MASTER OF COMPUTER APPLICATIONS

CURRICULUM

[EFFECTIVE FROM 2024 - 25 ONWARDS]

DEPARTMENT OF COMPUTER APPLICATIONS
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620 015

VISION OF THE INSTITUTE

• To be a university globally trusted for technical excellence where learning and research integrate to sustain society and industry.

MISSION OF THE INSTITUTE

- To offer undergraduate, postgraduate, doctoral and modular programmes in multi-disciplinary / inter-disciplinary and emerging areas.
- To create a converging learning environment to serve a dynamically evolving society.
- To promote innovation for sustainable solutions by forging global collaborations with academia and industry in cutting-edge research.
- To be an intellectual ecosystem where human capabilities can develop holistically.

VISION OF THE DEPARTMENT

- Towards building a school of Information Science and Technology conforming to international standards to provide valuable resources to the society

MISSION OF THE DEPARTMENT

- To offer state-of-art education in Information Science and Technology
- To provide strong theoretical foundation complemented with extensive practical training
- To inculcate value-based, socially committed professionalism to the cause of holistic development of students and society

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1	Prepare graduates to become computer professionals with comprehensive knowledge and skills to produce software for emerging requirement
PEO2	Prepare graduates to become continuous learner with aptitude for teaching and research with societal focus
PEO3	Prepare graduates to become Consultant / Entrepreneurs in the IT and ITES industries with confidence in self-employment

PROGRAMME OUTCOMES (POs)

PO1	**(Foundation Knowledge)**: Apply knowledge of mathematics, programming logic and coding fundamentals for solution architecture and problem solving.
PO2	**(Problem Analysis)**: Identify, review, formulate and analyse problems primarily focusing on customer requirements using critical thinking frameworks.
PO3	**(Development of Solutions)**: Design, develop and investigate problems with an innovative approach for solutions incorporating ESG/SDG goals.
PO4	**(Modern Tool Usage):** Select, adapt and apply modern computational tools such as development of algorithms with an understanding of the limitations including human biases.
PO5	**(Individual and Teamwork)**: Function and communicate effectively as an individual or a team leader in diverse and multidisciplinary groups. Use methodologies such as agile.
PO6	**(Project Management and Finance):** Use the principles of project management such as scheduling, work breakdown structure and be conversant with the principles of Finance for profitable project management.
PO7	**(Ethics):** Commit to professional ethics in managing software projects with financial aspects. Learn to use new technologies for cyber security and insulate customers from malware
PO8	**(Life-long learning):** Change management skills and the ability to learn, keep up with contemporary technologies and ways of working

CURRICULUM FRAMEWORK / FLEXIBLE CURRICULUM / NEP 2020 / MCA

Components	Number of Courses	Number of Credits
Programme Core (PC)	5 / Semester (10 / Year)	82
Programme Elective (PE)	2 / Semester (3 / Year)	
Essential Laboratory Requirements (ELR)	4 / Year	22
Internship / Industrial Training / Academic Attachment (I/A)	1	2
Project Phase-I	1	2
Project Phase-II	1	12
Total	**20**	**120**

CURRICULUM

SEMESTER I

Code	Course of Study	Credit
CA711	Problem Solving and Programming	3
CA713	Mathematical Foundations of Computer Applications	4
CA715	Digital Logic and Computer Organization	3
CA717	Data Structures and Applications	3
CA719	Operating Systems	4
CA701	Problem Solving Lab using Python	2
CA703	Data Structures Lab using C	2
		21

SEMESTER II

Code	Course of Study	Credit
CA710	Design and Analysis of Algorithms	4
CA712	Database Management Systems	3
CA714	Probability and Statistical Methods	4
CA716	Object-oriented Programming	4
CA718	Computer Networks	3
CA702	DBMS Lab	2
CA704	Computer Networks Lab	2
	Internship	1
		22

SEMESTER III

Code	Course of Study	Credit
CA721	Machine Learning Techniques	3
CA723	Computational Intelligence	3
CA725	Software Engineering	4
CA727	Accounting and Financial Management	3
CA7A_	Elective-I	3
CA705	Machine Learning Lab	2
CA707	Business Communication	2
CA709	Computational Intelligence Lab	2
		20

SEMESTER IV

Code	Course of Study	Credit
CA720	Deep Learning and Its Applications	3
CA722	Web Technology and Its Applications	4
CA724	Distributed and Cloud Computing	3
CA7A_	Elective-II	3
CA7B_	Elective-III	3
CA706	Deep Learning Lab	2
CA708	Distributed and Cloud Computing Lab	2
	Internship	1
		20

SEMESTER V

Code	Course of Study	Credit
CA731	Cyber Security	3
CA733	Mobile Applications Development	3
CA735	Organizational Behavior	3
CA7C_	Elective-IV	3
CA7D_	Elective-V	3
CA70A	Cyber Security Lab	2
CA70B	Mobile Applications Development Lab	2
CA749	Project Work Phase I	2
		19

SEMESTER VI

Code	Course of Study	Credit
CA750	Project Work Phase II	12
		12

SUMMER TERM **(evaluation in the III semester)**

Code	Course of Study	Credit
	Internship / Industrial Training / Academic Attachment (I/A) (6 weeks to 8 weeks)	2

SEMESTER III

Code	Course of Study	Credit
CA749	Project Work (Phase I)	2

SEMESTER IV

Code	Course of Study	Credit
CA750	Project Work (Phase II)	12

PROGRAMME ELECTIVES (PE)

Sl. No.	Code	Course of Study	Credit
1.	CA7A1	Data Science	3
2.	CA7A2	Social Network Analysis	3
3.	CA7A3	Advanced Database Technology	3
4.	CA7A4	Data Mining and Warehousing	3
5.	CA7A5	Resource Management Techniques	3
6.	CA7A6	Image Processing	3
7.	CA7B1	Software Architecture and Project Management	3
8.	CA7B2	Service Oriented Architecture	3
9.	CA7B3	Agile Technology	3
10.	CA7B4	Marketing Management	3
11.	CA7C1	Bioinformatics	3
12.	CA7C2	Evolutionary Computing	3
13.	CA7C3	Modelling and Computer Simulation	3
14.	CA7C4	Natural Language Processing	3
15.	CA7C5	DevOps	4
16.	CA7C6	Mobile Computing	4
17.	CA7C7	Block Chain Technology	3

18.	CA7C8	Business Ethics	3
19.	CA7D1	Big Data Management	4
20.	CA7D2	Green Computing	3
21.	CA7D3	Internet of Things	4
22.	CA7D4	Human Computer Interaction	3
23.	CA7D5	Multi-core Programming	3
24.	CA7D6	MEAN Stack Development	3
25.	CA7D7	Computer Vision	3
26.	CA7D8	Business Intelligence	3

COURSE OUTCOME AND PROGRAMME OUTCOME MAPPING

PROGRAMME CORE (PC)

Course Outcomes: On successful completion of the course, students will be able to:

Course Code	Course Title	CO	Course outcomes At the end of the course student will be able	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CA711	Problem Solving and Programming	CO1	To write structured pseudo codes for a given problem.	3	3	3	3	3	2	0	2
		CO2	To develop Python programs with conditionals- loops and data structures	3	2	3	3	3	3	1	2
		CO3	To design and create Python applications using functions and files	2	2	2		2	2	1	0
		CO4	To build and package Python modules for reusability	0	2	1	1	2	3	0	0
CA713	Mathematical Foundations of Computer Applications	CO1	To explain the mathematical principles for computer applications.	3	3	3	3	2	2	2	1
		CO2	To describe about the concept of logical propositions	1	2	3	3	2	3	2	1
		CO3	To explain about Graph Theory and its Applications	1	2	2	1	2	1	2	1
		CO4	To summarize the ideas of Automata Theory	0	2	2	0	2	0	1	1
CA715	Digital Logic and Computer Organization	CO1	Explain the principles of Digital systems and its design	3	3	3	3	0	0	0	0
		CO2	Describe the functional units of the CPU and Memory	2	3	3	0	0	0	0	0
		CO3	Brief the concepts of Pipelining	2	3	0	0	0	0	0	0

		CO4	Summarize about advanced computer architectures	0	0	2	2	0	0	0	1
CA717	Data Structures and Applications	CO1	Understand and classify data structures	3	0	0	0	0	0	0	3
		CO2	Use linear data structures to solve real-time problems	0	0	3	3	0	0	0	3
		CO3	Use non-linear data structures to solve real-time problems	0	0	3	3	0	0	0	3
		CO4	Apply advanced data structures in different application domains	0	0	3	3	0	0	0	3
CA719	Operating Systems	CO1	Understand the functional architecture of an operating system.	3	3	3	0	0	0	0	0
		CO2	Design device drivers and multithreading libraries for a tiny OS	3	3	3	3	0	0	0	0
		CO3	Design and solve synchronization problems	3	3	3	0	3	0	0	0
		CO4	Understand standard UNIX and FAT file systems, Protection and Security.	3	3	0	0	0	3	0	0
CA710	Design and Analysis of Algorithms	CO1	Design algorithms using various strategies	2	0	3	3	0	0	0	3
		CO2	Compute time- and space complexities of various algorithms	3	0	3	3	0	0	0	3
CA712	Database Management Systems	CO1	Get practical knowledge on designing and creating relational database systems	2	3	3	2	3	0	0	0
		CO2	Describe the nuances of Data retrieval methods	0	2	3	2	0	0	0	0
		CO3	Apply normalization techniques in DB design	2	2	3	0	0	0	0	0

		CO4	Perform concurrency and Transaction Management operations	0	2	3	2	0	0	0	0
CA714	Probability and Statistical Methods	CO1	Explain basic probabilistic and statistical models and illustrate their related applications	3	3	3	2	2	3	2	3
		CO2	Estimate the likelihood of events from population	1	1	1	2	2	3	2	3
		CO3	Propose, test and evaluate hypothesis.	2	3	3	2	2	3	3	3
CA716	Object-oriented Programming	CO1	Describe object-oriented programming principles and comprehend the java architecture.	2	2	3	3	1	1	1	1
		CO2	Understand and use of object-oriented programming principles such as inheritance and polymorphism.	3	3	3	2	1	1	1	1
		CO3	Apply exception handling mechanism to deal with runtime errors.	3	3	3	2	1	1	1	1
		CO4	Understand and use java APIs to build GUI-based Applications.	3	3	3	2	1	1	1	1
CA718	Computer Networks	CO1	List the functionalities of networking layers available in both OSI reference model and TCP/IP model.	2	2	2	2	2	2	1	2
		CO2	Describe available LAN and WAN Technologies.	2	2	2	2	2	2	1	2
		CO3	Describe the principles of packet switching, forwarding, and routing.	2	2	2	2	2	2	1	2
		CO4	Distinguish between TCP and UDP packet formats.	2	3	3	2	2	2	1	2
		CO5	Describe the available application protocols and networking services.	3	3	2	2	2	2	2	2
CA721	Machine Learning Techniques	CO1	Select real-world applications that needs machine learning based solutions.	3	3	3	2	2	1	1	2

		CO2	Implement and apply machine learning algorithms.	3	3	3	2	2	1	1	3
		CO3	Select appropriate algorithms for solving a particular group of real-world problems.	3	3	3	2	2	1	1	2
		CO4	Recognize the characteristics of machine learning techniques that are useful to solve real-world problems.	3	3	3	2	2	1	1	2
CA723	Computational Intelligence	CO1	Explain the basics of computational intelligence techniques and their suitable industry related applications	3	2	2	3	2	3	2	0
		CO2	Apply neural network principles and algorithms for given problems	3	2	2	3	2	3	2	1
		CO3	Apply the principles of fuzzy and hybrid algorithms for real time applications	3	2	2	3	0	3	2	1
		CO4	Solve problems using evolutionary algorithms	3	2	2	3	1	1	0	0
CA725	Software Engineering	CO1	Demonstrate a basic understanding of software engineering practices from vision to analysis, design, development, validation, deployment and maintenance.	2	3	3	2	3	3	3	3
		CO2	Develop skills to create and use various software Engineering based techniques and tools to solve real world problems.	2	3	3	2	2	2	2	2
		CO3	Estimate cost, effort and risk involved in a software project development.	1	1	1	2	1	3	3	1
CA727	Accounting and Financial Management	CO1	Prepare and analyse the final accounts of the firm	3	2	2	2	3	3	3	3
		CO2	Prepare and analyse the funds & cash flow statements of the firm	3	3	2	2	2	2	3	3
		CO3	Perform basic analysis of financial statements and write a report on the financial	1	2	3	3	3	3	3	3

			performance, conditions and effectiveness of the firm								
		CO4	Analyse and evaluate costing systems	1	2	3	0	3	0	3	0
		CO5	Prepare different types of budgets and policies	1	2	3	3	3	3	2	3
CA720	Deep Learning and Its Applications	CO1	Explore the essentials of Deep Learning based architectures	3	3	3	3	0	1	1	1
		CO2	Design and Develop Deep Neural Networks for solving real world problems that require artificial intelligence-based solutions	0	2	2	2	2	2	0	0
CA722	Web Technology and Its Applications	CO1	Design and develop applications using client-side technologies	3	2	2	2	2	1	1	1
		CO2	Demonstrate the skills required for working Single Page and Dynamic Page Applications	3	1	3	3	3	3	2	0
		CO3	Develop and deploy server-side applications.	3	0	0	0	3	3	3	3
		CO4	Understand the significance JavaScript frameworks in web applications development.	3	0	2	1	1	1	3	0
CA724	Distributed and Cloud Computing	CO1	Understand the fundamentals of distributed computing	3	3	3	3	0	0	0	0
		CO2	Explain the principles of virtualization	3	3	3	3	0	0	0	0
		CO3	Acquire knowledge on the concepts and technologies of cloud computing	3	3	3	3	0	0	0	0
		CO4	Identify the service-oriented architecture for distributed computing workflow	3	3	3	3	0	0	0	0
		CO5	Use various performance criteria for evaluating the quality of cloud models	3	3	3	3	0	0	0	0
CA731	Cyber Security	CO1	Explain the concepts of Cyber Security.	3	1	3	3	3	1	3	2
		CO2	Explain the cause for Hardware, Network and Software attacks	3	2	3	3	3	2	3	2

		CO3	Detect an attack and develop an appropriate response for it	3	2	3	3	3	2	3	3
CA733	Mobile Applications Development	CO1	Describe the requirements for mobile applications.	3	3	3	3	1	0	1	2
		CO2	Design and develop mobile applications for specific needs.	1	3	3	3	3	0	1	2
		CO3	Differentiate the development aspects using Android and iOS.	1	0	2	2	2	2	1	0
		CO4	Implement the design using mobile application development frameworks.	2	2	2	2	1	1	1	0
CA735	Organizational Behaviour	CO1	Practice ethical behaviour and community responsibilities in organizations and society.	3	3	3	2	3	3	2	0

LABORATORY

Course Code	Course Title	CO	Course Outcomes At the end of the course student will be able	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CA701	Problem Solving Lab using Python	CO1	Demonstrate the different programming paradigms in python for problem solving	3	3	3	2	2	1	0	0
CA703	Data Structures Lab using C	CO1	Write C programs for solving any problems.	1	2	2	3	3	3	0	2
		CO2	Implement linear and nonlinear data structures to solve real time problem.	0	3	3	3	0	2	2	0
		CO3	Perform searching and sorting techniques to	0	2	3	3	3	3	0	0

			different application domains.								
		CO4	Implement different design strategies to solve complex problems.	3	3	3	3	3	2	0	0
CA702	DBMS Lab	CO1	Design Databases for querying and manipulation in real time	3	3	3	3	3	0	0	0
		CO2	Develop use case-based databases for Integration with front end tools	3	3	2	2	2	0	0	0
CA704	Computer Networks Lab	CO1	Configure different network topologies.		3	3	3	3	2	0	0
		CO2	Build the network according to the requirement.	2	2	2	2	1	1	1	0
		CO3	Configure different routing protocols.	3	3	3	1	1			0
		CO4	Implement different networking principles.		3	3	3	2	2	2	0
CA705	Machine Learning Lab	CO1	Implement and apply machine learning algorithms to solve problems.	2	2	2	2	2			0
		CO2	Select appropriate algorithms for solving a of real-world problems.		3	3	3	3	3	3	0
CA707	Business Communication	CO1	Communicate in the business world using	3	0	3	1	2	0	0	0

			different communication tools								
CA709	Computational Intelligence Lab	CO1	Apply and implement evolutionary, neural network, fuzzy and hybrid systems to solve real-world problems	3	0	2	1	2	0	0	0
CA706	Deep Learning Lab	CO1	Implement and apply deep learning algorithms to solve problems.	3	0	2	1	2	0	0	0
		CO2	Use deep learning techniques in a high-performance computing environment to solve real-world problems	3	0	2	1		0	0	0
CA708	Distributed and Cloud Computing Lab	CO1	Implement and apply distributed and cloud computing techniques to solve problems.	3	3	3	3	3	0	0	0
CA70A	Cyber Security Lab	CO1	Implement Cryptography techniques to data	2	3	3	3	2	1	0	0
		CO2	Simulate the various network security issues	2	3	3	3	2	1	0	0
		CO3	Experiment with application security	2	3	3	3	2	1	0	0
		CO4	Explore the nature and logic behind the various security threats on the web.	2	3	3	3	2	1	0	0
CA70B	Mobile Applications Development Lab	CO1	Develop Android applications with GUI	3	3	2	2	2	1	1	1

			components, layout managers, and multithreading.								
		CO2	Create Android apps that include general purpose applications, database interactions, and GPS functionalities.	3	3	2	2	2	1	1	1
		CO3	Design iOS general purpose applications and location-based iOS applications	3	3	2	2	2	1	1	1
		CO4	Publish and submit iOS applications to the App Store.	3	3	2	2	2	1	1	1

PROGRAMME ELECTIVES (PE)

Course Code	Course Title	CO	Course outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8
CA7A1	**DATA SCIENCE**	CO1	Convert real world problems to hypothesis and perform statistical testing	3	3	2	0	1	1	0	0
		CO2	Perform data analysis using R.	3	3	2	0	1	1	0	0

