VISION AND MISSION

VISION OF THE DEPARTMENT
The Department of Computer Science and Engineering strives to create computing professionals, researchers, and entrepreneurs, with high technical knowledge, communication skills, values and ethics. It collaborates with academia, industry and community to set high standards in academic excellence and in fulfilling societal responsibilities.

MISSION OF THE DEPARTMENT
The mission of the Department of Computer Science and Engineering is to

- Provide motivated faculty and state of the art facilities for education and research, both in foundational aspects and of relevance to emerging computing trends.
- Develop knowledgeable, industry-ready students with pertinent competencies.
- Inculcate responsibility through sharing of knowledge and innovative computing solutions that benefit the society-at-large.
- Engage in collaborative research with academia and industry for seamless transfer of knowledge resulting in patentable solutions.
- Generate adequate resources for research activities from sponsored projects and consultancy.
ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
M.E. COMPUTER SCIENCE AND ENGINEERING
(SPECIALIZATION IN OPERATIONS RESEARCH)
REGULATIONS – 2023
CHOICE BASED CREDIT SYSTEM

PROGRAM EDUCATIONAL OBJECTIVES:
1. Prepare students to review and understand concepts in Computer Science and Engineering and optimization techniques
2. Empower students to critically analyze current trends and learn future issues from a system perspective at multiple levels of detail and abstraction
3. Enable students to apply theory and practice for problem solving based on case studies
4. Enable students to pursue lifelong multidisciplinary learning as professional engineers and scientists to effectively communicate technical information, function effectively on teams, and apply computer science & engineering and optimization techniques within a global, societal, and environmental context by following ethical practices.
5. Prepare students to critically analyze existing literature, identify the gaps in the existing literature and propose innovative and research oriented solutions.

PROGRAM OUTCOMES:
Students will be able to:
1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex computer science problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and computer science related tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
5. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one’s own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
6. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the programme educational objective and the outcomes is given in the following table

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Mapping of Course Outcome and Programme Outcome

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YEAR 1

SEM1

YEAR 2

SEM3

YEAR 4

SEM4

Attested
# ANNA UNIVERSITY, CHENNAI  
**UNIVERSITY DEPARTMENTS**  
**M.E. COMPUTER SCIENCE AND ENGINEERING**  
**(SPECIALIZATION IN OPERATIONS RESEARCH)**  
**REGULATIONS – 2023**  
**CHOICE BASED CREDIT SYSTEM**  
**CURRICULA AND SYLLABI**

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## Research Methodology and IPR (RMC)

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MA3154  ADVANCED MATHEMATICS FOR SCIENTIFIC COMPUTING  

UNIT I  LINEAR PROGRAMMING  12
Formulation – Graphical solution – Simplex method – Two phase method -Transportation and Assignment Problems

UNIT II  SIMULATION  12
Discrete Event Simulation – Monte – Carlo Simulation – Stochastic Simulation – Applications to real time problems.

UNIT III  ESTIMATION THEORY  12

UNIT IV  TESTING OF HYPOTHESIS  12

UNIT V  MULTIVARIATE ANALYSIS  12

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, students will be able to
CO1 Formulate and find optimal solution in the real life optimizing/allocation/assignment problems involving conditions and resource constraints.
CO2 Simulate appropriate application/distribution problems.
CO3 Obtain the value of the point estimators using the method of moments and method of maximum likelihood.
CO4 Apply the concept of various test statistics used in hypothesis testing for mean and variances of large and small samples.
CO5 Get exposure to the principal component analysis of random vectors and matrices.

REFERENCES:
CO-PO Mapping

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RM3151 RESEARCH METHODOLOGY AND IPR L T P C
2 1 0 3

UNIT I RESEARCH PROBLEM FORMULATION 9
Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT II RESEARCH DESIGN AND DATA COLLECTION 9
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9
Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

UNIT IV INTELLECTUAL PROPERTY RIGHTS 9
Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT V PATENTS 9
Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL: 45 PERIODS

COURSE OUTCOMES
Upon completion of the course, the student can
CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
CO5: Execute patent filing and licensing

REFERENCES:
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,

CP3151 DATA STRUCTURES AND ALGORITHMS

UNIT I BASIC STRUCTURES AND ALGORITHM
Stack- Queue - Linked List Implementation - Min/Max heap – Algorithm Analysis- Asymptotic Analysis- Solving Recurrence Relation – Amortized Analysis

