SEMESTER 1

20MCA101	MATHEMATICAL FOUNDATIONS FOR COMPUTING	CATEGORY	L	T	P	CREDIT
		GENERAL	3	1	0	4

Preamble: This course introduces students to some basic mathematical ideas and tools which are at the core of MCA course. It introduces the concepts of graph theory, set theory and statistics.

Prerequisite: A basic course in set theory and statistics.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand mathematical reasoning in order to read, comprehend and construct mathematical arguments
CO 2	Count or enumerate objects and solve counting problems and analyze algorithms
CO 3	Solve problems in almost every conceivable discipline using graph models
CO 4	Solve the linear system of equations and Calculate the eigen values and eigen vectors of matrices.
CO 5	Apply the principles of correlation and regression in practical problems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	3			3					
CO 2	3	3	3	3			3					
CO 3	3	3	3	3			3					
CO 4	3	3	3	3			3					
CO 5	3	3	3	3			3					

Mapping	L/ M/ H	Justification
CO1-PO1	H	The knowledge of mathematical reasoning, set theory functions and relations helps in the abstraction and conceptualization of computing models from defined problems to various real-life applications for any given requirements.
CO1-PO2	H	The knowledge of mathematical reasoning, set theory functions and relations helps to understand and analyse a given real-world problem and propose feasible computing solutions
CO1-PO3	H	The knowledge of mathematical reasoning, set theory functions and relations helps in Analysing customer requirements, create H-level design, and select modern computing tools and techniques and use them with dexterity and integrate it to all computer applications
CO1-PO4	H	The knowledge of mathematical reasoning, set theory functions and relations helps to transform complex business scenarios and contemporary issues to problems, investigate, understand and propose integrated solutions to meet desired needs within realistic constraints such as safety, security and applicability especially folLing cyber regulations using emerging technologies.
CO1-PO7	H	The knowledge of mathematical reasoning, set theory functions and relations helps to develop the expertise in using modern hardware and software tools which can applied in professional career consecutively to provide innovative software solutions. (K3)
CO1-PSO1	L	The knowledge of mathematical reasoning, set theory functions and relations helps to apply the knowledge of computer systems and design principles in building software and hardware components.
CO2-PO1	H	The knowledge of solving counting problems and analysing algorithms helps in the abstraction and conceptualization of computing models from defined problems to various real-life applications for any given requirements.
CO2-PO2	H	The knowledge of solving counting problems and analysing algorithms helps to understand and analyse a given real-world problem and propose feasible computing solutions
CO2-PO3	H	The knowledge of solving counting problems and analysing algorithms helps in analysing customer requirements, create H-level design, and select modern computing tools and techniques and use them with dexterity and integrate it to all computer applications
CO2-PO4	H	The knowledge of solving counting problems and analysing algorithms helps to transform complex business scenarios and contemporary issues to problems, investigate, understand and propose integrated solutions to meet desired needs within realistic constraints such as safety, security and applicability especially folLing cyber regulations using emerging technologies.
CO2-PO7	H	The knowledge of solving counting problems and analysing algorithms helps to develop the expertise in using modern hardware and software tools which can applied in professional career consecutively to provide innovative software solutions. (K3)

CO2-PSO1	M	The knowledge of solving counting problems and analysing algorithms helps to apply the knowledge of computer systems and design principles in building software and hardware components.
CO3 -PO1	H	The knowledge of solving problems using graph theory helps in the abstraction and conceptualization of computing models from defined problems to various real-life applications for any given requirements.
CO3-PO2	H	The knowledge of solving problems using graph theory helps to understand and analyze a given real-world problem and propose feasible computing solutions
CO3-PO3	H	The knowledge of solving problems using graph theory helps in analyzing customer requirements, create H-level design, and select modern computing tools and techniques and use them with dexterity and integrate it to all computer applications
CO3-PO4	H	The knowledge of solving problems using graph theory helps to transform complex business scenarios and contemporary issues to problems, investigate, understand and propose integrated solutions to meet desired needs within realistic constraints such as safety, security and applicability especially folLing cyber regulations using emerging technologies.
CO3-PO7	H	The knowledge of solving problems using graph theory helps to expertise in using modern hardware and software tools which can applied in professional career consecutively to provide innovative software solutions. (K3)
CO3-PSO1	L	The knowledge of solving problems using graph theory helps to apply the knowledge of computer systems and design principles in building software and hardware components.
CO4-PO1	H	The knowledge of solving linear system of equations and calculate eigen values and eigen vectors of matrices helps in the abstraction and conceptualization of computing models from defined problems to various real life applications for any given requirements.
CO4-PO2	H	The knowledge of solving linear system of equations and calculate eigen values and eigen vectors of matrices helps to understand and analyze a given real-world problem and propose feasible computing solutions
CO4-PO3	H	The knowledge of solving linear system of equations and calculate eigen values and eigen vectors of matrices helps Analyzing customer requirements, create H-level design, and select modern computing tools and techniques and use them with dexterity and integrate it to all computer applications
CO4-PO4	H	The knowledge of solving linear system of equations and calculate eigen values and eigen vectors of matrices helps to transform complex business scenarios and contemporary issues to problems, investigate, understand and propose integrated solutions to meet desired needs within realistic constraints such as safety, security and applicability especially following cyber regulations using emerging technologies.

CO4-PO7	H	The knowledge of solving linear system of equations and calculate eigen values and eigen vectors of matrices helps to expertise in using modern hardware and software tools which can applied in professional career consecutively to provide innovative software solutions. (K3)
CO4-PSO1	L	The knowledge of solving linear system of equations and calculate eigen values and eigen vectors of matrices helps to apply the knowledge of computer systems and design principles in building software and hardware components.
CO5-PO1	H	The knowledge of correlation and regression helps in the abstraction and conceptualization of computing models from defined problems to various real life applications for any given requirements.
CO5-PO2	H	The knowledge of correlation and regression helps in understanding and analyze a given real-world problem and propose feasible computing solutions
CO5-PO3	H	The knowledge of correlation and regression helps in analysing customer requirements, create H-level design, and select modern computing tools and techniques and use them with dexterity and integrate it to all computer applications
CO5-PO4	H	The knowledge of correlation and regression helps to transform complex business scenarios and contemporary issues to problems, investigate, understand and propose integrated solutions to meet desired needs within realistic constraints such as safety, security and applicability especially folLing cyber regulations using emerging technologies.
CO5-PO7	H	The knowledge of correlation and regression helps in expertising modern hardware and software tools which can applied in professional career consecutively to provide innovative software solutions. (K3)
CO5-PSO1	L	The knowledge of correlation and regression helps in applying the knowledge of computer systems and design principles in building software and hardware components.

20MCA103	DIGITAL FUNDAMENTALS & COMPUTER ARCHITECTURE	CATEGORY	L	T	P	CREDIT
		GENERAL	3	1	0	4

Preamble:

The primary aim of this course is to understand the fundamentals behind the digital logic design and gain the experience to design digital circuits and systems. Students should also acquire some understanding and appreciation of a computer system's functional components, their characteristics, performance and interactions. They need to understand the computer architecture in order to make best use of the software tools and computer languages they use to create programs.