		CO3	Work with big data platform and its analysis techniques.	3	2	3	0	0	0	0	0
		CO4	Identify and design efficient modelling of very large data.	3	3	2	0	1	0	0	0
		CO5	Implement suitable data analysis for stream data.	3	3	2	0	1	0	0	0
		CO6	Write efficient MapReduce programs for small problem-solving methods.	3	3	2	0	1	0	0	0
CA7A2	**SOCIAL NETWORK ANALYSIS**	CO1	Describe the issues and challenges in social network functions.	3	3	2	2	0	0	0	0
		CO2	Represent social networks in a suitable form for Analysis	3	3	2	2	0	0	0	0
		CO3	Describe various algorithms used in the analysis of social networks.	3	3	2	2	0	0	0	0

		CO4	Apply the algorithms of social network analysis to real world problems.	3	3	2	2	0	0	0	0
CA7A3	**ADVANCED DATABASE TECHNOLOGY**	CO1	Design various databases	3	3	2	2	0	0	0	0
		CO2	Apply indexing techniques	3	3	2	2	0	0	0	0
		CO3	Use query languages	3	3	2	2	0	0	0	0
CA7A4	**DATA MINING AND WAREHOUSING**	CO1	Explain the Data warehouse and its implementation	3	2	2	1	0	0	0	0
		CO2	Design applications for implementation of Data mining tasks	3	2	2	1	0	0	0	0
		CO3	Implement Classification and Prediction algorithms	3	2	2	1	0	0	0	0
		CO4	Experiment the Clustering methods.	3	2	2	1	0	0	0	0
CA7A5	**RESOURCE MANAGEMENT TECHNIQUES**	CO1	Formulate and solve LP /NLP /DP Problems	3	2	1	0	0	0	0	0
		CO2	Identify appropriate model for given	3	2	1	0	0	0	0	0

			inventory problems and solve the problems								
		CO3	Solve queuing problems using queuing models	3	2	1	0	0	0	0	0
CA7A6	**IMAGE PROCESSING**	CO1	Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms	3	2	3	0	0	0	0	0
		CO2	Operate on images using the techniques of smoothing, sharpening and enhancement	3	2	3	0	0	0	0	0
		CO3	Understand the restoration concepts and filtering techniques	3	2	3	0	0	0	0	0
		CO4	Learn the basics of segmentation,	3	2	3	0	0	0	0	0

			features extraction, compression and recognition methods for colour models								
CA7B1	**SOFTWARE ARCHITECTURE AND PROJECT MANAGEMENT**	CO4	Explain various design and evaluation methods	3	3	3	2	0	0	1	1
		CO2	Employ design patterns in the software architecture	3	3	3	2	0	0		
		CO3	Apply various phases of life cycle models	3	3	3	2	0	0	1	1
		CO4	List various process models and describe issues related with quality assurance	3	3	3	2	0	0	1	1
		CO5	Apply engineering activities involved in various project management phases	3	3	3	2	0	0	1	1
CA7B2		CO1	Explain the principles of service-oriented architecture	3	2	1	1	0	0	0	0

	SERVICE ORIENTED ARCHITECTURE	CO2	Use the concepts of SOA in developing Web Services based applications	3	2	1	1	0	0	0	0
		CO3	Develop enterprise applications using Web Services	3	2	1	1	0	0	0	0
		CO4	Understand the Microservices architectures and apply in application development	3	2	1	1	0	0	0	0
CA7B3	**AGILE TECHNOLOGY**	CO1	Realize the importance of interacting with business stakeholders in determining the requirements for a software system	3	3	2	2	0	0	0	0
		CO2	Perform iterative software development processes: how to plan them, how to execute them	3	3	2	2	0	0	0	0

		CO3	Point out the impact of social aspects on software development success	3	3	2	2	0	0	0	0
		CO4	Develop techniques and tools for improving team collaboration and software quality	3	3	2	2	0	0	0	0
		CO5	Perform Software process improvement as an ongoing task for development teams	3	3	2	2	0	0	0	0
		CO6	Show how agile approaches can be scaled up to the enterprise level	3	3	2	2	0	0	0	0
CA7B4	**MARKETING MANAGEMENT**	CO1	Define the fundamentals of marketing	3	2	1	0	0	0	0	0
		CO2	List the issues related to buying and target marketing	3	2	1	0	0	0	0	0

		CO3	Apply the new product development strategies	3	2	1	0	0	0	0	0
		CO4	Use product promotional techniques	3	2	1	0	0	0	0	0
		CO5	Familiar with trends in analysis & control in marketing	3	2	1	0	0	0	0	0
CA7C1	**BIOINFORMATICS**	CO1	Demonstrate different biological databases and tools	3	2	1	0	0	0	0	0
		CO2	Apply algorithms for searching the biological databases	3	2	1	0	0	0	0	0
		CO3	Categorize sequence alignment methods	3	2	1	0	0	0	0	0
		CO4	Implement phylogenetic tree construction algorithms	3	2	1	0	0	0	0	0
		CO5	Predict gene and protein secondary structure	3	2	1	0	0	0	0	0

		CO6	Analyse genomic sequence	3	2	1	0	0	0	0	0
CA7C2	**EVOLUTIONARY COMPUTING**	CO1	Describe the Evolutionary algorithms and solve complex problem using evolutionary algorithms	3	3	2	2	0	0	0	0
		CO2	Identify the issues in design and implementation of genetic algorithm	3	3	2	2	0	0	0	0
		CO3	Explain the concepts of Swarm Intelligence techniques	3	3	2	2	0	0	0	0
		CO4	Describe the social network structure	3	3	2	2	0	0	0	0
CA7C3	**MODELING AND COMPUTER SIMULATION**	CO1	Practice simulation tools and build simulation systems	3	3	2	1	0	0	0	0
		CO2	Assess the techniques of random number generations and testing its randomness	3	3	2	1	0	0	0	0

		CO3	Design various simulation models for real time situation	3	3	2	1	0	0	0	0
CA7C4	**NATURAL LANGUAGE PROCESSING**	CO1	Identify the patterns in text and pre-process the large text corpus	3	3	3	0	0	0	0	0
		CO2	Describe and work with basic NLP tasks	3	3	3	0	0	0	0	0
		CO3	Use statistical and machine learning models for text	3	3	3	0	0	0	0	0
		CO4	Adopt embeddings and Deep learning models for NLP	3	3	3	0	0	0	0	0
		CO5	Apply the NLP concepts for solving Applications	3	3	3	0	0	0	0	0
CA7C5	**DEVOps**	CO1	Apply various DevOps tools including Git, Jenkins, Docker, Ansible during problem solving	3	3	2	2	1	1	1	1

CA7C6	**MOBILE COMPUTING**	CO1	Develop a strong grounding in the fundamentals of mobile Networks	3	3	2	2	0	0	0	0
		CO2	Apply knowledge in MAC, Network, and Transport Layer protocols of Wireless Network	3	3	2	2	0	0	0	0
		CO3	Comprehend, design, and develop a lightweight network stack	3	3	2	2	0	0	0	0
CA7C7	**BLOCKCHAIN TECHNOLOGY**	CO1	Understand the technology components of Blockchain and how it works behind – the scenes	3	2	3	1	0	0	0	0
		CO2	Be aware of different approaches to developing decentralized applications	3	2	3	1	0	0	0	0
		CO3	Understand the Bitcoin and its	3	2	3	1	0	0	0	0

			limitations by comparing with other alternative coins								
		CO4	Establish deep understanding of the Ethereum model, its consensus model and code execution	3	2	3	1	0	0	0	0
		CO5	Understand the architectural components of a Hyperledger and its development framework	3	2	3	1	0	0	0	0
		CO6	Aware of the Alternative blockchains and emerging trends in blockchain	3	2	3	1	0	0	0	0
CA7C8	**BUSINESS ETHICS**	CO1	Define the principles of ethics and morals of business	3	3	2	0	0	0	0	0
		CO2	Convey ethical response with respect	3	3	2	0	0	0	0	0

			to Competitors & Business Partners								
		CO3	Enhance the leadership skills with respect to decision making & business management	3	3	2	0	0	0	0	0
CA7D1	**BIG DATA MANAGEMENT**	CO1	Understand the fundamentals of various big data analytics techniques	3	3	3	0	0	0	0	0
		CO2	Design efficient algorithms for mining the data from large volumes	3	3	3	0	0	0	0	0
		CO3	Analyze the HADOOP and Map Reduce technologies associated with big data analytics	3	3	3	0	0	0	0	0
		CO4	Build a complete business data analytics solution	3	3	3	0	0	0	0	0
CA7D2		CO1	Deduce the need and basics of Green IT	3	3	2	1	0	0	0	0

	GREEN COMPUTING	CO2	Compare the collaborative effort of various agencies for the effectiveness of the Green IT	3	3	2	1	0	0	0	0
		CO3	State the need for virtualization and its impact	3	3	2	1	0	0	0	0
		CO4	List and categorize various IT energy-use metrics	3	3	2	1	0	0	0	0
		CO5	Use Green IT in various areas and the future needs and trends	3	3	2	1	0	0	0	0
CA7D3	**INTERNET OF THINGS**	CO1	Analyze various protocols for IoT	3	3	2	1	0	0	0	0
		CO2	Develop web services to access/control IoT devices	3	3	2	1	0	0	0	0
		CO3	Design a portable IoT using Raspberry Pi	3	3	2	1	0	0	0	0

		CO4	Deploy an IoT application and connect to the cloud	3	3	2	1	0	0	0	0
		CO5	Analyze applications of IoT in real time scenario	3	3	2	1	0	0	0	0
CA7D4	**HUMAN COMPUTER INTERACTION**	CO1	To understand HCI principles and apply them in product designs	3	3	2	2	1	1	1	1
		CO2	To develop user-centric applications	3	3	2	2	1	1	1	1
CA7D5	**MULTI-CORE PROGRAMMING**	CO1	List the features of multi core systems and assess the challenges of multi core programming	3	3	3	2	0	0	0	0
		CO2	Apply process techniques	3	3	3	2	0	0	0	0
		CO3	Identify the approaches to application design	3	3	3	2	0	0	0	0

		CO4	Describe the communication and fine issues	3	3	3	2	0	0	0	0
CA7D6	**MEAN Stack Development**	CO1	Understand the principles of MEAN Stack Web development and practice them in product design and development	3	3	2	1	0	0	0	0
CA7D7	**COMPUTER VISION**	CO1	Apply fundamental algorithms in Image Processing and analyse their applicability for real time problems	3	2	2	1	1	0	0	0
CA7D8	**BUSINESS INTELLIGENCE**	CO1	Understand the concepts and techniques of business intelligence	3	3	2	2	0	0	0	0
		CO2	Link data mining with business intelligence	3	3	2	2	0	0	0	0
		CO3	Apply various modelling techniques	3	3	2	2	0	0	0	0

		CO4	Understand data analysis and knowledge delivery stages	3	3	2	2	0	0	0	0
		CO5	Apply business intelligence methods to various situations	3	3	2	2	0	0	0	0

3 - High; 2 - Medium; 1 - Low

Semester-I

Course Code	**:**	**CA711**
Course Title	**:**	**PROBLEM SOLVING AND PROGRAMMING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn problem solving methodologies and aspects of Python programming.

Course Content

Programming paradigms- Program Development Cycle- Evolution of Programming languages - Computational Problem Solving - Principles of Structured programming: Sequential, selective and repetitive structures- Modular Programming: Functions and Procedures-Algorithms.

Introduction to Python Programming: Python interpreter- Garbage collection- Python working Environment-Mutable and Immutable objects- Variables- Dynamic typing- expressions- Operators: precedence and Associativity- comments- Conditionals: conditional - alternative -chained conditional - Short Circuits; Iteration: while- for-range- break- continue- pass; Strings: string slices- immutability- string methods- Regular Expression: Patterns- Matching- Search and replace.

Lists: Traversing a List- list operations- list slices- list methods- list loop- mutability- aliasing- cloning lists- list parameters; Tuples: tuple assignment- tuple as return value. Dictionary: operations and methods- Tuples as key; Set: Creation- Methods. Comprehension: List comprehension and Dictionary comprehensions; Map- Filter and Reduce.

Functions: Definitions- parameters and arguments: Keyword arguments- Positional arguments- Parameter unpacking- Scope: Local, Global and Enclosed. Recursion- Lambda functions- Higher order Functions; Object orientation in Python: Classes- Objects.

Files and exception: text and binary files- CSV files- JSON Files- reading and writing files- Object serialization; Exception Handling: Errors and exceptions- handling exceptions- modules- packages: Creating modules and packages- Python standard Library: OS- Sys- Collections- Random- Library for Data science: PANDAS- NUMPY.

References

1.	John V. Guttag, Introduction to Computation and Programming Using Python: with Application to Computational Modelling and Understanding Data- Third Edition- MIT press- 2021.
2.	Paul J. Deitel- Harvey Deitel- Python for Programmers- First Edition- Pearson- 2020.
3.	Martin C. Brown- Python: The Complete Reference-Fourth Edition-Mc-Graw Hill- 2018.
4.	Robert Sedgewick- Kevin Wayne- Robert Dondero- —Introduction to Programming in Python: An Inter-disciplinary Approach- First Edition-Pearson India- 2016.
5.	Allen B. Downey- Think Python: How to Think like a Computer Scientist- 2nd edition- Updated for Python 3- O'Reilly- 2015.

Course Outcomes (CO)

At the end of the course student will be able

CO1	To write structured pseudo codes for a given problem.
CO2	To develop Python programs with conditionals- loops and data structures
CO3	To design and create Python applications using functions and files
CO4	To build and package Python modules for reusability

Course Code	**:**	**CA713**
Course Title	**:**	**MATHEMATICAL FOUNDATIONS OF COMPUTER APPLICATIONS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the mathematical aspects in computer applications.
CLO2	To familiarize students with the concepts of Sets, Function, Logic Propositions
CLO3	To make the students to describe the concepts of Graph Theory and Automata

Course Content

Set Theory - Basic concepts –Algebra of sets – The power sets –Cartesian products – Relation and its types – Properties – Relational Matrix and the graph of relation – Partitions –Equivalence relations – Poset – Hasse diagram – Lattices and their properties – Sublattice – Boolean Algebra - Algebraic manipulation of Boolean expressions - Simplification of Boolean expressions - Karnaugh maps - Logic gates - Digital circuits and Boolean algebra.

Functions - Definitions of functions and its Classification – Types – Examples – Composition of functions – Inverse functions – Binary and n-ary operations – Characteristic function of a set – Hashing functions – Recursive functions – Permutation functions – Fuzzy set – fuzzy set operations - membership function - Triangular, Trapezoidal, Gaussian.

Logic Propositions – Logical Connectives - Compound statements – Conditional and Biconditional Propositions – Truth tables – Tautologies and Contradictions – Logical equivalence and implications – DeMorgan’s Law – Normal forms – PDNF and PCNF – Predicate Calculus – Free and bound variables – Quantifiers – Universe of discourse – Theory of inference – Rules of universal specification and generalization – Arguments – Validity of Arguments. Fuzzy Logic - Linguistic Truth Table - Approximate and Plausible Reasoning.

Graph Theory - Graphs - Basic concepts - Isomorphism – complements - Matrix representation of graphs - Trees, Spanning trees, Minimal Spanning tree Algorithms - Euler graphs - Hamiltonian graphs.

Finite State Automata - Finite Automata – Context-Free Grammars – Chomsky"s Normal form -Griebach Normal Form - Push-down Automata - Equivalence of CFL"s and PDA"s - Non-context free languages.

References

1.	Trembley J.P and Manohar.R, “Discrete Mathematical Structures with Applications to Computer Science”, First Edition, Tata McGraw-Hill Pub. Co. Ltd, New Delhi, 2017.
2.	Ralph. P.Grimmaldi, “Discrete and Combinatorial Mathematics An applied Introduction”, Fourth Edition, Pearson Education, Asia, Delhi, 2002.
3.	Hopgaff and Ullman, “Introduction to Automata Theory, Languages and Computation”, Third Edition, Pearson Education, 2008, Asia, Delhi.
4.	Doerr Alan and Levasseur Kenneth, “Applied Discrete Structures for Computer Sciences”, Galgotia Publications Pvt. Ltd., 2002.
5.	George J Klir and Bo Yuan, “Fuzzy Sets and Fuzzy Logic: Theory and Applications”, First Edition, Pearson India, 2015.

Course Outcomes (CO)

At the end of the course student will be able

CO1	To explain the mathematical principles for computer applications.
CO2	To describe about the concept of logical propositions
CO3	To explain about Graph Theory and its Applications
CO4	To summarize the ideas of Automata Theory

Course Code	**:**	**CA715**
Course Title	**:**	**DIGITAL LOGIC AND COMPUTER ORGANIZATION**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the basic operational characteristics of digital systems.
CLO2	To familiarize students about the working principles of CPU and Memory
CLO3	To make the students to understand the Multi-core Architecture and Pipelining

Course Content

Computer system: Basic Concepts and Computer Evolution- Performance Concepts-A Top-Level View of Computer Function and Interconnection-Arithmetic and Logic: Number Systems – Binary Arithmetic - Boolean algebra - Map Simplifications - Gates - Combinational Circuits - Sequential Circuits.

Computer Memory: Cache memory principles-Elements of Cache Design-Internal Memory: Semiconductor Main Memory-Advanced DRAM Organization-External Memory: Magnetic Disk-RAID-SSD-Optical memory.

Instruction Sets and CPU: Instruction Sets: Characteristics and Functions - Instruction Sets: Addressing Modes and Formats-Processor Structure and Function: Processor Organization-Register Organization-Instruction Cycle- Instruction Pipelining-Arithmetic Pipelining – Control Unit Operation- RISC- CISC.

Input/Output: External Devices: I/O modules - Programmed I/O – Interrupts - Interrupt Driven I/O - Direct Memory Access – I/O Channels – External Interface.