UNIT II BALANCED TREE STRUCTURES

UNIT III MELDABLE HEAP STRUCTURES

UNIT IV NP COMPLETENESS
NP Classes- Polynomial Time Verification – Theory of Reducibility - NP Completeness Proof for Vertex Cover & Hamiltonian Cycle

UNIT V APPROXIMATION ALGORITHMS
Approximation Algorithms: Vertex Cover & Euclidean Travelling Salesperson Problem- Randomized Algorithms: Closest Pair Problem & Minimum Spanning Trees

TOTAL: 45 PERIODS

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to

CO1: Understand, design and implement balanced search structures
CO2: Analyse algorithms for time complexity
CO3: Understand and implement different meldable priority queues
CO4: Appreciate Approximation and randomized algorithm design
CO5: Apply various data structures for solving problems

CO-PO Mapping

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CP3153  MULTICORE ARCHITECTURES  L  T  P  C
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UNIT I  FUNDAMENTALS OF COMPUTER DESIGN AND ILP  9

UNIT II  MEMORY HIERARCHY DESIGN  9

UNIT III  MULTIPROCESSOR ISSUES  9

UNIT IV  EXPLOITING DIFFERENT TYPES OF PARALLELISM  9

UNIT V  DOMAIN SPECIFIC ARCHITECTURES  9
Introduction to Domain Specific Architectures - Guidelines for DSAs. Case Studies - Example Domain: Deep Neural Networks - Google’s Tensor Processing Unit - Microsoft Catapult - Intel Crest - Pixel Visual Core. CPUs Versus GPUs Versus DSAs.

TOTAL: 45 PERIODS

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Discuss and evaluate the performance of computer systems
CO2: Discuss and point out the various ways of exploiting ILP
CO3: Point out the various optimizations that can be performed to improve the memory hierarchy design
CO4: Discuss the issues related to multiprocessing and suggest solutions
CO5: Point out the salient features of different multicore architectures and how they exploit different types of parallelism
CO6: Point out the salient features of different example domain specific architectures

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CP3154  
NETWORKING TECHNOLOGIES  
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UNIT I  NETWORK ARCHITECTURE AND QoS  

UNIT II  CELLULAR NETWORKS  

UNIT III  WIRELESS NETWORKS  
UNIT IV  4G NETWORKS

UNIT V  5G NETWORKS

SUGGESTED LIST OF EXPERIMENTS:
1. Configure networks using:
   a. Distance Vector Routing protocol
   b. Link State Vector Routing protocol
2. Implement the congestion control using Leaky bucket algorithm.
3. Installation of NS3.
4. Implementation Point to Point network using duplex links between the nodes. Analyze the packet transfer by varying the queue size and bandwidth. (using simulator)
5. Implement the dynamic routing protocol by varying the CBR traffic for each node and use a flow monitor( ) to monitor losses at nodes. (using simulator)
6. Create a wireless mobile ad-hoc network environment and implement the OLSR routing protocol. (using simulator)
7. Implement CDMA by assigning orthogonal code sequence for 5 stations, generate the CDMA code sequence and communicate between the stations using the generated code.
8. Create a GSM environment and implement inter and intra handover mechanisms. (using simulator)
10. Write python script to create topology in Mininet and configure OpenFlow switches with POX controller to communicate between nodes.

TOTAL: 90 PERIODS

REFERENCES
COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Identify the different features of integrated and differentiated services.
CO2: Demonstrate various protocols of wireless networks.
CO3: Analyze the use of next generation networks.
CO4: Design protocols for cellular networks.
CO5: Explore 5G networks and applications.

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OR3101 LINEAR PROGRAMMING AND APPLICATIONS L T P C 3 0 2 4

UNIT I BASIC STRUCTURES AND ALGORITHM 9

UNIT II ADVANCED LINEAR PROGRAMMING 9

UNIT III MELDABLE HEAP STRUCTURES 9
Sensitivity Analysis or Post Optimality Analysis – Changes in the Right-handside– Objective function – Changes affecting feasibility – Changes affecting optimality.

