SHREE CHANAKYA EDUCATION SOCIETY'S

INDIRA COLLEGE OF ENGINEERING AND MANAGEMENT

Approved by AICTE New Delhi, DTE (MS) and Affiliated to Pune University (Id-No.PU/PN/Engg/282/2007)
(An Autonomous Institute Affiliated to Savitribai Phule Pune University Pune)
NAAC Accredited

F.Y. M. Tech (Computer Engineering)
Academic Year – 2024-2025*(As per National Education Policy 2020)*

Semester- I Structure

Course Code	Name of Course	Teaching Scheme				Total Credits	Evaluation Scheme					
							Theory			Lab		Total Marks
		Theory	Tutorial	Lab	Total		TAE	CAE	ESE	INT	EXT	
24PCE101	Analysis of Algorithm	03	-	-	03	03	25	25	50	-	-	100
24PCE102	Block Chain Technology and Applications	03	-	-	03	03	25	25	50	-	-	100
24PCE103	Business Intelligence	03	-	-	03	03	25	25	50	-	-	100
24PCE104-X	Elective -I	03	-	-	03	03	25	25	50	-	-	100
24PCE105	Research Methodology	02	02	-	04	04	-	-	50	-	-	50
24PCE106	Laboratory Practice-I	-	-	08	08	04	25	-	-	-	25	50
	Total	**14**	**02**	**08**	**24**	**20**	**125**	**100**	**250**	**-**	**25**	**500**

Elective -I	
Course Code	**Name of Course**
24PCE104-A	Optimization Techniques in Problem Solving
24PCE104-B	Big Data Analytics
24PCE104-C	Digital Forensics

Dr. Soumitra Das
HOD Comp

Dr. Saurabh Gupta
Dean Academics

Dr. Nilesh Uke
Director

SHREE CHANAKYA EDUCATION SOCIETY'S

INDIRA COLLEGE OF ENGINEERING AND MANAGEMENT

Approved by AICTE New Delhi, DTE (MS) and Affiliated to Pune University (Id-No.PU/PN/Engg/282/2007)
(An Autonomous Institute Affiliated to Savitribai Phule Pune University Pune)
NAAC Accredited

F.Y. M. Tech (Computer Engineering)

Academic Year – 2024-2025*(As per National Education Policy 2020)*

Semester- II Structure

Course Code	Name of Course	Teaching Scheme				Total Credits	Evaluation Scheme					
							Theory			Lab		
		Theory	Tutorial	Lab	Total		TAE	CAE	ESE	INT	EXT	Total Marks
24PCE201	Advance Computer Architecture	03	-	-	03	03	25	25	50	-	-	100
24PCE202	Data Science	03	-	-	03	03	25	25	50	-	-	100
24PCE203-X	Elective -II	03	01	-	04	04	25	25	50	-	-	100
24PCE204	Laboratory Practice-II	-	-	08	08	04	25	-	-	-	25	50
24PCE205	Indian Knowledge Systems (IKS)	-	-	04	04	02	25	-	-	25	-	50
24PCE206	On Job Training (OJT) / SWAYAM	-	-	08	08	04	50	-	-	50	-	100
	Total	**09**	**01**	**20**	**30**	**20**	**175**	**75**	**150**	**75**	**25**	**500**

Elective -II	
Course Code	**Name of Course**
24PCE203-A	Wireless Sensor Networks
24PCE203-B	Generative Artificial Intelligence
24PCE203-C	Parallel Computing

Dr. Soumitra Das
HOD Comp

Dr. Saurabh Gupta
Dean Academics

Dr. Nilesh Uke
Director

INDIRA COLLEGE OF ENGINEERING & MANAGEMENT
Office
DTE Code 6179
Pune-410506

SHREE CHANAKYA EDUCATION SOCIETY'S

INDIRA COLLEGE OF ENGINEERING AND MANAGEMENT

Approved by AICTE New Delhi, DTE (MS) and Affiliated to Pune University (Id-No.PU/PN/Engg/282/2007)
(An Autonomous Institute Affiliated to Savitribai Phule Pune University Pune)
NAAC Accredited

S.Y. M. Tech (Computer Engineering)
Academic Year – 2024-2025*(As per National Education Policy 2020)*

Semester- III Structure

Course Code	Name of Course	Teaching Scheme				Total Credits	Evaluation Scheme					
							Theory			Lab		
		Theory	Tutorial	Lab	Total		TAE	CAE	ESE	INT	EXT	Total Marks
24PCE301	Seminar-I	-	-	04	04	02	25	-	-	50	-	75
24PCE302	Research Paper Publication-I	-	-	04	04	02	25	-	-	50	-	75
24PCE303	Research Project Stage-I (Dissertation)	-	-	32	32	16	25	-	-	50	25	100
	Total	**-**	**-**	**40**	**40**	**20**	**75**	**-**	**-**	**150**	**25**	**250**

Semester- IV Structure

Course Code	Name of Course	Teaching Scheme				Total Credits	Evaluation Scheme					
							Theory			Lab		
		Theory	Tutorial	Lab	Total		TAE	CAE	ESE	INT	EXT	Total Marks
24PCE401	Research Paper Publication-II	-	-	04	04	02	25	-	-	25	-	50
24PCE402	Research Project Stage-II (Dissertation)	-	-	36	36	18	50	-	-	75	75	200
	Total	**-**	**-**	**40**	**40**	**20**	**75**	**-**	**-**	**100**	**75**	**250**

Dr. Soumitra Das
HOD Comp

Dr. Saurabh Gupta
Dean Academics

Dr. Nilesh Uke
Director

INDIRA COLLEGE OF ENGINEERING & MANAGEMENT Office DTE Code 6179 Pune-410506

[24PCE101]: Analysis of Algorithm

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	03	Teachers Assessment Examination (TAE):	25
		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: Proficiency in any programming language, Understanding of data structures, Knowledge of basic discrete mathematics			

Course Objectives

1 Demonstrate a familiarity with major algorithm design techniques.
2 Apply important algorithmic design paradigms and methods of analysis.
3 Solve simple to moderately difficult algorithmic problems arising in applications.

Course Outcomes

CO1 Understand and analyze fundamental algorithms that operate on common data structures
CO2 Apply concepts of searching and sorting & its mathematical problems
CO3 Understand and apply Dynamic programming techniques to solve the complex problems on graph theory
CO4 Understand randomized and approximation algorithms with practical examples.
CO5 Demonstrate the importance and use of Parallel and Distributed Algorithms using suitable examples
CO6 Apply Linear Programming technique on various complex algorithms

Unit 1: Analysis of Algorithms	
Review of algorithmic strategies, Asymptotic analysis: upper and lower complexity bounds. Identifying differences among best, average and worst Case Behaviours. Big O, little O, omega and theta notations, Standard complexity classes. Empirical measurements of performance. Time and space trade-offs in algorithms. Analysing recursive algorithms using recurrence relations.	8 Hours
Unit 2: Divide & Conquer and Greedy Algorithms	
Numerical algorithms, Sequential and binary search algorithms. Quadratic sorting algorithms and O (n log n) sorting algorithms. Algorithms on graphs and their complexities using Greedy Approach for - Prim's and Krushkal's Algorithm for minimum spanning tree, Single source shortest path Algorithm, all pair shortest paths in Graph	8 Hours
Unit 3: Dynamic programming	
Dynamic programming: Control abstraction for dynamic programming, elements of dynamic programming, use of dynamic programming method to solve the problems: chain matrix multiplication, longest common subsequence**,** 0/1 Knapsack problem, Travelling Salesman problem	8 Hours

Unit 4: Randomized and Approximation Algorithms	
Randomized Algorithms: Reasons for using randomized algorithms, Examples: Randomized Qsort, min-cut problems. Introduction to approximation algorithms, Examples: TSP, 3-coloring problem.	8 Hours
Unit 5: Parallel and Distributed Algorithms	
Parallel and Distributed Algorithms: Parallel loops, Race conditions, Problem Solving using Multithreaded Algorithms, Multithreaded matrix multiplication, Multithreaded merge sort. Distributed Algorithms: Introduction, distributed breadth first search, Distributed Minimum Spanning Tree. String Matching: Introduction, The Naïve string-matching algorithm, the Rabin-Karp algorithm.	8 Hours
Unit 6: Linear Programming	
Standard and Slack forms, formulation of problems as linear programs, simplex algorithm, duality, initial basic feasible solution. Problem formulation for – single source shortest path, maximum flow problem, Vertex cover problem, Knapsack problem.	8 Hours

Learning Resources:

1 Introduction to Algorithms" by Cormen, Leiserson, Rivest, Stein.
2 Computer Algorithms" by Horowitz and Sahani, Computer Science Press, New York, ISBN: 0-7167-8316-9
3 Design and Analysis of Algorithms" by Parag & Himanshu Dave, Pearson Education Press, ISBN 81-775-8595-9
4 The Design and Analysis of Computer Algorithms" by Aho, Hopcroft, Ullman.
5 Algorithm Design" by Kleinberg and Tardos.
6 Fundamentals of Algorithmics" by Gilles Brassard and Paul Bratley.
7 Rajeev Motwani and Prabhakar Raghavan, "Randomized Algorithms," Cambridge University Press, ISBN: 978-0-521-61390-3, 1st edition, 2004.
8 Michael T. Goodrich, Roberto Tamassia, "Algorithm Design: Foundations, Analysis and Internet Examples," Wiley, ISBN 978-81-265-0986-7, 1st edition 2006.
9 Dan Gusfield, "Algorithms on Strings, Trees and Sequences," Cambridge University Press, ISBN:0- 521-67035-7,1st edition 1997.
10 Horowitz and Sahani, "Fundamentals of Computer Algorithms," University Press, ISBN: 978 817371 6126, 81 7371 61262, 2nd edition 2008.
11 Online: Coursera- Analysis of Algorithms
12 Online: Stanford.edu- CS 161 - Design and Analysis of Algorithms
13 Swayam: Design and Analysis of algorithms

[24PCE102]: Block Chain Technology and Applications

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	03	Teachers Assessment Examination (TAE):	25
		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: A foundational understanding of computer science concepts, programming skills (preferably in Python or JavaScript), and basic knowledge of cryptography and distributed systems.			