Parallel Organization and Processors: Parallel – Multi-core – Mobile – Embedded – GPU and TPU.

References

1.	M. Morris Mano, Michael D. Ciletti, "Digital Design", 6th Edition, Pearson Education, 2018.
2.	William Stallings, "Computer Organization and Architecture", 11th Edition, PHI, 2022
3.	Hennessy J. and Patterson D., "Computer Architecture: A Quantitative Approach", 6th Edition, Morgan Kaufmann, 2019.
4.	John P. Hayes, "Computer Architecture and Organization", McGraw Hill Education; 3rd edition, 2017.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explain the principles of Digital systems and its design
CO2	Describe the functional units of the CPU and Memory
CO3	Brief the concepts of Pipelining
CO4	Summarize about advanced computer architectures

Course Code	**:**	**CA717**
Course Title	**:**	**DATA STRUCTURES AND APPLICATIONS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To make students to learn different data structures and their applications.

Course Content

Introduction **–** Human analogy, Informal Definition, Formal Definition, examples – Differences among ADTs, data structures and data types – Classifications of data structures – Primitive data types – Non-primitive data types: Arrays and Records, Applications: sorting and searching.

Linear data Structures –List ADTs: Definition, Types: Linear Linked Lists, Stacks ADT, Queues ADT- Linear Linked Lists: Singly, Doubly, Circular linked lists, operations on them and applications - Stacks: operations and applications, representing Stacks - Queues: operations and applications, representing Queues, types: priority queue, Deque, IRD, ORD - Hashing.

Non-Linear data Structures - Binary Trees – Binary Tree Representations – Binary tree Traversals – Binary search trees: Definition, operations - Graphs – Matrix and list Representations – Graph Traversals – Applications: Diameter finding and topological sort.

Advanced Data Structures - Top-Down Splay Trees, Red-Black Trees - Bottom-Up Insertion, Top-Down Deletion, Suffix Arrays and Suffix Trees - Linear-Time Construction of Suffix Arrays and Suffix Trees, Trie structures.

B-trees: Definition, operations – Its variants with applications - Data Structures for Disjoint Sets: Disjoint-set operations, Linked-list representation of disjoint sets, Disjoint-set forests.

References

1.	T.H. Cormen, C.E. Leiserson, R.L. Rivest and C.Stein, "Introduction to Algorithms", 4th Edition, MIT Press, 2022.
2.	Goodrich, Tamassia and Goldwasser, "Data Structures & Algorithms in Java", 6th Edition, Wiley, 2014.
3.	D. Samanta, "Classic Data Structures", 2nd Edition, PHI, 2013.
4.	M.A.Weiss, "Data Structures and Problem Solving using Java", 4th Edition, Pearson Education, 2012.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand and classify data structures
CO2	Use linear data structures to solve real-time problems
CO3	Use non-linear data structures to solve real-time problems
CO4	Apply advanced data structures in different application domains

Course Code	**:**	**CA719**
Course Title	**:**	**OPERATING SYSTEMS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the generic structure of an Operating System
CLO2	To detail the concepts of Processes, Threads, and Synchronization principles
CLO3	To explain to the students about the Memory Management, Protection
CLO4	To provide an idea of different File Systems and I/O

Course Content

Introduction – Operating System Operations – Virtualization – Operating System Services – User and Operating System Interface – System Calls – Operating System Structures.

Process concept - Process Scheduling - Operation on Processes – Interprocess Communication - CPU Scheduling - Scheduling Criteria - Scheduling Algorithms - Multiple-Processor Scheduling.

Process Synchronization –The Critical-Section Problem – Semaphores – Monitors – Deadlock Characterization – Methods for handling Deadlocks – Deadlock Prevention- Deadlock avoidance – Deadlock Detection – Deadlock Recovery.

Main Memory – Contiguous Memory allocation – Paging – Swapping – Virtual Memory –Demand Paging – Page Replacement – Thrashing.

Disk Structures – Disk Scheduling – File-System Interface – File Concepts - Access Methods – Directory Structure – File-System Implementation – File-System Structure and Operations – Directory Implementation –Allocation Methods – Free-Space Management – File-System Internals – File-System Mounting – File Sharing – Virtual File Systems – Remote File Systems.

Case studies: Linux, Windows, Mac OS and Mobile OS.

References

1.	Silberschatz, Galvin and Gagne, “Operating System Concepts,” 10th Edition, John Wiley & Sons Inc, 2018.
2.	Sibsankar Haldar, Alex A.Aravind, “Operating systems”, 2nd Edition, Pearson Education, 2014.
3.	Andrew S. Tanenbaum, “Modern Operating Systems”, 4th Edition, Prentice-Hall of India, 2015.
4.	William Stallings, “Operating Systems –Internals and Design Principles”, 9/E, Pearson Publications, 2018.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the functional architecture of an operating system.
CO2	Design device drivers and multithreading libraries for a tiny OS
CO3	Design and solve synchronization problems
CO4	Understand standard UNIX and FAT file systems, Protection and Security.

Course Code	**:**	**CA701**
Course Title	**:**	**PROBLEM SOLVING LAB USING PYTHON**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	10 Sessions
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To make the students to experiment the problem-solving techniques using Python

Course Content

Exercises for learning basic features of Python and exercises to implement various applications in Python.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Demonstrate the different programming paradigms in python for problem solving

Course Code	**:**	CA703
Course Title	**:**	**DATA STRUCTURES LAB USING C**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	10 Sessions
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To make the students to problems in Data Structures using C.

Course Content

Exercises for learning basic features of C and exercises to implement various data structures for real world applications.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Write C programs for solving any problems.
CO2	Implement linear and nonlinear data structures to solve real time problem.
CO3	Perform searching and sorting techniques to different application domains.
CO4	Implement different design strategies to solve complex problems.

Semester-II

Course Code	**:**	**CA710**
Course Title	**:**	**DESIGN AND ANALYSIS OF ALGORITHMS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA 717
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce various design strategies in algorithm analysis and their applications.

Course Content

Algorithms – Definition and Algorithms as a technology – Design and Analysis of Insertion sort and merge sort - Recurrences and Solving recurrences - Asymptotic notations - Examples- heap sort and quick sort – Sorting in linear time - order statistics.

Divide-and-Conquer strategy**-** The maximum-subarray problem, Multiplication of two large integers, Strassen's algorithm for matrix multiplication - Dynamic Programming – Elements **-** Matrix-chain multiplication, Longest common subsequence, Optimal binary search trees.

Greedy Algorithms – Elements **-** An activity-selection problem, Huffman codes and Minimum Spanning tree algorithms – Graph Algorithms - Single source shortest paths problem – All-pairs shortest paths problem – Flow Networks.

Backtracking and Branch-and-Bound strategies with applications – Randomized algorithms **–** Examples.

NP concepts – Introduction - NP-hard and NP-complete problems – Definitions and Properties – Satisfiability problem - Reducibility – Cook's Theorem (without proof) - Approximation algorithms **-** examples.

References

1.	T.H. Cormen, C.E. Leiserson, R.L. Rivest and C.Stein, “Introduction to Algorithms”, 4th Edition, MIT Press, 2022.
2.	Robert Sedgewick and Kevin Wayne, “Algorithms”, 4th Edition, Addison Wesley, 2011.
3.	Steve S. Skiena, “The Algorithm Design Manual”, 2nd Edition, Springer, 2008.
4.	George T. Heineman, Gary Pollice and Stanley Selkow, “Algorithms in a Nutshell”, 2nd Edition, O’Reilley, 2016.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Design algorithms using various strategies
CO2	Compute time- and space complexities of various algorithms

Course Code	**:**	CA 712
Course Title	**:**	**DATABASE MANAGEMENT SYSTEMS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA713
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To make the students to learn different database models
CLO2	To provide knowledge of design of databases
CLO3	To explain the concepts of query languages and transaction management

Course Content

INTRODUCTION: File systems versus Database systems – Data Models – DBMS Architecture – Data Abstraction - Data Independence - Database Languages -Data models - Entity-relationship model - integrity constraints - Conceptual Design with ER Model-EER Model

Relational Model: Relational Query Language- Relational Operations- Relational Algebra – Selection and projection set operations – renaming – Joins – Division – Examples of Algebra overviews – Relational calculus – Basic Structure of SQL Queries, Set Operations, Aggregate- Functions – GROUPBY – HAVING, Nested Sub queries.

Database Design: Introduction of Normalization- Non-loss decomposition --functional dependencies -First normal form -Second normal forms - third normal forms – dependency preservation - Boyee/Codd normal form - Multi-valued dependencies - Fourth normal form- Join dependencies - Fifth normal form

Query processing and Optimization: Evaluation of relational algebra expressions – Query equivalence - Join strategies - Query optimization algorithms. Storage and File Structures: Indices - B + Trees - hashing.

Transaction Processing, Concurrency Control and Recovery Management: Transaction Concept- Transaction State- Implementation of Atomicity and Durability - Serializability- Recoverability – Implementation of Isolation –Lock –Based Protocols – Timestamp Based Protocols- Recovery with Concurrent Transactions- Concurrency control mechanisms – Recovery System; Introduction to Advanced Databases

References

1.	Silberschatz, Korth and Sudarshan, “Data Base System Concepts”, McGraw-Hill, 7th Edition, 2019.
2.	C. J. Date, “An Introduction to Database Systems”, 8th Edition, Addison-Wesley, 2003.
3.	R. Elmasri, S.B. Navathe, “Fundamentals of Database Systems”, 7th Edition, Pearson
4.	Raghu Ramakrishnan and Johannes Gehrke, “Data Base Management Systems”, 4th Edition, McGraw-Hill, 2018

Course Outcomes (CO)

At the end of the course student will be able

CO1	Get practical knowledge on designing and creating relational database systems
CO2	Describe the nuances of Data retrieval methods
CO3	Apply normalization techniques in DB design
CO4	Perform concurrency and Transaction Management operations

Course Code	**:**	**CA 714**
Course Title	**:**	**PROBABILITY AND STATISTICAL METHODS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the fundamentals of probability and statistical methods.

Course Content

Probability Spaces- Elementary Theorem – Conditional Probability – Independent events – Random variables – Probabilistic modeling

Binomial, Poison and Normal Distributions – Fitting of Probability distributions – Correlation and Regression – Linear regression – Correlation coefficient – Multiple linear regression

Sampling Distributions & Descriptive Statistics: The Central Limit Theorem, distributions of the sample mean and the sample variance for a normal population, Sampling distributions, problems. Graphical representation, measures of locations and variability

Estimation: Unbiasedness, consistency, the method of moments and the method of maximum likelihood estimation, confidence intervals for parameters in one sample and two sample problems of normal populations, confidence intervals for proportions, problems.

Test of Hypothesis- Testing for Attributes – Mean of Normal Population – One-tailed and two-tailed tests, F-test and Chi-Square test - ANOVA – One way and two-way classifications

References

1.	John.E..Freund, Irwin Miller, Marylees Miller "Mathematical Statistics with Applications ", 8th Edition, Prentice Hall of India, 2012
2.	Yannis viniotis, "Probability and Random Processes for electrical engineers", McGraw-Hill International Edition, 1998.
3.	Ross, Sheldon. M, "Introduction to Probability and Statistics for Engineers and Scientists", 5th Edition, Academic Press, 2014.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explain basic probabilistic and statistical models and illustrate their related applications
CO2	Estimate the likelihood of events from population
CO3	Propose, test and evaluate hypothesis.

Course Code	**:**	**CA716**
Course Title	**:**	**OBJECT ORIENTED PROGRAMMING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the object-oriented programming concepts.
CLO2	To understand object-oriented programming concepts, and apply them in solving problems.
CLO3	To introduce the principles of inheritance and polymorphism; and demonstrate how they relate to the design of abstract classes
CLO4	To introduce the implementation of packages and interfaces
CLO5	To introduce the concepts of exception handling and multithreading.
CLO6	To introduce the design of Graphical User Interface using applets and swing controls.

Course Content

Introduction: OOP Principles, Data types, Variables, Scope and life time of variables, Operators, Control statements, Type conversion and casting, Arrays. Concepts of classes and objects, Introducing methods, Method overloading, Constructors, Constructor overloading, Usage of static with data and methods, Access control, This key word, Garbage collection, String class.

Inheritance, Packages and Interfaces: Inheritance basics, Types of inheritance, Member access rules, Usage of super key word, Method overriding, Usage of final, Abstract classes, defining an interface, Differences between abstract classes and interfaces, implementing interface, applying interfaces, Variables in interface and extending interfaces; Defining, creating and accessing a Package, Importing packages, Access control in packages, Collections in Java.

Exception Handling & Multithreading: Concepts of exception handling, Types of exceptions, Usage of Try, Catch, Throw, Throws and Finally Keywords, Built-in exceptions, creating user defined exception; Concepts of multithreading, Differences between process and thread, Thread life cycle, creating multiple threads using thread class and runnable interface, Synchronization, Thread priorities, Inter thread communication.

GUI Programming with Swing: Introduction, limitations of AWT, MVC architecture, components, containers. Understanding Layout Managers, Flow Layout, Border Layout, Grid Layout, Card Layout, Grid Bag Layout. Event Handling- The Delegation event model- Events, Event sources, Event Listeners, Event classes, Handling mouse and keyboard events, Adapter classes, Inner classes, Anonymous Inner classes.

A Simple Swing Application, Applets – Applets and HTML, Security Issues, Applets and Applications, passing parameters to applets. Creating a Swing Applet, Painting in Swing, A Paint example. Exploring Swing Controls- JLabel and Image Icon, JText Field, The Swing Buttons- JButton, JToggle Button, JCheck Box, JRadio Button, JTabbed Pane, JScroll Pane, JList, JCombo Box, Swing Menus, Dialogs.

References

1.	Herbert Schildt, "Java The complete reference", 12th edition, McGraw Hill Education (India) Pvt. Ltd,2021.
2.	J. Nino and F.A. Hosch, "An Introduction to programming and OO design using Java" 3rd Edition, John Wiley & sons,2008.
3.	Y. Daniel Liang, "Introduction to Java programming", 11th Edition, Pearson Education, 2017.
4.	P. Radha Krishna, "Object Oriented Programming through Java",First Edition, Universities Press,2007.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Describe object-oriented programming principles and comprehend the java architecture and use the java APIs
CO2	Understand and use of inheritance and polymorphism
CO3	Apply exception handling mechanism
CO4	Understand and use GUI components

Course Code	**:**	**CA718**
Course Title	**:**	**COMPUTER NETWORKS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA719
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn various network architectures, protocols, and the functions of different networking layers in line with IEEE standards.

Course Content

Introduction to Computer Networks: Basics of Computer Networks - Problems associated with computer networks: Communication problems, Identification problems, and Connection problems – Network protocol basics – Service identification – MAC Address - IPv4 Addressing System, Subnetting and Super netting, IPv6 Addressing System - Network requirements: Network interface card (NIC), Media, and Networking devices – Hub, Switch, and Routers.

Network Topologies and Network Architectures: Network Topologies – Bus, Star, Ring, Mesh – Network Architectures – Client/Server Architecture, Peer-To-Peer Architecture - Open System Interconnect (OSI) Reference Model - TCP/IP Model - TCP Operation - UDP Operation – Flow Control – Congestion Control.

Local Area Networks: LAN components – Packet Switching and Forwarding – LAN Technologies - Ethernet, Token Bus, Token Ring, Wireless LAN – Multiple Access Protocols – Error-Detection and Correction Techniques.

Wide Area Networks: WAN Components – WAN Technologies - WAN Encapsulation - Routing: Static Routing and Dynamic Routing - Routed Protocols (IP and IPX) - Routing Protocols.

Protocols: Address Resolution Protocol (ARP) Protocol - Dynamic Host Configuration Protocol (DHCP)- Domain Name System (DNS) – Internet Protocol (IP) – Internet Control Message Protocol (ICMP) - Hypertext Transfer Protocol (HTTP) - File Transfer Protocol (FTP) - Simple Mail Transfer Protocol (SMTP), Remote Administration Protocols: Telnet and Secure Shell (SSH).

References

1.	Behrouz A. Forouzan, “Data Communications and Networking”, 5th Edition, McGraw-Hill, July 2017.
2.	James F. Kurose and Keith W. Ross, “Computer Networking - A Top-Down Approach”, 8th Edition, Pearson, 2020.
3.	William Stallings, “Data and Computer Communications” 10th Edition, Pearson, 2013.
4.	Andrew S. Tanenbaum, David J. Wetherall, “Computer Networks”, 6th Edition, Pearson, 2020.
5.	Chwan-Hwa Wu, J. David Irwin, “Introduction to Computer Networks and Cybersecurity”, 1st Edition, CRC Press, 2013.

Course Outcomes (CO)

At the end of the course student will be able

CO1	List the functionalities of networking layers available in both OSI reference model and TCP/IP model.
CO2	Describe available LAN and WAN Technologies.
CO3	Describe the principles of packet switching, forwarding, and routing.
CO4	Distinguish between TCP and UDP packet formats.
CO5	Describe the available application protocols and networking services.

Course Code	**:**	**CA702**
Course Title	**:**	**DBMS LAB**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA712
Contact Hours	**:**	10 Sessions
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To make the students to experiment Queries for Database Design and Manipulation
CLO2	To provide basic understanding of Front-End Tools to integrate with Databases

Lab Experiments:

1. Data Definition, Table Creation, Constraints
2. Insert, Select Commands, Update & Delete Commands
3. Inbuilt functions in RDBMS
4. Nested Queries & Join Queries
5. Set operators & Views
6. Control structures
7. Procedures and Functions
8. Triggers
9. Front End Tool, Forms, Menu Design, Reports

Course Outcomes (CO)

At the end of the course student will be able

CO1	Design Databases for querying and manipulation in real time
CO2	Develop use case-based databases for Integration with front end tools

Course Code	**:**	**CA704**
Course Title	**:**	**COMPUTER NETWORKS LAB**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA727
Contact Hours	**:**	10 Sessions
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To practice installation and configuration of different network architecture.
CLO2	To practice and configure different routing protocols.