UNIT IV INTEGER PROGRAMMING 9

UNIT V CASE STUDIES AND TOOLS 9
Case Studies – Production Planning– Manpower planning– Solving LP problems using TORA / LINDO / LINGO / LP Solver using R

LIST OF EXPERIMENTS:
1. Solving simplex maximization problems using R programming.
2. Solving simplex minimization problems using R programming.
3. Solving mixed constraints problems – Big M & Two phase method using TORA.
4. Solving transportation problems using R.
5. Solving assignment problems using R.
6. Solving optimization problems using LINGO.
7. Studying Primal-Dual relationships in LP using TORA.
8. Solving LP problems using dual simplex method using TORA.
9. Sensitivity & post optimality analysis using LINGO.

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Mathematically formulate and solve minimization/maximization problems.
CO2: Solve transportation and assignment problems.
CO3: Analyse sensitivity, post optimality, changes affecting feasibility and optimality.
CO4: Model and solve integer programming problems like travelling salesman problems.
CO5: Solve linear programming problems using software tools.

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CP3161 DATA STRUCTURES AND ALGORITHMS LABORATORY

LIST OF EXPERIMENTS:
1. Linked list implementation of Stack and Queue ADTs
2. Binary Search tree
3. Min/Max Heap
4. AVL tree
5. Red-Black tree
6. Splay Tree
7. Leftist Heap
8. Binomial Heap

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Apply suitable data structures in problem solving.
CO2: Select suitable search structures for an application
CO3: Understand priority queue implementations

TOTAL: 45+30=75 PERIODS

TOTAL: 60 PERIODS
CO4: Differentiate between approximation and Randomized algorithms
CO5: Understand NP complete problem solutions

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CP3152 DATABASE TECHNOLOGIES

UNIT I RELATIONAL MODEL

UNIT II PARALLEL AND DISTRIBUTED DATABASES

UNIT III ADVANCED DATABASES

UNIT IV ACTIVE TEMPORAL AND DEDUCTIVE DATABASES

UNIT V NOSQL DATABASES

TOTAL: 45 PERIODS
REFERENCES
8. David Lane, Hugh.E.Williams, Web Database Applications with PHP and MySQL, O'Reilly Media; 2nd edition, 2004

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Design a Relational Database for an Enterprise.
CO2: Design a Distributed Database, Active Database and Temporal Database for an Enterprise.
CO3: Gain the knowledge in advanced databases.
CO4: Comprehend the use of XML Database, Web Database, Spatial Database, Multimedia Database and Deductive Database.
CO5: Use MongoDB NoSQL Database to Maintain Data of an Enterprise.

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CP3252 MACHINE LEARNING

UNIT I INTRODUCTION

UNIT II SUPERVISED LEARNING METHODS
UNIT III  UNSUPERVISED AND REINFORCEMENT LEARNING  9

UNIT IV  PROBABILISTIC GRAPHICAL MODELS AND EVOLUTIONARY LEARNING  9

UNIT V  NEURAL NETWORKS AND DEEP LEARNING  9

TOTAL: 45 PERIODS

SUGGESTED LIST OF EXPERIMENTS  45
1. Problem solving using Regression models: Linear regression, Logistic regression and to evaluate the performance.
2. Problem solving using Classification: SVM, K-nearest Neighbour, and Decision Trees and evaluate the performance.
3. Solving problems based on Decision by committee approach : Bagging and Boosting application
4. Problem solving using unsupervised learning models : Clustering algorithms and to evaluate the performance.
5. Application of dimensionality reduction techniques for numeric and text and image data.
6. Game development and robotic application development using reinforcement learning model.
7. Implement Bayesian Inference in Gene Expression Analysis
8. Implement Sequential Learning using Hidden Markov Model
9. Application of CRFs in Natural Language Processing
11. Image Classification using Convolutional Neural Networks with cross validation.

TOTAL: 90 PERIODS

REFERENCES
COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Explain the basic concepts of machine learning
CO2: Analyze linear and non-linear techniques for classification problems
CO3: Apply unsupervised and reinforcement algorithms, probabilistic and evolutionary approaches for the given problems
CO5: Identify applications suitable for different types of Machine Learning and to Implement appropriate learning algorithm for an application and to analyze the results.

