2009.pdf
5. http://web.math.ucsb.edu/~moore/pde.pdf

COURSE OUTCOMES:

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

- Classify first order partial differential equations and their solutions.
- Solve first order equations and nonlinear partial differential equations using various methods.
- Use the method of characteristics to solve first order partial differential equations.
- Identify and solve the three main classes of second order equations, elliptic, parabolic and hyperbolic.
- Solve one dimensional wave equations using method of separation of variables.
- Classify the boundary value problems and analyse its solutions.
- Solve Heat conduction problem using Fourier series and cosines.
- Illustrate the use of PDE in problems from Engineering and Biological Sciences.

*****

First Year | **CORE CHOICE COURSE II** | **Semester: II**

2) NON LINEAR DIFFERENTIAL EQUATIONS

Code: | **(Theory)** | **Credit: 5**

COURSE OBJECTIVES:

- To study Non linear Differential Equation and its properties.
- To study oscillation and stability properties of the solutions.

UNIT – I:

First order systems in two variables and linearization: The general phase plane-some population models – Linear approximation at equilibrium points – Linear systems in matrix form.

UNIT – II:

Averaging Methods: An energy balance method for limit cycles – Amplitude and frequency estimates – slowly varying amplitudes – nearly periodic solutions - periodic solutions: harmony balance – Equivalent linear equation by harmonic balance – Accuracy of a period estimate.

UNIT – III:

Perturbation Methods: Outline of the direct method – Forced Oscillations far from resonance - Forced Oscillations near resonance with Weak excitation – Amplitude equation for undamped pendulum – Amplitude Perturbation for the pendulum equation – Lindstedt's Method – Forced oscillation of a self – excited equation – The Perturbation Method and Fourier series.

UNIT – IV:

Linear Systems: Time Varying Systems – Constant coefficient System – Periodic Coefficients – Floquet Theory – Wronskian.

UNIT – V:

Stability: Poincare stability – solutions, paths and norms – Liapunov stability Stability of linear systems – Comparison theorem for the zero solutions of nearly – linear systems.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Solving non-linear equations using MATLAB

REFERENCES:

1. D.W. Jordan & P. Smith, Nonlinear Ordinary Differential Equations, Clarendon Press, Oxford, 1977.

2. Differential Equations by G.F.Simmons, Tata McGraw Hill, NewDelhi (1979).
3. Ordinary Differential Equations and Stability Theory ByD.A.Sanchez, Freeman (1968).
4. Notes on Nonlinear Systems by J.K.Aggarwal, Van Nostrand, 1972.
5. http://www.freebookcentre.net/maths-books-download/gotoweb.php?id=8715
6. http://mdudde.net/pdf/study_material_DDE/M.Sc.MAthematics/DIFFERENTIAL%20EQUATIONS.pdf

COURSE OUTCOMES:

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

- Find linear approximation at equilibrium points
- Solve simple non linear differential equation using averaging methods.
- Solve some non linear differential equation using perturbation methods.

*****

First Year | **ELECTIVE COURSE II** | **Semester: II**

1) OPTIMIZATION TECHNIQUES

Code: | **(Theory)** | **Credit: 4**

COURSE OBJECTIVES:

- To provide insights into structures and processors that operations research can offer and the enormous practical utility of its various techniques.
- To explain the concepts and simultaneously to develop an understanding of problem solving methods based upon model formulation, solution procedures and analysis.

UNIT – I:

Linear Programming Problem – Pure and Mixed Integer Programming Problems – Gromory's All I.P.P. Method – Construction of Gomory's Constraints - Fractional Cut Method-All Integer LPP – Fractional Cut Method-Mixed Integer LPP – Branch and Bound Method – Applications of Integer Programming.

UNIT – II:

Dynamic Programming – The Recursive Equation Approach – Characteristics of Dynamic Programming – Dynamic Programming Algorithm – Solution of Discrete DPP – Applications – Solution of LPP by Dynamic Programming.

UNIT – III:

Goal Programming – Categorisation of Goal Programming – Formulation of Linear Goal Programming Problem – Graphical Goal Attainment Method – Simplex Method for Goal Programming Problem.

UNIT – IV:

Non-Linear Programming - Formulation - constrained optimization - with equalingconstraints, with in-equaling constraints - saddle point problems.