Lab Experiments:

1. Introduction to Components for building Network Topologies
2. Switch Configuration, Addressing, Port and terminal Security, VLAN and Trunk link configuration
3. Router Configuration – Static, Default routing, Dynamic Routing
4. IP Subnetting
5. Implementation of TCP and UDP
6. Implementation of OSI Layers

Course Outcomes (CO)

At the end of the course student will be able

CO1	Configure different network topologies.
CO2	Build the network according to the requirement.
CO3	Configure different routing protocols.
CO4	Implement different networking principles.

Semester-III

Course Code	**:**	**CA721**
Course Title	**:**	**MACHINE LEARNING TECHNIQUES**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the basic concepts and techniques of Machine Learning.
CLO2	To develop the skills in using recent machine learning software for solving practical problems
CLO3	To be familiar with a set of well-known supervised, semi-supervised and unsupervised learning algorithms

Course Content

INTRODUCTION –Introduction Artificial Intelligence (AI)- Evolution of AI - Different approaches of AI- Expert based approach-Rule Based; Intelligence based approach-Computational Intelligence, Swarm Intelligence – Problem Solving and Search Algorithms: Problem Solving Agents, Heuristic Search, Local Search, Adversarial Search - Applications of AI: Gaming, Robotics, etc.

Learning – Designing a Learning System – Traditional Learning vs Machine Learning – Various types of Machine Learning: Supervised Learning – Unsupervised Learning – Reinforcement Learning – Machine Learning workflow – Machine Learning issues and challenges – Machine Learning Applications in real world problems.

SUPERVISED LEARNING – Predictive Models: Regression – Multivariate Regression – Types of Regression Models – Estimation of Regression coefficients -Evaluation metrics of regression models – issues and challenges – applications. – Classification Models: Introduction – Different types of classifiers: Naive Bayes – Decision Tree – Logistic Regression – K-Nearest Neighbor – Perceptron- Types of perceptron - Artificial Neural Networks – Support Vector Machine – Evolution metrics for supervised learning – Issues and challenges – applications.

UNSUPERVISED LEARNING –Clustering Models: Partitioning based clustering – Hierarchical based clustering – Density based clustering – Grid based clustering – Mixture Models and EM Algorithm – Fuzzy k-Means Algorithm – Evolution metrics for clustering models - Dimensional Reduction Techniques: Need – Various types: PCA – ICA – FA – t-SNE - Case studies.

ENSEMBLE LEARNING – Boosting – AdaBoost Algorithm – Bagging – Random Forest – No-Free-Lunch Theorem – XGBoost Algorithm – Stacking – Voting – Ensemble Diversity – Error Decomposition – Diversity Measures – Evaluating Ensembles of Classifiers – Case studies.

References

1.	S. Russell and P. Norvig, Artificial Intelligence: A Modern Approach, 4th Edition, Pearson Education, 2022
2.	Ethem Alpaydin, Introduction to Machine Learning, 4th edition, MIT Press 2020.
3.	Bishop, Christopher M., Pattern Recognition and Machine Learning. Springer-Verlag, 2006.
4.	Zhi-Hua Zhou, Ensemble Methods: Foundations and Algorithms, CRC Press, 2012.
5.	Lior Rokach, Ensemble Learning: Pattern Classification using Ensemble Methods, 2nd ed., World Scientific, 2019.
6.	Tom M. Mitchell, Machine Learning, McGraw-Hill Education (India) Private Limited, 2013.
7.	Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press, 2014.
8.	Andrew Glassner, Deep Learning from basics to practice. Volume1 & 2, Kindle Edition, 2018.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Select real-world applications that needs machine learning based solutions.
CO2	Implement and apply machine learning algorithms.
CO3	Select appropriate algorithms for solving a particular group of real-world problems.
CO4	Recognize the characteristics of machine learning techniques that are useful to solve real-world problems.

Course Code	**:**	**CA723**
Course Title	**:**	**COMPUTATIONAL INTELLIGENCE**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA713
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know artificial neural network concepts
CLO2	To learn the applications of evolutionary and genetic algorithms
CLO3	To know the design of fuzzy controller
CLO4	To know the neurocomputing and hybridization of systems

Course Content

Introduction: Adaptation – Types of Adaptation – Learning – Self-organization – Historical views – Comparison with artificial intelligence – Application areas

Artificial Neural Networks (ANNs): Neuron models – Activation functions – Topologies – Single-layer and multi-layer networks – Neural Network Adaptation – Backpropagation and Gradient descent algorithms

Evolutionary Computation: Genetic algorithms – Evolutionary programming – Evolutionary strategies – Genetic programming – Swarm intelligence – Particle swarm optimization – Ant colony optimization

Fuzzy Systems: Fuzzy sets – Fuzzy logic – Fuzzy rules and reasoning – Fuzzification methods – Fuzzy inference systems – Defuzzification methods – Fuzzy Decision Making - Developing a Fuzzy controller - Applications

Neurocomputing and Hybrid Systems: Integration of neural networks and fuzzy systems – Neuro-fuzzy modeling and control – Genetic-fuzzy systems – Hybrid Learning Algorithm – Adaptive Neuro-Fuzzy Inference System – Coactive Neuro Fuzzy Modeling

References

1.	Eberhart and Shi, “Computational Intelligence - Concepts to Implementations”, Morgan Kaufmann, 2007.
2.	A.P. Engelbrecht, “Computational Intelligence: An Introduction”, 2nd Edition, John Wiley & Sons, 2012.
3.	H.K. Lam, S.S.H. Ling, and H.T. Nguyen, “Computational Intelligence and Its Applications: Evolutionary Computation, Fuzzy Logic, Neural Network and Support Vector Machine”, Imperial College Press, 2012.
4.	J. S. R. Jang, C. T. Sun, and E. Mizutani, Neuro-Fuzzy and Soft Computing, PHI, 2015

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explain the basics of computational intelligence techniques and their suitable industry related applications
CO2	Apply neural network principles and algorithms for given problems
CO3	Apply the principles of fuzzy and hybrid algorithms for real time applications
CO4	Solve problems using evolutionary algorithms

Course Code	**:**	**CA725**
Course Title	**:**	**SOFTWARE ENGINEERING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To impart concepts of a comprehensive study on the theories, processes, methods, and techniques of building high-quality software in cost-effective ways.

Course Content

Characteristics of Software, Software Quality Attributes, Software Crisis, Software Engineering Methods, Activities Common to Software Projects, Software Engineering Layers, Software Development Process, Process Flow, Software Lifecycle Models – Waterfall Model, Incremental Process Model, Evolutionary Process Model, Concurrent Process Model, Component-based Development Model, Formal methods-based model, Personal and Team Process Model. The Capability Maturity Model.

Feasibility Study, Software Project Planning, Software Project Estimation – Decomposition Techniques, Empirical Models, The Software Equation. Decision Tree, Software Project Monitoring and Control – Critical Path Method, Project Evaluation and Review Technique. Software Reliability and Quality Management, Risk Management, Software Quality Assurance.

Classification of Software Requirements, Requirement Process Engineering, Requirement Elicitation and Analysis, Techniques for Requirement Gathering, IEEE Format of SRS Document, Data Flow Diagram (DFD), Software Design Issues, Software Design Concepts, Function Oriented Software Design, Object Oriented Software Design, Unified Modeling Language (UML).

Software Coding, Code Review, Halstead's Software Science, Software Testing, Software Verification vs Software Validation, Levels of Software Testing, Black Box Testing vs White Box Testing, Software Debugging, Software Maintenance, Software Reengineering.

Agile Software Development, Agility and the Cost of change, Agile Manifesto and Principles, Agile Project Management, Agile Methods – Extreme Programming (XP), Adaptive Software Development (ASD), Scrum, Dynamic System Development Method (DSDM), Crystal, Feature Driven Development (FDD), Lean Software Development (LSD). Agile Modeling.

References

1.	Ian Sommerville, Software Engineering, 10th Edition, Pearson, 2017
2.	Roger Pressman, Software Engineering: A Practitioner's Approach, 8th Edition, McGraw Hill, 2014.
3.	Rajib Mall, Fundamentals of Software Engineering, 5th Edition, PHI Learning, 2018.
4.	Craig Larman, Agile and Iterative Development: A Manager's Guide, 1st Edition, Addison Wesley, 2003
5.	David J. Anderson, Agile Management for Software Engineering: Applying the Theory of Constraints for Business Results, Prentice Hall, 2003.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Demonstrate a basic understanding of software engineering practices from vision to analysis, design, development, validation, deployment and maintenance.
CO2	Develop skills to create and use various software Engineering based techniques and tools to solve real world problems.
CO3	Estimate cost, effort and risk involved in a software project development.

Course Code	**:**	**CA727**
Course Title	**:**	**ACCOUNTING AND FINANCIAL MANAGEMENT**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the fundamentals of accounting and financial management.

Course Content

Assets – Liabilities – Types - Trading account – Accounting records and Systems – Limitations - Income statement – Preparation and Interpretation.

Depreciation – Methods - Inventory methods, Sources of working capital, Fund flows, Cash flows – Financial Statement analysis.

Ratio analysis - Use of ratios in interpreting Trading Accounts and Financial Statements, Limitations – Management Accounting.

Variable costs – Fixed costs – Cost Volume Profit Analysis – Break even marginal and full costing contribution, Standard costing - Analysis of variance - Computer accounting and algorithms.

Characteristics of Budgets - Forecasting – Long term, Short term – Methods of capital investment decision making, Sensitivity Analysis, Cost of capital.

References

1.	S.N. Maheswari and S.K. Maheswari, “An Introduction to Accountancy”, 12th Edition, Vikas Publishing, 2018.
2.	Manmohan and Goyal, “Principles of Management and Accounting”, 5th Edition, Sahitya Bhawan, 1994.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Prepare and analyse the final accounts of the firm
CO2	Prepare and analyse the funds & cash flow statements of the firm
CO3	Perform basic analysis of financial statements and write a report on the financial performance, conditions and effectiveness of the firm
CO4	Analyse and evaluate costing systems
CO5	Prepare different types of budgets and policies

ELECTIVE – I

One Elective to be chosen from CA7A group.

Course Code	**:**	**CA705**
Course Title	**:**	**MACHINE LEARNING LAB**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA 721
Contact Hours	**:**	10 Sessions
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce basic machine learning techniques.
CLO2	To develop the skills in recent machine learning software for solving practical problems in high-performance computing environment.
CLO3	To develop the skills in applying appropriate supervised, semi-supervised or unsupervised learning algorithms for solving practical problems

Lab Experiments:

- Problem Selection
- Data Collection & Generation
- Data Preprocessing Techniques
- Design and Develop Machine Learning Models
    - Regression Models (SLR, MLR, SVR)
    - Clustering Models (K-Means, CLARA, DBSCAN)
    - Classification Models (NB, DT, SVM. KNN, ANN, LR)
    - Ensemble Learning Models (RF, AdaBoost, XGB)
- Model Evaluation Metrics
- Model Deployment

Course Outcomes (CO)

At the end of the course student will be able

CO1	Implement and apply machine learning algorithms to solve problems.
CO2	Select appropriate algorithms for solving a of real-world problems.

Course Code	**:**	**CA707**
Course Title	**:**	**BUSINESS COMMUNICATION**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	10 Sessions
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	Introduce the dynamics of Communication in the Business world.
CLO2	Help to familiarize and practice the different kinds of communication tools.
CLO3	Give practice in the nuances of spoken communication.
CLO4	Expose to the different forms of Business communication.

Course Content

Communication in the Business World: Communication: Concepts and Goals – Theories of communication – Organizational and personal goals. Psychology of communication – Channels and Networks – Barriers to and cost of communication.

Listening and Speaking Practice: Message Planning – Purposive Listening – – Familiarizing to different accents and tones – Listening Practice - Oral Communication – Extempore speech practice – Presentation skills – Group Discussion Practice - Interview skills. Telephone strategies.

Writing practice: Business Correspondence – Different kinds of written communication in business Organizations - Marketing Language – Creativity and Appeal – Report writing practice.

Technology and Communication: Practice in telephone etiquette – Limitations & possibilities of E mail - Use of Power point- Role of mass media in business communication.

References

1.	Simon Sweeney, “English for Communication”, 2nd Edition, CUP, 2003.
2.	Leo Jones and Richard Alexander, “New International Business English”, CUP, 2000.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Communicate in the business world using different communication tools

Course Code	**:**	**CA709**
Course Title	**:**	**COMPUTATIONAL INTELLIGENCE LAB**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	10 Sessions
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To practice evolutionary and learning algorithms
CLO2	To develop fuzzy controller and hybrid systems

Suggested list of Exercises:

1. Implementation of evolutionary algorithms
2. Implementation of swarm intelligence algorithms
3. Implementation of neural network and learning algorithms
4. Developing a fuzzy controller
5. Implementation of hybrid systems

Course Outcomes (CO)

At the end of the course student will be able

CO1	Apply and implement evolutionary, neural network, fuzzy and hybrid systems to solve real-world problems

SEMESTER IV

Course Code	**:**	**CA720**
Course Title	**:**	**DEEP LEARNING AND ITS APPLICATIONS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA713
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the techniques of deep learning.
CLO2	To explore various deep learning techniques to solve the real-world problems

Course Content

INTRODUCTION – Learning – Various types Learning – Machine Learning: issues and challenges – CPU vs GPU – massive parallelism – Introduction to Deep Learning – Deep Learning Models: CNN – RNN – AE – GAN – real world applications of Deep Learning – Packages used for Deep Learning.

DEEP LEARNING – Introduction – shallow neural networks – Deep neural networks – Architecture Design – Convolutional Neural Networks – Introduction – Convolution (1D and 2D) – Pooling – Training of network – Hyper parameter tuning – pre-trained models: AlexNet – GoogleNet – Resnet – VGG-16 – VGG-19 – ImageNet – Case study of CNN (Healthcare – Agriculture – Stock Market – Weather Forecasting).

SEQUENCE MODELING – Recurrent Neural Network (RNN) Model – Types of RNNs – Vanishing Gradients with RNN – Gated Recurrent Unit – Long Short-Term Memory (LSTM) – Deep Recurrent Neural Networks – RNN for Time Series – Transformer Network Models - Case Studies on Recent Real-World Problems.

DEEP REINFORCEMENT LEARNING- Foundations of Reinforcement Learning – Value-based models – Policy-based models – Multi-Agent Reinforcement Learning – Deep Q-Learning – SARSA Learning – Real World Applications.

AUTOENCODERS AND GENERATIVE ADVERSARIAL NETWORKS - Autoencoders – Architecture of Autoencoders – Types of Autoencoders – Applications of Autoencoders – Generative Models – Generative Adversarial Networks – VAE -Variational Autoencoders - Applications – Autoencoders vs Generative Adversarial Networks – Use Cases.

References

1.	Ian Goodfellow, Yoshua Bengio, Aaron Courville, Deep Learning, MIT Press 2016.
2.	Andrew Glassner, Deep Learning from basics to practice. Volume 1 & 2, Kindle Edition, 2018.
3.	François Chollet, Deep Learning with Python, Manning Publications, 2018.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explore the essentials of Deep Learning based architectures
CO2	Design and Develop Deep Neural Networks for solving real world problems that require artificial intelligence-based solutions

Course Code	**:**	CA722
Course Title	**:**	**WEB TECHNOLOGIES AND APPLICATIONS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA716
Contact Hours	**:**	60 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn about essentials of web-based applications development
CLO2	To develop websites using markup languages, style sheets and multimedia tools
CLO3	To know about client-server application technologies and development
CLO4	To develop single page, dynamic and rich applications.

Course Content

Web essentials – W3C – Client-Server Communication – Markup Languages – HTML5 – Semantic Elements – Forms – Graphics – Media – CSS and Different Versions.

Client side programming – Java script language – Java script objects – Document Object Model - BOM Objects – Cookies - Event Handling – Javascript APIs.

Data Handling - XML – DTD – XML Family of Technologies - Schema – Xquery – Xpath - JSON – AJAX – Database Connectivity.

Single Page and Dynamic Page Aplications - JS AJAX – XMLHttp – Applications - jQuery Basics – Effects – jQuery HTML and Traversing – Bootstrap – Angular Js – Examples.

Server side programming – PHP – Forms – Sessions – Examples – MySql – Node Js – Modules – NPM – Applications using Node Js with Databases – Overview of React JS – Comparison with Angular JS.

References

1.	Jeffrey C Jackson, “Web Technology – A computer Science perspective”, 1st Edition, Pearson Education, 2012.
2.	Chris Bates, “Web Programming – Building Internet Applications “, 3rd Edition, Wiley India, 2006.
3.	Deitel, Deitel and Nieto, “Internet and Worldwide Web - How to Program”, 5th Edition, PHI, 2018.

4.	Akshi Kumar, “Web Technology: Theory and Practice”,1st Edition, Chapman and Hall/CRC, 2018.
5.	Steyer, R., “Learning JQuery: A Hands-on Guide to Building Rich Interactive Web Front Ends”, United States: Pearson Education,2013.
6.	Monteiro, F., “Learning Single-page Web Application Development”, United Kinngdom: Packt Publishing, 2014.
7.	Gascón, U, “Node.js for Beginners: A Comprehensive Guide to Building Efficient, Full-featured Web Applications with Node.js”, United Kingdom: Packt Publishing ,2024.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Design and develop applications using client-side technologies
CO2	Demonstrate the skills required for working Single Page and Dynamic Page Applications
CO3	Develop and deploy server-side applications.
CO4	Understand the significance JavaScript frameworks in web applications development.