Course Objectives

1 To learn basic knowledge and understandings of Blockchain
2 Learn about the mechanisms of Ethereum and Hyperledger
3 To learn privacy and security issues of block chain

Course Outcomes

CO1 Use blockchain in application development
CO2 Understand the Byzantine model of fault tolerance
CO3 Use blockchain scripting language
CO4 Apply Ethereum and its Smart Contracts in application development
CO5 Understand the next generation of Ethereum platform
CO6 Analyse privacy and security issues.

Unit 1: Basic Foundation of Crypto Primitives	
Cryptography : Need Of Cryptography, Symmetric and Asymmetric Key Cryptography, Cryptography Hash Function, Collison Resistant Hash ,digital Signature algorithm, Puzzle friendly hash, SHA-256 ,ECC.	8 Hours
Unit 2: Introduction to Blockchain	
Blockchain technology: An introduction to blockchain technology, its importance, Needs, Features of Blockchain, Architecture of Blockchain, Blockchain Layer Model, Blockchain platforms and ecosystems Types of Blockchain Platforms. Future trends and challenges	8 Hours
Unit 3: Consensus problem in Blockchain	
Asynchronous Byzantine Agreement - AAP protocol and its analysis , Byzantine models of Fault Tolerance, Nakamoto Consensus on permission-less, nameless, peer-to-peer network , Abstract Models for BLOCKCHAIN - GARAY model ,RLA Model - Proof of Work (PoW) as random oracle - formal treatment of consistency, liveness and fairness - Proof of Stake (PoS) based Chains - Hybrid models (PoW + PoS).	8 Hours

Unit4: Ethereum Platform in Blockchain	
Ethereum as a Next-Gen Block chain, Design Philosophy of Ethereum, Enter the Ethereum Blockchain, Ethereum Accounts, Trie Usage, Merkle Patricia Tree, RLP Encoding, Ethereum Transaction and Message Structure, Ethereum State Transaction Function, Gas and Transaction Cost Ethereum	8 Hours
Unit 5: Smart Contract and Dapps	
Ethereum and Smart Contracts, Contract Creation, Ethereum Virtual Machine and Code Execution, Ethereum Ecosystem, Swarm, Whisper, DApp, Development Components, Byzantine Generals' Problem, Zero-Sum Games, Why to Study Game Theory.	8 Hours
Unit 6: Use cases and Security Issues in Blockchain	
Zeash and Zk-SNARKS for anomity Preservation Prominent Blockchain Applications, Government Sector, Retail, Banking and Financial Services, Smart Card, Healthcare, IOT, Blockchain Integration with other Domains.	8 Hours

Learning Resources:

1 Imran Bashir "Mastering in Blockchain Fourth Edition" 2018
2 D. Welsh, Codes and Cryptography. Clarendon Press, Oxford, 1988
3 Blockchain Revolution by Don and Alex Tapscott
4 "Blockchain Bubble or Revolution" by Aditya Agashe, Neel Mehta, and Parth Detroja
5 https://github.com/topics/ethereum-dapp
6 https://www.blockchain-council.org/e-books

[24PCE103]: Business Intelligence

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	03	Teachers Assessment Examination (TAE):	25
		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: A basic understanding of data analysis, statistics, and proficiency in using spreadsheet software, along with familiarity with database concepts and SQL.			

Course Objectives

1. Equip students with skills to analyze and interpret data for informed decision-making using BI techniques.
2. Learn to apply mathematical models, data mining, and analytical techniques to real-world business challenges
3. Understand and implement knowledge management systems and OLAP technologies to optimize business processes and decision-making

Course Outcomes

CO1 Understand the concept of Business Intelligence & Decision support system
CO2 Apply mathematical models for decision making
CO3 Perform clustering & Classification
CO4 Understand the concept of Artificial Intelligence
CO5 Understand knowledge management
CO6 Understand and use OLAP

Unit 1: Introduction to Business Intelligence & Decision Support System	
Business intelligence: Effective and timely decisions, Data, information and knowledge, The role of mathematical models, Business intelligence architectures, Ethics and business intelligence **Decision support systems:** Definition of system, Representation of the decision-making process, Evolution of information systems, Definition of decision support system, Development of a decision support system	8 Hours
Unit 2: Data mining & Data Preparation	
Mathematical models for decision making: Structure of mathematical models, Development of a model, Classes of models **Data mining:** Definition of data mining, Representation of input data, Data mining process, Analysis methodologies **Data preparation:** Data validation, Data transformation, Data reduction	8 Hours
Unit 3: Classification & Clustering	
Classification: Classification problems, Evaluation of classification models, Bayesian methods, Logistic regression, Neural networks, Support vector machines. **Clustering:** Clustering methods, Partition methods, Hierarchical methods, Evaluation of clustering models	8 Hours

Unit4: Business intelligence applications	
Marketing models: Relational marketing, Sales force management **Logistic and production models:** Supply chain optimization, Optimization models for logistics planning, Revenue management systems. **Data envelopment analysis:** Efficiency measures, Efficient frontier, The CCR model, Identification of good operating practices	8 Hours
Unit 5: Knowledge Management	
Knowledge Management: Introduction to Knowledge Management, Organizational Learning and Transformation, Knowledge Management Activities, Approaches to Knowledge Management, Information Technology in Knowledge Management, Knowledge Management Systems Implementation, Roles of People in Knowledge Management. **Artificial Intelligence and Expert Systems:** Concepts and Definitions of Artificial Intelligence, Artificial Intelligence Versus Natural Intelligence, Basic Concepts of Expert Systems, Applications of Expert Systems, Structure of Expert Systems, Knowledge Engineering, Development of Expert System	8 Hours
Unit 6: On-Line Analytical Processing (OLAP)	
OLAP, OLTP, Operational Data Stores, Variations in Data and Approach, OLAP Applications and Functionality, Multi-Dimensions, OLAP Architecture, Cubism, Tools, ROLAP, MOLAP, HOLAP	8 Hours

Learning Resources:

1 Business Intelligence: Data Mining and Optimization for Decision Making by Carlo Vercellis, Wiley publisher
2 Decision support and Business Intelligence Systems by Efraim Turban, Ramesh Sharda, Dursun Delen, Pearson publisher
3 Fundamental of Business Intelligence by Grossmann W, Rinderle-Ma, Springer

[24PCE104-A]: Elective-I Optimization Techniques in Problem Solving

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	03	Teachers Assessment Examination (TAE):	25
		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: Database Management system , Design and Analysis of Algorithms			

Course Objectives

1. Develop an understanding of various optimization techniques and their applications in solving complex real-world problems.
2. Enhance problem-solving skills by applying mathematical models and algorithms to optimize decision-making processes.
3. Foster the ability to analyze and interpret optimization results to inform strategic business and operational decisions.

Course Outcomes

CO1 Understand importance of optimization of industrial process management
CO2 Apply basic concepts of mathematics to formulate an optimization problem using Linear programming
CO3 Learn efficient computational procedures to solve optimization problems using Non Linear Programming
CO4 Formulation simplex methods variable with upper bounds
CO5 Understand the maximization and minimization of convex functions
CO6 Understand Neural network based optimization techniques

Unit 1: Introduction	
Introduction: Engineering application of optimization, statement of an optimization problem with example for minimum weight and optimum cost consideration, classification of optimization problems and techniques, Single variable, multi-variable with equality and inequality constraints and without constraints.	8 Hours
Unit 2: Linear Programming	
Introduction, basic terminology Techniques of linear programming: Simplex method, Revised simplex method: Dual Simplex Method, decomposition principle, post-optimality analysis.	8 Hours
Unit 3: Non Linear Programming	
Introduction, elimination methods: various search methods Fibonacci method and golden section method Interpolation Method-Quadratic and cubic interpolation methods, KKT conditions, Direct root method.	8 Hours

Unit4: Unconstrained optimization Techniques	
Introduction; Standard form of the problem and basic terminology; Direct search method- Simplex method, Random search method, Univariate and pattern search method Indirect search method- Steepest Descent (Cauchy) method, Conjugate gradient method, Newton's method, Application to engineering problems.	8 Hours
Unit 5: Constrained Optimization Introduction	
Standard form of the problem and basic terminology; Direct method: Sequential Linear Programming; Generalized Reduced gradient method, Methods of feasible direction Indirect method: Penalty functionmethod Interior and exterior penalty function method, Convex programming problem, Check for convergence Application to engineering problems.	8 Hours
Unit 6: Introduction to non-traditional methods	
Genetic Algorithm: Introduction, Representation of design variables, objective function and constraints, Genetic operators and numerical results. Introduction to Neural network based optimization.	8 Hours

Learning Resources:	
1	S. S. Rao, Engineering Optimisation- Theory and Practice, New Age International.
2	Deb K., Optimisation for Engineering Design-Algorithms and Example, Prentice Hall.
3	U.Kirsch, Optimum structural design, McGrawHill, New York.
4	Gallagher and O.C Zeinkiewicz, Optimum Structural Design Theory & Applications, John Wiley.
5	D. Bertsekas Nonlinear programming, 2nd Edition, Athena Scientific, 1999, Nashua.
6	R. K. Sundaram, A first course in optimization theory, 1996, Cambridge University Press, Cambridge

[24PCE104-B]: Elective-I Big Data Analytics

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	03	Teachers Assessment Examination (TAE):	25
		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: A fundamental knowledge of statistics, programming (preferably in Python or R), and familiarity with databases and data manipulation techniques.			

Course Objectives

1 To be acquainted with the fundamental concepts of big data and analytics
2 To describe various tools andpractices for working with big data
3 To explore various big data visualization tools
4 To be aware of statistical and data analytics methods

Course Outcomes

CO1 Explain the fundamental concepts of big data
CO2 Summarize the fundamental concepts of data analytics.
CO3 Implement and manage Hadoop and its ecosystem components
CO4 Discuss the working of Hadoop and its ecosystem
CO5 Selecting appropriate data visualization tools for big data visualization
CO6 Apply Advanced Analytics and Statistical Modeling for Big Data.