Prerequisite: NIL

Course Outcomes: After the completion of the course the student will be able to

CO 1	Apply the basics of digital electronics to design and realize simple combinational logic circuits
CO 2	Apply the digital electronics principles to design sequential logic circuits.
CO 3	Understand the different design features of computer architecture, Five key components of a computer, processor and memory making technologies, addressing modes & instruction formats.
CO 4	Understand Processor logic design conventions and data path, pipelining and hazards, I/O organization, Interrupts and direct memory access
CO 5	Understand and different types of memories - RAM, ROM, Cache memory, virtual memory etc. Apply the different memory design techniques.
CO 6	Understand the concept of single board computers like Arduino, Raspberry Pi etc. and apply the same in practical applications.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2	1	-	-	1	-	-	-	-	-
CO 2	3	3	2	1	-	-	1	-	-	-	-	-
CO 3	1	1	-	1	-	-	1	-	-	-	-	-
CO 4	1	1	-	-	-	-	1	-	-	-	-	-
CO 5	2	2	1	1	-	-	1	-	-	-	-	-
CO 6	1	1	2	-	2	-	2	2	2	-	2	2

MAPPING	L/M/H	JUSTIFICATION
20MCA103.1-PO1	H	Students can gain the ability to form the foundations for designing H performance computers and for the development of supporting software and applications
20MCA103.1-PO2	M	Students can identify and formulate various flip flop models and their working
20MCA103.1-PO3	L	Students can gain knowledge to design system components in computer models.
20MCA103.1-PO4	L	Students will get an idea to interpret data from various models and will able to conclude information synthesized from it.
20MCA103.1-PO12	M	Students can recognize the need for H performance computers and ability to engage in independent and life-long learning in the technological change.
20MCA103.1-PO1	M	Students can apply and suggest appropriate parallel computer models for solving computing problems.
20MCA103.2-PO1	H	Students can apply the knowledge of mathematics, computer fundamentals to the solution of computing problems.
20MCA103.2-PO2	H	Students can apply the digital electronics principles to design sequential logic circuits.
20MCA103.2-PO3	H	Understand the different design features of computer architecture, Five key components of a computer, processor and memory making technologies, addressing modes & instruction formats
20MCA103.2-PO4	M	Understand Processor logic design conventions and data path, pipelining and hazards, I/O organization, Interrupts and direct memory access

20MCA103.2-PO4	M	Students can recognize the need for and lifelong learning in design system components in MIPS machines and memory hierarchy.
20MCA103.2-PO4	M	Students can apply and suggest appropriate MIPS architecture for solving computing problems.
20MCA103.2-PO3	M	Students will be able to adapt emerging information from MIPS and to suggest solutions to novel problems.
20MCA103.3-PO1	H	Students can apply the knowledge of computer fundamentals in interconnection of multiprocessor systems.
20MCA103.3-PO2	H	Students are able to identify the best interconnection mechanisms for multiprocessor system.
20MCA103.3-PO3	L	Students can gain knowledge to design system components in in interconnection of multiprocessor systems.
20MCA103.3-PO4	M	Students will get an idea to interpret data from interconnection of multiprocessor systems and will able to conclude information synthesized from it.
20MCA103.3-PO6	M	Students will able to apply reasoning to interpret data from interconnection of multiprocessor systems
20MCA103.3-PO10	M	Students will able to communicate effectively about multiprocessor system interconnections.
20MCA103.3-PO12	M	Students can recognize the need for, and lifelong learning in multiprocessor system interconnections
20MCA103.3-PO1	L	Students can apply and suggest appropriate multiprocessor system interconnections for solving computing problems

20MCA103.4-PO1	H	Students can apply the knowledge of mathematics, engineering fundamentals in addressing cache coherence problems.
20MCA103.4-PO2	H	Students will be able to identify the appropriate mechanisms used for enforcing cache coherence.
20MCA103.4-PO3	L	Students can gain knowledge to interpret the mechanisms for enforcing cache coherence.
20MCA103.4-PO4	M	Students will get an idea to interpret the mechanisms for enforcing cache coherence. and will able to conclude information synthesized from it.
20MCA103.4-PO12	M	Students will be able to recognize the need for novel solutions for enforcing cache coherence by lifelong learning.
20MCA103.4-PO1	L	Students can apply and suggest appropriate cache coherence mechanisms for solving computing problems
20MCA103.4-PO3	L	Understand and different types of memories - RAM, ROM, Cache memory, virtual memory etc. Apply the different memory design techniques..
20MCA103.5-PO1	H	Students will understand and different types of memories - RAM, ROM, Cache memory, virtual memory etc. Apply the different memory design techniques..
20MCA103.5-PO2	M	Students can apply different memory design techniques for solving computing problems
20MCA103.5-PO3	H	Students will be able to develop solutions for multicomputer message passing mechanisms by analyzing different schemes used in it and also they will be able to design and develop specific techniques for building instruction pipelines, arithmetic pipelines etc.
20MCA103.5-PO4	M	Students will get an idea to analyse different message passing mechanisms and pipelining techniques and will able to conclude information synthesised from it.

20MCA103.5-PO5	M	Students can apply appropriate techniques in message passing mechanisms and pipelining techniques
20MCA103.5-PO5	M	Students will able to apply reasoning to interpret techniques in message passing mechanisms and pipelining techniques.
20MCA103.5-PO7	M	Students will able to communicate effectively about message passing mechanisms and pipelining techniques.
20MCA103.5-PO7	M	Students will be able to recognize various message passing mechanism mechanisms by lifelong learning.
20MCA103.5-PO11	L	Students will be able to develop solutions for multicomputer message passing mechanisms by applying foundational concepts of computer science and engineering.
20MCA103.5-PO12	M	Students will be able to adapt to emerging concepts of computer science and engineering.
20MCA103.5-PO2	M	Students will be able to identify the appropriate mechanisms used for multithreaded and data fLarchitectures.
20MCA103.5-PO3	H	Students will be able to provide suitable multithreaded and data fLarchitectures to solve novel problems in communication and information.
20MCA103.5-PO5	M	Students can apply appropriate techniques in message passing mechanisms and pipelining techniques

20MCA105	ADVANCED DATA STRUCTURES	CATEGORY	L	T	P	CREDIT
		GENERAL	3	1	0	4

Preamble: A graduate course in Computer Applications should give due exposure to the recent developments. Since Data structures is a central pillar of any program on Computer Science/ Applications, this course is designed to build upon the knowledge acquired at the undergraduate level and familiarise students with a bunch of modern data structures which are quite useful to solve, in the most effective manner, the modern, real life problems.

Prerequisite: Basic Data Structures

Course Outcomes: After the completion of the course the student will be able to

CO 1	Remember the Basic Data Structures and understand the Set Data Structure and its implementation.
CO 2	Understand Advanced Tree Structures for the design of efficient algorithms
CO 3	Understand Advanced Heap Structures suitable for solving Computational problems involving Optimisation and analysing these data structures using amortised analysis.
CO 4	Understand Advanced Graph algorithms suitable for solving advanced computational problems
CO 5	Understand the basic operation of Blockchaining along with the data structures used in it and the challenges in Blockchain data.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2		1							
CO 2	2	2	3	2	1		1					
CO 3	2	3	3	2	1		1					
CO 4	3	3	2	1	2		1					
CO 5	3	2	2	2	3		1					

20MCA107	ADVANCED SOFTWARE ENGINEERING	CATEGORY	L	T	P	CREDIT
		GENERAL	3	1	0	4

Preamble:

Most of the programs on Computer Applications do not give due importance to teach Software Engineering in an Industry perspective. But this course, built upon the tools and techniques prevalent in Industry today, is supposed to make students Industry-ready.

Prerequisite: Programming proficiency in at least one of C, C++, Java, Python or PHP programming languages.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Get a full view of the Software life cycle
CO 2	Gain a deep knowledge of Software Planning, Analysis and Design and Software Engineering Models
CO 3	Have a great comprehension of Coding Practices, Version Control using 'git' and Software Quality
CO 4	Acquire ample grasp of Design Patterns
CO 5	Get deeply familiarised with Software Testing and its automation
CO 6	Start using Agile Methodology
CO 7	Begin to apply CI/CD techniques in Software development

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1		2	2					3			1	1
CO 2		3	3					3				
CO 3					3				3	2	2	
CO 4			3		3							
CO 5					3					2	3	
CO 6					2			2	2		2	3
CO 7					3			1		2		

CO-PO	LEVEL (L/Moderate/H)	JUSTIFICATION
20MCA107.1-PO2	M	Apply the basic concepts of for software development
20MCA107.1-PO2	H	Understand the software life cycle that will help in managing tasks and projects for a computer professional
20MCA107.1-PO3	M	Understand the software development as an engineering process and its stages for applying at professional leavel.
20MCA107.1-PO8	M	Understand the functions of SDLC, challenges encountered and adapt emerging information's and communications and to solutions to existing problems
20MCA107.1-PO11	L	Apply the concept of SDLC in real time situations and will be able to adapt to any environment
20MCA107.1-PO12	M	Learn how to prepare software requirements specification, approaches and methodologies to prepare requirement specifications document.
20MCA107.2-PO8	M	Understand what to ensure at various stage of SDLC to ensure quality of developed software system.
20MCA107.2-PO3	L	Understand core concepts of software version control system and common operations with Git distributed version control system
20MCA107.2-PO3	M	Understand writing industry-grade software programs, folLing style guides and coding standards.
20MCA107.2-PO8	H	Understanding software quality concepts with respect to software requirement specifications document, what to conform to at various stages of SDLC
20MCA107.3-PO5	M	Students will be able to learn Object Oriented Programming concepts comprehensively