UNIT – V:

Non-Linear Programming problems Methods - Graphical sign - Kuhn-Tucker conditions with non- negative constrains - quadratic programming - Wolfe's modified simplex method - Beale's method - separable convex programming - separable programming Algorithm.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Solving problems using PYTHON Programming

REFERENCES:

1. KantiSwarup, P.K. Gupta, Man Mohan, Operations Research, Sultan Chand & sons, New Delhi, 2019.

UNIT – I Chapter 7
UNIT – II Chapter 13
UNIT – III Chapter 8
UNIT – IV Chapter 27
UNIT – V Chapter 28

2. Hamdy A. Taha, Operations Research (10th Edn.), McGraw Hill Publications, New Delhi.2019.
3. Bazaara, Jarvis and Sherali, Linear Programming and Network Flows, 4th ed., John Wiley, 2010
4. O.L. Mangasarian, Non Linear Programming, McGraw Hill, New York, 1994.
5. Mokther S. Bazaraa and C.M. Shetty, Non Linear Programming, Theory and Algorithms, 3rd edn, Willy, New York, 2013.
6. Prem Kumar Gupta and D.S. Hira, Operations Research: An Introduction, S. Chand and Co., Ltd. New Delhi, 2014.
7. S.S. Rao, Optimization Theory and Applications, 4th edn, Wiley, 2009.
8. G. Hadley, Linear Programming, Narosa Publishing House, 2002
9. http://www.ru.ac.bd/stat/wp-content/uploads/sites/25/2019/03/405_01_Srinivasan_Operations-Research_-Principles-and-Applications-Prentice-Hall-of-India-2010.pdf
10. https://www.bbau.ac.in/dept/UIET/EME-601%20Operation%20Research.pdf

COURSE OUTCOMES:

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

1. Do mathematical formulation of a real life problem into a linear programming problem.
2. Solve linear programming problem using graphical method and simplex method.
3. Understand Integer programming problem.
4. Find solutions to linear programming problem by dynamic programming.
5. Understand the concepts of nonlinear programming problems.
6. Solve nonlinear programming problems using Wolfe’s method and Beale's method.

*****

First Year | **ELECTIVE COURSE II** | **Semester: II**

2) MATHEMATICAL MODELING

Code: | **(Theory)** | **Credit: 4**

COURSE OBJECTIVES:

- To study the different mathematical models in ODE and Difference equations.
- To study graph theoretical models.

UNIT – I:

Mathematical Modelling through Ordinary Differential Equations of First order: Linear Growth and Decay Models – Non-Linear Growth and Decay Models – Compartment Models – Dynamics problems – Geometrical problems.

UNIT – II:

Mathematical Modelling through Systems of Ordinary Differential Equations of First Order: Population Dynamics – Epidemics – Compartment Models – Economics – Medicine, Arms Race, Battles and International Trade – Dynamics.

UNIT – III:

Mathematical Modelling through Ordinary Differential Equations of Second Order: Planetary Motions – Circular Motion and Motion of Satellites – Mathematical Modelling through Linear Differential Equations of Second Order – Miscellaneous Mathematical Models.

UNIT – IV:

Mathematical Modelling through Difference Equations: Simple Models – Basic Theory of Linear Difference Equations with Constant Coefficients – Economics and Finance – Population Dynamics and Genetics – Probability Theory.

UNIT – V:

Mathematical Modelling through Graphs: Solutions that can be Modelled through Graphs – Mathematical Modelling in Terms of Directed Graphs, Signed Graphs, Weighted Digraphs and Unoriented Graphs.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Mathematical Modelling through mathematical programming, maximum principle and maximum entropy principle.

REFERENCES:

1. J.N. Kapur, Mathematical Modelling, Wiley Eastern Limited, New Delhi, 1988.
   UNIT I - Chapter 2
   UNIT II - Chapter 3
   UNIT III - Chapter 4

UNIT IV - Chapter 5 except 5.6
UNIT V - Chapter 7

2. J. N. Kapur, Mathematical Models in Biology and Medicine, Affiliated East – West Press Pvt Limited, New Delhi, 19.
3. http://mtm.ufsc.br/~daniel/matap/IntMatMod.pdf
4. https://repository.ung.ac.id/get/kms/16993/Referensi-Mata-Kuliah-An-Introduction-to-Mathematical-Modelling.pdf

COURSE OUTCOMES:

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

1. Understand the concept of a mathematical model and explain the series of steps involved in mathematical modelling.
2. Classify different classes of mathematical models.
3. Discuss features of a good model and the benefits of using a mathematical model.
4. Identify some simple real-life problems that can be solved using mathematical models.
5. Convert the physical problems as differential equations through mathematical modelling.
6. Use the ideas of directed graphs, weighted digraphs and unoriented graphs for modelling real life problems.
7. Model the problems in economics and finance, population dynamics and genetics.

*****

First Year	ELECTIVE COURSE II 3) STOCHASTIC PROCESSES (Theory)	Semester: II
Code:		Credit: 4

COURSE OBJECTIVES:

- Acquire the knowledge about the concept of Markov Chain and Queuing system.
- Understand the methods of birth and death queues with finite and infinite capacity.
- Develop the ability of Standard Brownian Motion

UNIT – I:

Stochastic Processes: Some notions – Specification of Stochastic processes – Stationary processes – Markov Chains – Definitions and examples – Higher Transition probabilities – Generalization of independent Bernoulli trails.