Unit 1: Introduction To Big Data	
Evolution of Big data – Best Practices for Big data Analytics – Big data characteristics – Validating – The Promotion of the Value of Big Data – Big Data Use Cases- Characteristics of Big Data Applications – Perception and Quantification of Value -Understanding Big Data Storage – A General Overview of High-Performance Architecture – HDFS – MapReduce and YARN – Map Reduce Programming Model	8 Hours
Unit 2: Overview of Data Analytics Lifecycle	
Phases of a typical analytics lifecycle – discovery, data preparation, model planning, model building, communicating results and findings, and operationalizing. Data Analytic Life Cycle: Overview, phase1- Discovery, Phase 2- Data preparation, Phase 3- Model Planning, Phase 4- Model Building, Phase 5- Communicate Results, Phase 6- Operationalize	8 Hours
Unit 3: Technologies for Handling Big Data	
Big Data is primarily characterized by Hadoop. This module cover topics such as Introduction to Hadoop, functioning of Hadoop, Cloud computing (features, advantages, applications) etc, Hadoop and its ecosystem which includes HDFS, MapReduce, YARN	8 Hours

Unit4: Hadoop Ecosystems	
HBase, Hive, Pig, Sqoop, Zookeeper, Flume, Oozie etc., framework of Map Reduce and uses ofmap reduce.	8 Hours
Unit 5: Big Data Visualization	
Why Visualize Data? Importance of data visualization, Examples of data visualization, Inpu for Visualization: Data and Tasks, Common Visualization Idioms Bar Chart, Vertical & Horizontal Pie Chart and Coxcomb Plot, Line Chart, Area Char, Encoding Data using Color Encoding Data using Size, Stacked & Grouped Bar Chart, Stacked Area Chart & Streamgraph Line Chart with Multiple Lines, Data Reduction : Histograms, Aggregating Data with Group By, Hexbin Mapping Cross- filtering	8 Hours
Unit 6: Advanced Analytics and Statistical Modelling for Big Data	
Naïve Bayesian Classifier, categorization using K-means clustering and association rules, predictive modelling using decision trees, linear and logistic regression, and time-series analysis, and text analysis.	8 Hours

Learning Resources:	
1	David Dietrich, Barry Hiller, “Data Science and Big Data Analytics”, EMC education services, Wiley publications, 2012, ISBN0-07-120413-X
2	Chris Eaton, Dirk deroos et al., “Understanding Big data”, McGraw Hill, 2012.
3	Visualization Analysis & Design by Tamara Munzner (2014) (Links to an external site.) Links to an External site. (ISBN 9781466508910)
4	Maheshwari Anil, Rakshit, Acharya, “Data Analytics”, McGraw Hill, ISBN: 789353160258.
5	Luís Torgo, “Data Mining with R, Learning with Case Studies”, CRC Press, Talay and Francis Group, ISBN9781482234893
6	Vignesh Prajapati, “Big Data Analytics with R and Haoop”, Packet Publishing 2013.
7	EMC2 Education Services,”Data Science and Big Data Analytics”, Wiley Publications

[24PCE104-C]: Elective-I Digital Forensics

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	03	Teachers Assessment Examination (TAE):	25
		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: A basic understanding of computer systems, networking concepts, and familiarity with operating systems and file structures.			

Course Objectives

1. To focus on the procedures for identification, preservation, and extraction of electronic evidence, auditing and investigation of network and host system intrusions, analysis and documentation of information gathered, and preparation of expert testimonial evidence
2. To provide hands on experience on various forensic tools and resources for system administrators and information system security officers.
3. Equip students with the skills to systematically investigate digital incidents, collect and analyze evidence, and apply forensic techniques to ensure data integrity and legal compliance.

Course Outcomes

CO1 To classify various cybercrimes, its prevention methods and understand the phases of Digital forensic investigation using different forensic tools.
CO2 To develop a strong familiarity with Windows evidence including file systems, operating systems, user, and application artefacts.
CO3 To perform forensic analysis in Linux/ MAC operating system environments
CO4 To perform forensic analysis of multimedia files.
CO5 To apply the knowledge of IDS to secure network and performing router and network analysis.
CO6 To conduct a digital forensics investigation of mobile devices and perform recovery of digital evidence using variety of software utilities.

Unit 1: Introduction to Digital Forensics	
Introduction, Classification of Digital Crimes. Forensics Investigation Process- Pre-search consideration, Collection of Evidences from crime scene, Acquisition, Duplication & Preservation of evidences, Examination and Analysis of evidences, Storing of Evidences, Documentation and Reporting, Maintaining the Chain of Custody. Hashing and its importance. Understanding Storage Formats for Digital Evidences – Raw Format, Proprietary Formats, Advanced Forensic Formats. Data Acquisition of live system, Shutdown Systems and Remote systems. Digital Forensics Standard Operating Procedures. Software and Hardware Tools used in Forensic Analysis – Open Source and Proprietary tools. Challenges and issues in Cyber-crime investigation and Digital forensics	8 Hours

Unit 2: Windows Forensics	
Windows Systems Artifacts: File Systems, Registry, Event logs, Shortcut files, Executables. Alternate Data Streams (ADS), Hidden files, Slack Space, Disk Encryption, Windows registry, startup tasks. Forensic Analysis of the Registry – Use of registry viewers, Regedit. Extracting USB related artifacts and examination of protected storages. Email investigations. Data recovery – Tools and techniques. Malware Analysis.	8 Hours
Unit 3: Linux and MAC Forensics	
Linux system and Artifacts – Use of built-in command line tools for forensic investigation – dd, dcfldd, fdisk, mkfs, mount, unmount, md5sum, sha1sum, dmseg; Ownership and Permissions, Hidden files, User Accounts and Logs. Mounting of hard disk having forensic image, Use of "FIND" command for searching and timeline analysis of files. Mac OS system and Artifacts -System startup and services, Hidden directories, System Logs and user Artifacts	8 Hours
Unit4: Image Analysis	
Formation of Image, Image Sampling and Quantization, Basics of Full-color Image Processing, Image Enhancement Techniques, Filters for Image Enhancement, JPEG, PNG, Header Data Analysis, Noise Analysis, Linkage of Camera. Image Steganography, Image Forgery Detection, Detect Steganography from Image, Digital Watermark, Forensic Analysis of Multimedia Files. Video Analysis Forensic Video Analysis, Enhancement Techniques, Specific Frame Analysis.	8 Hours
Unit 5: Network Forensics	
Intrusion detection; Different Attacks in network, analysis Collecting Network Based Evidence - Investigating Routers - Network Protocols -Email Tracing- Internet Fraud.	8 Hours
Unit 6:Mobile Forensics	
Advantage and Disadvantages of Mobile Phones and their Forensic Applications. Operating Systems: Introduction, Objective and Types of Operating System- Java, Symbian, Window, Android and iPhone. Evidence Collection from Mobile Phones and SIM Cards. Recovering and Reconstructing of Deleted Data (call records, phone books, massages, multimedia files i.e. image, video etc.) from Mobile Phones and SIM Cards. Process of Cloning of SIM Data and Password Extraction from Mobile Phones.	8 Hours

Learning Resources:

1 Bill Nelson, Amelia Philips and Christopher Steuart, "Guide to computer forensics investigation", Course technology, 6th edition

2 Kevin Mandia, Chris Prosise, "Incident Response and computer forensics", Tata McGrawHill,2006

3 John Sammons; "The basics of Digital Forensics: The Primer for getting started in Digital Forensics", Elsevier, Syngress, 2014.

4 Eoghan Casey, "Handbook Computer Crime Investigation's Forensic Tools and Technology", Academic Press, 2009.

5 Anthony T.S. Ho and Shujun Li, "Handbook of digital forensics of multimedia data and devices" Wiley Publications 2015

[24PCE105]: Research Methodology

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 2 Hours/Week	04	End Semester Examination (ESE):	50
Tutorial: 2 Hours/Week			
		Total	**50**
Course Prerequisites: Foundational knowledge in statistics and data analysis, Proficiency in academic writing and citation styles, Awareness of research ethics and integrity			

Course Objectives

1. To understand Research and Research Process
2. To acquaint students with identifying problems for research and develop research strategies
3. To familiarize students with the techniques of data collection, analysis of data and interpretation
4. To understand and apply different techniques for formulating research problem

Course Outcomes

CO1 Understand basics of research concepts including objectives, issues and problems
CO2 Summarize and compare different types of research
CO3 Prepare a preliminary research design for projects in their subject matter areas
CO4 Accurately collect, analyze and report data
CO5 Present complex data or situations clearly and formulate research problem
CO6 Review and analyze research findings

Unit 1: Introduction and Basic Research Concepts	
Research – Definition; Concept of Construct, Postulate, Proposition, Thesis, Hypothesis, Law, Principle. Research methods vs Methodology, Need of Research in Business and Social Sciences, Objectives of Research, Issues and Problems in Research, Characteristics of Research: Systematic, Valid, Verifiable, Empirical and Critical	8 Hours
Unit 2: Types of Research	
Basic Research, Applied Research, Descriptive Research, Analytical Research, Empirical Research, Qualitative and Quantitative Approaches	8 Hours
Unit 3: Research Design and Sample Design	
Research Design – Meaning, Types and Significance, Sample Design – Meaning and Significance Essentials of a good sampling, Stages in Sample Design Sampling methods/techniques Sampling Errors	8 Hours
Unit4: Research Methodology	
Meaning of Research Methodology, Stages in Scientific Research Process: Identification and Selection of Research Problem, Formulation of Research Problem, Review of Literature, Formulation of Hypothesis, Formulation of research Design, Sample Design, Data Collection, Data Analysis, Hypothesis testing and Interpretation of Data, Preparation of	8 Hours

Research Report	
Unit 5: Formulating Research Problem	
Considerations: Relevance, Interest, Data Availability, Choice of data, Analysis of data, Generalization and Interpretation of analysis.	8 Hours
Unit 6: Outcome of Research	
Preparation of the report on conclusion reached, Validity Testing & Ethical Issues, Suggestions and Recommendation	8 Hours

Learning Resources:

1 Dawson, Catherine, 2002, "Practical Research Methods", New Delhi, UBS Publishers Distributors
2 Kothari, C.R.,1990, "Research Methodology-Methods and Techniques", New Delhi, Wiley Eastern Limited
3 Kumar, Ranjit, 2005, "Research Methodology-A Step-by-Step Guide for Beginners", (2nded), Singapore, Pearson Education
4 Best and Kahn, "Research Methodology", PHI Limited
5 Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. "An introduction to Research Methodology", RBSA Publishers
6 Sinha, S.C. and Dhiman, A.K., 2002. "Research Methodology", Ess Ess Publications. 2 volumes
7 **Swayam:** Research Methodology

[24PCE106]: Laboratory Practice-I

Teaching Scheme	Credit	Examination Scheme	Marks
Practical:8 Hours/Week	04	Teachers Assessment Examination (TAE):	25
		External Oral Exam:	25
		Total	**50**
Course Prerequisites: All Major Core (MJ), All Major Elective(MJE)			

Laboratory Practice-I (LP-I) is companion course of theory courses (core and elective) in Semester I. It is recommended that set of assignments or case studies per course is to be completed. Set of problem statements are suggested. Laboratory instructor may choose suitable problem statements from the list. Student has to submit a report/Journal consisting of appropriate documents - prologue, Certificate, table of contents, and other suitable write up like (Introduction, motivation, aim and objectives, outcomes, brief theory, requirements analysis, design aspects, algorithms, mathematical model, complexity analysis, results, analysis and conclusions). Softcopy of report /journal and code is to be maintained by department/ institute in digital repository.