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OR3201 NON-LINEAR PROGRAMMING  
UNIT I INTRODUCTION  
Linear vs nonlinear programming – basic properties of solutions and algorithms – first order necessary conditions – examples of unconstrained problems – second order conditions – convex and concave functions – minimization and maximization of convex functions – saddle points – jacobian matrix

UNIT II ONE DIMENSIONAL OPTIMIZATION  

UNIT III MULTI-DIMENSIONAL OPTIMIZATIONS  

UNIT IV UNCONSTRAINED OPTIMIZATION FOR CONSTRAINED PROBLEMS  

UNIT V EVOLUTIONARY PROGRAMMING  
LIST OF EXPERIMENTS:
1. Develop a program to solve first order ordinary differential equations
2. Develop a program to determine minima and maxima when given a of convex function
3. Implement Golden section search for solving one dimensional optimization problems
4. Implement Steepest descent method for solving one dimensional optimization problems
5. Implement Newton’s method for solving one dimensional optimization problems
6. Implement Conjugate directions method for solving multi-dimensional optimization problems
7. Implement Conjugate gradient method for solving multi-dimensional optimization problems
8. Implement Quasi-Newton method for solving multi-dimensional optimization problems
9. Implement Lagrange method for solving unconstrained optimization problems
10. Implement Parallel Steepest descent method for solving one dimensional optimization problems

TOTAL: 45+30=75 PERIODS

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to

CO1: Formulate mathematically the optimization problem and solve minimization/ maximization problems.

CO2: Mathematically formulate and solve 1-dimensional/multi-dimensional nonlinear problems.

CO3: Identify methods to solve constrained and unconstrained optimization problems.

CO4: Understand meta-heuristic and evolutionary approaches to obtain global optima and their application scenarios.

CO5: Apply the concepts of nonlinear programming in complex multi-disciplinary fields of engineering.

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UNIT I  EVOLUTION OF IT ORGANIZATIONS
Governance Structure-Decentralized and Ad Hoc Governance – Centralized Governance
Agile and DevOps- Digital Transformation and Cloud Computing- Continuous Governance
and Automation – Vision, mission, and goals- Technology landscape –
Offerings and revenues – Geography and niche products–Growth trajectory-Comprehend the roles
and functions of supporting organizations (R&D, Innovation, Infrastructure, L&D,
Knowledge Management, Asset Creation).

UNIT II  PROJECT DEVELOPMENT LIFE CYCLE (PDLC)
Know Your Customer (KYC) process – Business case preparation – Cost-benefit analysis –
Benchmarking – Approval and execution. Artefacts: User Requirements Specification (URS),
System Requirements Specification (SRS), High-Level Design (HLD), Low-Level Design (LLD),
testing phases

UNIT III  CUSTOMER ACQUISITION PROCESS
Non-Disclosure Agreement (NDA) - Request for Information (RFI) - Request for Quotation (RFQ) -
Request for Proposal (RFP) - Award of Contracts, Various types of Contracts such as Fixed Price
(FP), Time and Material (T&M), Outcome-Based.

UNIT IV  PROJECT EXECUTION MODELS
Water Fall, Agile, Incremental – Scrum Framework – Clauses in contracts – SDLC – Roles and
Responsibilities – Industry 4.0 – Quality Requirements and Quality Management – NFR – Software

UNIT V  INDUSTRY STANDARDS
Cyber security & Data- governance – CMMI – Security standards (ISO27001) – Environment
standard (ISO12000).

TOTAL: 60 PERIODS

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1:Understand the IT organizations governance and various factors influencing them.
CO2:Understand the customer acquisition process and the working models of various IT
organizations and services.
CO3:Understand the technologies for various requirements & develop competences in those
respective technical areas to deliver transformational projects.
CO4:Understand the value creation by the supporting organisation to deliver world class software
projects and to gain highest customer satisfaction to the QCD.
CO5:Apply breakthrough technical competencies in producing futuristic models, estimation of NFRs,
Risks.