20MCA107.3-PO9	M	Students will be able to learn the concept of Design Patterns, category of patterns, and became capable of how to select appropriate design patterns.
20MCA107.3-PO10	H	Understand Unit testing concepts and xUnit architecture. Learn Unit testing frameworks and be able to write unit testing for Java and one of PHP or Python
20MCA107.3-PO11	M	Understand the concepts Continuous Integration and Continuous Delivery (CICD)
20MCA107.4-PO3	M	Knowledge of Git distributed version control system to use in a product environment and knowledge of OOP paradigm and software Design Patterns to design the software system
20MCA107.4-PO5	M	Knowledge of unit testing frameworks such as Junit, uniitest, phpdbg for wiring units tests in a software production environment and knowledge of software testing CI/CD practices
20MCA107.5-PO8	H	Understand software testing concepts and principles and learn common approaches to ensure software quality through testing
20MCA107.5-PO9	M	In-depth understanding of various types of testing methodologies and learn about testing automation and understand commonly used test automation types
20MCA107.5-PO10	M	Understand the concepts of Agile methodology. And learn to use Scrum framework for implementing Agile methodology for executing a software development process and also learn to monitor a software development project using a Scrum tool. .

20MCA131	PROGRAMMING LAB	CATEGORY	L	T	P	CREDIT
		PRACTICAL	0	1	3	2

Preamble: This course introduces a basic step towards program writing and develops the logical ability and problem-solving skill using Python Programming Language. Students are able to do testing and debugging of code written in Python.

Prerequisite: None

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understands basics of Python Programming language including input/output functions, operators, basic and collection data types
CO 2	Implement decision making, looping constructs and functions
CO 3	Design modules and packages - built in and user defined packages
CO 4	Implement object-oriented programming and exception handling.
CO 5	Create files and form regular expressions for effective search operations on strings and files.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	2	1	2							
CO 2	3	3	3	2	2							
CO 3	3	3	3	3	3						1	
CO 4	3	3	3	3	3						1	
CO 5	3	3	3	3	3						1	

Mapping	L/M/ H	Justification
CO1-PO1	M	Students will be able to use Programming knowledge by Analyzing a computational problem and develop an algorithm/fLchart.
CO1-PO2	M	With analyzing a computational problem and develop an algorithm/fLchart, the students are able to analyze complex programming problems.
CO1-PO3	M	By analyzing a computational problem and develop an algorithm/fLchart, the students are able to design solutions for complex programming problems.
CO1-PO4	L	Through analyzing a computational problem and develop an algorithm/fLchart, the students are able to conduct investigations of complex problems.
CO1-PO5	H	Students will be able to apply knowledge to assess social issues and responsibilities relevant to the professional programming practice through analyzing a computational problem and developing solutions for that.
CO2-PO1	H	With the knowledge of different Arithmetic, Logical, Relational or Bitwise operators, the students will be able to use Programming knowledge.
CO2-PO2	H	With developing programs using branching and looping statements, which uses Arithmetic, Logical, Relational or Bitwise operators, the students are able to analyze complex programming problems.
CO2-PO3	H	With the knowledge of branching and looping statements and operators and by developing programs using them, the students are able to design solutions for complex programming problems.
CO2-PO4	M	The students are able to conduct investigations of complex problems with the knowledge of programming using branching and looping statements and operators.
CO2-PO5	M	With the knowledge of programming using branching and looping statements and operators, students will be able to select and apply appropriate techniques and IT tools like prediction and modelling to complex problems.
CO2-PO6	M	The students are able to communicate effectively on complex programming activities with the programming community with the knowledge of programming using branching and looping statements.

CO3-PO1	H	By examining how arrays, structure or union are used for storing data to be processed, the students will be able to apply knowledge in fundamentals of programming and mathematics.
CO3-PO2	H	Students will be able to perform analysis of complex programming problems by examining how arrays, structure or union are used for storing data to be processed
CO3-PO3	H	With the knowledge of how arrays, structure or union are used for storing data to be processed, the students will be able to design solutions for complex programming problems.
CO3-PO4	L	With the knowledge of how arrays, structure or union are used for storing data to be processed, the students will be able to conduct investigations of complex problems.
CO3-PO5	M	With the knowledge of how arrays, structure or union are used for storing data to be processed, students will be able to select and apply appropriate techniques and IT tools like prediction and modelling to complex problems.
CO3-PO6	M	Students will be able to communicate effectively on complex programming activities with the programming community with the knowledge of how arrays, structure or union are used for storing data to be processed.
CO3-PO11	L	Students will be able to communicate effectively on complex programming activities with the programming community with the knowledge of how arrays, structure or union are used for storing data to be processed.
CO4-PO1	H	Students will be able to use Programming knowledge with developing readable multi-function Python programs to find the solution to the computational problem.
CO4-PO2	H	Students will be able to perform analysis of complex programming problems with developing readable multi-function Python programs to find the solution to the computational problem.
CO4-PO3	H	Students will be able to design solutions for complex programming problems by dividing a problem into modules and developing readable multi-function Python programs to find the solution to the computational problem
CO4-PO4	L	With the knowledge of sub modules and by developing readable multi-function Python programs to find the solution to the computational problem, the students will be able to conduct investigations of complex problems.

CO4-PO5	M	With the knowledge of Identifying Subtasks and developing readable multi-function Python programs to find the solution to the computational problem, students will be able to select and apply appropriate techniques and IT tools like prediction and modelling to complex problems.
CO4-PO6	M	Students will be able to communicate effectively on complex programming activities with the programming community with the knowledge of Identifying Subtasks and developing readable multi-function Python programs to find the solution to the computational problem.
CO4-PO11	L	The students will be able to demonstrate knowledge and understanding of the programming principles and apply them in multi-disciplinary environments with the knowledge of Identifying Subtasks and developing readable multi-function Python programs to find the solution to the computational problem
CO5-PO1	H	Students will be able to use fundamental Programming knowledge by writing readable Python programs which use pointers for array processing and parameter passing.
CO5-PO2	H	Students will be able to perform analysis of complex programming problems with the knowledge of Python programs which use pointers for array processing and parameter passing.
CO5-PO3	M	By writing readable Python programs which use pointers for array processing and parameter passing, students will be able to select and apply appropriate techniques and IT tools like prediction and modelling to complex problems.
CO5-PO4	L	With writing Python programs which use pointers for array processing and parameter passing, the students will be able to communicate effectively on complex programming activities with the programming community
CO5-PO5	H	With the knowledge of programs which use pointers for array processing and parameter passing., the students will be able to recognize the need for and to engage in independent and life-long learning in the broadest context of technological change
CO5-PO6	H	Students will be able to analyze, design and develop computing solutions by writing readable Python programs which use pointers for array processing and parameter passing.
CO5-PO11	L	Students will be able to apply software programming principles and practices for developing quality software with the gained knowledge of writing Python programs which use pointers for array processing and parameter passing.

20MCA133	WEB PROGRAMMING LAB	CATEGORY	L	T	P	CREDIT
		PRACTICAL	0	1	3	2

Preamble: With a dynamic learn-by-doing focus, this laboratory course encourages the students to explore the designing of web application by implementing the relevant and recent techniques. This course challenges the students to exercise their creativity in both programming and designing.

Prerequisite: Basic understanding of computer programming, Internet and Database etc. is very helpful.