Suggested List of Laboratory Assignments

Group A: Analysis of Algorithm (Any Two Assignments)

1. Optimization techniques for N-Queen's problem: Implement N Queen Problem to Return all Distinct Solutions to the N-Queens Puzzle. First solution is brute force approach and the optimization is to be done in the problem to reduce the time complexity (**Hint:** use hashing to maintain a list to check whether that position can be the right one or not.)

2. Elections are on for the **Pune City Council**. Elections in **Pune** work in a rather odd manner. Each candidate is assigned a unique identification number. The town is divided into five zones and each zone proposes a list of candidates, in some arbitrary order, that it would like to nominate to the Council. Any candidate who is proposed by three or more zones is elected. There is no lower limit or upper limit on the size of the Council.

   Your task is to to calculate how many candidates are elected to the Council, given the lists proposed by the five zones.

For example, suppose the candidates proposed by the five zones are as follows:

- *Zone 1:* [12,387,15,162,5]
- *Zone 2:* [14,162,92,387,7,748]
- *Zone 3:* [14,5,12,387]
- *Zone 4:* [17,952,12,92,398,849]
- *Zone 5:* [14,5,92,12,387]

In this example, 5 candidates are elected: these are [12,387,5,14,92].

Solution hint

Sort each list and then do a 5-way merge.

Input format

The first line of the input contains five integers N_1, N_2 N_3, N_4 and N_5, where N_j is the number of candidates proposed by zone j, $1 \leq j \leq 5$. This is followed by five lines of space separated integers. For $1 \leq j \leq 5$, line j+1 of the input has N_j integers representing the list of candidates proposed by zone j.

Output format

Your output should be a single line consisting of one integer, the total number of candidates elected to the Town Council.

Test data

In all cases, $1 \leq N_1, N_2, N_3, N_4, N_5 \leq 50{,}000$. Each candidate ID is between 0 and 500,000. Also, each individual list is guaranteed to be free of duplicate entries.

Sample Input

5 6 4 6 5

12 387 15 162 5

14 162 92 387 7 748

14 5 12 387

17 952 12 92 398 849

14 5 92 12 387

Sample Output

5

3. The bustling town of **Balewadi, Pune** has just one sports stadium. There are a number of schools, colleges, sports associations, etc. that use this stadium as the venue for their sports events. Anyone interested in using the stadium has to apply to the Manager of the stadium indicating both the starting date (a positive integer S) and the length of the sporting event in days (a positive integer D) they plan to organise. Since these requests could overlap it may not be possible to satisfy everyone.

   It is the job of the Manager to decide who gets to use the stadium and who does not. The Manager, being a genial man, would like to keep as many organisations happy as possible and hence would like to allocate the stadium so that maximum number of events are held.

   Suppose, for example, the Manager receives the following 4 requests:

Event No.	Starting Date	Length
1	2	5

2	9	7
3	15	6
4	9	3

He would allot the stadium to events 1, 4 and 3. Event 1 begins on day 2 and ends on day 6, event 4 begins on day 9 and ends on day 11 and event 3 begins on day 15 and ends on day 20. You can verify that it is not possible to schedule all the 4 events (since events 2 and 3 overlap and only one of them can get to use the stadium).

Your task is to help the manager find the best possible allotment (i.e., the maximum number of events that can use the stadium).

Solution hint

Use the greedy algorithm for interval scheduling.

Input format

The first line of the input will contain a single integer N ($N \leq 100000$) indicating the number of events for which the Manager has received a request. Lines 2,3,...,N+1 describe the requirements of the N events. Line i+1 contains two integer Si and Di indicating the starting date and the duration of event i. You may assume that $1 \leq Si \leq 1000000$ and $1 \leq Di \leq 1000$.

Output format

Your output must consist of a single line containing a single integer M, indicating the maximum possible number of events that can use the stadium.

Constraints

The range of values over which your program is to be tested is mentioned above. In addition, 50% of the test cases will also satisfy $N \leq 10000$.

Example:

We now illustrate the input and output formats using the example described above.

Sample input:

4

2 5

9 7

15 6

9 3

Sample output:

3

4. A machine center in a job for a local fabrication company has five unprocessed job remaining at a particular point of time. The jobs are labelled as 1,2,3,4,5 in the ordered that they entered the shop. The respective processing times (in hours) and due time for delivery (in hours) are given in the table below.

Job number	Processing time (hours)	Due time for delivery (hours)
1	11	61
2	29	45
3	31	31
4	1	33
5	2	32

Sequence the 5 jobs using Shortest Processing Time (SPT) rule and First Come First Serve (FCFS) rule. Also calculate the mean flow time, average tardiness and average tardy jobs. Use GREEDY method to solve the problem. Also compare the output of SPT & FCFS.

Group B: Block Chain Technology and Applications (Any Two Assignments)

1. Create Crypto wallet for crypto transaction using Metamask.
   Description:
   i. Install Metamask as Extension
   ii. Create an account, setting username and password
   iii. Check account and make some virtual transaction

2. Simulating a Hybrid Consensus (PoW + PoS)

   Tools/Technologies: Python or JavaScript.
   Description:
   i. Implement a hybrid system where miners must solve a PoW puzzle to create a block, but validators with a higher stake confirm and finalize the block.
   ii. Simulate different scenarios to see how the hybrid model handles security and fairness.
   iii. Analyze the pros and cons of this approach versus using either PoW or PoS alone.

3. Build a decentralized file storage system that allows users to store and retrieve files securely.

   Tools/Technologies: IPFS (Inter Planetary File System), Ethereum smart contracts for payment and access control.
   Description:
   i. Set up IPFS nodes to store and retrieve files.
   ii. Write smart contracts to handle file ownership and permissions.
   iii. Create a frontend to interact with the file storage system.

4. Study 2 uses cases of Blockchain and write a detailed report on every aspect implemented in the same.

Description: write down report of 2000 words

Group C: Business Intelligence (Any Two Assignments)

1. Building a Simple Decision Support System:

Create a basic decision support system (DSS) to aid in selecting the best marketing strategy for a company.

Task:

- Use Microsoft Excel to create a DSS that evaluates three marketing strategies: Social Media, Email Campaigns, and Paid Ads.
- Consider the following criteria: Budget, Expected Reach, Conversion Rate, and Time to Implement. Assign different weights to each criterion.
- Use a weighted scoring method to determine the best strategy.

2. Data Mining for Customer Segmentation

Perform clustering to segment customers based on purchasing patterns using a dataset.

Task:

- Use Python and the sklearn library to perform K-means clustering.
- Use a dataset with features like age, income, and purchase frequency.
- Determine the optimal number of clusters using the elbow method.

3. Case Study 2: Data Mining for Market Basket Analysis

A grocery store wants to understand customer purchasing patterns to optimize product placement and promotions.

Task:

Conduct a market basket analysis using association rule mining techniques to identify common item combinations purchased together.

4. OLAP Data Analysis

Perform a simple OLAP analysis using a sample sales dataset.

Task:

- Use Microsoft Excel to create a pivot table from a dataset that includes sales data across different regions, products, and time periods.
- Analyze the data to identify trends, such as total sales per region and product category.

Group D-1: Optimization Techniques in Problem Solving (Any Two Assignments)

1. Single Variable Optimization for Minimum Weight Design:
   Design a solid cylindrical rod with a length of 2 meters, subjected to a tensile load of 5000 N. The material has a yield stress of 250 MPa. The goal is to minimize the weight of the rod by optimizing its diameter, considering that the rod's cross-sectional area must support the load without yielding.

2. Linear Programming for Cost Minimization:
   A factory produces two products (P1 and P2) that use two types of resources (R1 and R2). Each unit of P1 requires 3 units of R1 and 2 units of R2, while each unit of P2 requires 1 unit of R1 and 3 units of R2. The available quantities of R1 and R2 are 60 and 36 units, respectively. The profit per unit of P1 is Rs 40, and for P2 is Rs 30. Determine the optimal production quantities of P1 and P2 to maximize profit.

3. Constrained Optimization using Sequential Linear Programming:
   Consider the design of a rectangular storage tank with a square base and open top. The goal is to minimize the cost of materials for building the tank, given that the volume of the tank must be 32 cubic meters. The cost per square meter of the base is Rs.10, and the cost per square meter of the sides is Rs.6.
   The dimensions of the base are x×x, and the height of the tank is h. Formulate the optimization problem and solve it using the Sequential Linear Programming method**.**

4. Genetic Algorithm for Minimization (Unit 6)

   Problem: Minimize the function:

   $$f(x)=x^2 - 4x+4$$

   using a Genetic Algorithm over the range $x \in [0,10]$

Group D-2: Big Data Analytics (Any Two Assignments)

1. Understand the MapReduce programming model by implementing a simple word count program.

a) Write a MapReduce program in Java or Python that counts the occurrences of each word in a text file.

b) Execute the job on a Hadoop cluster and collect results.