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UNIT I  INTRODUCTION  9

UNIT II  DETERMINISTIC DYNAMIC PROGRAMMING  9

UNIT III  PROBABILISTIC DYNAMIC PROGRAMMING  9

UNIT IV  DYNAMIC PROGRAMMING IN MARKOV CHAINS  9

UNIT V  RISK AND UNCERTAINTY  9

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Identify and formulate dynamic programming problems and also comprehend characteristics of dynamic programming problems.
CO2: Analyse and solve deterministic dynamic programming problems.
CO3: Analyse the computational feasibility and solve multi-stage stochastic dynamic programming problems using known efficient methods.
CO4: Understand and apply HMM models.
CO5: Design and solve decision making problems under risk.
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OR3001 PYTHON PROGRAMMING FOR OPTIMIZATION TECHNIQUES  L T P C
3 0 2 4

UNIT I INTRODUCTION TO PYTHON

UNIT II PROGRAM ORGANIZATION AND FUNCTIONS
Organize Large programs into functions – Python functions including scoping rules and Documentation strings – Modules and Libraries – Organize programs into modules – Installing third-party libraries. System administration, Text processing, Subprocesses, Binary data handling, XML parsing and Database Access

UNIT III CLASSES AND OBJECTS
Introduction to Object-oriented programming – Basic principles of Object-oriented programming in Python – Class definition, Inheritance, Composition, Operator overloading and Object creation – Solving problems in calculus, linear algebra and differentiation using libraries like scipy, numpy, sympy – Plotting using matplotlib

UNIT IV SOLVING OPTIMIZATION PROBLEMS USING SCIPY.OPTIMIZE

UNIT V MATHEMATICAL MODELING AND SOLVING USING PYomo
Mathematical modeling – Overview of modeling components and processes – Abstract vs Concrete models – Simple abstract pyomo model – simple concrete pyomo model – Solving simple examples

TOTAL : 45+30 = 75 PERIODS

REFERENCES
COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Design solutions using python classes and objects.
CO2: Mathematically model real time problems and solve using python packages.
CO3: Identify and apply suitable python functions for a given problem.
CO4: Apply the knowledge of optimization techniques and create solutions to complex engineering problems using python.
CO5: Demonstrate skill in development of optimization solvers and synthesis of the information to provide valid inferences.

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OR3002 SYSTEMS MODELLING AND SIMULATION  L T P C
3 0 2 4

UNIT I  INTRODUCTION  9+6
System definition - Types and characteristics - Need for modelling and simulation - Types of Simulation - Introduction to discrete event simulation - Single server - Multiserver Exercises - System modelling - Simple Petrinets

UNIT II  MODELLING APPROACHES  9+6
Modelling concurrent systems - Analysis of Petrinets - Finite state Automata and Regular Expressions - Relationship - FSA with silent transitions - Pumping lemma for regular sets - Analysis using DFS and model checking

UNIT III  QUEUING MODELS  9+6
Characteristics of queuing systems - Notations - Types of Queues - Markovian model - Non-Markovian model - Queuing Networks - Applications of queuing systems

UNIT IV  SIMULATION DATA  9+6
Methods for generating random numbers - Testing of random numbers - Methods of generating random variants - Problem formulation - input modelling - Verification and Validation - Output Analysis

UNIT V  CASE STUDY  9+6
NS2 - Simulation of Computer Systems - Simulation of Computer Networks - Simulation of Mobile Networks - Simulation of Manufacturing and Material Handling Systems

TOTAL : 45+30 = 75 PERIODS

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Understand the characteristics of system modelling and the importance of simulation.
CO2: Design system model using various approaches.
CO3: Apply queueing theory to various systems.
CO4: Generate data for simulation.
CO5: Model and analyse a given system using simulation tools.

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OR3003 PROJECT MANAGEMENT WITH PERT/CPM

UNIT I INTRODUCTION
PERT and CPM come of age – planning scheduling and control planning - scheduling networks – The activity – Node Diagram – Building a house – Network scheduling

UNIT II ALGORITHMS FOR CRITICAL PATH
Finding the critical path – Multiple critical paths – Job slack – Algorithm for finding the critical path – Late start and Late finish times – Total slack – Free slack – project due dates that differ from earliest completion time – A digression on stack – Back to the contractor

UNIT III PERT MODEL
UNIT IV  COST ANALYSIS  9+6
PERT/ cost : A network cost accounting system - Basic concepts of Network Cost Systems - cost accounting by work packages - forecast of project costs - Analysis and control of project costs - Graphic displays of cost and time data - cost curve for activities and departments - possible accounting problems with PERT/cost.

