Holy Cross College (Autonomous), Nagercoil

Kanyakumari District, Tamil Nadu.

Accredited with A^{+} by NAAC - IV cycle – CGPA 3.35

Affiliated to

Manonmaniam Sundaranar University, Tirunelveli

Semester I - IV

POs, PSOs & COs

DEPARTMENT OF MATHEMATICS

2023-2026

(With effect from the academic year 2024-2025)

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

POs	Upon completion of M. Sc. Degree Programme, the graduates will be able to:	Mapping with Mission
PEO1	apply scientific and computational technology to solve social and ecological issues and pursue research.	**M1, M2**
PEO2	continue to learn and advance their career in industry both in private and public sectors.	**M4 & M5**
PEO3	develop leadership, teamwork, and professional abilities to become a more cultured and civilized person and to tackle the challenges in serving the country.	**M2, M5 & M6**

PROGRAMME OUTCOMES (POs)

Pos	Upon completion of M.Sc. Degree Programme, the graduates will be able to:	Mapping with PEOs
PO1	apply their knowledge, analyze complex problems, think independently, formulate and perform quality research.	**PEO1 & PEO2**
PO2	carry out internship programmes and research projects to develop scientific and innovative ideas through effective communication.	**PEO1, PEO2 & PEO3**
PO3	develop a multidisciplinary perspective and contribute to the knowledge capital of the globe.	**PEO2**
PO4	develop innovative initiatives to sustain ecofriendly environment	**PEO1, PEO2**
PO5	through active career, team work and using managerial skills guide people to the right destination in a smooth and efficient way.	**PEO2**
PO6	employ appropriate analysis tools and ICT in a range of learning scenarios, demonstrating the capacity to find, assess, and apply relevant information sources.	**PEO1, PEO2 & PEO3**
PO7	learn independently for lifelong executing professional, social and ethical responsibilities leading to sustainable development.	**PEO3**

Programme Specific Outcomes (PSOs)

PSO	Upon completion of M.Sc. Degree Programme, the graduates of Mathematics will be able to:	PO Addressed
PSO–1	acquire good knowledge and understanding, to solve specific theoretical & applied problems in different area of mathematics & statistics	**PO1 & PO2**
PSO–2	understand, formulate, develop mathematical arguments, logically and use quantitative models to address issues arising in social sciences, business and other context /fields.	**PO3 & PO5**
PSO–3	prepare the students who will demonstrate respectful engagement with other's ideas, behaviors, beliefs and apply diverse frames of references to decisions and actions	**PO6**
PSO–4	pursue scientific research and develop new findings with global Impact using latest technologies.	**PO4 & PO7**

PSO–5	possess leadership, teamwork and professional skills, enabling them to become cultured and civilized individuals capable of effectively overcoming challenges in both private and public sectors.	**PO5 & PO7**

Mapping of PO'S and PSO'S

POs	PSO1	PSO2	PSO3	PSO4	PSO5
PO 1	**S**	M	S	S	S
PO 2	S	S	S	S	M
PO 3	S	S	M	S	S
PO4	S	M	S	S	M
PO5	M	S	M	S	S
PO6	S	S	S	M	S
PO7	S	S	S	S	S

Strong -S (3), Medium – M (2), Low – L (1)

COURSE OUTCOMES

SEMESTER– I

CORE COURSE – I: ALGEBRAIC STRUCTURES
Course Code : MP231CC1

On the successful completion of the course, student will be able to:		
1.	recall basic counting principle, define class equations to solve problems, explain Sylow's theorems and apply the theorem to find number of Sylow subgroups.	**K1**
2.	define Solvable groups, define direct products, examine the properties of finite abelian groups, define modules	**K2**
3.	define similar Transformations, define invariant subspace, explore the properties of triangular matrix, to find the index of nilpotence to decompose a space into invariant subspaces, to find invariants of linear transformation, to explore the properties of nil potent transformation relating nilpotence with invariants.	**K3**
4.	define Jordan, canonical form, Jordan blocks, define rational canonical form, define companion matrix of polynomial, find the elementary devices of transformation, apply the concepts to find characteristic polynomial of linear transformation.	**K3, K4**
5.	define trace, define transpose of a matrix, explain the properties of trace and transpose, to find trace, to find transpose of matrix, to prove Jacobson lemma using the triangular form, define symmetric matrix, skew symmetricmatrix, adjoint, to define Hermitian, unitary, normal transformations and to Evaluate whether the transformation in Hermitian, unitary and normal	**K5**

K1-Remember**K2**- Understand K**3** - Apply **K4**- Analyze **K5** – Evaluate

SEMESTER – I

CORE COURSE – II: REAL ANALYSIS I

Course Code : MP231CC2

On the successful completion of the course, student will be able to:

1	analyze and evaluate functions of bounded variation and Rectifiable Curves.	**K4 & K5**
2	describe the concept of Riemann-Stieltjes integral and its properties.	**K1 & K2**
3	demonstrate the concept of step function, upper function, Lebesgue function and their integrals.	**K3**
4	construct various mathematical proofs using the properties of Lebesgue integrals and establish the Levi monotone convergence theorem.	**K3 & K5**
5	formulate the concept and properties of inner products, norms and measurable functions.	**K2 & K3**