2.Create visual representations of data using different visualization idioms.

a) Use a dataset (e.g., sales data) and create at least three different types of visualizations:

Bar Chart

Line Chart

Pie Chart

b) Use a visualization tool (e.g., Tableau, Matplotlib, or Excel) for this exercise.

3. Case Study 1: Retail Analytics Using Big Data

A retail company wants to analyze customer purchase behavior to optimize inventory and improve marketing strategies.

a) Analyze customer transaction data to identify buying patterns.

b) Use clustering techniques to segment customers based on behavior.

4. Case Study 2: Predictive Maintenance in Manufacturing

A manufacturing company aims to reduce downtime by predicting equipment failures using Big Data analytics.

a) Use sensor data from machines to predict when maintenance is needed.

b) Implement a decision tree model for predictive maintenance.

Group D-3: Digital Forensics (Any Two Assignments)

1. Study of Computer Forensics and different tools used for forensic investigation.
2. How to Recover Deleted Files using Forensics Tools.
3. Study the steps for hiding and extract any text file behind an image file/ Audio file using Command Prompt.
4. Find Last Connected USB on your system (USB Forensics).

Group E: Research Methodology (Any Two Assignments)

1. Define and explain key research terms such as constructs, hypotheses, and principles. Provide examples to distinguish between research methods and methodology.
   Deliverable: A short essay (1,500 words) discussing the differences and significance of each term.

2. Choose a real-world research project and classify it according to research types (e.g., basic, applied, descriptive, empirical). Discuss the qualitative or quantitative approach used.
   Deliverable: Case study analysis (2,000 words) discussing the selected research project's approach.

3. Analyze a business or social research project focusing on its research design and sampling methods. Discuss any sampling errors and their potential impact on the results.
   Deliverable: Case study report (2,000 words), explaining the methodology and sampling techniques.

4. Develop a research proposal and discuss how the research outcomes would be validated. Cover ethical considerations and suggest recommendations.
   Deliverable: Research proposal and conclusion report (2,500 words).

Semester-II

[24PCE201]: Advanced Computer Architecture

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	03	Teachers Assessment Examination (TAE):	25
		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: A basic understanding of Computer Organization and Architecture or Microprocessors			

Course Objectives	
1	Learn advanced processor design principles by exploring instruction set design, superscalar micro-architecture, hardware interactions, and multi-core system constraints.
2	Know about techniques to estimate, analyze and enhance performance as well as reduce power dissipation of computing systems.
3	Explore emerging computing trends, computing platforms, and design trade-offs Teaching Methodology.
Course Outcomes	
CO1	Explain the history, evolution, classifications, and current trends in Computer Architecture; evaluate and compare system performance using standard benchmarks.
CO2	Describe the basics of advanced microprocessor techniques and identify the key features of state-of-the-art processors used in High-Performance Computing systems.
CO3	Differentiate between System Area Networks and Storage Area Networks, and explain the current networking technologies used to implement them.
CO4	Compare advanced RAID levels, SAS vs. SATA disks, and explain the implementation of hierarchical storage systems.
CO5	Understand system software architecture, evaluate various parallel programming models, message-passing paradigms, and the typical HPCC software stack.
CO6	Apply and understand different preventive measures in system architecture.

Unit 1: System Architecture	
History /Evolution, Definition: Hardware /Software Architecture, Flynn's Classification: SISD, SIMD, MISD, MIMD. Physical Models: PVP, MPP, SMP& Cluster of Workstations (COW). Memory Architectures: Shared, Distributed & Hybrid. UMA, NUMA, CC-NUMA. Performance Metrics & Benchmarks (Micro/Macro) Architectural Trends based on TOP 500 List of Supercomputers.	8 Hours
Unit 2: Advanced Microprocessor Techniques	

CISC, RISC, EPIC, Superscalar, Superpipelined Architectures, Superscalar/ Superpipelined, In Order Execution /Out of Order Execution (OOO), ILP, TLP, Power Wall, Moore's Law Redefined, Multicore Technologies, Intel's Tick-Talk Model. Study of State-of-the- ART Processors: Intel / AMD X86-64 Bit Series: Intel Xeon Family (Xeon Haswell & Broadwell Architectures), Intel Xeon Phi Coprocessors (MIC Architecture) Intel/IBM Itanium/Power Series (Power 4 - Power 9). Introduction to Graphics Processing Units (GPU-NVIDIA).	8 Hours
Unit 3: System Interconnects	
SAN : System Area Networks, Storage Area Networks including InfiniBand, Gigabit , Ethernet, Scalable Coherent Interface (SCI) Standard.	8 Hours
Unit 4: Storage	
Internal/External , Disk Storage, Areal Density ,Seek Time ,Disk Power, Advanced RAID Levels, SATA vs SAS Disks ,Network Attached Storage (NAS) ,Direct Attached Storage (DAS), I/O Performance Benchmarks	8 Hours
Unit 5: Software Architecture	
Parallel Programming Models: Message Passing, Data Parallel , MPI/PVM .Typical HPCC Software Stack including Cluster Monitoring Tools, Public Domain Software like GANGLIA, CUDA Programming Environment.	8 Hours
Unit 6: Preventive and Mitigation Measures	
Pre-disaster, during disaster and post-disaster measures in some events in general, Structural mapping: Risk mapping, assessment and analysis, sea walls and embankments, Bio shield, shelters, early warning and communication. Non Structural Mitigation: Community based disaster preparedness, risk transfer and risk financing, capacity development and training, awareness and education, contingency plans. Do's and don'ts in case of disasters and effective implementation of relief aids	8 Hours

Learning Resources:	
1	Peter S. Pacheco, "An Introduction to Parallel Programming", Morgan Kaufmann, Elsevier Series, 2011, ISBN:978-0-12-374260-5.
2	John L. Hennesy and David Patterson, Computer Architecture : A Quantitative Approach, 6th Edition, Elsevier.
3	Kai Hwang and ZhiweiXu, Scalable Parallel Computers, McGraw- Hill, 1998.
4	Jason Sanders, Edward Kandrot, "CUDA by Example: An Introduction to General Purpose GPU Programming", 2011, ISBN:978-0-13-138768-3
5	Computer Systems Design and Architecture, 2nd Edition, Vincent P. Heuring
6	Computer Organization and Architecture, 6th Edition, William Stallings
7	Advanced Computer Architectures-A Design Space Approach, Dezsosima, Terence Fountain, Peter Kacsuk.
8	**Swayam Course:** Advanced Computer Architecture, By Prof. John Jose, IIT Guwahati, https://onlinecourses.nptel.ac.in/noc22_cs10/preview#:~:text=INTENDED%20AUDIENCE%3A%20Anyone%20in%20CSE,AMD%2C%20IBM%2C%20Nvidia%20etc.

[24PCE202]: Data Science

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	03	Teachers Assessment Examination (TAE):	25
		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: Statistics, Programming, SQL, Data visualization, Algorithms			

Course Objectives	
1	To understand the foundations of the Data Science process, methods and techniques.
2	To build descriptive and predictive modeling for statistical analysis of data.
3	To develop various applications of Data Science.
Course Outcomes	
CO1	Understand the fundamentals of data science to explain, reproduce, and utilize scalable data from various sources.
CO2	Apply statistical methods to analyse and interpret data sets, both large and small.
CO3	Implement regression techniques and machine learning algorithms on data sets to solve problems.
CO4	Analyse large-scale data using various visualization tools to gain insights.
CO5	Evaluate and use various tools and techniques for efficient big data processing.
CO6	Integrate the data science process in real-life applications and identify ethical challenges involved.

Unit 1: An Introduction to Data Science	
Facets of Data: Structured data, Unstructured data, Natural language, Machine generated data, Graph based or network data, Audio, Image and Video, Streaming data. **The Data Science Process: S**etting the research goal, retrieving data, Data preparation, Data exploration, model building, Presentation and Automation.	8 Hours
Unit 2: Descriptive Analysis	
Descriptive Statistics: Measure of Central Tendency, Measure of Dispersion, Formulae for the Mean and Standard Deviation. **Descriptive Modelling:** PCA, SVD, ICA, EM algorithm.	8 Hours
Unit 3: Predictive Analysis	
Review of Probability Theory, **Gaussian Discriminant analysis:** Linear Discriminant Analysis, **Predictive Modeling:** Predictive modelling process, Supervised and unsupervised learning, parametric and non-parametric model, challenges in predictive modelling.	8 Hours
Unit4: Data Visualization	
History of data Visualization, Basic Principles, visualization tools, using Python libraries for data visualization, interactive visualization ,visualization techniques for spatial data, geospatial data, time oriented data and multivariate data.	8 Hours

Unit 5: Scaling with Big Data	
Introduction of big data, characteristics of big data, data in the warehouse and data in Hadoop, Big data Use cases, **Hadoop Ecosystem:** HDFS and Map-Reduce, NoSQL, Analyzing data with Pig and R.	8 Hours
Unit 6: Data Science Applications and Ethics	
Applications: Text Analytics and Recommendation System, Time Series Analysis. **Ethical Issues :** Privacy and legal aspect of data.	8 Hours

Learning Resources:	
1	Davy Cielen,Meysman,Mohamed Ali, “Introducing Data Science”, Dreamtech Press
2	Kevin P. Murphy, “Machine Learning a Probabilistic Perspective”, The MIT Press
3	EMC2 Education Services,”Data Science and Big Data Analytics”, Wiley Publications
4	Dean Abbott, “Applied Predictive Analytics: Principles and Techniques for the Professional Data Analyst”, Wiley, 2014
5	Noel Cressie, Christopher K. Wikle , “Statistics for Spatio-Temporal Data”, Wiley
6	Rachel Schutt and Cathy O’Neil, “Doing Data Science”, O’Reilly Media
7	Joel Grus, “Data Science from Scratch: First Principles with Python”, O'Reilly Media

[24PCE203-A]: Elective-II- Wireless Sensor Network

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	04	Teachers Assessment Examination (TAE):	25
Tutorial: 1 Hours/Week		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: Basic knowledge of Data Communication Networks and Sensors			