UNIT V  HEURISTIC APPROACHES  9+6
Network scheduling with limited resources-The complexity of project scheduling with limited resources - Heuristic programs - Heuristic methods for resource leveling of project schedules - Example of a resource leveling programs - Heuristic methods for resource allocation in project scheduling- A simple heuristic program - The SPAR-1 resource allocation model - Conceptual problems of critical path analysis when resources are limited - Slack in a limited resource schedule-projects with uncertain activity estimates - planning versus scheduling - conclusion.

TOTAL : 45+30 = 75 PERIODS

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Conceptually understand the project elements, activities and its effect on project planning.
CO2: Identify the critical activities.
CO3: Identify parallel activities.
CO4: Create a project scheduling incorporating all critical values.
CO5: Optimize effectively through complementary tools

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UNIT I  INTRODUCTION  9
Classification of optimization problems - Queuing theory - Stochastic process - Birth and death model - Kendall’s notation for representing queuing model - Stochastic analysis - Little’s theorem - Jackson queuing networks

UNIT II  SHORTEST PATH PROBLEMS  9
Shortest path problems - max-flow problem - min-cost flow problem - Simplex methods for min-cost flow - Dual ascent methods for min-cost flow.

UNIT III  NON-LINEAR NETWORK OPTIMIZATION  9

UNIT IV  INTEGER CONTRAINTS NETWORK PROBLEMS  9

UNIT V  CASE STUDIES  9
Nature inspired algorithms - Optimization as markov chains - TCP modeling - solving optimization problems using NS3/OPNET/QUALNET.

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Apply the knowledge of optimization techniques in computer networks.
CO2: Design solutions to flow problems in real time networks.
CO3: Formulate network problems as optimization problems and obtain optimal solutions.
CO4: Apply linear, nonlinear and integer programming techniques to network problems.
CO5: Develop and test algorithms using simulation tools.
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### OR3005  SUPPLY CHAIN MANAGEMENT  L T P C

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### UNIT II  FORECASTING  9


### UNIT III  INVENTORY MANAGEMENT AND RISK POOLING  9


### UNIT IV  NETWORK PLANNING AND PROCUREMENT STRATEGY  9


### UNIT V  INFORMATION TECHNOLOGY IN SUPPLY CHAIN MANAGEMENT  9

Enabling supply chain through IT – ERP vendor platforms – Service oriented architecture (SOA) – RFID

TOTAL : 45 PERIODS

### REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Understand the management of supply chain assembly.
CO2: Forecast the demand and plan for supply.
CO3: Manage large inventory system with various system approaches.
CO4: Acquire knowledge in planning and procurement strategies.
CO5: Apply IT solutions like ERP & SOA to manage supply chain.

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OR3006 CONVEX OPTIMIZATION TECHNIQUES L T P C 3 0 0 3

UNIT I INTRODUCTION 9

UNIT II CONVEX OPTIMIZATION PROBLEMS 9

UNIT III DUALITY 9

UNIT IV UNCONSTRAINED AND EQUALITY CONSTRAINED MINIMIZATION 9

UNIT V INTERIOR POINT METHODS 9

TOTAL: 45 PERIODS
REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Identify and mathematically formulate convex optimization problems.
CO2: Solve constrained and unconstrained optimization problems by identifying and using various algorithms.
CO3: Understand duality and interior point methods in solving convex optimization problems.
CO4: Apply the concepts of convex optimization in real life scenarios.
CO5: Provide inferences from the obtained solutions to aid planning and decision making.

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OR3007 NUMERICAL OPTIMIZATION L T P C
3 0 0 3

UNIT I INTRODUCTION

UNIT II COMPLEXITY ISSUES

UNIT III UNCONSTRAINED OPTIMIZATION

UNIT IV CONSTRAINED OPTIMIZATION
UNIT V  CASE STUDIES


TOTAL : 45 PERIODS

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to

CO1: Formulate and analyse the existence of solutions to optimization problems.

CO2: Understand the basics of linear programming, unconstrained and constrained optimization.

CO3: Analyse the stability, order of convergence and conditions of application of techniques.

CO4: Solve unconstrained and constrained optimization problems.