Course Outcomes: After the completion of the course the student will be able to;

CO 1	Explore markup languages features and create interactive web pages using them.
CO 2	Learn and design client-side validation using scripting languages.
CO 3	Design front end web page and connect to the back-end databases.
CO 4	Do Client-side & Server-side scripting
CO 5	Develop Web Applications

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	2	2		3	3				
CO 2	3	3	3	2	2		3	3	1			
CO 3	3	3	3	2	2		3	3				
CO 4	3	3	3	2	2		3	3				2
CO 5	3	3	3	3	3		3	3			2	2

20MCA135	DATA STRUCTURES LAB	CATEGORY	L	T	P	CREDIT
		PRACTICAL	0	1	3	2

Preamble: This is the companion course of 20MCA105 Advanced Data Structures and provides the students hands-on experience of the advanced data structures which will boost up the knowledge and confidence of students in applying these techniques while dealing with real life computing problems.

Prerequisite: Basic Data Structures, Knowledge of any programming language, preferably 'C'.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Use Debuggers, Profilers and advanced Compiler options.
CO 2	Implement the Set and Disjoint Set Data Structures.
CO 3	Understand the practical aspects of Advanced Tree Structures.
CO 4	Realise Modern Heap Structures for effectively solving advanced Computational problems.
CO 5	Implement Advanced Graph algorithms suitable for solving advanced computational problems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2				3		1					
CO 2	3	2	2		1							
CO 3	2	2	3	2	1		1					
CO 4	2	3	3	2	1		1					
CO 5	3	3	2	1	2		1					

Mapping	L/M/ H	Justification
CO1-PO1	M	Students will be able to Use Debuggers, Profilers and advanced Compiler options.
CO1-PO5	H	With analyzing a computational problem and develop an algorithm/fLchart, the students are able to analyze complex programming problems.
CO1-PO7	L	By analyzing a computational problem and develop an algorithm/fLchart, the students are able to design solutions for complex programming problems.
CO2-PO1	H	With the knowledge of different data structures implement the Set and Disjoint Set Data Structures.
CO2-PO2	M	With developing programs using branching and looping statements, which uses Arithmetic, Logical, Relational or Bitwise operators, the students are able to analyze complex programming problems.
CO2-PO3	H	With the knowledge of branching and looping statements and operators and by developing programs using them, the students are able to design solutions for complex programming problems.
CO2-PO5	L	With the knowledge of programming using branching and looping statements and operators, students will be able to select and apply appropriate techniques and IT tools like prediction and modelling to complex problems.
CO3-PO1	M	By examining how arrays, structure or union are used for storing data to be processed, the students will be able to apply knowledge in fundamentals of programming and mathematics.
CO3-PO2	M	Students will be able to perform analysis of complex programming problems by examining how arrays, structure or union are used for storing data to be processed
CO3-PO3	H	With the knowledge of how arrays, structure or union are used for storing data to be processed, the students will be able to design solutions for complex programming problems.
CO3-PO4	M	With the knowledge of how arrays, structure or union are used for storing data to be processed, the students will be able to conduct investigations of complex problems.
CO3-PO5	L	With the knowledge of how arrays, structure or union are used for storing data to be processed, students will be able to select and apply appropriate techniques and IT tools like prediction and modelling to complex problems.
CO3-PO7	L	Students will be able to communicate effectively on complex programming activities with the programming community with the knowledge of how arrays, structure or union are used for storing data to be processed.
CO4-PO1	H	Students will be able to use Realize Modern Heap Structures for effectively solving advanced Computational problems.

CO4-PO2	H	Students will be able to perform analysis of complex programming problems with developing readable multi-function Data structure programs to find the solution to the computational problem.
CO4-PO3	H	Students will be able to design solutions for complex programming problems by dividing a problem into modules and developing readable multi-function Data structure programs to find the solution to the computational problem
CO4-PO4	H	With the knowledge of sub modules and by developing readable multi-function Data structure programs to find the solution to the computational problem, the students will be able to conduct investigations of complex problems.
CO4-PO5	H	With the knowledge of Identifying Subtasks and developing readable multi-function Data structure programs to find the solution to the computational problem, students will be able to select and apply appropriate techniques and IT tools like prediction and modelling to complex problems.
CO4-PO7	H	Students will be able to communicate effectively on complex programming activities with the programming community with the knowledge of Identifying Subtasks and developing readable multi-function Data structure programs to find the solution to the computational problem.
CO5-PO1	H	Students will be able to Implement Advanced Graph algorithms suitable for solving advanced computational problems.
CO5-PO2	H	Students will be able to perform analysis of complex programming problems with the knowledge of Data structure programs which use pointers for array processing and parameter passing.
CO5-PO3	M	By writing readable Data structure programs which use pointers for array processing and parameter passing, students will be able to select and apply appropriate techniques and IT tools like prediction and modelling to complex problems.
CO5-PO4	L	With writing Data structure programs which use pointers for array processing and parameter passing, the students will be able to communicate effectively on complex programming activities with the programming community
CO5-PO5	H	With the knowledge of programs which use pointers for array processing and parameter passing., the students will be able to recognize the need for and to engage in independent and life-long learning in the broadest context of technological change
CO5-PO7	H	Students will be able to analyze, design and develop computing solutions by writing readable Data structure programs which use pointers for array processing and parameter passing.

SEMESTER 2

20MCA102	ADVANCED DATABASE MANAGEMENT YSTEMS	CATEGORY	L	T	P	CREDIT
		GENERAL	3	1	0	4

Preamble: This course provides the basic concepts and terminology related to relational and non-relational database management systems. The concept of advanced DBMS techniques and new generation databases like MongoDB, HBase and Cassandra are also introduced. This course serves as a prerequisite for many advanced courses in Data Science and Machine Learning areas.

Prerequisite: Basic knowledge in Database Management Systems.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand the fundamentals of relational database systems including: data models, database architectures and ER features.
CO 2	Analyze and apply the different normalization techniques.
CO 3	Assess the basic issues of transaction processing and concurrency control.
CO 4	Understand the roles that databases play in organizations and familiarize with basic database storage, file organization, database accessing techniques.
CO 5	Understand the basics of query processing, object-oriented, distributed databases.
CO 6	Analyze non-relational database systems and structures and XML.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1				1			1					
CO 2	3	3	3	2			2	2			2	2
CO 3	1	2	2	2		2					2	2
CO 4					1		1					
CO 5	1			1								
CO 6	1											

20MCA104	ADVANCED COMPUTER NETWORKS	CATEGORY	L	T	P	CREDIT
		GENERAL	3	1	0	4

Preamble: This course intends to provide insight into Advanced Computer Networks. A software professional should have an understanding of layered network architecture. Various kinds of network architectures, issues in integrating networks to modern application development are to be addressed. It is also intended to expose the student to modern technologies such as IPV6 and software defined networks. More detailed treatment can be done through seminars, assignments and talks by eminent external experts.

Prerequisite: Basic concepts of computer operating systems.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Comprehend the terminology and concepts of basic communication model, analyse the protocol layers and design application layer protocols.
CO 2	Understand and analyse the various transport layer protocols.
CO 3	Compare and contrast various routing algorithms in the network layer.
CO 4	Understand and analyse the concepts of link layer and physical layer.
CO 5	Understand how modern cellular and wireless networks work

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	2		2	2	2		3		2	
CO 2	3	3	2		2	2			3		2	
CO 3	3	3			2	2	2		3		2	
CO 4	3	3				2			3		2	
CO 5	3	3				2			3			