UNIT – II:

Markov chains: Classification of states and chains – determination of Higher transition probabilities – stability of a Markov system – Reducible chains – Markov chains with continuous state space.

UNIT – III:

Markov processes with Discrete state space: Poisson processes and their extensions – Poisson process and related distribution – Generalization of Poisson process- Birth and Death process – Markov processes with discrete state space (continuous time Markov Chains).

UNIT – IV:

Renewal processes and theory: Renewal process – Renewal processes in continuous time – Renewal equation – stopping time – Wald's equation – Renewal theorems.

UNIT – V:

Branching Processes: Introduction – Properties of generating functions of Branching process – Probability of extinction – Distribution of the total number of progeny – Conditional Limit Laws due to Kolmogrov and due to Yaglom – Classical Galton-Watson Process - Bellman-Harris Process

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Stochastic integration and functional limit theorems.

REFERENCES:

1. J. Medhi, Stochastic Processes, New age International Publishers, New Delhi– Second edition.

UNIT I	Chapter 2 Sec 2.1-2.3, Chapter III Sec 3.1-3.3
UNIT II	Chapter 3 Sec 3.4-3.6, 3.8, 3.9,3.11
UNIT III	Chapter 4 Sec 4.1-4.5
UNIT IV	Chapter 6 Sec 6.1-6.5
UNIT V	Chapter 9 Sec 9.1-9.8

2. Samuel Karlin, Howard M. Taylor, A first course in stochastic processes, Academic press, Second Edition, 1975.
3. Narayan Bhat, Elements of Applied Stochastic Processes, John Wiley, 1972.
4. S.K. Srinivasan and K. Mehata, Stochastic Processes, Tata McGraw Hill, 1976.
5. N.V. Prabhu, Stochastic Processes, Macmillan (NY).
6. Robert G. Gallager, Stochastic Processes: Theory for Applications, Cambridge University Press, 2013.
7. http://home.ustc.edu.cn/~alex2014/SPpdf/Stochastic%20Processes%20SM.pdf
8. https://www.pdfdrive.com/download.pdf?id=187079740&h=9e25b152bf6e3cd7ad9c4e54c836b4fc&u=cache&ext=pdf

COURSE OUTCOMES:

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

1. Acquire adequate knowledge about Continuous Time Markov chain and Queuing system.
2. Gain understanding on the Renewal process, Cumulative process and Semi-Markov process.
3. Apply different methods to solve birth and death queues.
4. Examine the computations of renewal process and theory.
5. Conclude the idea of Branching process.

*****

First Year **NON MAJOR ELECTIVE COURSE I** **Semester: II**

STATISTICS

Code: **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

- To introduce the concepts involved in basic statistics and learn them with plenty of demonstrating examples.
- To emphasize the correct statistical tools required to analyze and understand the results based on them.

UNIT – I:

Collection, classification and tabulation of data, graphical and diagrammatic representation - Bar diagrams, Pie diagram, Histogram, Frequency polygon, frequency curve and Ogive.

UNIT – II:

Measures of central tendency - Mean, Median and Mode – Geometric Mean – Harmonic Mean – Selection of an average – Partition Values.

UNIT – III:

Measures of dispersion - Range, Quartile deviation, Mean deviation about an average, Standard deviation and co-efficient of variation for individual, discrete and continuous type data.

UNIT – IV:

Correlation - Different types of correlation - Positive, Negative, Simple, Partial Multiple, Linear and non-Linear correlation.Methods of correlation – Karl Pearson's Spearman's correlations and Concurrent deviation.

UNIT – V:

Regression types and method of analysis, Regression line, Regression equations, Deviation taken from arithmetic mean of X and Y, Deviation taken from assumed mean, Partial and multiple regression coefficients - Applications

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Usage of package R, SPSS

REFERENCES:

1. Gupta S.C. and Kapoor V.K., Fundamentals of Mathematical Statistics, Sultan Chand & Sons, 1994.
2. Freund J.E.(2001); Mathematical Statistics, Prentice Hall of India.
3. Goon, A.M., Gupta M.K., Dos Gupta, B, (1991), Fundamentals of Statistics, Vol. I, World Press, Calcutta.