K1-Remember**K2**- Understand K**3** - Apply **K4**- Analyze **K5** - Evaluate

SEMESTER – I

CORE COURSE -III: ORDINARY DIFFERENTIAL EQUATIONS

Course Code : MP241CC3

On the successful completion of the course, students will be able to:		
1	recall and describe the fundamental concepts of second-order linear ordinary differential equations, including homogeneous and non-homogeneous forms.	K1
2	understand the method of variation of parameters for solving non-homogeneous second-order linear differential equations and illustrate its application through examples.	K2
3	apply power series solutions to solve first and second-order linear ordinary differential equations, distinguishing between ordinary points and regular singular points.	K3
4	analyze the stability and behaviour of solutions for systems of first-order linear differential equations with constant coefficients, identifying critical points and their implications.	K4
5	utilize special functions such as Legendre polynomials and Bessel functions to solve differential equations and evaluate their effectiveness in addressing specific mathematical and physical problems.	K5

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate;

SEMESTER I

ELECTIVE COURSE I: a**) NUMBER THEORY & CRYPTOGRAPHY**

Course Code : MP231EC1

On the successful completion of the course, student will be able to:		
1	understand quadratic and power series forms and Jacobi symbol.	**K1 & K2**
2	apply binary quadratic forms for the decomposition of a number into sum of sequences.	**K3**
3	determine solutions using Arithmetic Functions.	**K3**
4	calculate the possible partitions of a given number and draw Ferrer's graph.	**K4**
5	identify the public key using Cryptography.	**K5 & K6**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

SEMESTER – I

ELECTIVE COURSE I: b) GRAPH THEORY AND APPLICATIONS
Course Code : MP231EC2

On the successful completion of the course, student will be able to:		
1	recall the basic concepts of graph theory and know its various parameters.	**K1**
2	understand the many results derived on the basis of known parameters.	**K2**
3	apply the concepts to evaluate parameters for the family of graphs.	**K3 & K5**
4	analyze the steps of various theorems and know its applications.	**K1 &K4**
5	create a graphical model for the real-world problem using the relevant ideas.	**K6**

K1-Remember**K2**- Understand K**3** - Apply **K4**- Analyze K**5**–Evaluate**K6** - Create

SEMESTER – I

ELECTIVE COURSE I c): PROGRAMMING IN C++
Course Code : MP231EC3

On the successful completion of the course, student will be able to:		
1	understand and analyze the concepts of tokens, expressions and control structures	**K1**
2	develop the knowledge in functions and arguments	**K2**
3	solve simple programs using classes and objects in C++	**K3**
4	apply the properties of constructors and destructors to solve programs	**K4**
5	create programs and applications using C++	**K5**

K1– Remember**K2 -** Understand **K3 -** Apply **K4**– Analyze**K5**–Evaluate **K6 -** Create

SEMESTER I

ELECTIVE COURSE II: a) DISCRETE MATHEMATICS
Course Code : MP241EC4

On the successful completion of the course, student will be able to:		
1.	recall the basic concepts of measurable sets, measurable function, integration of functions, Fourier series on real line and multivariable differential calculus, implicit functions and extremum problems.	**K1**
2.	describe the elementary facts of Lebesgue measure, Lebesgue integral, Fourier series and multivariable differential calculus; understand the implicit functions and extremun problems.	**K2**
3.	determine the measurable sets, measurable functions, the matrix representation and Jacobian determinant of functions.	**K3**
4.	analyze the properties of measurable functions, Riemann and Lebesgue integrals, convergence of Fourier series and extrema of real valued functions.	**K4**
5.	test measurable sets and measurable functions.	**K5**

K1 – Remember; **K2**– Understand; **K3 –** Apply; **K4**-Analyze; **K5** – Evaluate

SEMESTER I

ELECTIVE COURSE II: b) ANALYTIC NUMBER THEORY
Course Code : MP231EC5

On the successful completion of the course, student will be able to:		
CO1	study the basic concepts of elementary number theory	**K1, K2**
CO2	explain several arithmetical functions and construct their relationships	**K3**
CO3	apply algebraic structure in arithmetical functions	**K3**
CO4	demonstrate various identities satisfied by arithmetical functions	**K2**
CO5	determine the application to $\mu(n)$&$\wedge(n)$ and several equivalent form of prime number theorem	**K4**

K1 – Remember **K2** - Understand **K3** - Apply **K4** – Analyse**K5** – Evaluate **K6** - Create

SEMESTER I

ELECTIVE COURSE II: c) FUZZYSETS AND THEIR APPLICATIONS
Course Code : MP231EC6

On the successful completion of the course, student will be able to:		
CO1	understand the definition of Fuzzy sets and its related concepts	**K1, K2**
CO2	define Fuzzy Graphs and can explain the concepts	**K3**
CO3	explain the concepts in Fuzzy sets and its relations	**K3**
CO4	Discuss about Fuzzy logic	**K2**
CO5	analyze the compositions of Fuzzy sets.	**K4**