Mapping	L/M/ H	Justification
CO1-PO1	H	Students will be able understand various synchronization problems and issues in distributed systems by applying the knowledge of mathematics, management, computing fundamentals and computing specialization
CO1-PO2	H	By understanding synchronization and distributed system problems the students are able to analyze the issues and propose solutions
CO1-PO3	M	Students will be able to know about various tools used for solving synchronization problems.
CO1-PO5	M	By gaining knowledge about various synchronization issues students will be able to communicate them with others orally as well as literally.
CO1-PO6	M	Students will be able to classify various mutual exclusion algorithms by applying the knowledge in mathematics & computer fundamentals.
CO1-PO7	M	Students will be able to analyze various mutual exclusion algorithms and security violations
CO1-PO9	H	The knowledge about mutual exclusion and security violations helps students to communicate about complex computing concept to others
CO1-PO11	M	By applying the Knowledge on Mathematics and computing fundamentals students will be able to understand the concept of distributed systems and issues in load sharing
CO2-PO1	H	Students will be able to analyze the design of distributed systems and issues in load distribution
CO2-PO2	H	Students will be able to communicate orally and literally about distributed system design and issues in load sharing
CO2-PO3	M	With the knowledge mathematics and computer fundamentals students will be able to understand various design issues and synchronization problems in multiprocessor systems
CO2-PO5	M	Students will be able to analyze various design issues and synchronization problems in multiprocessor systems and its solutions.
CO2-PO6	M	Students will be able to communicate effectively on complex programming activities with the programming community with the knowledge of how arrays, structure or union are used for storing data to be processed.
CO2-PO9	H	Students will be familiarized with various tools used for handling the synchronization and concurrency control in database systems.
CO2-PO11	M	Students will be able to understand the concept of synchronization and concurrency control in database systems that will give the ability to engage

		in independent and lifelong learning in the context of changes in the database designs
CO3-PO1	H	Students will be able to communicate effectively on complex computing aspects with the knowledge acquired on synchronization and concurrency control concepts in database systems.
CO3-PO2	H	Students will be able understand various synchronization problems and issues in distributed systems by applying the knowledge of mathematics, management, computing fundamentals and computing specialization
CO3-PO3	M	By understanding synchronization and distributed system problems the students are able to analyze the issues and propose solutions
CO3-PO5	M	Students will be able to know about various tools used for solving synchronization problems.
CO3-PO6	M	By gaining knowledge about various synchronization issues students will be able to communicate them with others orally as well as literally.
CO3-PO7	M	Students will be able to classify various mutual exclusion algorithms by applying the knowledge in mathematics & computer fundamentals.
CO3-PO9	H	Students will be able to analyze various mutual exclusion algorithms and security violations
CO3-PO11	H	The knowledge about mutual exclusion and security violations helps students to communicate about complex computing concept to others
CO4-PO1	H	Students will be able understand various synchronization problems and issues in distributed systems by applying the knowledge of mathematics, management, computing fundamentals and computing specialization
CO4-PO2	H	By understanding synchronization and distributed system problems the students are able to analyze the issues and propose solutions
CO4-PO3	M	Students will be able to know about various tools used for solving synchronization problems.
CO4-PO5	M	By gaining knowledge about various synchronization issues students will be able to communicate them with others orally as well as literally.
CO4-PO6	M	Students will be able to classify various mutual exclusion algorithms by applying the knowledge in mathematics & computer fundamentals.
CO4-PO7	M	Students will be able to analyze various mutual exclusion algorithms and security violations

CO4-PO9	H	The knowledge about mutual exclusion and security violations helps students to communicate about complex computing concept to others
CO4-PO11	M	By applying the Knowledge on Mathematics and computing fundamentals students will be able to understand the concept of distributed systems and issues in load sharing
CO5-PO1	H	Students will be able to analyze the design of distributed systems and issues in load distribution
CO5-PO2	H	Students will be able to communicate orally and literally about distributed system design and issues in load sharing
CO5-PO3	M	With the knowledge mathematics and computer fundamentals students will be able to understand various design issues and synchronization problems in multiprocessor systems
CO5-PO5	M	Students will be able to analyze various design issues and synchronization problems in multiprocessor systems and its solutions.
CO5-PO6	M	Students will be able to communicate effectively on complex programming activities with the programming community with the knowledge of how arrays, structure or union are used for storing data to be processed.
CO5-PO9	H	Students will be familiarized with various tools used for handling the synchronization and concurrency control in database systems.
CO5-PO11	M	Students will be able to understand the concept of synchronization and concurrency control in database systems that will give the ability to engage in independent and lifelong learning in the context of changes in the database designs

20MCA172	ADVANCED OPERATING SYSTEMS	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	4

Preamble: This course intends to provide insight into more Advanced Operating Systems. Detailed discussion on various concepts like process synchronization, mutual exclusion, resource sharing, concurrency control and security are discussed at algorithm level. Various kinds of advanced operating systems like Distributed Systems, Multiprocessor systems, and Database Systems are included to the level possible within the scope of a single course. More detailed treatment can be done through seminars , assignments and talks by eminent external experts .

Prerequisite: Basic concepts of desktop computer operating systems.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Identify synchronization problems in operating systems and issues in distributed systems.
CO 2	Explain classification of mutual exclusion algorithms and security violations.
CO 3	Explain the design of distributed shared memory and issues in load distribution.
CO 4	Explain design issues and synchronization in multiprocessor systems.
CO 5	Explain synchronization and concurrency control in database systems.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2			2				1			
CO 2	2	1							1			
CO 3	2	1							1			
CO 4	2	1							1			
CO 5	2	2			1		1		1			

20MCA132	OBJECT ORIENTED PROGRAMMING LAB	CATEGORY	L	T	P	CREDIT
		PRACTICAL	0	1	3	2

Preamble: This course enables the students to understand the concepts of object-oriented programming and to develop skills using these paradigms using Java.

Prerequisite: Knowledge of any programming language preferred.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Understand object-oriented concepts and design classes and objects to solve problems
CO 2	Implement arrays and strings.
CO 3	Implement object-oriented concepts like inheritance, overloading and interfaces
CO 4	Implement packages, exception handling, multithreading and generic programming. Use java.util package and Collection framework
CO 5	Develop applications to handle events using applets
CO 6	Develop applications using files and networking concepts

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	2	2	2	3							
CO 2	3	2	2		3							
CO 3	3	2	2		3							
CO 4	3	2	2		3							
CO 5	3	3	3		3	2			3		3	
CO 6	3	3	3		3	2			3		3	

20MCA192	IPR AND CYBER LAWS	CATEGORY	L	T	P	CREDIT
		ELECTIVE	3	1	0	4

Preamble: This course intends to provide insight into Intellectual Property Rights and Cyber Laws. It includes detailed discussion on various intellectual property rights, procedures to apply for copyrights &patents, legalities of intellectual property to avoid plagiarism and other IPR related crimes. Effectiveness of cyber-laws and other countermeasures against cybercrime and cyber warfare are discussed in detail. Various kinds of Intellectual Property issues in cyberspace and the growth and development of the law in this regard are included to the level possible within the scope of a single course. More detailed treatment can be done through seminars, assignments and talks by eminent external experts including industry.

Prerequisite: General awareness on internet essentials, web technologies, e-commerce.

Course Outcomes: After the completion of the course the student will be able to

CO 1	Explain the fundamentals of IPR and patents.
CO 2	Apply intellectual property related tools such as trademark and copyright to real problems.
CO 3	Discuss Industrial designs, trade secret and geographic Indications.
CO 4	Describe laws governing cyberspace and analyze the role of Internet Governance in framing policies for Internet security.
CO 5	Discuss different types of cybercrimes and penalties under IT Act.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	2	1		1						
CO 2	3	3	2	1		1						
CO 3	3	2	1	1								
CO 4	2	2	1			1						
CO 5	2	2	1	1		1						

20MCA134	ADVANCED DBMS LAB	CATEGORY	L	T	P	CREDIT
		PRACTICAL	0	1	3	2

Preamble: This course is to provide understanding on relational and non-relational database systems and its design. The course covers SQL, PL/SQL and NoSQL programs which are essential for the development and deployment of web based applications. Also this course serves as a prerequisite for many advanced courses in Data Science areas.

Prerequisite: Database Management Systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Design and build a simple relational database system and demonstrate competence with the fundamentals tasks involved with modelling, designing and implementing a database.
CO 2	Apply PL/SQL for processing databases.
CO 3	Comparison between relational and non-relational (NoSQL) databases and the configuration of NoSQL Databases.
CO 4	Apply CRUD operations and retrieve data in a NoSQL environment.
CO 5	Understand the basic storage architecture of distributed file systems.
CO 6	Design and deployment of NoSQL databases with real time requirements.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	2	3	2	2					1	1	
CO 2	2	2	2		1							
CO 3	2	2	2	2						1	1	
CO 4	2	2	3	1	2		1			1	1	1
CO 5	3	2	2				1				1	1
CO 6	2	2	3	1	1			1		1	1	2

20MCA136	NETWORKING & SYSTEM ADMINISTRATION LAB	CATEGORY	L	T	P	CREDIT
		PRACTICAL	0	1	3	2

Preamble: This laboratory course is intended to provide the background knowledge required for a software professional in the fields of networking and system administration. Students will acquire necessary knowledge to deploy and administer systems.