LAB EXPERIMENTS:

1. Build a website from scratch using basic HTML5 tags, and CSS functionalities.
2. Create JavaScript event handlers for alert messages and attach button clicks and mouse-over events.
3. Create a form to collect user information and use JavaScript to display details and search links.
4. Use JavaScript to create a rollover image that changes on mouse-over.
5. Utilize PHP variables for session handling.
6. Writing applications accessing files and databases using PHP.
7. Create a basic HTTP server responding with "Hello, World!" and set it up using npm and the http module.
8. Build a simple To-Do list application with NodeJS and Express for adding, viewing, and deleting tasks.
9. Create a simple weather application with NodeJS and Express for current weather information.
10. Create a basic AngularJS application with a module and controller to display a list of items.
11. Implement two-way data binding with an input field and a model.
12. Using Dialog service in a controller to create a popup dialog box using AngularJS

Course Code	**:**	**CA724**
Course Title	**:**	**DISTRIBUTED AND CLOUD COMPUTING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA710
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the concepts and architectures of distributed computing paradigms
CLO2	To learn the principles of virtualization
CLO3	To learn the concepts of service oriented architecture and web services
CLO4	To understand cloud computing architecture and techniques
CLO5	To analyze and evaluate cloud computing models

Course Content

Distributed Computing-Fundamentals of Distributed Computing – Inter Process Communications – Distributed Computing Paradigms - Distributed Objects

Virtualization-Introduction to Virtualization - Different Approaches to Virtualization - Server, Storage, Network Virtualization - Virtual Machine (VM) Provisioning and Manageability - VM Placement- VM Migration - Hypervisors – Containers

Service Oriented Architecture - Service Science - Web Services: SOAP, WSDL, UDDI - Web Services Discovery and Composition - REST based Web Services – Microservices

Cloud Computing Deployment and Delivery Models-Cloud Computing Properties and Characteristics - Business Drivers for Adopting Cloud Computing - Cloud Computing Architecture - Cloud Computing Service Delivery Models: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS) Deployment Models: Public cloud, Private cloud, Hybrid cloud – Cloud Data Center Design and Management - Case Studies: Amazon AWS, Microsoft Azure, Amazon EC2, Google Cloud

Business and Operational Aspects of Cloud Computing-Service Level Agreements (SLAs) – Pricing Models of Cloud - Migrating to Cloud – Task Scheduling - Resource Management - Cloud Security and Privacy - Emerging Trends in Cloud Computing

References

1.	Kai Hwang, Jack Dongarra, Geoffrey C. Fox: Distributed and Cloud Computing: From Parallel Processing to the Internet of Things, Morgan Kaufmann, 2013
2.	Gustavo Alonso, Fabio Casati, Harumi Kuno, Vijay Machiraju: Web Services: Concepts, Architectures and Applications, 1st Edition, Springer, 2010
3.	Rajkumar Buyya, Christian Vecchiola, and Thamarai Selvi: Mastering Cloud Computing, 2nd Edition, McGraw Hill, 2024.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the fundamentals of distributed computing
CO2	Explain the principles of virtualization
CO3	Acquire knowledge on the concepts and technologies of cloud computing
CO4	Identify the service-oriented architecture for distributed computing workflow
CO5	Use various performance criteria for evaluating the quality of cloud models

Elective - II

To be chosen from CA7A group

Elective – III

To be chosen from CA7B group

Course Code	:	**CA706**
Course Title	:	**DEEP LEARNING LAB**
Type of Course	:	PC / PE / OE
Prerequisites	:	
Contact Hours	:	10 Sessions
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce basic deep learning techniques.
CLO2	To develop the skills in using recent deep learning software for solving practical problems in high-performance computing environment.
CLO3	To develop the skills in applying appropriate deep learning algorithms for solving practical problems.

Lab Experiments:

- Problem Selection
- Data Collection & Generation
- Data Preprocessing Techniques
- Design and Develop Deep Learning Models
    - CNN based Models
    - RNN based Models
    - Deep Q-learning & SARASA learning models
    - Reinforcement Learning Models (Q-Learning, SARASA learning)
    - GAN & VAE Models
- Model Evaluation Metrics
- Model Deployment

Course Outcomes (CO)

At the end of the course student will be able

CO1	Implement and apply deep learning algorithms to solve problems.
CO2	Use deep learning techniques in a high-performance computing environment to solve real-world problems

Course Code	**:**	**CA708**
Course Title	**:**	**DISTRIBUTED AND CLOUD COMPUTING LAB**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	10 Sessions
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the design and development process involved in creating cloud-based applications

Lab Experiments:

Synchronization with shared data and threads

Applications using Java remote method invocation

Create virtualization using any hypervisor and execute simple programs. Transfer the files from one virtual machine to another virtual machine.

Develop Web services using SOAP/WSDL/UDDI.

Install any cloud services. Create simple web applications using Python/Java. Use the cloud services to launch the web applications.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Implement and apply distributed and cloud computing techniques to solve problems.

Semester V

Course Code	**:**	**CA731**
Course Title	**:**	CYBER SECURITY
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA 713, CA718
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the basic concepts of Cyber Security
CLO2	To understand the cause for Hardware, Network and Software attacks
CLO3	To detect an attack and develop an appropriate response for it.

Course Content

Cyber Security – CIA Triad – authentication methods - authentication protocols - authorization mechanisms - access control policies - access control matrix - CAPTCHA - Reasons of cyber-crimes - history of cyber-crimes - types of cyber crimes

Cryptography - symmetric key cryptography - public key cryptography – cryptanalysis - hash functions - digital certificates and public key infrastructure (PKI) - key distribution

Network security - Domain Name System - firewall - intrusion detection and prevention system (IDPS) - unified threat modeling (UTM) - demilitarized zone (DMZ) – virtual private networks – e-payment systems - Network security threats - wireless security – Mobile Security

Application Security - software vulnerabilities - software supply chain vulnerabilities, vulnerability assessment and penetration testing (VAPT), software reverse engineering (SRE), digital rights management (DRM), email Security (PGP, S/MIME); web application security (OWASP), cloud security, Internet of things (IoT) security - Smart grid security

Attacker techniques – Tunnelling – fraud – Threat Infrastructure – Exploitation – techniques to gain a foothold – Malicious code – forensics

References

1.	Anand Shinde, Introduction to Cyber Security Guide to the World of Cyber Security, 2021
2.	James Graham, Ryan Olson, Rick Howard, Cyber Security Essentials, CRC Press, 2016
3.	William Stallings, “Cryptography and Network Security Principles and Practices”, 7th Edition, Pearson Education, 2017.
4.	Douglas R. Stinson, “Cryptography: theory and practice”, 3rd Edition, CRC Press, 2021
5.	Nina Godbole, Sumit Belapure, “Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives”,1st Edition, Wiley, April 2011

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explain the concepts of Cyber Security.
CO2	Explain the cause for Hardware, Network and Software attacks
CO3	Detect an attack and develop an appropriate response for it

Course Code	**:**	**CA 733**
Course Title	**:**	MOBILE APPLICATIONS DEVELOPMENT
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand mobile applications for specific needs.
CLO2	To differentiate the development aspects using Android and iOS.
CLO3	To understand the mobile application development frameworks.

Course Content

Introduction and Design Aspects – Embedded systems - Market and business drivers for mobile applications – Publishing and delivery of mobile applications – Requirements gathering and validation for mobile applications – Design constraints – Architecting applications – user interfaces– touch events and gestures – Achieving quality constraints – performance, usability, security, availability, and modifiability.

Advanced Design - Designing applications with multimedia and web access capabilities – Integration with GPS and social media networking applications – Significance of Cloud – Design Patterns for Development.

Android - Introduction – Establishing the development environment – Android architecture – Activities and views – Interacting with UI – Persisting data using SQLite – Packaging and deployment – Interaction with server-side applications – Using Google Maps GPS and WiFi – Integration with social media applications.

iOS - Introduction to Objective C – iOS features – UI implementation – Touch frameworks – Data persistence using Core Data and SQLite – Location-aware applications using Core Location and Map Kit – Integrating calendar and address book with social media applications – Using WiFi - iPhone marketplace.

Hybrid Development – Native vs Hybrid Mobile Applications – Building Blocks of HMAD – Internals – Data Access – UI – Set up and Deployment – XAMARIAN vs HMAD – Case Study.

References

1.	Jeff McWherter and Scott Gowell, “Professional Mobile Application Development,” Wrox 2012.
2.	Charlie Collins, Michael Galpin, and Matthias Kappler, “Android in Practice,” DreamTech 2012.
3.	James Dovey and Ash Furrow, “Beginning Objective C,” Apress 2012.
4.	David Mark, Jack Nutting, Jeff LaMarche, and Frederic Olsson, “Beginning iOS 6 Development: Exploring the iOS SDK,” Apress 2013.
5.	Panhale, M. Beginning Hybrid Mobile Application Development. United States: Apress, 2015.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Describe the requirements for mobile applications.
CO2	Design and develop mobile applications for specific needs.
CO3	Differentiate the development aspects using Android and iOS.
CO4	Implement the design using mobile application development frameworks.

Course Code	**:**	**CA735**
Course Title	**:**	ORGANIZATIONAL BEHAVIOR
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	40 Hours
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the leadership skills and group behavior.

Course Content

History of Management - The human relations movement - The Hawthorne studies - Models for organizational behavior – Management concepts.

Foundations of Individual Behavior - Personality – Meaning and development - Major determinants of Personality and Values -Theories of Personality – Perception and Individual Decision Making – sensation versus perception - Stress – Causes and effect of job stress - coping strategies for stress.

Foundations of Group Behavior - Understanding Work Teams - Communication - Basic Approaches to Leadership - Contemporary Issues in Leadership – Motivation Concepts - Motivation From Concepts to Applications –Work motivation – Attitude and Job Satisfaction - Power and Politics - Job design - Goal setting

Conflicts - Individual conflict, Interpersonal conflict, Inter-group conflict– Conflict Resolution - Negotiation

Foundations of Organization Structure - Organizational Culture – Organizational Dynamics

References

1.	Stephen P. Robbins, Timothy A. Judge, “Organizational Behavior”, 18th Edition, Pearson Education, 2018.
2.	Robert Kreitner, Angelo Kinicki, “Organizational Behavior”, 10th Edition, McGraw-Hill,2012.
3.	Fred Luthans, "Organizational Behavior", 12th Edition, McGraw Hill, 2017.
4.	Keith Davis, "Human behavior at work: Human relations and Organizational Behavior", Tata McGraw Hill, 1982.
5.	Rudrabasavaraj M.N. “Dynamic personnel Administration”, 3rdEdition, Himalaya Publishing House, 2015.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Practice ethical behavior and community responsibilities in organizations and society.

Industrial Component:

A series of tutorials on Organization development

Elective – IV

To be chosen from CA7C group

Elective – V

To be chosen from CA7D group

Course Code	**:**	**CA70A**
Course Title	**:**	**Cyber Security Lab**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	
Contact Hours	**:**	10 Sessions
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Lab Experiments:

Exercises from cyber security related programming using Tools

Course Outcomes (CO)

At the end of the course student will be able

CO1	Implement Cryptography techniques to data
CO2	Simulate the various network security issues
CO3	Experiment with application security
CO4	Explore the nature and logic behind the various security threats on the web.

Course Code	**:**	**CA70B**
Course Title	**:**	**Mobile Applications Development Lab**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA 733
Contact Hours	**:**	10 Sessions
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

LAB EXPERIMENTS:

Android

1. Develop an application that uses GUI components, Font and Colors.

2. Develop an application that uses Layout Managers and event listeners.

3. Develop a calculator application.

4. Write an application to display basic graphical primitives on the screen.

5. Develop an application that works with database.

6. Implement an application that implements multi-threading.

8. Develop a native application that uses GPS location information.

9. Implement an application that creates an alert upon receiving a message.

iOS

1. Create user interfaces for iOS applications with UIKit, Auto Layout, and SwiftUI.

2. Use Core Data to persist data within an iOS application.

3. Utilize Core Location and MapKit for location-based applications.

4. Describe the process required to publish and submit an iOS application to the App Store.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Develop Android applications with GUI components, layout managers, and multithreading.
CO2	Create Android apps that include general purpose applications, database interactions, and GPS functionalities.
CO3	Design iOS general purpose applications and location-based iOS applications
CO4	Publish and submit iOS applications to the App Store.

CA749 Project Work Phase I

Case Study/ Mini Project using the concepts and techniques

covered in the syllabus/the state-of-art techniques.

Semester VI

CA750 Project Work – Phase II

ELECTIVES

Course Code	:	**CA7A1**
Course Title	:	**DATA SCIENCE**
Type of Course	:	PC / PE / OE
Prerequisites	:	-
Contact Hours	:	45
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know the fundamental concepts of data science and analytics.
CLO2	To learn fundamental data analysis using R.
CLO3	To understand various data modeling techniques.
CLO4	To learn the basic and advanced features of open-source big data tools and frameworks.
CLO5	To study various analytics on stream data.

Course Content

Introduction to Data Science – Data Science Process – Exploratory Data analysis –Collection of Data – Graphical Presentation of Data – Classification of Data – Storage and Retrieval of Data, Big data: Definition, Risks of Big Data, Structure of Big Data – Web Data: The Original Big Data – Evolution Of Analytic Scalability – Analytic Processes and Tools –Analysis versus Reporting – Core Analytics versus Advanced Analytics– Modern Data Analytic Tools – Statistical Concepts: Sampling Distributions – Re-Sampling – Statistical Inference – Introduction to Data Visualization.

Univariate Analysis: Frequency, Mean, Median, Mode, Variance, Standard Deviation, Skewness and Kurtosis – Bivariate Analysis: Correlation – Regression Modeling: Linear and Logistic Regression – Multivariate Analysis – Graphical representation of Univariate, Bivariate and Multivariate Analysis in R: Bar Plot, Histogram, Box Plot, Line Plot, Scatter Plot, Lattice Plot, Regression Line, Two-Way cross Tabulation.

DATA MODELING - Bayesian Modeling – Support Vector and Kernel Methods – Neuro – Fuzzy Modeling – Principal Component Analysis – Introduction to NoSQL: CAP Theorem, MongoDB: RDBMS Vs MongoDB, Mongo DB Database Model, Data Types and Sharding – Data Modeling in HBase: Defining Schema – CRUD Operations.

DATA ANALYTICAL FRAMEWORKS - Introduction to Hadoop: Hadoop Overview – RDBMS versus Hadoop – HDFS (Hadoop Distributed File System): Components and Block Replication –

Introduction to MapReduce – Running Algorithms Using MapReduce – Introduction to HBase: HBase Architecture, HLog and HFile, Data Replication – Introduction to Hive, Spark and Apache Sqoop.

STREAM ANALYTICS - Introduction to Streams Concepts – Stream Data Model and Architecture – Stream Computing – Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments – Counting Oneness in a Window – Decaying Window.

References

1.	Anand Rajaraman, Jeffrey David Ullman, "Mining of Massive Datasets", 3rd Edition, Cambridge University Press, 2020.
2.	Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", 1st Edition, John Wiley & sons, 2012.
3.	Umesh R Hodeghatta, Umesha Nayak, "Business Analytics Using R – A Practical Approach", 1st Edition, Apress, 2017.
4.	Rachel Schutt, Cathy O'Neil, "Doing Data Science", 1st Edition, O'Reilly, 2013.
5.	Foster Provost, Tom Fawcet, "Data Science for Business",1st Edition, O'Reilly, 2013.
6.	Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", 1st Edition, Wiley, 2014.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Convert real world problems to hypothesis and perform statistical testing
CO2	Perform data analysis using R.
CO3	Work with big data platform and its analysis techniques.
CO4	Identify and design efficient modelling of very large data.
CO5	Implement suitable data analysis for stream data.
CO6	Write efficient MapReduce programs for small problem-solving methods.

Course Code	:	**CA7A2**
Course Title	:	**SOCIAL NETWORK ANALYSIS**
Type of Course	:	PC / PE / OE
Prerequisites	:	CA713
Contact Hours	:	45
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the concepts and methods of Social Network Analysis
CLO2	To apply computational tools for Social Network Analysis to solve problems

Course Content

Social network Analysis- Social network concepts – Applications of Social network Analysis- Social Network Data - Issues and challenges.

Mathematical Representation of social networks -Network measures -Structural analysis – Link Analysis- Content-based analysis - Static and dynamic analysis – Dynamic properties of Social network

Community Detection in Social Networks – Disjoint community detection – Overlapping Community Detection-Node Classification in Social Networks-Evolution in Dynamic Social Network- Information diffusion in Social Network

Social Influence Analysis -Link Prediction in Social Networks - Anomaly detection - Anomaly detection in Static Network- Anomaly detection in Dynamic Network-Text Mining in Social Networks

Social Knowledge graphs- Graph representation Learning – Graph visualization tools- Applications of social network Analysis – Sock puppets in Online Social Networks, Cyber bullying detection, Analysis of Links in Wikidata

References

1.	Xiaoming Fu, Jar-Der Luo, Margarete Boos, Social Network Analysis Interdisciplinary Approaches and Case Studies, Taylor and Francis,2017
2.	Tanmoy Chakraborty, Social Network Analysis, Wiley, 2021.
3.	Christina Prell, Social Network Analysis: History, Theory and Methodology, 1st Edition, SAGE Publications Ltd, Publication Year, 2011.
4.	David Easley and Jon Kleinberg, “Networks, Crowds, and Markets: Reasoning About a Highly Connected World”, Cambridge University Press, 2010.
5.	Carrington and Scott, The SAGE Handbook on Social Network Analysis, First Edition, SAGE, 2011.

Course Outcomes (CO)

At the end of the course student will be able

CO1	Describe the issues and challenges in social network functions.
CO2	Represent social networks in a suitable form for Analysis.
CO3	Describe various algorithms used in the analysis of social networks.
CO4	Apply the algorithms of social network analysis to real world problems.

Course Code	**:**	**CA7A3**
Course Title	**:**	**ADVANCED DATABASE TECHNOLOGY**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA712
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn different types of databases.
CLO2	To study various indexing techniques.
CLO3	To study query languages

Course Content

Parallel and Distributed Databases: Architectures for Parallel Databases - Parallel Query Evaluation - Parallelizing Individual Operations - Parallel Query Optimization - Distributed DBMS Architectures – Storing data - Distributed Catalog Management - Distributed Query Processing - Updating Distributed Data - Distributed Transactions - Distributed Concurrency Control - Distributed Recovery.