Course Objectives	
1	To make students learn and understand the concept of sensor networks for various application setups.
2	To explore the design space and conduct trade-off analysis between performance and resources
3	To Devise appropriate data dissemination protocols and model links cost
Course Outcomes	
CO1	Understand the fundamental concepts of sensor network technology and its applications.
CO2	Understanding different Operating System and its working
CO3	Understand the concept of MAC protocols in wireless sensor network
CO4	Explain Transport layer protocols & middleware applications
CO5	Apply network management system in WSNs
CO6	Analyze operating system used in WSNs

Unit 1: Overview of Wireless Sensor Networks	
Introduction: Background of Sensor Network Technology, Applications of Sensor Networks, **Basic Overview of the Technology:** Basic Sensor Network Architectural Elements, Brief Historical Survey of Sensor Networks, Challenges and Hurdles, **Basic Wireless Sensor Technology:** Introduction, Sensor Node Technology, Hardware and Software, Sensor Taxonomy, WN Operating Environment.	8 Hours
Unit 2: Operating Systems for Wireless Sensor Networks	
Functional Aspects: Data Types, Scheduling, Stacks, System Calls, Handling Interrupts, Multithreading, Thread-Based vs Event-Based Programming, Memory Allocation, **Non-functional Aspects:** Separation of Concern, System Overhead, Portability, Dynamic Reprogramming, **Prototypes:** TinyOS, SOS, Contiki, LiteOS, Evaluation.	8 Hours
Unit 3: Wireless Transmission Technology and Systems	
Introduction, Radio Technology Primer, Propagation and Propagation Impairments, Modulation, Available Wireless Technologies, Campus Applications, MAN/WAN Applications	8 Hours
Unit4: Routing Protocols for Wireless Sensor Networks	

Introduction, Background, Data Dissemination and Gathering, **Routing Challenges and Design Issues in Wireless Sensor Networks:** Network Scale and Time-Varying Characteristics, Resource Constraints, Sensor Applications Data Models, **Routing Strategies in Wireless Sensor Networks:** WSN Routing Techniques, Flooding and Its Variants, Sensor Protocols for Information via Negotiation, Low-Energy Adaptive Clustering Hierarchy, Power-Efficient Gathering in Sensor Information Systems, Directed Diffusion, Geographical Routing.	8 Hours
Unit 5: Sensor Network Programming	
Challenges in Sensor Network Programming, **Node-Centric Programming:** nesC Language, TinyGALS, Sensor Network Application Construction Kit, Thread-Based Model, **Macro programming:** Abstract Regions, EnviroTrack, Database Approaches, Dynamic Reprogramming, **Sensor Network Simulators:** Network Simulator Tools and Environments.	8 Hours
Unit 6: Applications of Wireless Sensor Networks	
Introduction, Range of Applications, **Examples of Category 1 WSN Applications:** Sensor and Robots, Reconfigurable Sensor Networks, Highway Monitoring, Military Applications, Civil and Environmental Engineering Applications, Wildfire Instrumentation, Habitat Monitoring, Nanoscopic Sensor Applications, **Examples of Category 2 WSN Applications:** Home Control, Building Automation, Industrial Automation, Medical Applications	8 Hours

Learning Resources:	
1	Kazemsohraby Daniel Minoli Taieb Znati, "Wireless Sensor Networks Technology, Protocols, and Applications", Publisher- John Wiley & Sons, ISBN 978-0-471-74300-2
2	Waltenegus Dargie, Christian Poellabauer, "Fundamentals Of Wireless Sensor Networks Theory And Practice", Publisher- John Wiley & Sons, ISBN 978-0-470-99765-9
3	K. Sohraby Minoli And T. Zanti, "Wireless Sensor Networks: Technology, Protocols, and Applications", Publisher- John Wiley And Sons.
4	H. Karl, And A. Willig, "Protocols And Architectures For Wireless Sensor Networks", Publisher-John Wiley And Sons.
5	C. S. Raghavendra, K.M. Sivalingam And T. Zanti," Wireless Sensor Networks", Springer Verlag,
	E. H. Callaway, Jr. Auerbach," Wireless Sensor Networks: Architectures And Protocols"
6	**Online:** Https://Userpages.Cs.Umbc.Edu/Younis/Sensor_Networks/Cmpe684.Htm

[24PCE203-B]: Elective-I- Generative Artificial Intelligence

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	04	Teachers Assessment Examination (TAE):	25
Tutorial: 1 Hours/Week		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: Artificial Intelligence , Natural Language Processing			

Course Objectives	
1	To understand the core concepts of Generative Adversarial Networks (GANs)
2	To understand the architecture and training methods of language models
3	To explore the significance of prompt engineering
Course Outcomes	
CO1	Understand generative AI, including its techniques, and applications.
CO2	Understand language models, their architectures.
CO3	Explain the core principles of generative models.
CO4	Recognize the role of Large Language Models (LLMs) in text generation.
CO5	Identify the significance of NLP within broader AI frameworks.
CO6	Demonstrate techniques and applications of prompt engineering.

Unit 1: Introduction to Generative AI	
Introduction to generative AI: Neural Network, Definition AI, What Is Generative AI? Components of AI Domains of Generative AI, Text Generation, Image Generation, Audio Generation, Video Generation Generative AI: Current Players and Their Models Generative AI Applications. Importance of Generative AI in various domains .Brief discussion on ethical considerations and challenges .	8 Hours
Unit 2: Language Models	
Evolution of Neural Networks to Large Language Models, Natural Language Processing, Tokenization N-grams, Language Representation and Embedding's Probabilistic Models, Neural Network–Based Language Models, Recurrent Neural Networks (RNNs) Long Short-Term Memory (LSTM) Gated Recurrent Unit (GRU) Encoder-Decoder Networks, Transformer Large Language Models (LLMs).	8 Hours
Unit 3: Generative Models	
Generative Models: Introduction to Generative Models, Generative Adversarial Networks (GANs), Variational Autoencoders (VAEs), Autoregressive Models Evaluation Metrics for Generative Models: FID score, Inception score, Visual analysis, domain-specific evaluations.	8 Hours
Unit4: LLMs and Transformers	

The Power of Language Models, Transformer Architecture, Motivation for Transformer Architecture , Encoder-Decoder Architecture, Attention Position-wise Feed-Forward Networks, Advantages and Limitations of Transformer Architecture, AI Building an LLM application, LLMs use cases.	8 Hours
Unit 5: LLM for Text. Generation and NLP	
Vector Representations,, Probabilistic Text Generation, OpenAI's Generative Pre-Trained Transformers GPT-3.5-turbo and ChatGPT GPT-4 Google's Gemini Meta's LLaMA, Statistical Model (n-Grams), Knowledge based Models,Contextual language Models, Neural Network Based Models.	8 Hours
Unit 6: Prompt Engineering for Generative AI	
Introduction to prompt engineering, principles for creating effective prompts, Techniques for crafting compelling prompts, Overview of Generative Pre-trained Transformers (GPT) models, Comparison: API usage vs. web interface, Tokens and costs: understanding usage and calculating model cost, API parameters and how to optimize them, Introduction to vector databases, Retrieval Augmented Generation (RAG), Prompt engineering strategies: Zero-shot & Few-shot prompting, Advanced techniques: Chain of Thought (CoT), Automatic Chain of Thought (Auto-CoT), **Applications:** Question-Answering systems, Conversational AI, and Sentiment Analysis, Template-based prompt generation, Text augmentation strategies.	8 Hours

Learning Resources:	
1	David Foster, "Generative Deep Learning: Teaching Machines to Paint, Write, Compose,and Play" O'Reilly Media, ISBN-13: 978-1492041948
2	Ethan James Whitfield , "Generative AI for Beginners", Independently published, ISBN-13: 979-8869928337
3	Tom Taulli, "Generative AI", Springer ,Apress, 2023,ISBN : 978-1-4842-9369-0
4	James Phoenix, Mike Taylor, "Prompt Engineering for Generative AI", O'Reilly Media, Inc., ISBN: 9781098153434
5	Josh Kalin,"Generative Adversarial Networks Cookbook: Over 100 recipes to build generative models using Python, TensorFlow, and Keras" Packt Publishing ISBN-13: 978-1789139907
6	Robert E. Miller, "Prompt Engineering Bible: Join and Master the AI Revolution", Independently Published, ISBN-13: 979-8861782944
7	Scikit-Learn, Keras, and Tensor Flow, "Hands-On Machine Learning", O'Reilly Media, 2nd Edition. ISBN-13: 978-9352139057
8	e Books : Mastering Prompt Engineering: A Free eBook | by Natasha | Medium

[24PCE203-C]: Elective-II- Parallel Computing

Teaching Scheme	Credit	Examination Scheme	Marks
Theory: 3 Hours/Week	04	Teachers Assessment Examination (TAE):	25
Tutorial: 1 Hours/Week		Class Assessment Examination (CAE):	25
		End Semester Examination (ESE):	50
		Total	**100**
Course Prerequisites: Advance Algorithm and Programming			

Course Objectives	
1	To analyse the role of various programming platform in designing high performance computing systems
2	To explain how massive parallelisms are implemented in accelerated architecture
3	To design parallel algorithm for GPGPU
Course Outcomes	
CO1	To understand parallel algorithms for different applications
CO2	To understand and implement shared memory Parallelism
CO3	To understand and apply parallelism model in CUDA
CO4	To understand the concepts of memory management including virtual memory
CO5	Implement Parallel Patterns Convolution and Prefix sum
CO6	To understand Heterogeneous Programming

Unit 1: Parallel Algorithm Design	
Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing Methods for Containing Interaction Overheads, Parallel Algorithm Models.	8 Hours
Unit 2: Shared Memory Parallelism: Basic and Programming	
Programming Shared Address Space Platforms: Thread Basics, Why Threads?, The POSIX Thread API Thread Basics: Creation and Termination, Synchronization Primitives in Pthreads, Controlling Thread and Synchronization Attributes Thread Cancellation, Composite Synchronization Constructs Tips for Designing Asynchronous Programs, OpenMP: a Standard for Directive Based Parallel Programming.	8 Hours
Unit 3: GPU computing and CUDA	
CUDA data parallelism model, CUDA program structure, Device memories and data transfer, Kernel function and threading, CUDA threads organization using blockIdx and ThreadIdx synchronization and transparent scalability, Thread assignment Tthread scheduling and Latency Tolerance.	8 Hours
Unit4: CUDA Memories	