Prerequisite: Basic understanding of computer programming, Internet and operating systems

Course Outcomes: After the completion of the course the student will be able to

CO 1	Install and configure common operating systems.
CO 2	Perform system administration tasks.
CO 3	Install and manage servers for web applications.
CO 4	Write shell scripts required for system administration.
CO 5	Acquire skill sets required for a DevOps.

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1		2		2							
CO 2	1		2									
CO 3			2		2							
CO 4					2							
CO 5	2				2							

Mapping	L/M/ H	Justification
CO1-PO1	L	Students will be able to Install and configure common operating systems.
CO1-PO3	M	With analyzing a networking problem , the students are able to solve complex scripting problems.
CO1-PO5	M	By analyzing a problem and develop solutions for complex scripting problems.
CO2-PO1	M	With the knowledge of shell scripts perform system administration tasks.
CO2-PO3	H	With the knowledge of branching and looping statements and operators and by developing scripts using them, the students are able to design solutions for complex scripting problems.
CO3-PO3	H	With the knowledge of software tools install and manage servers for web applications.
CO3-PO5	L	Students will be able to select and apply appropriate techniques and IT tools like prediction and modelling to complex problems.
CO4-PO5	H	Will gain the knowledge of shell scripts required for system administration.
CO5-PO1	H	Students will be able to acquire skill sets required for a DevOps.
CO5-PO5	H	With the knowledge of scripts the students will be able to recognize the need for and to engage in independent and life-long learning in the broadest context of technological change

SEMESTER 3

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
20MCA201	DATA SCIENCE & MACHINE LEARNING	CORE	3	1	0	4

Preamble: This is an introductory course on data science and basic concepts behind various machine learning techniques. Machine learning is the study of adaptive computational systems that improve their performance with experience. At the end of the course the students should be able to design and implement machine learning solutions to classification, regression, and clustering problems and to evaluate and interpret the results of the algorithms.

Prerequisite: Probability and Statistics, Linear Algebra, Programming in Python/R.

Course Outcomes: After the completion of the course the student will be able to:

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Discuss the fundamental concepts of data science and data visualization techniques.	Level 2: Understand
CO 2	Explain the basics of machine learning and use lazy learning and probabilistic learning algorithms to solve data science problems.	Level 3: Apply
CO 3	Describe decision trees, classification rules & regression methods and how these algorithms can be applied to solve data science problems.	Level 3: Apply
CO 4	Solve data science problems using neural networks and support vector machines.	Level 3: Apply
CO 5	Discuss clustering using k-means algorithm and evaluate & improve the performance of machine learning classification models.	Level 3: Apply

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	1	1	-	-	-	-	3	-	-	-	-	-
CO 2	3	3	3	2	-	-	3	-	-	-	-	-
CO 3	3	3	3	2	-	-	3	-	-	-	-	-
CO 4	3	3	3	2	-	-	3	-	-	-	-	-
CO 5	3	3	3	2	-	-	3	-	-	-	-	-

3/2/1: High/Medium/Low

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
20MCA203	DESIGN & ANALYSIS OF ALGORITHMS	CORE	3	1	0	4

Preamble: The syllabus is prepared with a view to provide a strong foundation to students in design and analysis of computer algorithms and to introduce them the advanced topics such as Network Flows, Approximation algorithms and Randomised algorithms.

Prerequisite: Knowledge in Data Structures

Course Outcomes: After completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Discuss the basic concepts in computer algorithms and their analysis & design using Divide and Conquer.	Level 2: Understand
CO 2	Explain the concepts of Greedy Strategy and Dynamic Programming to use it in solving real world problems.	Level 3: Apply
CO 3	Explain the Branch & Bound technique, Backtracking technique and Lower bounds.	Level 2: Understand
CO 4	Describe the fundamental concepts of Computational Complexity and Network Flows.	Level 2: Understand
CO 5	Discuss the concepts of Approximation and Randomised Algorithms.	Level 2: Understand

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	1	2			2					
CO 2	3	3	1	2			2					
CO 3	3	3	1	2			2					
CO 4	3	3	1	2			2					
CO 5	3	3	1	2			2					

3/2/1: High/Medium/Low

CO	LEVEL	JUSTIFICATION
CO1-PO1	H	By analysing various iterative and recursive algorithms & divide and conquer strategies and express their time complexities in asymptotic notations, the students will be able to solve algorithms for complex Computational problems
CO1-PO2	H	By analysing various iterative and recursive algorithms & divide and conquer strategies and express their time complexities in asymptotic notations, the students will be able to analyse for complex Computational problems
CO1-PO3	L	By analysing various iterative and recursive algorithms & divide and conquer strategies and express their time complexities in asymptotic notations, the students will be able to Design or develop solutions for complex Computational problems
CO1-PO4	M	By analysing various iterative and recursive algorithms , solving problems using dynamic programming and divide and conquer strategies, and express their time complexities in asymptotic notations, the students will be able Conduct investigations of complex problems
CO1-PO7	M	By solving problems using dynamic programming and divide and conquer strategies, students will be able to continue their practise of Life-long learning
CO2-PO1	H	By understand the concepts of Greedy Strategy and Dynamic Programming to use it in solving real world problems, the students will be able to solve algorithms for complex Computational problems
CO2-PO2	H	By understand the concepts of Greedy Strategy and Dynamic Programming to use it in solving real world problems, the students will be able to analyse for complex Computational problems
CO2-PO3	L	By understand the concepts of Greedy Strategy and Dynamic Programming to use it in solving real world problems, the students will be able to Design or develop solutions for complex Computational problems
CO2-PO4	M	By understand the concepts of Greedy Strategy and Dynamic Programming to use it in solving real world problems, the students will be able Conduct investigations of complex problems

CO2-PO7	M	By understand the concepts of Greedy Strategy and Dynamic Programming to use it in solving real world problems, students will be able to continue their practise of Life-long learning
CO3-PO1	H	By understand the Branch & Bound technique, Backtracking technique and Ler bounds the students will be able to acquire more Computational knowledge
CO3-PO2	H	By understand the Branch & Bound technique, Backtracking technique and Ler bounds the students will be able to analyse for complex Computational problems
CO3-PO3	L	By understand the Branch & Bound technique, Backtracking technique and Ler bounds the students will be able to Design or develop solutions for complex Computational problems
CO3-PO4	M	By understand the Branch & Bound technique, Backtracking technique and Ler bounds the students will be able Conduct investigations of complex problems
CO3-PO7	M	By understand the Branch & Bound technique, Backtracking technique and Ler bounds students will be able to continue their practise of Life-long learning
CO4-PO1	H	The knowledge about fundamental concepts of Computational Complexity and Network FLs the students will be able to solve algorithms for complex Computational problems
CO4-PO2	H	The knowledge about fundamental concepts of Computational Complexity and Network FLs the students will be able to analyse for complex Computational problems
CO4-PO3	L	The knowledge about fundamental concepts of Computational Complexity and Network FLs the students will be able to Design or develop solutions for complex Computational problems
CO4-PO4	M	The knowledge about fundamental concepts of Computational Complexity and Network FLs the students will be able Conduct investigations of complex problems
CO4-PO7	M	The knowledge about fundamental concepts of Computational Complexity and Network FLs students will be able to continue their practise of Life-long learning
CO5-PO1	H	The concepts of Approximation and Randomised Algorithms prepare the students to solve algorithms for complex Computational problems
CO5-PO2	H	The concepts of Approximation and Randomised Algorithms prepare the students to analyse for complex Computational problems

CO5-PO3	L	The concepts of Approximation and Randomised Algorithms prepare the students to Design or develop solutions for complex Computational problems
CO5-PO4	M	The concepts of Approximation and Randomised Algorithms prepare the students to Conduct investigations of complex problems
CO5-PO7	M	The concepts of Approximation and Randomised Algorithms prepare the students to continue their practise of Life-long learning

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
20MCA263	CYBER SECURITY & CRYPTOGRAPHY	ELECTIVE	3	1	0	4

Preamble: This course is designed to provide theoretical concepts used in cryptography and to introduce the students to various cryptographic algorithms and techniques used for implementing data security and protection. This course also discusses common web application security vulnerabilities.