Active and Deductive Databases: Syntax and Semantics - Applications – rule generation - Design Principles of active databases – IDEA - Datalog - fixpoint - Least Fixpoint Semantics for Datalog - Stratification - Fixpoint Semantics for Stratified Programs - Magic Sets Algorithm - Adorned Rules.

Temporal and Object Databases: Data types - Associating Facts - Temporal Query Languages – TSQL2 - Time Ontology - Data Model – Language constructs – System architecture – Adding temporal support - Object Database and Change Management – Change of Schema – Implementing Database Updates in O2 – Benchmark Database Updates – Performance Evaluation.

Complex Queries and Reasoning: Relational Algebra - From Safe Datalog to Relational Algebra - The Logic of Query Languages – Recursive rules - Syntax and Semantics of Datalog Languages - Implementation of Rules and Recursion – Bottom-Up and Top-Down Execution - Rule-Rewriting Methods - Compilation and Optimization - Recursive Queries in SQL.

Spatial, Text, and Multimedia Databases: Indexing methods – Inverted files – k-D trees – Spatial Access Methods – R-trees – Text retrieval – multimedia indexing – 1-D time series – DFT – 2-D color images – Sub pattern matching.

References

1.	Carlo Zaniolo, Stefano Ceri "Advanced Database Systems", Morgan Kauffmann Publishers. 1997
2.	Raghu Ramakrishnan "Database Management System", 3rd Edition, McGraw Hill Publications, 2014
3.	R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", 7th Edition, Pearson Education/Addison Wesley, 2017

Course Outcomes (CO)

At the end of the course student will be able

CO1	Design various databases
CO2	Apply indexing techniques
CO3	Use query languages

Course Code	**:**	**CA7A4**
Course Title	**:**	**DATA MINING AND WAREHOUSING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	**CA712**
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To explain the architecture of Data Mining and Warehousing
CLO2	To describe the various techniques in Data mining for knowledge discovery
CLO3	To understand Genomic data acquisition and analysis, comparative and predictive analysis of DNA and protein sequence, Phylogenetic inference etc.

Course Content

Fundamentals of data mining and Data Pre-processing: Motivation, Importance, Definition of Data Mining - Data Mining Functionalities - Classification of Data Mining systems - Data Mining Task Primitives - Integration of a Data Mining System with a Database or a Data Warehouse System - Major issues in Data Mining. Types of Data Sets and Attribute Values - Basic Statistical Descriptions of Data - Data Visualization - Measuring Data Similarity Data. Pre-processing: Need for Pre-processing the Data - Data Cleaning - Data Integration and Transformation - Data Reduction - Discretization and Concept Hierarchy Generation.

Data Warehouse and OLAP Technology for Data Mining: Data Warehouse - Multidimensional Data Model - Data Warehouse Architecture - Data Warehouse Implementation - Further Development of Data Cube Technology - From Data Warehousing to Data Mining Data Cube Computation and Data Generalization: Efficient Methods for Data Cube Computation, Further Development of Data Cube and OLAP Technology.

Mining Frequent Patterns, Associations and Correlations: Basic Concepts on Frequent Item sets - Efficient and Scalable Frequent Item set Mining Methods - Mining various kinds of Association Rules – Apriori Algorithm – FP-tree algorithm - From Association Mining to Correlation Analysis, Constraint-Based Association Mining.

Classification and Prediction: Issues Regarding Classification and Prediction - Classification by Decision Tree Induction - Bayesian Classification - Rule-Based Classification - Classification by Back propagation - Support Vector Machines – Prediction - Accuracy and Error measures - Evaluating the accuracy of a Classifier or a Predictor - Ensemble Methods.

Clustering Methods: Cluster Analysis Introduction - Types of Data in Cluster Analysis - A Categorization of Major Clustering Methods- Partitioning Methods, Hierarchical Methods, Density-Based Methods, Grid Based Methods, Model-Based Clustering Methods - Clustering High-Dimensional Data – Constraint Based Cluster Analysis; Outlier Analysis; Fundamentals of Web Data Mining .

References

1.	Jiawei Han & Micheline Kamber, Data Mining – Concepts and Techniques, 3rd Edition, Morgan Kaufmann Publishers, Elsevier, 2012
2.	Margaret H Dunham, Data Mining Introductory and Advanced Topics, 2nd edition, Pearson Education, New Delhi, India,2006
3.	Arun K Pujari, Data Mining Techniques, 3rd edition, Universities Press, 2013
4.	Amitesh Sinha, Data Warehousing, First Edition, Thomson Learning, India, 2007
5.	Xingdong Wu, Vipin Kumar, The Top Ten Algorithms in Data Mining, CRC Press, UK, 2009

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explain the Data warehouse and its implementation
CO2	Design applications for implementation of Data mining tasks
CO3	Implement Classification and Prediction algorithms
CO4	Experiment the Clustering methods.

Course Code	**:**	**CA7A5**
Course Title	**:**	**RESOURCE MANAGEMENT TECHNIQUES**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	-
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn different resource management techniques

Course Content

Linear programming problems: Formulation – Simplex method – Big M method – Two Phase method – Revised Simplex method-Primal Dual problems- Dual Simplex method.

Network Programming models: Transportation problem – Assignment problem -Dynamic programming: Multi-stage graph formulation– Stage coach problem- Resource allocation problem- Inventory problem.

Non-linear Programming: One dimensional unconstrained optimization – Fibonacci method – Golden section method – Quadratic approximation method – constrained optimization with Lagrangian multipliers.

Integer Programming: All integer programming problem –- Mixed integer programming- Gomory Cutting plane method- Branch and Bound method- Zero-one integer programming problem-Balas-additive algorithm.

Queuing theory - notation and assumptions – characteristics of queue – Poisson input process – exponential service times – Queuing models – M/M/1 – M/M/C – M/M/1/N – M/M/C/N

References

1.	H.A. Taha, “Operations Research: An Introduction”, 10th Edition, Pearson Education, 2019
2.	Swarup.K, Gupta and P.K Man Mohan, “Operations Research”, 20th Edition, Sultan Chand &Sons, 2019

3.	S.R.Yadav, A.K.Malik, "Operations Research", Oxford University Press, First Edition, 2014

Course Outcomes (CO)

At the end of the course student will be able

CO1	Formulate and solve LP /NLP /DP Problems
CO2	Identify appropriate model for given inventory problems and solve the problems
CO3	Solve queuing problems using queuing models

Course Code	**:**	**CA7A6**
Course Title	**:**	**IMAGE PROCESSING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	-
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To become familiar with digital image fundamentals
CLO2	To get exposed to simple image enhancement techniques in Spatial and Frequency domain
CLO3	To learn concepts of degradation function and restoration techniques
CLO4	To study the image segmentation and representation techniques
CLO5	To become familiar with image compression and recognition methods

Course Content

Fundamentals of Image Processing: Introduction to Digital Image Processing - Characteristics of Digital Image - Basic relationship between pixels - Image sampling and quantization - Color models - Basic Geometric Transformations - Fourier Transform - Cosine-Sine and Hartley Transform - Hadamard-Haar-Slant Transform - Discrete Fourier Transform.

Image Enhancement in the Spatial and Frequency Domain Filtering: Basic Intensity Transformation Functions, Histogram Processing, Basics of spatial filtering, Smoothing and Sharpening Spatial filters, the basics of filtering in the Frequency Domain, Image smoothing and sharpening using Frequency Domain Filters- Ideal, Butterworth and Gaussian Filters, Homomorphic filtering, Color image enhancement.

Image Restoration: A model of the image Degradation/Restoration process, Noise models, mean filters, inverse filtering, Wiener filtering, Geometric Mean Filter.

Image Compression: Fundamentals, Types of redundancies, Lossy and Lossless compression, Entropy of an information source, Shannon Fano Coding, Huffman Coding, Golomb Coding, Arithmetic Coding, LZW coding, Run length coding.

Morphological Image Processing: Basics, Erosion and Dilation, Opening and Closing, The Hit-or-Miss Transform, Morphological Algorithms-Boundary extraction, Hole filling, convex hull, thinning, skeletons.

Image Segmentation: Fundamentals, Basics of Point, Line, Edge detection, Thresholding, Iterative thresholding, Otsu's method, Multivariable thresholding, Region based segmentation, Segmentation using Morphological Watershed algorithm, The use of motion in segmentation.

References

1.	Rafael C Gonzalez, Richard E Woods, “Digital Image Processing”, Fourth Edition, Pearson Education, 2018
2.	William K Pratt, “Digital Image Processing”, Fourth Edition, John Wiley, 2010
3.	S E Umbaugh, “Digital Image Processing and Analysis: Application with MATLAB and CVIP Tools”, Third Edition, Taylor & Francis, CRC Press, 2018
4.	Frank Y. Shih, “Image Processing and Pattern Recognition”, Wiley – IEEE Press, 2010

Course Outcomes (CO)

At the end of the course student will be able

CO1	Know and understand the basics and fundamentals of digital image processing, such as digitization, sampling, quantization, and 2D-transforms
CO2	Operate on images using the techniques of smoothing, sharpening and enhancement
CO3	Understand the restoration concepts and filtering techniques
CO4	Learn the basics of segmentation, features extraction, compression and recognition methods for color models

Course Code	**:**	**CA7B1**
Course Title	**:**	**SOFTWARE ARCHITECTURE AND PROJECT MANAGEMENT**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	-
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To know the issues related to the design of complex software and to learn the project management concepts and the use of tools

Course Content

Software components - COTS and infrastructure - Software variability management-Software architecture design methods - Architecture evaluation and assessment methods - architectural styles.

Design Patterns - Evolution patterns - Software artifact evolution processes - Case studies - Java Beans.

Product, Process and Project – Definition – Product Life Cycle – Project Life Cycle Models.

Format Process Models and Their Use -Definition and Format model for a process – The ISO 9001 and CMM Models and their relevance to Project Management –Emerging Models - People CMM-Metrics – Configuration Management – Software Quality Assurance – Risk Analysis.

Engineering and People Issues in Project Management-Phases (Requirements, Design, Development, Testing, Maintenance, Deployment) –Engineering Activities and Management Issues in Each Phase – Special Considerations in Project Management for India and Geographical Distribution Issues.

References

1.	Len Bass, Paul Clements, and Rick Kazman, "Software Architecture in Practice", 4th Edition, Addison-Wesley Longman, Inc., Reading, MA, 2021
2.	Richard N.Taylor, NenadMedvidovic, and Eric M.Dashofy, “Software Architecture: Foundations, Theory and Practice”, Wiley India Edition, 2012
3.	Mary Shaw, and David Garlan ,” Software Architecture in Practice: Perspectives on an Emerging Discipline", PHI Learning Private Limited,2010
4.	Ramesh and Gopalaswamy, "Managing Global Projects", Tata McGraw Hill,2001

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explain various design and evaluation methods
CO2	Employ design patterns in the software architecture
CO3	Apply various phases of life cycle models
CO4	List various process models and describe issues related with quality assurance
CO5	Apply engineering activities involved in various project management phases

Course Code	:	**CA7B2**
Course Title	:	**SERVICE ORIENTED ARCHITECTURE**
Type of Course	:	PC / PE / OE
Prerequisites	:	CA716
Contact Hours	:	45
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the basic principles of service orientation
CLO2	To learn concepts such as web services, WS* specification standards, service composition, orchestration, and choreography
CLO3	To develop and deploy Web Services
CLO4	To understand and apply the principles of Micro service.

Course Content

Introduction: Concepts of Distributed Computing, XML, Fundamental of SOA, Evolution of SOA, Principles of Service-Oriented Architecture- Service-orientation and object- orientation, SOA Standards Stack, SOA with Web Services, Key Principles of SOA.

Web Services Fundamentals: Web Services: Definition, Architectures and Standards. Directory services, SOAP message structure - SOAP encoding - Message exchange models - Communications and Messaging - Limitations of SOAP - Fundamentals of RESTFUL web services - Development and deployment of RESTFUL services - Web service life cycle - Anatomy of WSDL document - Describing web services - WSDL bindings, tools - Limitations - Discovering web services using UDDI.

Web Services Security and Transaction: Meta Data Management - Advanced Messaging - Addressing - Reliable Messaging - Policies - WS Policy - Security - WS Security - Transaction Management.

Business Process Management and Multi-channel Access: Basic Business process management concepts - Examples - Business modelling - Options - Basis of workflow - Atomic services and composite services - Service Orchestration and Choreography - Business Process Execution Language - Business process modelling Notations - Business process re-engineering and management - Combining BPM, SOA and Web Services - SOA for Multi-Channel Access.

SOA Platforms: Design and implementation of Inter-Enterprise applications using services and micro services - SOA support in J2EE – Java API for XML- based web services (JAX-WS) - Java architecture for XML binding (JAXB) – Java API for XML Registries (JAXR) - Java API for XML based RPC (JAX-RPC)- SOA support in .NET-Web services and micro services in .NET - Software stacks-Cloud Platforms.

References

1.	Thomas Erl, "Service Oriented Architecture (SOA): Concepts, Technology and Design ", Prentice Hall, USA, 2016
2.	Eric Newcomer, Greg Lomow, "Understanding SOA with Web Services", Pearson Education India, New Delhi, 2016
3.	Dirk Krafzig, Karl Banke, Dirk Slama , "Enterprise SOA, Service Oriented Architectures Best Practices", Prentice Hall, 2016
4.	Mark D. Hansen , "SOA Using Java™ Web Services ",Illustrated edition, Prentice Hall; 2009
5.	James McGovern, Sameer Tyagi, Michael E Stevens, Sunil Mathew, "Java Web Services Architecture", Elsevier, 2003
6.	Shankar Kambhampaty, "Service - Oriented Architecture & Micro services Architecture: for Enterprise, Cloud, Big Data and Mobile", 3rd Edition, Wiley, 2018

Course Outcomes (CO)

At the end of the course student will be able

CO1	Explain the principles of service-oriented architecture
CO2	Use the concepts of SOA in developing Web Services based applications
CO3	Develop enterprise applications using Web Services
CO4	Understand the Microservices architectures and apply in application development

Course Code	**:**	**CA7B3**
Course Title	**:**	**AGILE TECHNOLOGY**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA725
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To provide students with a theoretical as well as practical understanding of agile software development practices and how small teams can apply them to create high-quality software
CLO2	To provide a good understanding of software design and a set of software technologies and APIs
CLO3	To do a detailed examination and demonstration of Agile development and testing techniques
CLO4	To understand the benefits and pitfalls of working in an Agile team
CLO5	To understand Agile development and testing

Course Content

AGILE METHODOLOGY**:** Theories for Agile Management – Agile Software Development – Traditional Model vs. Agile Model - Classification of Agile Methods – Agile Manifesto and Principles – Agile Project Management – Agile Team Interactions – Ethics in Agile Teams - Agility in Design, Testing – Agile Documentations – Agile Drivers, Capabilities and Values.

AGILE PROCESSES**:** Lean Production - SCRUM, Crystal, Feature Driven Development- Adaptive Software Development - Extreme Programming: Method Overview – Lifecycle – Work Products, Roles and Practices.

AGILITY AND KNOWLEDGE MANAGEMENT**:** Agile Information Systems – Agile Decision Making - Earl_S Schools of KM – Institutional Knowledge Evolution Cycle – Development, Acquisition, Refinement, Distribution, Deployment, leveraging – KM in Software Engineering – Managing Software Knowledge – Challenges of Migrating to Agile Methodologies – Agile Knowledge Sharing – Role of Story-Cards – Story-Card Maturity Model (SMM).

AGILITY AND REQUIREMENTS ENGINEERING**:** Impact of Agile Processes in RE–Current Agile Practices – Variance – Overview of RE Using Agile – Managing Unstable Requirements – Requirements Elicitation – Agile Requirements Abstraction Model – Requirements Management in Agile Environment, Agile Requirements Prioritization – Agile Requirements Modeling and Generation – Concurrency in Agile Requirements Generation.

AGILITY AND QUALITY ASSURANCE**:** Agile Product Development – Agile Metrics – Feature Driven Development (FDD) – Financial and Production Metrics in FDD – Agile Approach to Quality Assurance - Test Driven Development – Agile Approach in Global Software Development.

References

1.	David J. Anderson and Eli Schragenheim, Agile Management for Software Engineering: Applying the Theory of Constraints for Business Result, Prentice Hall, 2003
2.	Craig Larman, —Agile and Iterative Development: A Managers Guide, 1st Edition, Addison-Wesley, 2004
3.	Kevin C. Desouza, —Agile Information Systems: Conceptualization, Construction, and Management, Butterworth-Heinemann, Penguin Books Ltd 2007

Course Outcomes (CO)

At the end of the course student will be able

CO1	Realize the importance of interacting with business stakeholders in determining the requirements for a software system
CO2	Perform iterative software development processes: how to plan them, how to execute them
CO3	Point out the impact of social aspects on software development success
CO4	Develop techniques and tools for improving team collaboration and software quality
CO5	Perform Software process improvement as an ongoing task for development teams
CO6	Show how agile approaches can be scaled up to the enterprise level

Course Code	:	**CA7B4**
Course Title	:	**MARKETING MANAGEMENT**
Type of Course	:	PC / PE / OE
Prerequisites	:	CA727, CA722
Contact Hours	:	45
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To facilitate understanding of the conceptual framework of marketing and its applications in decision making under various environmental constraints

Course Content

Introduction to marketing, scope of marketing, core marketing concepts, new marketing realities, production concept, product concept, selling concept, marketing concept, Relationship Marketing, Integrated Marketing, Performance Marketing, new 4P's.

Buying Behaviour: key psychological process, buying decision process, stages in buying process. Bases for Segmenting: Consumer, Business Markets, Market Targeting, Positioning.

Product : Levels , hierarchy , Classification of products, Major product decisions, Product line and product mix; Branding, brand equity, Product life cycle – strategic implications, New product development and consumer adoption process. Pricing: Objective of pricing decision, factors affecting price determination, pricing policies, developing pricing strategies, strategies for new products and existing products.