K1 – Remember **K2** - Understand **K3** - Apply **K4** – Analyse**K5** – Evaluate **K6** - Create

SEMESTER I

SPECIFIC VALUE ADDED COURSE –SCILAB

Course Code : MP231V01

On the successful completion of the course, student will be able to:		
1	learn basic SCILAB programming.	**K1**
2	understand the basic mathematical operations using SCILAB software.	**K2**
3	execute SCILAB codes for vectors, matrices, plotting lines, polynomial and differential equations	**K3**
4	implement simple mathematical functions/ equations in numerical computation environment such as SCILAB.	**K4**
5	interpret and visualize simple mathematical functions and operations by using plots.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

SEMESTER I

SPECIFIC VALUE- ADDED COURSE: Creating Documents using LaTex

Course Code : MP231V02

On the successful completion of the course, student will be able to:		
1.	typeset complex mathematical formulae using LaTeX	**K2& K3**
2.	use tabular and array environments within LaTeX	**K2 & K3**
3.	prepare a LaTeX document, to make scientific article and project report	**K3 & K6**
4.	create automatic generation of table of contents, bibliographies	**K6**
5.	learn about graphics in LaTex	**K2& K3**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

SEMESTER – I

LIFE SKILL TRAINING – I ETHICS

Course Code : PG23LST1

Course Outcomes	**On completion of this course the student will be able to**	
CO1	understand deeper insight of the meaning of their existence.	K1
CO2	recognize the philosophy of life and individual qualities	K2
CO3	acquire the skills required for a successful personal and professional life.	K3
CO4	develop as socially responsible citizens.	K4
CO5	create a peaceful, communal community and embrace unity.	**K3**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** – Analyze

SEMESTER I
SPECIFIC VALUE ADDED COURSE
RESOURCE MANAGEMENT TECHNIQUES
Course Code : MP231V03

On the successful completion of the course, students will be able to:		
1	understand the methods of optimization and to solve the problems	**K2**
2	define how to formulate an LPP with linear constraints	**K2**
3	maximize the profit, minimize the cost, minimize the time in transportation problem, Travelling salesman problem, Assignment problem	**K3**
4	analyze a problem and formulate it as an LPP	**K4**
5	solve problems using Critical path method	**K5**

K2 - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate

SEMESTER I
SPECIFIC VALUE- ADDED COURSE-
MATHEMATICAL FOUNDATIONS FOR DATA SCIENCE
Course Code : MP231V04

On the successful completion of the course, students will be able to:		
1	acquire necessary skills and knowledge to excel in the fields of computer graphics development and cryptography, enabling them to design	**K2& K3**

	advanced graphics applications and implement secure communication systems effectively.	
2	understand the concept of confidence intervals, hypothesis testing of means and variances	**K2& K4**
3	use linear algebra techniques such as matrix operations, eigenvalue decomposition for data transformation and dimensionality reduction, enabling efficient data representation and visualization.	**K3**
4	use probability theory to assess uncertainties, calculate probabilities of events, and make probabilistic decisions in data-driven scenarios, such as risk assessment, predictive modeling, and business analytics.	**K3**
5	solve real-world data science problems, collaborate with domain experts, and contribute meaningfully to data science projects and initiatives.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate; **K6**– Create

SEMESTER II

CORE COURSE IV: ADVANCED ALGEBRA

Course Code : MP232CC1

On the successful completion of the course, students will be able to:		
1.	exhibit a foundational understanding of essential concepts, including field extensions, roots of polynomials, Galois Theory, and finite extensions	**K1**
2.	demonstrate knowledge and understanding of the fundamental concepts including extension fields, Galois Theory, Automorphisms and Finite fields	**K2**
3.	compose clear and accurate proofs using the concepts of Field extension, Galois Theory and Finite field	**K3**
4.	examine the relationships between different types of field extensions and their implications by applying algebraic reasoning	**K4**
5.	evaluate the validity of statements and theorems in field theory by providing proofs or counter examples	**K5**

K1 – Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate

SEMESTER – II

CORE COURSE V: REAL ANALYSIS - II

Course Code : MP232CC2

On the successful completion of the course, student will be able to:		
1	recall the basic concepts of measurable sets, measurable function, integration of functions, Fourier series on real line and multivariable differential calculus, implicit functions and extremum problems.	**K1**
2.	describe the elementary facts of Lebesgue measure, Lebesgue integral, Fourier series and multivariable differential calculus; understand the implicit functions and extremun problems.	**K2**
3.	determine the measurable sets, measurable functions, the matrix representation and Jacobian determinant of functions.	**K3**
4.	analyze the properties of measurable functions, Riemann and Lebesgue integrals, convergence of Fourier series and extrema of real valued functions.	**K4**
5.	test measurable sets and measurable functions.	**K5**