Prerequisite: Student is expected to have studied mathematics courses that cover Elementary Number Theory, Finite Field, Discrete Logarithm and Euclidean Algorithm.

Course Outcomes: After completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Explain various types of security attacks, security mechanisms, security services and classical encryption techniques.	Level 2: Understand
CO 2	Make use of Symmetric and Asymmetric encryption techniques to solve cryptographic problems.	Level 3: Apply
CO 3	Describe the concepts of message authentication codes, hash functions and digital signing techniques for ensuring secure transactions.	Level 2: Understand
CO 4	Discuss security services in Application, Transport and Network layers.	Level 2: Understand
CO 5	Explain common web application security vulnerabilities and various prevention mechanisms.	Level 2: Understand

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	1	1				1					
CO 2	2	2	2	1			1					
CO 3	2	1	1				1					
CO 4	2	1	1			2	1					
CO 5	2	1	1			2	1					

3/2/1: High/Medium/Low

Mapping	L/M/ H	Justification
CO1-PO1	M	Students will be able understand various synchronization problems and issues in distributed systems by applying the knowledge of mathematics, management, computing fundamentals and computing specialization
CO1-PO2	L	By understanding synchronization and distributed system problems the students are able to analyze the issues and propose solutions
CO1-PO3	L	Students will be able to know about various tools used for solving synchronization problems.
CO1-PO5	M	By gaining knowledge about various synchronization issues students will be able to communicate them with others orally as well as literally.
CO1-PO7	L	Students will be able to analyze various mutual exclusion algorithms and security violations
CO1-PO9	H	The knowledge about mutual exclusion and security violations helps students to communicate about complex computing concept to others
CO1-PO11	M	By applying the Knowledge on Mathematics and computing fundamentals students will be able to understand the concept of distributed systems and issues in load sharing
CO2-PO1	H	Students will be able to analyze the design of distributed systems and issues in load distribution
CO2-PO2	H	Students will be able to communicate orally and literally about distributed system design and issues in load sharing
CO2-PO3	M	With the knowledge mathematics and computer fundamentals students will be able to understand various design issues and synchronization problems in multiprocessor systems
CO2-PO5	M	Students will be able to analyze various design issues and synchronization problems in multiprocessor systems and its solutions.
CO2-PO6	M	Students will be able to communicate effectively on complex programming activities with the programming community with the knowledge of how arrays, structure or union are used for storing data to be processed.
CO2-PO9	H	Students will be familiarized with various tools used for handling the synchronization and concurrency control in database systems.
CO2-PO11	M	Students will be able to understand the concept of synchronization and concurrency control in database systems that will give the ability to engage

		in independent and lifelong learning in the context of changes in the database designs
CO3-PO1	H	Students will be able to communicate effectively on complex computing aspects with the knowledge acquired on synchronization and concurrency control concepts in database systems.
CO3-PO2	H	Students will be able understand various synchronization problems and issues in distributed systems by applying the knowledge of mathematics, management, computing fundamentals and computing specialization
CO3-PO3	M	By understanding synchronization and distributed system problems the students are able to analyze the issues and propose solutions
CO3-PO5	M	Students will be able to know about various tools used for solving synchronization problems.
CO3-PO6	M	By gaining knowledge about various synchronization issues students will be able to communicate them with others orally as well as literally.
CO3-PO7	M	Students will be able to classify various mutual exclusion algorithms by applying the knowledge in mathematics & computer fundamentals.
CO3-PO9	H	Students will be able to analyze various mutual exclusion algorithms and security violations
CO3-PO11	H	The knowledge about mutual exclusion and security violations helps students to communicate about complex computing concept to others
CO4-PO1	H	Students will be able understand various synchronization problems and issues in distributed systems by applying the knowledge of mathematics, management, computing fundamentals and computing specialization
CO4-PO2	H	By understanding synchronization and distributed system problems the students are able to analyze the issues and propose solutions
CO4-PO3	M	Students will be able to know about various tools used for solving synchronization problems.
CO4-PO5	M	By gaining knowledge about various synchronization issues students will be able to communicate them with others orally as well as literally.
CO4-PO6	M	Students will be able to classify various mutual exclusion algorithms by applying the knowledge in mathematics & computer fundamentals.
CO4-PO7	M	Students will be able to analyze various mutual exclusion algorithms and security violations

CO4-PO9	H	The knowledge about mutual exclusion and security violations helps students to communicate about complex computing concept to others
CO4-PO11	M	By applying the Knowledge on Mathematics and computing fundamentals students will be able to understand the concept of distributed systems and issues in load sharing
CO5-PO1	H	Students will be able to analyze the design of distributed systems and issues in load distribution
CO5-PO2	H	Students will be able to communicate orally and literally about distributed system design and issues in load sharing
CO5-PO3	M	With the knowledge mathematics and computer fundamentals students will be able to understand various design issues and synchronization problems in multiprocessor systems
CO5-PO5	M	Students will be able to analyze various design issues and synchronization problems in multiprocessor systems and its solutions.
CO5-PO6	M	Students will be able to communicate effectively on complex programming activities with the programming community with the knowledge of how arrays, structure or union are used for storing data to be processed.
CO5-PO9	H	Students will be familiarized with various tools used for handling the synchronization and concurrency control in database systems.
CO5-PO11	M	Students will be able to understand the concept of synchronization and concurrency control in database systems that will give the ability to engage in independent and lifelong learning in the context of changes in the database designs

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
20MCA265	Cloud Computing	ELECTIVE	3	1	0	4

Preamble: The syllabus is prepared with a view to equip the students to learn basic concepts in cloud computing - compute, storage, networking. They should gain basic understanding of orchestration, HA and failover.

Prerequisite: Awareness in Virtualisation and Containers is desirable.

Course Outcomes: After completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Understand the basic concepts in cloud computing and OpenStack logical architecture	Level 2: Understand
CO 2	Discuss OpenStack cloud controller and common services	Level 3: Apply
CO 3	Compare different OpenStack compute service components and storage types	Level 2: Understand
CO 4	Describe the OpenStack Networking- Connection types and networking services	Level 2: Understand
CO 5	Discuss orchestration, HA and failover in OpenStack	Level 2: Understand

Mapping of Course Outcomes with Program Outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2				3		2					1
CO 2	2				3		2					1
CO 3	2				3		2					1
CO 4	2				3		2					1
CO 5	2				3		2					1

3/2/1: High/Medium/Low

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
20MCA281	INTERNET OF THINGS	ELECTIVE	3	1	0	4

Preamble: This course intends to provide insight into new innovations that will build novel type of interactions among things and humans, and enables the realization of smart cities, infrastructures, and services for enhancing the quality of life and utilization of resources. An overview of IOT and its related concepts, different IOT architectures and their components, emerging paradigms such as Fog computing, Platforms and solutions supporting development and deployment of IOT applications, message passing mechanisms such as RPC, REST, and CoAP, data and knowledge management, data confidentiality, data integrity, and operation control issues faced by IOT are included in the course.

Prerequisite: Basic concepts of Information Technology and Internet.

Course Outcomes: After completion of the course the student will be able to

CO No:	Course Outcome (CO)	Blooms Category Level
CO 1	Describe the main concepts and features of the IOT paradigm.	Level 2: Understand
CO 2	Discuss Fog computing, TinyOS - nesC and programming frameworks for IOT	Level 2: Understand
CO 3	Describe the data management techniques applied to the IOT environment.	Level 2 Understand
CO 4	Explain security, and privacy in IOT environments	Level 2 Understand
CO 5	Discuss key enablers and solutions to enable practical IoT systems	Level 2 Understand

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3						2					
CO 2	3	1					2					
CO 3	3	1					2					
CO 4	3	1					2					
CO 5	3	1	1				2					

3/2/1: High/Medium/Low

20MCA241	DATA SCIENCE LAB	CATEGORY	L	T	P	CREDIT
		LAB	0	1	3	2

Preamble: This is an introductory practical course on Data Science and student will learn how to use various scientific libraries in python to implement data mining techniques and machine learning algorithms.