Promotion: Communication Process; Promotion mix – advertising, personal selling, sales promotion, publicity and public relations, direct marketing ; Determining advertising budget; Copy designing and testing; Media selection; Advertising effectiveness; Sales promotion – tools and techniques.

Market control: Annual plan control, sales analysis market share analysis, profitability control, marketing profitability analysis, efficiency control and strategic control. Trends in marketing, socially responsible marketing, internal marketing, green marketing, cause marketing, cause related marketing.

References

1.	Philip Kotler,"Marketing Management", 16th Edition, Pearson Prentice Hall,2022
2.	Ramaswamy V.S and Namakumari .S," Marketing Management: Planning, implementation and control", 5th Edition, Macmillan, New Delhi,2009
3.	Michael J. Etzel, Bruce J. Walker, William J. Stanton, Ajay Pandit, "Marketing – concepts and cases", 8th Edition, McGraw Hill, 2004
4.	Zikmund d Amico, "The power of Marketing", 7th edition, Sowth Western , Thomson Learning Publications, 2006

Course Outcomes (CO)

At the end of the course student will be able

CO1	Define the fundamentals of marketing
CO2	List the issues related to buying and target marketing
CO3	Apply the new product development strategies
CO4	Use product promotional techniques
CO5	Familiar with trends in analysis & control in marketing

Course Code	**:**	**CA7C1**
Course Title	**:**	**BIOINFORMATICS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA713, CA717
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the techniques of soft
CLO2	To explain the hybridization of soft computing systems which differ from conventional AI and computing in terms of its tolerance to imprecision and uncertainty

Course Content

Introduction to bioinformatics, classification of biological databases, Biological data formats, application of bioinformatics in various fields. Introduction to single letter code of amino acids, symbols used in nucleotides, data retrieval – Entrez and SRS.

Introduction to sequence alignment, substitution matrices, scoring matrices – PAM and BLOSUM. Local and Global alignment concepts, dot plot, dynamic programming methodology, Multiple sequence alignment –Progressive alignment. Database searches for homologous sequences –FASTA AND BLAST versions.

Evolutionary analysis: distances - clustering methods – rooted and unrooted tree representation –Bootstrapping strategies.

Fragment assembly-Genome sequence assembly - Gene finding method, Gene prediction - Analysis and prediction of regulatory regions.

Concepts and secondary structure prediction –Probabilistic models: Markov chain, Hidden Markov Models -Gene identification and other applications.

References

1.	Andreqas D. Baxevanis, B. F. Francis Ouellette, "Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins", 4th Edition, John Wiley and Sons, 2020
2.	Shanmughavel, P., "Principles of Bioinformatics", Pointer Publishers, 2008
3.	Richard Durbin, Sean Eddy, Anders Krogh, and Graeme Mitchison, "Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids", Cambridge University Press,1998
4.	Bishop M.J., Rawlings C.J. (Eds.), "DNA and protein sequence analysis: A Practical Approach", IRL Press, Oxford, 1997
5.	Doolittle R.F. (Ed.), "Computer methods for macromolecular sequence analysis Methods in Enzymology", Academic Press, 1996

Course Outcomes (CO)

At the end of the course student will be able

CO1	Demonstrate different biological databases and tools
CO2	Apply algorithms for searching the biological databases
CO3	Categorize sequence alignment methods
CO4	Implement phylogenetic tree construction algorithms
CO5	Predict gene and protein secondary structure
CO6	Analyse genomic sequence

Course Code	**:**	**CA7C2**
Course Title	**:**	**EVOLUTIONARY COMPUTING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	--
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce evolutionary Computation and global optimization techniques

Course Content

Evolutionary computing: Biological foundation of Evolutionary computing, introduces evolutionary algorithms, a class of stochastic, population-based algorithms inspired by natural evolution theory, capable of solving complex problems for which other techniques fail.

Genetic Algorithms (GA): Biological foundation of GA, General steps in GA, Genetic Operations: cloning, crossover and mutation, Encoding and Selection techniques,

Mathematical foundation and Schemata, Holland Schemata theorem, design and implementation of GA, issues in implementation of GA, applications of GA, Classifier systems, Genetic programming, new trends in GA. Applications of GA.

Swarm Intelligence (SI): Biological foundation of SI, SI Techniques: Ant Colony Optimization (ACO) and Particle Swarm optimization (PSO). General steps in ACO, the "Invisible Manager" (Stigmergy), the Pheromone, Ant Colonies and Optimization, Ant Colonies and Clustering, Applications of Ant Colony Optimization. Applications of ACO.

PSO: Social Network Structure: The Neighborhood Principle, PSO Algorithm, Fitness Calculation, Convergence, PSO System Parameters, Particle Swarm Optimization versus Evolutionary Computing and Applications of PSO.

Mimetic algorithm, Firefly Algorithm, multi objective algorithms.

References

1.	A.E. Eiben, J.E. Smith , Introduction to Evolutionary Computing (Natural Computing Series) Springer, 2016
2.	D. E. Goldberg, “Genetic Algorithms in Search, Optimization, and Machine Learning,” Addison Wesley,1989
3.	R.Eberhart, P.Simpson and R.Dobbins, Computational Intelligence - PC Tools, AP Professional, 1996

Course Outcomes (CO)

At the end of the course student will be able

CO1	Describe the Evolutionary algorithms and solve complex problem using evolutionary algorithms
CO2	Identify the issues in design and implementation of genetic algorithm
CO3	Explain the concepts of Swarm Intelligence techniques
CO4	Describe the social network structure

Course Code	**:**	**CA7C3**
Course Title	**:**	**MODELING AND COMPUTER SIMULATION**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA713
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the techniques of random number generations and testing randomness
CLO2	To design simulation models for various case studies like inventory, traffic flow networks, etc
CLO3	To practice on simulation tools and impart knowledge on building simulation systems

Course Content

Simulation and Simulation Software - Systems – Models – Types, Components, Steps in Modeling –Simulation of statistical queuing, manufacturing and material handling.

Useful Statistical Models – Discrete Distribution – Continuous Distributions – Poisson – Empirical Distribution – Manufacturing and Material Handling System – Models – Goals and Performances Measure – Issues – Queuing System – Characteristics – Transient and Steady-State Behaviour of Queues – Long-Run Measures – Infinite – Population Markovian Models.

Random Numbers - Generation of Pseudo Random Numbers – Mid-Square Method – Linear Congruential Generators – Generating Random Variates from Continuous and Discrete Probability Distributions. System dynamics and object-oriented approach in simulation.

Generalization of Growth Models – System Dynamics Diagram – Decision Function – Multi Segment Model – Representation of Time Delays – Inventory and Flow Distribution Systems.

World Model – Object Oriented Approach – Rule Based Approaches– Casual Loops – Flow Diagrams – Levels and Rates – Simple examples of Animation.

Analysis – Input – Output – Verification and Validation of Simulation Models – Comparison and Evaluation of Alternative System Design - Development of simulation models using simulation language.

References

1.	Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol, “Discrete-Event System Simulation”, 5th Edition, Pearson Education, 2009
2.	Lawrence M. Leemis, Stephen K. Park, “Discrete-Event Simulation: A First Course”, First Edition, Pearson Education, 2006

Course Outcomes (CO)

At the end of the course student will be able

CO1	Practice simulation tools and build simulation systems
CO2	Assess the techniques of random number generations and testing its randomness
CO3	Design various simulation models for real time situation

Course Code	**:**	**CA7C4**
Course Title	**:**	**NATURAL LANGUAGE PROCESSING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	--
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce the basic NLP tasks
CLO2	To comprehend the statistical and machine learning models for text processing

Course Content

Introduction to NLP: Ambiguities in NLP tasks –Regular Expressions – Text Normalization - Edit Distance - Tokenization -Stemming-Lemmatization- Named Entities-coreference.

Linguistic Fundamentals for NLP: Morphological Analysis – Part of speech tagging – Shallow Parsing-Dependency Parsing- Lexical Semantics – Word Sense Disambiguation (WSD)- Semantic Role labelling - Pragmatics Analysis – Anaphora Resolution.

Classical NLP Techniques: Introduction to Language Models- N-gram Models- Hidden Markov Model- Conditional Random Fields -Latent Dirichlet Allocation- Maximum Entropy Classifier-Text Classification and Clustering

Deep Learning for NLP: Word Embeddings- Sequential Models- Attention Mechanism- Transformers- Large Language models- Natural Language Generators

Applications and Case Studies: Question Answering, Machine Translation- Information Extraction-Dialogue Systems and Chatbots-Sentiment Analysis-Text Generation

References

1.	Daniel Jurfsky, James H. Martin , Speech and Language Processing: An Introduction to Natural Language Processing, Computational Linguistics and Speech Recognition, Second Edition, Pearson 2013
2.	Stephan Raaijmakers, Deep Learning for Natural Language Processing, Published by Manning, First Edition 2022

3.	Jacob Eisenstein, Introduction to Natural Language Processing (Adaptive Computation and Machine Learning series), Kindle Edition, MIT Press, 2019
4.	Anders Sogaard, Ivan Vulic, Sebastian Ruder, Manaal Faruqui , Cross-Lingual Word Embeddings (Synthesis Lectures on Human Language Technologies), Morgan & Claypool Publishers , 2019
5.	Christopher D. Manning and Hinrich Schutze, "Foundations of Statistical Natural Language Processing", First Edition,MIT Press, 1999

Course Outcomes (CO)

At the end of the course student will be able

CO1	Identify the patterns in text and pre-process the large text corpus
CO2	Describe and work with basic NLP tasks
CO3	Use statistical and machine learning models for text
CO4	Adopt embeddings and Deep learning models for NLP
CO5	Apply the NLP concepts for solving Applications

Course Code	**:**	**CA7C5**
Course Title	**:**	**DEVOps**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA719, CA733
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To provide in-depth knowledge on various DevOps tools including Git, Jenkins, Docker, Ansible
CLO2	To acquire knowledge on best practices in Continuous Development, Configuration Management and Continuous Integration, and finally, Continuous Monitoring of software throughout its development life cycle

Course Content

DevOps : DevOps and Software - Development Life Cycle - Waterfall Model - Agile Model - Continuous Integration & Deployment – Jenkins Containers and Virtual Development – Docker – Vagrant - Configuration Management Tools – Ansible – Puppet – Chef..

Jenkins - Continuous Integration with Jenkins - Configure Jenkins - Jenkins Management- Scheduling build Jobs - POLL SCM - Maven Build Scripts - Support for the GIT version control System - Types of Jenkins Jobs -Jenkins Build Pipe Line - Parent and Child Builds - Sequential Builds - Jenkins Master & Slave Node Configuration - Jenkins Workspace Management - Securing Jenkins – Authentication –Authorization –Confidentiality -Creating Users - Jenkins Plugins - Installing Jenkins Plugins - SCM plugin - Build and test.

Version Control-GIT : GIT Features - 3-Tree Architecture - GIT – Clone /Commit / Push - GIT Hub Projects - GIT Hub Management - GIT Rebase & Merge - GIT Stash, Reset, Checkout - GIT Clone, Fetch, Pull.

Build tool- Maven: Maven Installation - Maven Build requirements -Maven POM Builds (pom.xml) -Maven Build Life Cycle- Maven Local Repository (.m2) - Maven Global Repository -Group ID, Artifact ID, Snapshot -Maven Dependencies - Maven Plugins.

ANSIBLE : Introduction to Ansible - Ansible Server Configuration - Infrastructure Management - SSH Connection in Ansible Master - YAML Scripts -Host Inventory -Hosts and Groups - Host Variables - Group Variables - Host and Group Specific Data - Ad-hoc Commands – Playbooks – Variables – Conditionals – Loops – Blocks – Handlers – Templates – Modules - Core Modules - Extra Modules - Ansible Roles.

Docker : How to get Docker Image - What is Docker Image - Docker Installation - Working with Docker Containers -What is Container - Docker Engine - Crating Containers with an Image - Working with Images - Docker Command Line Interphase - Docker Compose - Docker Hub - Docker Trusted Registry - Docker swarm - Docker attach - Docker File & Commands.

References

1.	Emily Freeman, DevOps For Dummies, First Edition, John Wiley & Sons, 2019
2.	Barrie Sosinsky ,Cloud Computing Bible, First Edition, Wiley-India, 2010
3.	Sonatype Company ,Maven The Definitive Guide, Second Edition, O'Reilly Media, 2015
4.	Lorin Hochstein , Rene Moser , Ansible: Up and Running: Automating Configuration Management and Deployment the Easy Way, 2nd Edition, O'Reilly Media, Inc,2017
5.	Adrian Mouat, Using Docker: Developing and Deploying Software with Containers ,1st Edition , O'Reilly Media,2016

Course Outcomes (CO)

At the end of the course student will be able to

CO1	Apply various DevOps tools including Git, Jenkins, Docker, Ansible during problem solving

Course Code	**:**	**CA7C6**
Course Title	**:**	**MOBILE COMPUTING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	--
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the fundamentals of mobile communication
CLO2	To understand the architecture of various Wireless Communication Networks
CLO3	To understand the significance of different layers in mobile system

Course Content

Introduction to Wireless Networks - Applications - History - Simplified Reference Model - Wireless transmission - Frequencies - Signals - Antennas - Signal propagation - Multiplexing - Modulation - Spread spectrum - Cellular Systems: Frequency Management and Channel Assignment - types of hand-off and their characteristics.

MAC - Motivation - SDMA - FDMA - TDMA - CDMA - Telecommunication Systems – GSM: Architecture Location tracking and call setup - Mobility management - Handover - Security - GSM - SMS - International roaming for GSM - call recording functions - subscriber and service data management - DECT - TETRA - UMTS - IMT-2000.

Wireless LAN - Infrared vs. Radio transmission - Infrastructure - Adhoc Network - IEEE 802.11WLAN Standards - Architecture - Services - HIPERLAN - Bluetooth Architecture & protocols.

Mobile Network Layer - Mobile IP - Dynamic Host Configuration Protocol - Mobile Transport Layer - Traditional TCP - Indirect TCP - Snooping TCP - Mobile TCP - Fast retransmit/Fast recovery - Transmission/Time-out freezing - Selective retransmission - Transaction Oriented TCP.

WAP Model - Mobile Location based services - WAP Gateway - WAP protocols - WAP user agent profile caching model - wireless bearers for WAP - WML - WML Scripts – WTA – iMode – SyncML

References

1.	Jochen Schiller, “Mobile Communication”, Second Edition, Pearson Education, 2008
2.	Theodore, S. Rappaport, “Wireless Communications, Principles, Practice”, Second Edition, PHI, 2010
3.	C. Siva Ram Murthy, B. S. Manoj, “Adhoc Wireless Networks: Architectures and Protocols”, Second Edition, Pearson Education, 2008

4.	Vijay. K. Garg, "Wireless Communication and Networking", First Edition, Morgan Kaufmann Publishers, 2008

Course Outcomes (CO)

At the end of the course student will be able

CO1	Develop a strong grounding in the fundamentals of mobile Networks
CO2	Apply knowledge in MAC, Network, and Transport Layer protocols of Wireless Network
CO3	Comprehend, design, and develop a lightweight network stack

Course Code	**:**	**CA7C7**
Course Title	**:**	**BLOCKCHAIN TECHNOLOGY**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	--
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To decompose a blockchain system's fundamental components, how they fit together and examine a decentralization using blockchain
CLO2	To explain how Cryptocurrency works, from when a transaction is created to when it is considered part of the blockchain
CLO3	To explain the components of Ethereum and programming languages for Ethereum
CLO4	To study the basics Hyperledger and Web3
CLO5	To provide details of alternative blockchain and blockchain projects in different perspective

Course Content

History of Blockchain – Types of Blockchain – Consensus – Decentralization using Blockchain – Blockchain and Full Ecosystem Decentralization – Platforms for Decentralization.

Bitcoin – Digital Keys and Addresses – Transactions – Mining – Bitcoin Networks and Payments – Wallets – Alternative Coins – Theoretical Limitations – Bitcoin limitations – Name coin – Prime coin – Zcash – Smart Contracts – Ricardian Contracts.

The Ethereum Network – Components of Ethereum Ecosystem – Ethereum Programming Languages: Runtime Byte Code, Blocks and Blockchain, Fee Schedule – Supporting Protocols – Solidity Language.

Introduction to Web3 – Contract Deployment – POST Requests – Development Frameworks – Hyperledger as a Protocol – The Reference Architecture – Hyperledger Fabric – Distributed Ledger – Corda.

Kadena – Ripple – Rootstock – Quorum – Tendermint – Scalability – Privacy – Other Challenges – Blockchain Research – Notable Projects – Miscellaneous Tools.

References

1.	Joseph J. Bambara, Paul R. Allen, Block Chain : A Practical Guide To Developing Business, Law And Technology Solutions, McGrawHill, 2020
2.	Andreas Antonopoulos, Satoshi Nakamoto, "Mastering Bitcoin", Second Edition,O'Reilly, 2017
3.	A. Narayanan, J. Bonneau, E. Felten, A. Miller, S. Goldfeder, "Bitcoin and Cryptocurrency Technologies: A Comprehensive Introduction", Illustrated Edition, Princeton University Press, 2016

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the technology components of Blockchain and how it works behind – the scenes
CO2	Be aware of different approaches to developing decentralized applications
CO3	Understand the Bitcoin and its limitations by comparing with other alternative coins
CO4	Establish deep understanding of the Ethereum model, its consensus model and code execution
CO5	Understand the architectural components of a Hyperledger and its development framework
CO6	Aware of the Alternative blockchains and emerging trends in blockchain

Course Code	**:**	**CA7C8**
Course Title	**:**	**BUSINESS ETHICS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA722
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce business ethics and its practices

Course Content

Introduction to Business Ethics, Ethics, Morals and Values, Concepts of Utilitarianism and Universalism – Theory of rights, theory of Justice – Virtue ethics – ethics of care– Law and Ethics – The Nature of Ethics in management – Business Standards and Values – Value Orientation of the Firm.