Importance of memory access efficiency, Memory types, Global memory traffic, Performance consideration :Thread execution, Global memory bandwidth, Dynamic partitioning of SM resources, Data prefetching, instruction mix, Thread Granularity, Measured Performance.	8 Hours
Unit 5: Parallel Patterns Convolution and Prefix sum	
1D Parallel convolution : A basic algorithm ,constant memory and caching ,Tiled 1D convolution with Halo elements ,a Simpler Tiled 1D convolution, A simple parallel scan ,Work efficiency considerations, a Work efficiency parallel scan , parallel scan for arbitrarily scan Length inputs.	8 Hours
Unit 6: Heterogeneous Programming	
Introduction ,overlapping computation and communication ,MPI CUDA-C programming, OpenMP CUDA-C programming, Open ACC	8 Hours

Learning Resources:	
1	Ananth Grama, Anshul Gupta, George Karypis, and Vipin Kumar, "Introduction to Parallel Computing", 2nd edition, Addison-Wesley, 2003, ISBN: 0-201-64865-2.
2	Jason sanders, Edward Kandrot, “CUDA by Example”, Addison-Wesley, ISBN-13: 978-0- 13-138768- 3
3	Shane Cook, “CUDA Programming: A Developer's Guide to Parallel Computing with GPUs”, Morgan Kaufmann Publishers Inc. San Francisco, CA, USA 2013 ISBN: 9780124159884
4	David Culler Jaswinder Pal Singh, ”Parallel Computer Architecture: A Hardware/Software Approach”,Morgan Kaufmann,1999, ISBN 978-1-55860-343-1
5	Rod Stephens, “ Essential Algorithms”, Wiley, ISBN: ISBN: 978-1-118-61210-1

[24PCE204]: Laboratory Practice-II

Teaching Scheme	Credit	Examination Scheme	Marks
Lab: 8 Hours/Week	04	Teachers Assessment Examination (TAE):	25
		External Oral Exam:	25
		Total	**50**
Course Prerequisites: All Major Core, All Major Elective			

- Laboratory Practice-II (LP-II) is a companion course to the core and elective theory courses in Semester II.
- It is recommended that two assignments or case studies be completed for each course.
- A set of four problem statements is provided, and the laboratory instructor may select any two from this list.
- Students are required to submit a report or journal in the prescribed format provided by the laboratory instructor.

Suggested List of Laboratory Assignments

Group A: Advance Computer Architecture (Any Two Assignments)

1. Study Shared, Distributed, and Hybrid memory architectures.
2. Simulate a Superscalar architecture using GEM5 and observe how parallel instruction execution improves performance.
3. Compare the Intel Xeon Phi coprocessor with a typical x86 CPU in terms of instruction set, power efficiency, and performance in data-parallel tasks.
4. Submit a summary report (500 words) discussing SISD, SIMD, MISD, and MIMD architectures.

Group B: Data Science (Any Two Assignments)

1. Set a research goal for a simple data science problem (e.g., predicting house prices or analyzing customer reviews).
2. Load a dataset and perform data cleaning operations (handling missing values, outliers, duplicates).
3. Automate the data retrieval process by writing a Python script to fetch data from an API or scrape data from the web.
4. Visualize the distribution of key features using histograms, boxplots, and scatterplots in Python.

Group C-1: Wireless Sensor Networks (Any Two Assignments)

1. Identify and explain the basic components of the sensor node hardware.
2. Install and configure **TinyOS** or **Contiki** OS on a sensor node or simulator.
3. Explore sensor network simulators (e.g., Cooja or TOSSIM) to test large-scale deployment and assess performance.
4. Simulate a wireless sensor network using any network simulator (e.g., NS2/NS3 or TOSSIM).

Group C-2: Generative Artificial Intelligence (Any Two Assignments)

1. Implement Generative Adversarial Networks (GANs) in Python for translating images from one domain to another, fostering creativity in visual content generation.
2. Given a text prompt and the pixel locations of the subject or background, replace part of the image

with an AI generated image.

3. Build a “real estate agent” application that uses LLMs for content generation, vector databases, semantic search and RAG techniques to transform standard real estate listings into personalized narratives.
4. Generate music playlists based on users’ facial expressions or emotional input, curating music to match their current mood.

Group C-3: Parallel Computing (Any Two Assignments)

1. Simple C programs to review of Process creation, synchronization and IPC.
2. Programs using Message passing and Message matching in MPI
3. Programs using Broadcast and reduction in MPI
4. Working with MPI derived types.

[24PCE205]: Indian Knowledge Systems (IKS)

Teaching Scheme	Credit	Examination Scheme	Marks
Lab: 4 Hours/Week	02	Teachers Assessment Examination (TAE):	25
		Internal Oral Exam:	25
		Total	**50**

Course Prerequisites: This course is without any prerequisites.

Learning Objectives:

To provide a general introduction to Indian Knowledge System (IKS) and sensitize the students to the contributions made by ancient Indians in the field of Science, Philosophy and related applications and concepts.

Course Objectives	
1	Indian Knowledge Systems: Origin, Evolution and Ontological Approach
2	Sciences of Life and Mind
3	Self-Exploration and Self Knowledge for Personal Effectiveness
Course Outcomes	
CO1	Understand the foundational principles and organization of the Indian Knowledge System (IKS), and assess its relevance and historical significance in modern times.
CO2	Analyse the structure, classifications, and key messages of the Vedic corpus, including an introduction to the Vedāṅgas and their influence on Vedic life.
CO3	Evaluate the Indian scheme of knowledge and its logical frameworks, including the principles of pramāṇa, saṃśaya, and siddhānta, to establish valid knowledge.
CO4	Explore the principles of Āyurveda, the tri-doṣa system, and the holistic approach to health and wellness, including the psychological and consciousness studies.
CO5	Examine the key elements of governance in ancient India, including the role of raja dharma, the Arthaśāstra, and their relevance to modern public administration.
CO6	Understand the historical development of Indian number systems, including the Bhūta-Saṃkhyā system, and their applications in measurement and early binary systems.

Unit 1: Indian Knowledge System – An Introduction	
What is IKS?, Why do we need IKS?, Organization of IKS, Historicity of IKS, Some salient aspects of IKS.	8 Hours
Unit 2: The Vedic Corpus	
Introduction to Vedas, A synopsis of the four Vedas, Sub-classification of Vedas, Messages in Vedas, Introduction to Vedāṅgas , Prologue on Śikṣā and Vyākaraṇa , Basics of Nirukta and Chandas , Introduction to Kalpa and Jyotiṣa, Vedic Life: A Distinctive Features.	8 Hours
Unit 3: Knowledge Framework and classifications	

Indian scheme of knowledge, The knowledge triangle, Prameya – A vaiśeṣikan approach to physical reality, Dravyas – the constituents of the physical reality, Attributes – the properties of substances and Action – the driver of conjunction and disjunction, Sāmānya, viśēṣa, samavāya , Pramāṇa – the means of valid knowledge, Saṃśaya – ambiguities in existing knowledge, Framework for establishing valid knowledge, Deductive or inductive logic framework, Potential fallacies in the reasoning process, Siddhānta: established tenets in a field of study.	8 Hours
Unit4: Health Wellness and Psychology	
Introduction to health, Āyurveda: approach to health, Sapta-dhātavaḥ: seven-tissues, Role of agni in health, Tri-doṣas, Āyurveda: definition of health, Psychological aspects of health, Disease management elements, Dinacaryā: daily regimen for health & wellness, Importance of sleep, Food intake methods and drugs, Approach to lead a healthy life, Indian approach to psychology, The tri guṇa system & holistic picture of the individual, The Nature of Consciousness, Consciousness studies and issues.	8 Hours
Unit 5: Governance and Public Administration	
Introduction to raja dharma, Arthaśāstra: a historical perspective, Elements of a kauṭilyan state, The king & the amātya, Janapada & durga, Treasury and the State Economy (Kośa), Danda, Mitra, The Administrative Setup, Relevance of Arthaśāstra, Public Administration in Epics.	8 Hours
Unit 6: Number Systems and Units of Measurement	
Number systems in India – Historical evidence, Salient aspects of Indian Mathematics, Bhūta-Saṃkhyā system, Kaṭapayādi system , Measurements for time, distance, and weight, Piṅgala and the Binary system.	8 Hours

Learning Resources:	
1	An Introduction to Indian Knowledge Systems: Concepts and Applications, B Mahadevan, V R Bhat, and Nagendra Pavana R N; 2022 (Prentice Hall of India).
2	Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
3	Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
4	Indian Knowledge Systems: Vol I and II, Kapil Kapoor and A K Singh; 2005 (D.K. Print World Ltd).
5	Dasgupta,S. (1975). A History of Indian Philosophy- Volume 1, Motilal Banarsidass, New Delhi.
6	The Beautiful Tree: Indigenous India Education in the Eighteenth Century, Dharampal, Biblia Impex, New Delhi, 1983. Reprinted by Keerthi Publishing House Pvt Ltd., Coimbatore, 1995.
7	Indian Science and Technology in the Eighteenth Century, Dharampal. Delhi: Impex India, 1971. The British Journal for the History of Science.
8	The Wonder That Was India, Arthur Llewellyn Basham, 1954, Sidgwick& Jackson.
9	The India they saw series (foreigner visitors on India in history from 5CE to 17th century), Ed. Meenakshi Jain and Sandhya Jain, Prabhat Prakashan

10	**Swayam Course : https://onlinecourses.swayam2.ac.in/imb23_mg55/preview**
11	Dharampal, Indian Science and Technology in the Eighteenth Century, Academy of Gandhian Studies, Hyderabad, 1971, republic. Other India Bookstore, Goa, 2000
12	Alok Kumar, Sciences of the Ancient Hindus: Unlocking Nature in the Pursuit of Salvation, CreateSpace Independent Publishing, 2014
13	B.V. Subbarayappa, Science in India: A Historical Perspective, Rupa, New Delhi, 2013
14	S. Balachandra Rao, Indian Mathematics and Astronomy: Some Landmarks, Jnana Deep Publications, Bangalore, 3rdedn, 2004
15	Anil Agarwal & Sunita Narain, (eds), Dying Wisdom: Rise, Fall and Potential of India's Traditional Water-Harvesting Systems, Centre for Science and Environment, New Delhi, 1997
16	Dr. Subhash Kak , Computation in Ancient India,Mount, Meru Publishing (2016)
17	'Knowledge traditions and practices of India', Kapil Kapoor, Michel Danino, CBSE, India.