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K1 – Remember; **K2** - Understand **K3** - Apply **K4**– Analyze**K5** – Evaluate

SEMESTER II

CORE COURSE VI: PARTIAL DIFFERENTIAL EQUATIONS

Course Code : MP232CC3

On the successful completion of the course, students will be able to:		
1	recall the definitions of complete integral, particular integral, and singular integrals.	**K1 & K2**
2	learn some methods to solve the problems of non-linear first-order partial differential equations. homogeneous and non-homogeneous linear partial differential equations with constant coefficients and solve related problems.	**K2 & K3**
3	analyze the classification of partial differential equations in three independent variables – Cauchy's problem for a second-order partial differential equation.	**K2 & K3**
4	solve the boundary value problem for the heat equations and the wave equation.	**K1 & K2**
5	apply the concepts and methods in physical processes like heat transfer and electrostatics.	**K2 & K3**

K1 - Remember; **K2** - Understand; **K3** - Apply

SEMESTER II

ELECTIVE COURSE III: a) MATHEMATICAL STATISTICS

Course Code : MP232EC1

On the successful completion of the course, students will be able to:		
1	recall the basic probability axioms, conditional probability, random variables and related concepts	**K1**
2	learn the transformation technique for finding the p.d.f of functions of random variables and use these techniques to solve related problems	**K2**
3	compute marginal and conditional distributions and check the stochastic independence	**K3**
4	employ the relevant concepts of analysis to determine limiting distributions of random variables	**K2**
5	design probability models to deal with real world problems and solve problems involving probabilistic situations.	**K3**

K1 - Remember; **K2** - Understand; **K3**– Apply

SEMESTER – II

ELECTIVE COURSE III: b) STATISTICAL DATA ANALYSIS USING R PROGRAMMING

Course Code : MP232EC2

On the successful completion of the course, students will be able to:		
1.	recall R and its development history	**K1**
2.	demonstrate how to import and export data with R	**K2 & K4**
3.	explain discrete distributions	**K3**
4.	apply various concepts to write programs in R	**K3 & K5**
5.	apply estimation concepts in R programming	**K2 & K3**

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate

SEMESTER II

ELECTIVE COURSE III: c) PROGRAMMING with C++ PRACTICAL

Course Code : MP232EC3

On the successful completion of the course, students will be able to:		
1.	understand about object oriented programming and learn how to store one object inside another object	**K2, K3**
2.	gain knowledge about the capability to store information together in an object.	**K1**
3.	understand the capability of a class to rely upon another class.	**K1, K4**
4.	analyze the process of exposing the essential data to the outside of the world andhiding the low level data	**K4**
5.	understand about constructors which are special type of functions	**K2**

K1– Remember; **K2** – Understand; **K3** – Apply; **K4**– Analyze

SEMESTER II

ELECTIVE COURSE IV: a) OPERATIONS MODELING

Course Code : MP232EC4

On the successful completion of the course, students will be able to:		
1	build and solve Transportation and Assignment problems using appropriate method	**K1**
2	learn the constructions of network and optimal scheduling using CPM and PERT	**K2**
3	ability to construct linear integer programming models and solve linear integer programming models using branch and bound method	**K3**
4	understand the need of inventory management.	**K2**
5	to understand basic characteristic features of a queuing system and acquire skills in analyzing queuing models	**K3**

K1 - Remember; **K2** - Understand; **K3** - Apply

SEMESTER – II
ELECTIVE COURSE IV: b) MATHEMATICAL PYTHON

On the successful completion of the course, student will be able to**:**		
1	acquire knowledge on Python and learn to run the program.	**K1**

2	understand and discuss about different data types and flow control statements.	**K2 & K4**
3	write programs in python using Lists Tuples, Sets and Dictionaries	**K3**
4	understand For and While loops and conditional statements.	**K3 & K5**
5	creates Functions and Arrays in Python	**K2 & K3**

K1 - Remember; **K2** – Understand; **K3** – Apply; **K4** – Analyze; **K5** – Evaluate

SEMESTER II

ELECTIVE COURSE IV: c) NEURAL NETWORKS

Course Code :MP232EC6

On the successful completion of the course, students will be able to:		
1	understand and analyze different neutron network models	**K2, K4**
2	understand the basic ideas behind most common learning algorithms for multilayerperceptions, radial basis function networks.	**K2**
3	describe Hebb rule and analyze back propagation algorithms with examples	**K1, K4**
4	study convergence and generalization and implement common learning algorithms.	**K3**
5	study directional derivatives and necessary conditions for optimality and to evaluate quadratic functions.	**K5**

K1– Remember**K2 -** Understand **K3 -** Apply **K4**– Analyze**K5**–Evaluate **K6 -** Create