Prerequisite: Fundamentals of programming, python programming fundamentals, Machine learning, fundamentals of web programming.

Course Outcomes: After the completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Use different python packages to perform numerical calculations, statistical computations and data visualization	Level 3: Apply
CO 2	Use different packages and frameworks to implement regression and classification algorithms.	Level 3: Apply
CO 3	Use different packages and frameworks to implement text classification using SVM and clustering using k-means	Level 3: Apply
CO 4	Implement convolutional neural network algorithm using Keras framework.	Level 3: Apply
CO 5	Implement programs for web data mining and natural language processing using NLTK	Level 3: Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	1	3	2	3		2			
CO 2	3	3	3	2	3	2	3		2			
CO 3	3	3	3	2	3	2	3		2			
CO 4	3	3	3	2	3	2	3		2			
CO 5	3	3	3	2	3	3	3		2			

3/2/1: High/Medium/Low

20MCA243	MOBILE APPLICATION DEVELOPMENT LAB	CATEGORY	L	T	P	CREDIT
		LAB	0	1	3	2

Preamble: This is a practical course on Mobile Application Development and student will learn how to program in Android Platform and develop applications using SQLite that run on Andriod Operating System.

Prerequisite: Basic knowledge on programming and database concepts.

Course Outcomes: After the completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Design and develop user interfaces for mobile apps using basic building blocks, UI components and application structure using Emulator	Level 3: Apply
CO 2	Write simple programs and develop small applications using the concepts of UI design, layouts and preferences	Level 3: Apply
CO 3	Develop applications with multiple activities using intents, array adapter, exceptions and options menu.	Level 3: Apply
CO 4	Implement activities with dialogs, spinner, fragments and navigation drawer by applying themes	Level 3: Apply
CO 5	Develop mobile applications using SQLite.	Level 3: Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3	3	1	3	2	3		2			
CO 2	3	3	3	2	3	2	3		2			
CO 3	3	3	3	2	3	2	3		2			
CO 4	3	3	3	2	3	2	3		2			
CO 5	3	3	3	2	3	3	3		2			

3/2/1: High/Medium/Low

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
20MCA245	MINI PROJECT	PROJECT	-	-	4	2

Preamble: This project work aims to enable the students to apply the software engineering principles on a real software project, to make the students familiar with the stages of a deployment pipeline and to develop a software product using the latest software development methodology.

Prerequisite: Knowledge in software engineering principles and programming skills.

Course Outcomes: After the completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Identify a real-life project which is useful to society / industry	Level 2: Understand
CO 2	Interact with people to identify the project requirements	Level 3: Apply
CO 3	Apply suitable development methodology for the development of the product / project	Level 3: Apply
CO 4	Analyse and design a software product / project	Level 4: Analyse
CO 5	Test the modules at various stages of project development	Level 5: Evaluate
CO 6	Build and integrate different software modules	Level 6: Create
CO 7	Document and deploy the product / project	Level 3: Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	3	3	3	1	2	3	3	3	3	3	3
CO 2	2	3	2	3	2	3	2	1	3	2	3	
CO 3	3	3	3	3	3	1	3	3	1		2	
CO 4	3	3	3	3	3		3	3	1	1	2	
CO 5	3	3	3	3	3		2	3			1	
CO 6	3	3	3	3	3	2	3	3		2	3	3
CO 7	1	1	3	3	3	2	3	3	2	1	2	

3/2/1: High/Medium/Low

SEMESTER- 4

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
20MCA244	SEMINAR	SEMINAR	-	-	2	2

Preamble: This course intends to enable the students to gain knowledge in any of the technically relevant current topics on Computer Science or Information Technology, and to acquire confidence in presenting the topic and preparing a report.

Prerequisite: Nil

Course Outcomes: After the completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Annotate the ideas presented in technical papers	Level 2: Understand
CO 2	Comprehend a concept by referring different technical documents	Level 2: Understand
CO 3	Prepare technical documents	Level 3: Apply
CO 4	Present a topic before an audience	Level 3: Apply
CO 5	Interact with the audience	Level 2: Understand

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	3	1	3	2		3		3	2		2
CO 2	2	3	1	3	2		3		3	2		2
CO 3	2		1	2	3	2	3		3	2		2
CO 4	2	2			3	3			3		2	
CO 5	2	2			3	3			3		2	

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
20MCA242	COMPREHENSIVE VIVA	VIVA	-	-	-	6

Preamble: Comprehensive Viva intends to assess the knowledge gained by a student in the core courses of this programme and to make the student aware of his/her knowledge level and where he/she stands after completing this programme. This course will help the student in preparing for comprehensive examinations and improve the confidence in answering questions in objective mode.

Prerequisite: Thorough knowledge in all the courses he/she learned during this programme.

Course Outcomes: After the completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Articulate the concepts in the core courses learned through this programme.	Level 2: Understand
CO 2	Attend technical interviews with confidence.	Level 2: Understand
CO 3	Interpret questions and answer them with clarity.	Level 2: Understand
CO 4	Make use of the concepts learned through this programme in future.	Level 3: Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	3	3		2	2		2		3			
CO 2	3	3	1	2	3	2	3		3			
CO 3	1	2				2	2		3			
CO 4	3	2	3	2	2	3	3		2			

CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
20MCA246	MAIN PROJECT	PROJECT	-	-	27	12

Preamble: This project work aims to enable the students to apply the software engineering principles on a real software project, to make the students familiar with the stages of a deployment pipeline and to develop a software product using the latest software development methodology.

Prerequisite: Knowledge in software engineering principles and programming skills.

Course Outcomes: After the completion of the course the student will be able to

CO No.	Course Outcome (CO)	Bloom's Category Level
CO 1	Identify a real-life project which is useful to society / industry	Level 2: Understand
CO 2	Interact with people to identify the project requirements	Level 3: Apply
CO 3	Apply suitable development methodology for the development of the product / project	Level 3: Apply
CO 4	Analyse and design a software product / project	Level 4: Analyse
CO 5	Test the modules at various stages of project development	Level 5: Evaluate
CO 6	Build and integrate different software modules	Level 6: Create
CO 7	Document and deploy the product / project	Level 3: Apply

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1	2	3	3	3	1	2	3	3	3	3	3	3
CO 2	2	3	2	3	2	3	2	1	3	2	3	
CO 3	3	3	3	3	3	1	3	3	1		2	
CO 4	3	3	3	3	3		3	3	1	1	2	
CO 5	3	3	3	3	3		2	3			1	
CO 6	3	3	3	3	3		3	3		2	3	3
CO 7	1	1	3	3	3	2	3	3	2	1	2	

Mapping	Low/Medium/ High	Justification
CO1-PO1	M	Students will be able to use Programming knowledge by Analyzing a computational problem and develop an algorithm/flowchart.
CO1-PO2	H	With analyzing a computational problem and develop an algorithm/flowchart, the students are able to analyze complex programming problems.
CO1-PO3	M	By analyzing a computational problem and develop an algorithm/flowchart, the students are able to design solutions for complex programming problems.
CO1-PO4	L	Through analyzing a computational problem and develop an algorithm/flowchart, the students are able to conduct investigations of complex problems.
CO1-PO5	H	Students will be able to apply knowledge to assess social issues and responsibilities relevant to the professional programming practice through analyzing a computational problem and developing solutions for that.
CO2-PO1	H	With the knowledge of different Arithmetic, Logical, Relational or Bitwise operators, the students will be able to use Programming knowledge.
CO2-PO2	H	With developing programs using branching and looping statements, which uses Arithmetic, Logical, Relational or Bitwise operators, the students are able to analyze complex programming problems.
CO2-PO3	H	With the knowledge of branching and looping statements and operators and by developing programs using them, the students are able to design solutions for complex programming problems.
CO2-PO4	M	The students are able to conduct investigations of complex problems with the knowledge of programming using branching and looping statements and operators.
CO2-PO5	M	With the knowledge of programming using branching and looping statements and operators, students will be able to select and apply appropriate techniques and IT tools like prediction and modelling to complex problems.
CO2-PO6	M	The students are able to communicate effectively on complex programming activities with the programming community with