COURSE OUTCOMES:

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

- Collect, classify and tabulate a given data and study graphical and diagrammatic representations through Bar diagrams, Pie diagram, Histogram, Frequency polygon
- Understand measures of central tendency, viz., Mean, Median and Mode in series of individual observations.
- Workout simple problems in discrete and continuous series.
- Analyze measures of dispersion namely range, quartile deviation, Mean deviation about mean, standard deviation and co-efficient of variation for individual, discrete and continuous type data.
- Distinguish different types of correlation
- Calculate Karl Pearson's correlation coefficient for a lot of problems
- Thoroughly understand and analyze the given problems with the standard regression types.
- Compute partial and multiple regression coefficient for a plenty of problems.

*****

First Year | **VALUE ADDED COURSE I** | **Semester: II**

1) INTRODUCTION TO LATEX

Code: | **(Theory)** | **Credit: *2**

COURSE OBJECTIVES:

- To make the students learn the art of typing mathematics text on their own.
- To inculcate professional training required to become a scholar in mathematics.

UNIT – I:

Basic Structure of Latex 2e - Input file structure - Layout -Editors - Forward Search- Inverse Search - Compiling - Conversion to various formats.

UNIT – II:

Typesetting simple documents - sectioning - Titles- page layout -listing – enumerating - quote - letter formats.

UNIT – III:

Using package amsmath typing equations labeling and referring.

UNIT – IV:

Figure inclusion - Table inclusion.

UNIT – V:

Bibliography - Index typing - Beamer presentation Styles.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Type a mathematical article using various journal style files

REFERENCES:

1. Leslie Lamport. LATEX: A Document Preparation System, Addison-Wesley, Reading, Massachusetts, second edition, 1994.
2. Tobias Oetiker, Hubert Partl, Irene Hyna and Elisabeth Schlegl., The (Not So) Short Introduction to LATEX2e, Samurai Media Limited (or available online at http://mirrors.ctan.org/info/lshort/english/lshort.pdf)
3. LATEX Tutorials - A Primer, Indian TeX Users Group, available online at https://www.tug.org/twg/mactex/tutorials/ltxprimer-1.0.pdf
4. H. J. Greenberg. A Simplified introduction to LATEX, available online at https://www.ctan.org/tex-archive/info/simplified-latex/
5. Using Kile - KDE Documentation, https://docs.kde.org/trunk4/en/extragear_office/kile/quick-using.html
6. Amsmath and geometry package available in Ctan.org.

COURSE OUTCOMES:

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

- Type their own mathematical article/notes/book/journal paper/project work.
- Meticulously prepare their own mathematical notes.
- Understand basic structure of Latex 2e and conversions of them to various formats.
- Typeset and compile documents with titles, sectioning and enumeration etc.
- Use various style files and in particular amsmath, amsfonts, amsthm.
- Understand how to align math equations, matrices etc.
- Include the figures in various formats into their latex document and compile it successfully.
- Utilize bibtex feature of including bibliographies and indexes.

*****

First Year **VALUE ADDED COURSE I** **Semester: II**

2) INTRODUCTION TO MAT LAB

Code: **(Theory)** **Credit: *2**

COURSE OBJECTIVES:

- To learn features of MATLAB as a programming tool.
- To promote new teaching model that will help to develop programming skills and technique to solve mathematical problems.
- To understand MATLAB graphic feature and its applications.
- To use MATLAB as a simulation tool.

UNIT – I:

Starting with MATLAB, MATLAB windows – Working in command window - Arithmetic operations with scalars – Display Formats - Elementary math built-in functions – Defining scalar variables - Useful commands for managing variables - Script files.

UNIT – II:

Creating Arrays – Variables - Transpose Operator - Array addressing - Adding elements to existing variables - Deleting elements - Built-in functions for handling arrays - strings and strings as variables.

UNIT – III:

Mathematical Operations with Arrays: Addition and Subtraction – Multiplication – Division - Element-by-element operations - Built-in math functions - Built-in functions for analysing arrays - Generation of random numbers.

UNIT – IV:

MATLAB workspace and the workspace window – Script file – Output commands – save and load commands – Importing and exporting commands.

UNIT – V:

plot command – fplot command - Plotting multiple graphs in the same plot – Formatting a plot – Plots with Logarithmic axes – Plots with error bars – Plots with special graphics.

UNIT – VI: CURRENT CONTOURS (For Continuous Internal Assessment Only):

Programming in MATLAB

REFERENCES:

1. Amos Gilat, MATLAB An Introduction with Applications, John Wiley & Sons, 2011.

2. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, A Guide to MATLAB - for Beginners and Experienced Users, 2nd Edition, Cambridge University Press, 2006.
3. Stephen J. Chapman, Essentials of MATLAB Programming, Cengage Learning, 2009.

COURSE OUTCOMES:

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

1. Understand the main features of the MATLAB development environment.
2. Use the MATLAB GUI effectively.
3. Design simple algorithms to solve problems.
4. Write simple programs in MATLAB to solve scientific and mathematical problems.

*****