SEMESTER II

SKILL ENHANCEMENT COURSE I: INTRODUCTION TO MS EXCEL 2007

Course Code : MP242SE1

On the successful completion of the course, students will be able to:		
1.	understand the Excel interface including the ribbon, worksheets and cells	**K2**
2.	enter and format data effectively including text, numbers and formulas	**K3& K4**
3.	use basic functions like SUM, AVERAGE and COUNT for simple calculations	**K3 & K4**
4.	manage data effectively through organization, sorting and filtering	**K3 & K4**
5.	create various chart types including bar charts, line graphs, pie charts, and scatter plots to visually represent data.	**K4 & K5**

K2-Understand;**K3**-Apply;**K4**-Analyze;**K5**-Evaluate;**K6**– Create

SEMESTER – I & II

LIFE SKILL TRAINING – I ETHICS

Course Code : PG23LST1

Course Outcomes	On completion of this course the student will be able to	
CO1	understand deeper insight of the meaning of their existence.	K1
CO2	recognize the philosophy of life and individual qualities	K2
CO3	acquire the skills required for a successful personal and professional life.	K3
CO4	develop as socially responsible citizens.	K4
CO5	create a peaceful, communal community and embrace unity.	**K3**

SEMESTER III
CORECOURSE VII : COMPLEX ANALYSIS
Course Code : MP233CC1

On the successful completion of the course, students will be able to:		
1	demonstrate the ability to compute line integrals over rectifiable arcs and apply Cauchy's Theorem to evaluate integrals in various domains.	**K2, K3**
2.	interpret and apply advanced concepts such as Jensen's Formula and Hadamard's Theorem to analyze the behavior of entire functions and infinite products.	**K3, K4**
3.	apply the calculus of residues to evaluate definite integrals and utilize harmonic functions to solve boundary value problems using Poisson's Formula and Schwarz's Theorem.	**K3, K5**
4	construct power series expansions using Weierstrass's Theorem and apply partial fractions and factorization techniques to manipulate complex functions.	**K3, K6**
5.	analyze the local properties of analytic functions, including removable singularities, zeros, poles, and the Maximum Principle.	**K4**

K2 - Understand; **K3** – Apply; **K4 -** Analyse; **K5 -** Evaluate; **K6**– Create

SEMESTER III
CORE COURSE VIII: TOPOLOGY
Course Code : MP233CC2

On the successful completion of the course, students will be able to:		
1	recall the definitions of topological space, basis, various topologies, closed sets, limit points, continuity, connectedness, compactness, separation axioms, countability axioms and completeness	**K1**
2	defends the basic results in topological spaces, continuous functions, connectedness, compactness, countability and separation axioms and complete metric spaces	**K2**
3	solve problems on topological spaces, continuous functions and topological properties	**K3**
4	analyse various facts related to continuous functions, connected spaces, compact spaces, countable spaces, separable spaces, normal space and compact spaces	**K4**
5	evaluate the comparison between different types of topological spaces	**K5**

K1 - Remember; **K2 -** Understand; **K3** – Apply; **K4 -** Analyse; **K5 -** Evaluate;

SEMESTER III
CORECOURSE IX: TRADITIONAL MECHANICS
Course Code : MP233CC3

On the successful completion of the course, students will be able to:		
1.	grasp concepts like time dilation, relativistic dynamics, and the equivalence principle.	**K1**
2.	understand classical mechanics principles such as coordinates, constraints, and energy-momentum relationships for analyzing mechanical systems.	**K2**
3.	apply Lagrangian methods to special cases such as impulsive motion and systems with constraints, thereby expanding their problem-solving abilities	**K3**
4.	integrate classical and relativistic mechanics, enabling them to analyze systems ranging from everyday mechanics to those involving high speeds and gravity.	**K4**
5.	become proficient in using Lagrangian mechanics to solve complex problems and identify integral properties of motion.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate;

SEMESTER III
CORE - RESEARCH PROJECT
Course Code : MP233RP1

On the successful completion of the course, students will be able to:		
1.	learn to manage research projects, adhering to timelines and adapting to challenges.	**K1**
2.	understand ethical considerations in research and collaborate effectively with peers and advisors.	**K2**
3.	conduct independent research, from formulating questions to gathering data.	**K2**
4.	communicate their research findings through written reports and oral presentations.	**K3, K5**
5.	develop critical thinking skills, analyzing findings and drawing informed conclusions.	**K4, K6**

K1 - Remember; K2 - Understand; K3 – Apply; K4 - Analyse; K5 - Evaluate; K6 – Create

SEMESTER III
ELECTIVE COURSE V: a) ALGORITHMIC NETWORK ANALYSIS
Course Code : MP233EC1

On the successful completion of the course, students will be able to:		
1.	recall and identify basic concepts and facts related to algorithms, data structures, and graph theory, including definitions, properties, and terminology.	**K1**
2.	demonstrate a solid understanding of the principles and theories including their applications in problem-solving and computational analysis.	**K2**
3.	apply algorithmic techniques to solve real-world problems efficiently.	**K3**
4.	analyze algorithms, data structures, and graph theory concepts to identify	**K4**

	optimal solutions for computational problems.	
5.	represent graphs in a computer using different data structures.	**K5**