Environmental Pollution and Society - Marketing Ethics (in Products, Pricing, Promotion and Place) and Consumer protection – Ethics in Human Resources management (Recruitment and promotion policies, Working Conditions, Down Sizing Workforce), Ethical issues at the top management, Ethics in financial markets and investor protection – Ethical responsibility towards competitors and business partners.

A Historical Perspective from Industrial Revolution to Social Activism – Current CSR practices of the firms in India and abroad. Conflicts in decision making from ethical and economic point of view - Ethical Dilemma - Solving ethical dilemma -Managerial integrity and decision making.

Personal Integrity and self-development – wisdom-based leadership - History of Corporate form and models - Corporate Objective and goals, Ownership pattern – Issues in managing public limited firms – Agency problems.

References

1.	M. G. Velasquez, "Business Ethics: Concepts and Cases", 8th Edition, Prentice Hall of India,2017
2.	N. Minow and R. Monks, "Corporate Governance", 5th Edition, Wiley-Blackwell, 2011
3.	E. Banks, "Corporate Governance: Financial Responsibility, Ethics and Controls", Palgrave Macmillan, 2004
4.	Laura P. Hartman & Joe DesJardins, Business Ethics: Decision-Making for Personal Integrity and Social Responsibility, 5th Edition, NY: McGraw-Hill/Irwin, 2020

Course Outcomes (CO)

At the end of the course student will be able

CO1	Define the principles of ethics and morals of business
CO2	Convey ethical response with respect to Competitors & Business Partners
CO3	Enhance the leadership skills with respect to decision making & business management

Course Code	**:**	**CA7D1**
Course Title	**:**	**BIG DATA MANAGEMENT**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	--
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To explore the fundamental concepts of big data analytics
CLO2	To learn to analyze the big data using intelligent techniques
CLO3	To design a complete data analytics solution using big data frameworks

Course Content

Introduction to Big Data: Types of Digital Data - Characteristics of Data – Evolution of Big Data - Definition of Big Data - Challenges with Big Data - Dimensions of Big Data - Types of Big Data Analytics - Big Data Analytics Generic Flow and Big Data Stack.

Hadoop & Spark: Overview of Hadoop Ecosystems - Hadoop Architecture – HDFS - Map Reduce – Spark – Programming Examples.

Mining Data Streams: Stream Data Model – Sampling Data in the Stream – Filtering Streams – Counting Distance Elements in a Stream – Estimating Moments – Counting Ones in Window – Decaying Windows.

Next Generation Databases: CAP Theorem – SQL vs. NOSQL vs NewSQL - Mongo DB – Cassandra -Neo4J.

Big Data Management: Big Data Visualization - Managing and Optimizing the Analytics Value Chain - Selecting the Right Business Processes - Data Governance - Organizational Dynamics - Change Management - Security and Privacy for Big Data Applications - Case Studies.

References

1.	Tom White. Hadoop: The Definitive Guide. O'Reilly Publications. 2015
2.	Kyle Banker. Mongo DB in Action, 2nd Edition, Manning Publications. 2016
3.	Russell Bradberry, Eric Blow. Practical Cassandra A developers Approach, 1st Edition, Pearson Education. 2014
4.	Jure Leskovec, Anand Rajaraman, Jeffrey Ullman. Mining of Massive Datasets, 3rd Edition, Cambridge University Press. 2020

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the fundamentals of various big data analytics techniques
CO2	Design efficient algorithms for mining the data from large volumes
CO3	Analyze the HADOOP and Map Reduce technologies associated with big data analytics
CO4	Build a complete business data analytics solution

Course Code	**:**	**CA7D2**
Course Title	**:**	**GREEN COMPUTING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	--
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To introduce Green Computing in the ICT environments

Course Content

Importance of Green IT, The Growing Significance of Green IT and Green Data Centers, All Basic steps towards Green IT, The Basics of Green IT.

Collaboration is Key for Green IT, The Government's Role, Regulation and EPA Activity, Regulating Greenhouse Gases, Role of EPA, IT Company support of Government Regulation, Educational Institutions and Government Regulation.

Magic of Incentive, The Role of Electric Utilities, A most Significant Step – "Virtualizing IT Systems, Consolidation and Virtualization, Data Storage.

Need for Standard IT Energy-Use Metrics: SPEC – EPA – LEED, Green Grid Data Center Power Efficiency Metrics: PUE and DciE, Data Center: Strategies for Increasing Data Center- Cooling Efficiency, Fuel Cells for Data Center Electricity, Emerging Technologies for Data Centers.

IT Case Studies for Energy Utilities, Green IT Case Studies for Universities and a Large Company, Worldwide Green IT Case Studies, Future of Green IT for Corporations.

References

1.	John Lamb, "The Greening of IT-How Companies Can Make a Difference for the Environment", First Edition, IBM Press 2009
2.	Frederic P. Miller, Agnes F. Vandome, John McBrewster, "Green Computing", Alpha script publishing, 2011

Course Outcomes (CO)

At the end of the course student will be able

CO1	Deduce the need and basics of Green IT
CO2	Compare the collaborative effort of various agencies for the effectiveness of the Green IT
CO3	State the need for virtualization and its impact
CO4	List and categorize various IT energy-use metrics
CO5	Use Green IT in various areas and the future needs and trends

Course Code	**:**	**CA7D3**
Course Title	**:**	**INTERNET OF THINGS**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	--
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the fundamentals of Internet of Things
CLO2	To learn about the basics of IOT protocols
CLO3	To build a small low-cost embedded system using Raspberry Pi
CLO4	To apply the concept of Internet of Things in the real-world scenario

Course Content

Introduction to IoT - Physical and Logical Design- Enabling Technologies - Levels and Deployment Templates - Domain Specific IoTs – IoT system management using NETCONF & YANG - IoT Platforms Design Methodology, IoT Sensors – Temperature, Moisture, Light, Acoustic & Noise, Water level, Presence & Proximity, Motion, Gyroscope, Chemical, Image; IoT actuators.

IoT Architecture: ETSI, IETF, and OGC architectures - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture.

IoT Protocols - Protocol Standardization – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer –LowPAN - CoAP – Security.

Building IoT - RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi-Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms -Arduino.

Case Studies and Real-World Applications – Real-world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools - Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

References

1.	Adrian McEwen and Hakim Cassimally, “Designing the Internet of Things”, First Edition, John Wiley & Sons, 2013
2.	Cuno Pfister, “Getting Started with the Internet of Things: Connecting Sensors and Microcontrollers to the Cloud”, First Edition, Maker Media, 2011

Course Outcomes (CO)

At the end of the course student will be able

CO1	Analyze various protocols for IoT
CO2	Develop web services to access/control IoT devices
CO3	Design a portable IoT using Raspberry Pi
CO4	Deploy an IoT application and connect to the cloud
CO5	Analyze applications of IoT in real time scenario

Course Code	**:**	**CA7D4**
Course Title	**:**	**HUMAN COMPUTER INTERACTION**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA725
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn the fundamentals and components of HCI
CLO2	To understand the user centric parameters associated with HCI
CLO3	To know about various computational models and Formal models of HCI
CLO4	To understand the design requirements of various assistive technologies

Course Content

Introduction to fundamentals of HCI - The Human: I/O Channels – Memory - Reasoning and Problem Solving - The Computer: Devices- Memory - Processing and Networks - Interaction: Models-Frameworks – Ergonomics – Styles – Elements – Interactivity – Paradigms - User centric design - History - Issues and challenges.

User-Centric: An Engineering Perspective - Engineering a Software System – Usability - User Centric Design - Case Studies - User-Centric: A Computational Perspective - A Framework for User-Centric Computing - User-Centric Models - Models for User-Centric Computing – Taxonomy.

Computational Models of Users: Classical Models - The GOMS Models - Models of Specific User Behaviour - The Models and the Computational Framework - Contemporary Interfaces and Interactions: WIMP Interactions - 2D Pointing and Scrolling - Constrained Navigation on Interfaces - Mobile Typing - Touch Interaction - Design Implications and Present State: Design Case Study - Virtual Keyboard - Models for Non-Traditional Interactions - Learning-based Models - Emerging Trend in Interactive Systems.

Formal Models in User-Centric Computing: User-Centric Computing with Matrix Algebra - Use of Formal Models and Issues - Formal Modelling of Dialog - Other Formal Models and Trends - User-Centric Computing for Evaluation: Evaluation with Experts - Evaluation with Users - Model-Based Evaluation - A Framework for Usability Evaluation and Design - User-Centric Computing Beyond GUI: Ubiquitous Systems - Recent Trends: GUI and Beyond - User-Centric Issues and Challenges - Enabling Technologies.

Assistive Technologies – Case Studies – HCI using Mechanical Sensors – Brain Computer Interface and Applications – Gestures recognition – Video based eye tracking – Speech interfaces.

References

1.	Samit Bhattacharya, "Human-Computer Interaction User-Centric Computing for Design", McGraw-Hill Education. 2019
2.	Alan Dix, Janet Finlay, Gregory Abowd& Russell Beale, "Human-Computer Interaction", 3rd Edition, Prentice Hall, 2004
3.	Julie A. Jacko (Ed), "The Human-Computer Interaction Handbook", 3rd edition, CRC Press, 2012
4.	Jonathan Lazar, Jinjuan Heidi Feng, & Harry Hochheiser, "Research Methods in Human Computer Interaction", Wiley, 2010

Course Outcomes (CO)

At the end of the course student will be able

CO1	To understand HCI principles and apply them in product designs
CO2	To develop user-centric applications

Course Code	**:**	**CA7D5**
Course Title	**:**	**MULTI-CORE PROGRAMMING**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA715
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To learn different multi-core programming techniques

Course Content

Multi-core – Definition and hybrid architectures – The software developer's viewpoint – the bus connection – from single core to multi-core – Four effective multi-core designs.

Challenges of multi-core programming – Sequential model – definition – Concurrency – Definition – challenges pertaining to software development – Processor architecture challenges – Operating system's role.

Process – Definition – Process creation – working with process Environment Variables – killing a process – process- resources- synchronous and asynchronous processes – Multithreading – Comparing threads to processes – Architecture of a thread- creation and management of threads – CUDA programming.

Communication and synchronization – synchronizing concurrency – Thread strategy approaches – Decomposition and encapsulation of work- Approaches to application design – PADL and PBS.

UML and concurrent behavior – Basic testing types – Defect removal for parallel programs – Standard software engineering tests

References

1.	M. Herlihy and N. Shavit, "The Art of Multiprocessor Programming",2nd Edition, Morgan Kaufmann,2020
2.	D.B.Kirk and W.W.Hwu, "Programming Massively Parallel Processors: A Hands-on Approach",3rd Edition, Morgan Kaufmann,2016
3.	C.Huges and T.Huges, "Professional Multi-core Programming: Design and Implementation for C++ Developers", First Edition, Wrox, 2008

Course Outcomes (CO)

At the end of the course student will be able

CO1	List the features of multi core systems and assess the challenges of multi core programming
CO2	Apply process techniques
CO3	Identify the approaches to application design
CO4	Describe the communication and fine issues

Course Code	**:**	**CA7D6**
Course Title	**:**	**MEAN Stack Development**
Type of Course	**:**	PC / PE / OE
Prerequisites	**:**	CA735
Contact Hours	**:**	45
Course Assessment Methods	**:**	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the features of MEAN (Mongo, Express, AngularJS, and Node.js) set of technologies
CLO2	To develop robust, fast and maintainable web and mobile applications

Course Content

Modern Web Architecture - Static App - Thick Client - Angular. Js, Node.Js- Express- MongodB- Social Networking Project - Creating A Static Mockup of The Recent Posts Page - Angularizing The Page - Adding New Posts.

Building A Node.Js API - The Stock Endpoint - Creating Posts Via the API - MongoDB Models with Mongoose - Using Mongoose Models with The Post Endpoint - Integrating Node with Angular - $Http - Reading Posts from The Api With $Http - Serving Posts.Html Through Node - Saving Posts to The API With $Http - Fixing the Post Ordering - Cleaning Up Server.Js - Cleaning Up Angular.

Grunt and Gulp - Gulp Hello World - Building JavaScript with Gulp – Building CSS With Gulp - Gulp Dev Task - Other Gulp Plug-Ins - Building Authentication in Node.Js - Introducing Token Authentication – JSON-Web Token (Jwt) - Using BCrypt – Authentication with MongodB.

Adding Routing and Client Authentication - Web Sockets - Pushing Notifications with WebSocket – Web Sockets in Angular.Js – Architecture Testing - Protractor - Mocha for Node – Post Controller – Base Router – Testing Controllers – npm test – JSHint.

Karma – Bower – Heroku –Working of Heroku – MongoDB and Redis on Heroku – Single Server vs Multiserver – Fedora 2.0 – Multiserver migration.

References

1.	Jeff Dickey, “Write Modern Web Apps with the MEAN Stack: Mongo, Express, AngularJS, and Node.js”, First Edition, Peachpit Press, 2015
2.	Brad Dayley, Brendan Dayley, “Node.js, MongoDB and Angular Web Development”, 2nd Edition, Addison Wesley, 2017
3.	Amos Q. Haviv, Adrian Mejia,”Web Application Development with MEAN “, First Edition, Packt Publishing, 2016
4.	Nicholas McClay. MEAN Cookbook: The Meanest Set of MEAN Stack Solutions Around, First Edition, Packt Publishing Limited. 2017
5.	Chris Sevilleja, Holly Lloyd. MEAN Machine: A beginner’s practical guide to the JavaScript stack, First Edition,Leanpub Publishing Limited,2016

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the principles of MEAN Stack Web development and practice them in product design and development

Course Code	:	**CA7D7**
Course Title	:	**COMPUTER VISION**
Type of Course	:	PC / PE / OE
Prerequisites	:	CA713
Contact Hours	:	45
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To understand the fundamental concepts related to image processing, feature extraction, pattern analysis etc
CLO2	To apply the concepts to solve computer vision problems of different fields

Course Content

Fundamentals of Image Formation, Transformation, Image Transforms: DFT-DCT-WHT-Applications: filtering-compression, Image Enhancement-Histogram Processing.

Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH.

Image Segmentation: Graph-Cut, Mean-Shift, Texture Segmentation; Object detection: traditional methods-deep learning methods.

Motion analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.

Object tracking, Mean shift tacking, Object categorization, content based image retrieval, action recognition.

References

1.	Richard Szeliski, Computer Vision: Algorithms and Applications, 2nd Edition, Springer-Verlag London Limited 2022
2.	D. A. Forsyth, J. Ponce, Computer Vision: A Modern Approach, 2nd Edition, Pearson Education, 2011
3.	Mohamed Elgendy, Deep Leaning for Vision Systems, Manning Publications, 2020

Course Outcomes (CO)

At the end of the course student will be able

CO1	Apply fundamental algorithms in Image Processing and analyse their applicability for real time problems

Course Code	:	**CA7D8**
Course Title	:	**BUSINESS INTELLIGENCE**
Type of Course	:	PC / PE / OE
Prerequisites	:	CA707
Contact Hours	:	45
Course Assessment Methods	:	Continuous Assessment, End Assessment

Course Learning Objectives (CLO)

CLO1	To Know the process of Decision making and Evolution of BI from Decision Support System
CLO2	Be exposed with the basic rudiments of business intelligence system
CLO3	To understand the modeling aspects behind Business Intelligence
CLO4	To understand the business intelligence life cycle and the techniques used in it

Course Content

Foundations and Technologies for Decision Making - Decision Making: Introduction and Definitions; Phases of Decision-Making Process: Intelligence, Design, Choice and Implementation – DSS: Characteristics and Capabilities – DSS Classifications - Components of DSS.

Business Intelligence: Information support for Decision Making – Decision Support System - Introduction to Business Intelligence BI concept, BI architecture, BI in today's perspective, BI Process, Applications of BI like Financial analysis, statistical analysis, sales analysis, CRM, result pattern and ranking analysis, Balanced Scorecard, BI in Decision Modelling: Optimization, Decision making under uncertainty. Ethics and business intelligence.

Knowledge Delivery: Business intelligence user types, Standard reports, Interactive Analysis and Ad Hoc Querying, Parameterized Reports and Self-Service Reporting, dimensional analysis, Alerts/Notifications, Visualization: Charts, Graphs, Widgets, Scorecards and Dashboards, Geographic Visualization, Integrated Analytics, Considerations: Optimizing the Presentation for the Right Message.

Data Visualization and Dashboard Design: Importance of data visualization and different types of data that can be visually represented - characteristics of a dashboard, the types of dashboards, and the list attributes of metrics usually included in dashboards - guidelines for designing dashboard and the common pitfalls of dashboard design.

Applications and Future of BI: Marketing models – Logistic and Production models – Case studies.; Future of business intelligence – Emerging Technologies: Machine Learning, Predicting the Future with Data Analysis, BI Search & Text Analytics – Advanced Visualization – Rich Report, Future beyond Technology.

References

1.	Efraim Turban, Ramesh Sharda, Dursun Delen, "Decision Support and Business Intelligence Systems", 10th Edition, Pearson 2015
2.	Larissa T. Moss, S. Atre, "Business Intelligence Roadmap: The Complete Project Lifecycle for Decision Support Applications", First Edition, Addison Wesley, 2003
3.	Carlo Vercellis, "Business Intelligence: Data Mining and Optimization for Decision Making", First Edition,Wiley Publications, 2011
4.	David Loshin, "Business Intelligence: The Savvy Manager‟s Guide", Second Edition, Morgan Kaufman Publishers, 2012
5.	Cindi Howson, "Successful Business Intelligence: Secrets to Making BI a Killer App", First Edition, McGraw-Hill, 2008

Course Outcomes (CO)

At the end of the course student will be able

CO1	Understand the concepts and techniques of business intelligence
CO2	Link data mining with business intelligence
CO3	Apply various modelling techniques
CO4	Understand data analysis and knowledge delivery stages
CO5	Apply business intelligence methods to various situations