[24PCE206]: On Job Training (OJT) / Swayam (MOOC)

Teaching Scheme	Credit	Examination Scheme	Marks
Lab: 8 Hours/Week	04	Teachers Assessment Examination (TAE):	50
		Internal Oral Exam:	50
		Total	**100**
Course Prerequisites:			

Semester-III

[24PCE301]: Seminar-I

Teaching Scheme	Credit	Examination Scheme	Marks
Lab: 4 Hours/Week	02	Teachers Assessment Examination (TAE):	25
		Internal Oral Exam:	50
		Total	**75**

Course Objectives

- To explore the basic principles of communication (verbal and non-verbal) and active, empathetic listening, speaking and writing techniques.
- To Identify, understand and discuss current, real-world issues, new technologies, research, products, algorithms and services.

Course Outcomes

- To use multiple thinking strategies to examine real-world issues and explore creative avenues of expression.
- To acquire, articulate, create and convey intended meaning using verbal and nonverbal method of communication.
- To learn and integrate, through independent learning in sciences and technologies, with disciplinary specialization and the ability to integrate information across.

Guidelines
• The student shall have to deliver the seminar I on a topic approved by guide and authorities. • It is recommended to allot guide to the student since the commencement of semester III. • The guide allotment preferably needs to be carried out in synchronization with mutual domains of interest. • It is recommended that seminar shall be on the topic relevant to latest trends in the field of computer engineering branch. • The student shall submit the duly approved and certified seminar report in standard format, for satisfactory completion of the work by the concerned Guide and head of the department/institute. • The student will be assessed based on his/her presentation and preparations by the panel of experts. • The continuous assessment of the progress need to be documented by the concerned Guide.

[24PCE302]: Research Paper Publication-I

Teaching Scheme	Credit	Examination Scheme	Marks
Lab: 4 Hours/Week	02	Teachers Assessment Examination (TAE):	25
		Internal Oral Exam:	50
		Total	**75**

Course Objective
• Develop critical thinking and problem-solving skills through independent research. • Explore contemporary research trends and innovations in Computer Engineering. • Engage in scholarly writing by conducting a literature review, proposing solutions, and presenting findings in a well-structured research paper. • Gain experience in publishing academic work in reputed conferences.

Course Outcomes	
CO1	Demonstrate the ability to choose a relevant research topic by analyzing the gaps in the existing literature.
CO2	Summarize and synthesize key findings from recent research papers and apply this knowledge to frame their research question.
CO3	Develop a sound methodology to solve the research problem using appropriate tools, models, or simulations in line with the proposed solution.
CO4	Analyze experimental results and present findings through well-structured tables, graphs, or charts, comparing them with existing work.
CO5	Prepare a research paper following academic standards (e.g., IEEE, Springer format), ensuring originality and clarity in presenting the research work.
CO6	Successfully submit the research paper to a Scopus-indexed journal or a reputed conference and demonstrate the ability to follow submission protocols.

Guidelines

- **Topic Selection:**
  - Choose a relevant, innovative topic aligned with the Computer Engineering curriculum.
  - Submit 2-3 potential topics for approval by your guide/supervisor.
  - Prepare a 1-page Approved topic document.
- **Literature Review:**
  - Conduct a comprehensive review of existing research on the selected topic.
  - Summarize key findings from each paper.
  - Identify gaps in the literature that your research will address.
  - Prepare a 4-5 page review document.
- **Research Methodology:**
  - Define the research problem and outline the methods to be used for the research.
  - Write a detailed methodology section including: Problem statement, Proposed solution/approach, Tools, datasets, or simulation environments (if applicable).
  - Experiment design (algorithms, models, etc.).
  - Prepare 2-3 page document.
- **Implementation & Results:**
  - Implement the proposed solution and analyze the results.
  - Develop and implement your solution (coding, simulations, model training, etc.).
  - Prepare 2-3 page document.
- **Research Paper Draft:**
  - Write the research paper in the prescribed format (typically IEEE, Springer, or other journals' templates). Abstract, Introduction, Literature Review, Methodology, Results, Conclusion, References.
  - Full draft of the research paper (6-8 pages).
- **Submission to Conference:**
  - Submit the paper to a Scopus-indexed Conference.
  - Proof of submission document.

[24PCE303]: Research Project Stage-I (Dissertation)

Teaching Scheme	Credit	Examination Scheme	Marks
Lab: 32 Hours/Week	16	Teachers Assessment Examination (TAE):	25
		Internal Oral Exam:	50
		External Oral Exam:	25
		Total	**100**

Course Objectives

- To identify the domain of research
- To learn to communicate in a scientific language through collaboration with guide.
- To understand the various means of technical publications and terminologies associated with

publications
- To formulate research problem with the help of the guide/mentor elaborating the research.

Course Outcomes

- Conduct thorough literature survey confined to the domain of choice
- Develop presentation skills to deliver the technical contents
- Furnish the report of the technical research domain
- Analyze the findings and work of various authors confined to the chosen domain

Guidelines

- The student shall complete the partial work of the Dissertation which will consist of problem statement, literature review, design, scheme of implementation (Mathematical Model/SRS/UML/ERD/block diagram/ PERT chart,) and Layout & Design of the Set-up.
- The student is expected to complete the dissertation at least up to the design phase.
- As a part of the progress report of Dissertation work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic.
- The student shall submit the duly approved and certified progress report of Dissertation Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.
- The examiner will be assessed by a panel of examiners of which one is necessarily an external examiner.
- The assessment will be broadly based on literature study, work undergone, content delivery, presentation skills, documentation and report.
- The students are expected to validate their study undertaken by publishing it at standard platforms.
- The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal.
- The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.
- The continuous assessment of the progress need to be documented unambiguously.

Semester-IV

[24PCE401]: Research Paper Publication-II

Teaching Scheme	Credit	Examination Scheme	Marks
Lab: 4 Hours/Week	02	Teachers Assessment Examination (TAE):	25
		Internal Oral Exam:	25
		Total	**50**

Course Objective

- Develop critical thinking and problem-solving skills through independent research.
- Explore contemporary research trends and innovations in Computer Engineering.
- Engage in scholarly writing by conducting a literature review, proposing solutions, and presenting findings in a well-structured research paper.
- Gain experience in publishing academic work in reputed journals.

Course Outcomes

CO1	Demonstrate the ability to choose a relevant research topic by analyzing the gaps in the existing literature.
CO2	Summarize and synthesize key findings from recent research papers and apply this knowledge to frame their research question.
CO3	Develop a sound methodology to solve the research problem using appropriate tools, models, or simulations in line with the proposed solution.
CO4	Analyze experimental results and present findings through well-structured tables, graphs, or charts, comparing them with existing work.
CO5	Prepare a research paper following academic standards (e.g., IEEE, Springer format), ensuring originality and clarity in presenting the research work.
CO6	Successfully submit the research paper to a Scopus-indexed journal and demonstrate the ability to follow submission protocols.

Guidelines

- **Topic Selection:**
  - Choose a relevant, innovative topic aligned with the Computer Engineering curriculum.
  - Submit 2-3 potential topics for approval by your guide/supervisor.
  - Prepare a 1-page Approved topic document.
- **Literature Review:**
  - Conduct a comprehensive review of existing research on the selected topic.
  - Summarize key findings from each paper.
  - Identify gaps in the literature that your research will address.
  - Prepare a 4-5 page review document.
- **Research Methodology:**
  - Define the research problem and outline the methods to be used for the research.
  - Write a detailed methodology section including: Problem statement, Proposed solution/approach, Tools, datasets, or simulation environments (if applicable).
  - Experiment design (algorithms, models, etc.).
  - Prepare 2-3 page document.

- **Implementation & Results:**
  - Implement the proposed solution and analyze the results.
  - Develop and implement your solution (coding, simulations, model training, etc.).
  - Prepare 2-3 page document.
- **Research Paper Draft:**
  - Write the research paper in the prescribed format (typically IEEE, Springer, or other journals' templates). Abstract, Introduction, Literature Review, Methodology, Results, Conclusion, References.
  - Full draft of the research paper (6-8 pages).
- **Submission to Journal:**
  - Submit the paper to a Scopus-indexed journal.
  - Proof of submission document.

[24PCE402]: Research Project Stage-II (Dissertation)

Teaching Scheme	Credit	Examination Scheme	Marks
Lab: 36 Hours/Week	18	Teachers Assessment Examination (TAE):	50
		Internal Oral Exam:	75
		External Oral Exam:	75
		Total	**200**

Course Objectives

- To follow SDLC meticulously and meet the objectives of proposed work
- To test rigorously before deployment of system
- To validate the work undertaken
- To consolidate the work as furnished report

Course Outcomes

- Show evidence of independent investigation
- Critically analyze the results and their interpretation; infer findings
- Report and present the original results in an orderly way and placing the open questions in the right perspective.
- Link techniques and results from literature as well as actual research and future research lines with the research.
- Appreciate practical implications and constraints of the specialist subject.

Guidelines

- In Dissertation Work Stage–II, the student shall consolidate and complete the remaining part of the dissertation which will consist of Selection of Technology, Installations, UML implementations, testing, Results, measuring performance, discussions using data tables per

parameter considered for the improvement with existing/known algorithms/systems, comparative analysis, validation of results and conclusions.

- The student shall prepare the duly certified final report of Dissertation in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.
- The students are expected to validate their study undertaken by publishing it at standard platforms.
- The investigations and findings need to be validated appropriately at standard platforms – conference and/or peer reviewed journal.
- The student has to exhibit the continuous progress through regular reporting and presentations and proper documentation the frequency of the activities in the sole discretion of the PG coordination.
- The continuous assessment of the progress need to be documented unambiguously.