K1 - Remember; K2 - Understand; K3 – Apply; K4 - Analyse; K5 – Evaluate

SEMESTER III
ELECTIVE COURSE V: b) INTRODUCTION TO MACHINE LEARNING USING PYTHON
Course Code : MP233EC2

On the successful completion of the course, students will be able to:		
1	gain a solid understanding of probability theory, including random experiments and the binomial distribution.	**K1, K2**
2	understand the importance of machine learning and its application in analytics	**K2**
3	declare variables, use conditional statements, generate sequence numbers, implement control flow statements, and define functions.	**K3**
4	acquire knowledge of statistical concepts such as the normal distribution, and other important probability distributions, enabling them to analyze data effectively using Python	**K4**
5	possess skills in data exploration and visualization, capable of drawing various plots including bar charts and comparing distributions.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate;

SEMESTER III
ELECTIVE COURSE V : c) CODING THEORY
Course Code : MP233EC3

On the successful completion of the course, students will be able to:		
1	gain a deep understanding of fundamental concepts in coding theory, and their applications in error detection and correction.	**K1, K2**
2	understand how the information theory principles influence the design and optimization of error-correcting codes.	**K2**
3	apply combinatorial theory principles to construct efficient error-correcting codes, such as Hamming codes and Golay codes	**K3**
4	explore advanced coding methods and understand their constructions, properties, and applications in modern communication systems and cryptography.	**K4**
5	develop the ability to analyze and evaluate various coding techniques and algorithms, including majority logic decoding and weight enumerators	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyze; **K5** - Evaluate;

SEMESTER III
SKILL ENHANCEMENT COURSE II: RESEARCH METHODOLOGY
Course Code : MP233SE1

On the successful completion of the course, students will be able to:		
1	understand the objectives and methods of research , standard structure of a	**K2**

	scientific paper and avoid plagiarism.	
2	analyzing research data and statistical measures such as measures of central tendency, dispersion, and asymmetry.	**K4**
3	identify the ethics of scientific paper writing and analyze research problems	**K4**
4	develop research designs for specific research problems and assess the significance of research in various fields.	**K5**
5	create structured scientific research papers and write project proposals and progress reports for research funding.	**K6**

K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5**– Evaluate; **K6-** Create

SEMESTER III

SPECIFIC VALUE ADDED COURSE: DOCUMENTATION USING OVERLEAF AND MATHCHA

Course Code : MP233V01

On the successful completion of the course, students will be able to:		
1	type set complex mathematical formulae using LaTeX	**K2& K3**
2	use tabular and array environments within LaTeX	**K2 & K3**
3	prepare a LaTeX document, to make scientific article and project report	**K3 & K6**
4	create automatic generation of table of contents, bibliographies	**K6**
5	learn about graphics in LaTex using Mathcha	**K2& K3**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate; **K6** – Create

SEMESTER III

SPECIFIC VALUE ADDED COURSE – CHEMICAL GRAPH THEORY

Course Code : MP233V02

On the successful completion of the course, students will be able to:		
1	understand the relationship between graph theory and chemistry.	**K2**
2	apply graph theoretical concepts to model and analyze chemical compounds, molecular topology, and molecular structures.	**K3**
3	develop skills in analyzing and manipulating weighted graphs, including vertex and edge weighted graphs, and understanding their significance in optimization problems and network analysis.	**K2, K4**
4	develop critical thinking and problem-solving exercises involving various chemical graphs.	**K2, K3**
5	explore the mathematical properties and applications in areas like material science and network design.	**K4**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse

SEMESTER III

SPECIFICVALUE-ADDED COURSE*:* ADVANCED LATEX WITH OVERLEAF

Course Code : MP233V03

On the successful completion of the course, student will be able to:		
1	include mathematical expressions, tables, and images in documents using	**K2 & K3**

	LaTeX	
2	understand document structure and organization, including abstracts, chapters, sections, and lists.	**K2& K4**
3	create well-formatted documents and presentations suitable for academic and professional purposes.	**K3& K6**
3	generate tables of contents, captions, labels, and references in LaTeX documents	**K3& K6**
4	understand the Beamer class for creating presentations, including customization of themes, fonts, and layouts	**K6**

K2 - Understand; **K3 -** Apply; **K4 -** Analyze; **K5 -** Evaluate; **K6**– Create

SEMESTER III
SPECIFIC VALUE ADDED COURSE: SOCIAL NETWORK ANALYSIS
Course Code : MP233V04

On the successful completion of the course, student will be able to:		
1	understand the fundamental concepts and theories in social network analysis.	**K1 & K2**
2	develop the skills in collecting and organizing network data.	**K2 & K4**
3	apply appropriate methods and tools for analyzing social networks.	**K3**
4	interpret and visualize the network data effectively.	**K4 & K5**
5	explore real-world applications of social network analysis in different domains.	**K6**

K1 – Remember; **K2 -** Understand; **K3 -** Apply; **K4 -** Analyze; **K5 -** Evaluate; **K6**- Create

SEMESTER III
SELF LEARNING COURSE-
DIFFERENTIAL EQUATIONS FOR SET/ CSIR-NET EXAM
Course Code : MP234SL1

On the successful completion of the course, student will be able to:		
1	proficiency in solving second order ordinary differential equations with constant coefficients.	**K2 & K3**
2	develop deeper understanding of differential equations concepts.	**K2 & K4**
3	ability to solve various types of first order ordinary differential equations.	**K3 & K5**
4	critical thinking and problem solving skills through the analysis and interpretation of differential equations and their solutions.	**K3 & K6**
5	develop analytical thinking.	**K4**

K1 – Remember; **K2 -** Understand; **K3 -** Apply; **K4 -** Analyze; **K5 -** Evaluate; **K6**- Create

SEMESTER IV
CORE COURSE X : FUNCTIONALANALYSIS
Course Code : MP234CC1

On the successful completion of the course, students will be able to:		
1	able to demonstrate comprehension of the definitions and basic properties of Banach and Hilbert spaces	**K1**
2	able to apply the Hahn Banach theorem to extend continuous linear functionals on subspaces to the whole space	**K3**

3	describe the concept of adjoint operators in Hilbert spaces and recognize properties of self-adjoint, normal, and unitary operators	**K2**
4	analyze the concepts of determinants, spectrum, and the spectral theorem for operators in finite-dimensional spaces	**K4**
5	evaluate the structure of commutative Banach algebras, including understanding the Gelfand Mapping and applications of spectral radius formula	**K5**

K2 - Understand; **K3** - Apply; **K4** - Analyze; **K5**– Evaluate; **K6-** Create

SEMESTER IV
CORECOURSE XI: PROBABILITY THEORY
Course Code : MP234CC2

On the successful completion of the course, students will be able to:		
1	recall the basic probability axioms, conditional probability, random variables, and related concepts	**K1**
2	define Special Mathematical Expectations, The Binomial Distribution, and The Poisson Distribution.	**K2**
3	define The Exponential, Gamma, and Chi-square Distributions, The Normal Distribution.	**K2**
4	study Bivariate Distributions of discrete, and continuous types, The correlation coefficient, Conditional Distribution, and The Bivariate Normal Distribution.	**K5**
5	discuss Functions of one random variable, Transformations of two random variables, The central limit Theorem, Chebyshve's inequality, and convergence in probability, Limiting moment-generating functions.	**K3, K4**

K2 - Understand; **K3** - Apply; **K4** – Analyze

SEMESTER IV
CORE COURSE XII: NUMERICAL ANALYSIS
Course Code : MP234CC3

On the successful completion of the course, students will be able to:		
1	recall and list basic numerical methods covered in the course, including root-finding algorithms and interpolation techniques.	**K1**
2	understand the principles behind key numerical algorithms such as Newton's method, Gaussian elimination, and Runge-Kutta methods.	**K2**
3	apply numerical methods to solve algebraic equations, interpolate data points, fit curves to data sets, and solve systems of linear equations.	**K3**
4	analyse the accuracy, convergence, and stability of numerical solutions obtained using different techniques.	**K4**

5	evaluate the suitability and effectiveness of various numerical methods for specific mathematical problems based on computational efficiency and solution quality.	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate; **K6** – Create

SEMESTER IV
ELECTIVE COURSE VI: a) NETWORK SECURITY AND CRYPTOGRAPHY
Course Code : MP234EC1

On the successful completion of the course, students will be able to:		
1	demonstrate proficiency in employing classical encryption techniques, including symmetric cipher models, substitution techniques, and transposition techniques, to secure data transmission and storage.	**K3, K4**
2	design and implement message authentication mechanisms to verify the integrity and authenticity of transmitted data.	**K3, K6**
3	analyze and identify various security attacks and vulnerabilities in computer and network systems.	**K4**
4	evaluate the principles and algorithms of public-key cryptography for ensuring confidentiality, integrity, and authenticity in communication channels.	**K5**
5	develop expertise in deploying user authentication protocols to authenticate remote users securely and manage access control in networked environments.	**K6**

K3 – Apply; **K4** - Analyse; **K5** - Evaluate; **K6** – Create

SEMESTER IV
ELECTIVE COURSE VI :b) FOUNDATIONS OF COMPUTER NETWORKING
Course Code : MP234EC2

On the successful completion of the course, students will be able to:		
1	demonstrate a thorough understanding of network hardware, reference models (such as OSI and TCP/IP), and the architecture of the Public Switched Telephone Network (PSTN).	**K2**
2	describe the architecture and services of the application layer, analyze protocols such as HTTP for web communication, and understand the principles of streaming media and real-time conferencing over networks.	**K2, K4**
3	design data link layer protocols, analyze error detection and correction techniques, and implement routing algorithms for efficient data transmission.	**K3, k4**
4	develop skills in identifying congestion control issues, apply appropriate congestion control algorithms, and implement traffic-aware routing strategies to optimize network performance.	**K3, k4**
5	demonstrate proficiency in analyzing and implementing transport layer protocols, particularly TCP, including connection establishment, data transfer, and connection release mechanisms.	**K4**

K2 - Understand; **K3** – Apply; **K4** - Analyse;

SEMESTER IV

ELECTIVE COURSE VI: c) DATA COMMUNICATION

Course Code :MP234EC3

On the successful completion of the course, students will be able to:		
1	understand the concepts of data terminal equipment (DTE) and data circuit-terminating equipment (DCE) interfaces, and functionality of modems, including 56K modems and cable modems, in digital data transmission.	**K2**
2	explain the OSI model and the functions of its layers and apply this knowledge to understand the operation of the TCP/IP protocol suite.	**K2, K3**
3	understand the encoding and modulation techniques and gain knowledge of digital-to-digital, analog-to-digital, digital-to-analog, and analog-to-analog conversion methods, along with their applications in data transmission.	**K2, K3**
4	describe and analyze line configurations, topologies, transmission modes, and various categories of networks.	**K4**
5	distinguish between analog and digital signals, describe their characteristics, and analyze their representation in both time and frequency domains.	**K4**

K2 - Understand; **K3** – Apply; **K4 -** Analyse;

SEMESTER IV

ELECTIVE COURSE V: a) APPLICATIONS OF MATHEMATICS IN ARTIFICIAL INTELLIGENCE

Course Code : MP234EC4

On the successful completion of the course, students will be able to:		
1.	demonstrate proficiency in mathematical concepts as applied toAI	**K3**
2.	apply mathematical algorithms to build, train, AI models using the programming language Python	**K3**
3.	analyse and interpret the behaviour of AI models using mathematical techniques	**K4**
4.	tackle a variety of AI challenges using mathematical reasoning and analytical techniques	**K5**
5.	propose novel approaches and solutions to complex problems in AI	**K6**

K3 – Apply; **K4 -** Analyse; **K5 -** Evaluate; **K6** – Create

SEMESTER IV

ELECTIVE COURSE VII: b) FINANCIAL MATHEMATICS

Course Code : MP234EC5

On the successful completion of the course, student will be able to:		
1	gain a solid understanding of interest rates, present value analysis and their role in financial decision-making.	**K1**
2	understand the principles of arbitrage and its application in pricing various financial contracts, including options.	**K2**
3	comprehend the Arbitrage Theorem and its implications in identifying and exploiting pricing inefficiencies in financial markets.	**K3**
4	develop familiarity with the Black-Scholes Formula, its properties and its	**K4**

	application in options pricing.	
5	apply learned concepts to solve practical problems in options pricing, delta hedging strategies and identifying arbitrage opportunities in financial markets.	**K5**

K1 - Remember; **K2** - Understand; **K3** - Apply; **K4** - Analyze; **K5** - Evaluate

SEMESTER IV
ELECTIVE COURSE VII: c) STOCHASTIC PROCESS
Course Code : MP234EC6

On the successful completion of the course, students will be able to:		
1.	recall the basic results of Markov Chains as Graphs- Higher Transition Probabilities	**K1**
2.	understand Stability of a Markov System	**K2**
3.	apply Generalisations of Poison Process-Poison Process in Higher Dimensions-	**K3**
4.	determine Discrete Stat Space-Introduction-Chapman-Kolmogorov Equations	**K4**
5.	calculate the possible partitions of a given number and draw Ferrer's graph	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** - Evaluate;

SEMESTER IV
SKILL ENHANCEMENT COURSE III: TRAINING FOR COMPETITIVE EXAMINATIONS
Course Code : MP234SE1

On the successful completion of the course, students will be able to:		
1.	describe the concepts of topological properties of metric spaces.	**K1**
2.	associate the concept of continuity and connectedness	**K2**
3.	apply Cauchy's integral formula and Maximum modulus principle to evaluate integral	**K3**
4.	outline Liouville's theorem and open mapping theorem	**K4**
5.	built the mental ability to face GATE, CSIR and SET examinations	**K5**

K1 - Remember; **K2** - Understand; **K3** – Apply; **K4** - Analyse; **K5** – Evaluate

SEMESTER IV
SELF LEARNING COURSE
CALCULUS OF VARIATIONS AND INTEGRAL EQUATIONS
Course Code : MP234SL1

On completion of this course the student will be able to		
1	recognize the perception of life and lead a positive life	**K1**
2	understand relationship with family, friends and the society	**K2**
3	develop as socially responsible citizens.	**K3**
4	assess goals, fix targets and value life	**K4**
5	create a peaceful, communal community and embrace unity.	**K6**

SEMESTER – III & IV
LIFE SKILL TRAINING II – VALUES

Course Code : PG23LST2

On completion of this course the student will be able to		
1	recognize the perception of life and lead a positive life	**K1**
2	understand relationship with family, friends and the society	**K2**
3	develop as socially responsible citizens.	**K3**
4	assess goals, fix targets and value life	**K4**
5	create a peaceful, communal community and embrace unity.	**K6**