CO5: Apply the knowledge of numerical optimization techniques to complex engineering problems and provide inferences from the obtained solutions to aid planning and decision making.

CO-PO Mapping

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CP3056  CLOUD COMPUTING TECHNOLOGIES  L T P C
3 0 2 4

UNIT I  DISTRIBUTED SYSTEMS AND ENABLING TECHNOLOGIES  9

UNIT II  VIRTUALIZATION  9
Implementation Levels of Virtualization - Virtualization Structures, Tools and Mechanisms - Virtualization of CPU, Memory, and I/O Devices - Virtual Clusters and Resource Management - Virtualization for Data-Center Automation.
UNIT III  CLOUD COMPUTING  9

UNIT IV  EXPLORING CLOUD PLATFORMS AND SERVICES  9

UNIT V  SECURITY AND INTER-CLOUD  9
Trust Management - Defence Strategies - Distributed Intrusion/Anomaly Detection - Data and Software Protection Techniques - Reputation-Guided Protection of Data Centers - Inter-cloud Resource Management.

PRACTICAL EXERCISES  30
1. Experiment with public SaaS
2. Create a software using public PaaS
3. Experiment storage services in cloud
4. Create VMs in public cloud platforms
5. Experiment with load balancing
6. Experiment with elasticity in the cloud
7. Interlink storage services with VMs
8. Set up a virtual private cloud using public cloud platforms
9. Set up an open source private cloud
10. Experiment with CLI in the open source private cloud

TOTAL: 75 PERIODS

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1:Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
CO2:Identify the architecture, infrastructure and delivery models of cloud computing.
CO3:Explain the core issues of cloud computing such as security, privacy and interoperability.
CO4:Choose the appropriate technologies, algorithms and approaches for the related issues.
CO5: Set up and use cloud platforms and services.

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CP3063 ETHICAL HACKING

UNIT I INTRODUCTION TO HACKING 9

UNIT II INFORMATION SECURITY 9
Types of malware – Types of Vulnerabilities- Types of attacks and their prevention mechanism - Keystroke Logging - Denial of Service (DoS /DDoS) - Waterhole attack -brute force - phishing and fake WAP- Eavesdropping- Man-in-the-middle- Session Hijacking -Clickjacking -Cookie Theft - URL Obfuscation- buffer overflow- DNS poisoning -ARP poisoning -Identity Theft - IoT Attacks - BOTs and BOTNETs

UNIT III INFORMATION GATHERING AND SCANNING 9

UNIT IV EXPLOITATION 9

UNIT V ENTERPRISE SECURITY 9

**REFERENCES**


**COURSE OUTCOMES:**

Upon completion of the course, the students will be able to:

**CO1:** Use the various security tools to assess the computing system.

**CO2:** Predict the vulnerabilities across any computing system using penetration testing.

**CO3:** Identify prediction mechanism to prevent any kind of attacks.

**CO4:** Protect the system from malicious software and worms.

**CO5:** Analyze the risk and support the organization for effective security measures.

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**CP3068**

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**UNIT I**

**ARCHITECTURES AND MODELS**

9+6


**UNIT II**

**CONNECTIVITY**

9+6

Communications Criteria –PHY/MAC layer- Network Layer–Transport Layer –Application Transport Methods– Application Layer-Interoperability in IoT.

**UNIT III**

**SYSTEM DEVELOPMENT**

9+6

Design Methodology –Case study –Basic blocks of IoT device –Raspberry Pi –Board, Interfaces, Linux, Sensors, Programming –Arduino –Other IoT Devices.
UNIT IV  DATA ANALYTICS AND IoT SECURITY  9+6

UNIT V  IoT IN INDUSTRY  9+6

TOTAL: 75 PERIODS

REFERENCES
7. Matt Richardson & Shawn Wallace, Getting Started with Raspberry Pi, O'Reilly(SPD), 2014

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Explain the underlying architectures and models in IoT.
CO2: Analyze different connectivity technologies for IoT.
CO3: Develop simple applications using Arduino / Raspberry Pi.
CO4: Apply data analytics techniques to IoT.
CO5: Study the needs and suggest appropriate solutions for Industrial applications

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UNIT I PROCESS MODELS

UNIT II REQUIREMENTS MODELING

UNIT III ARCHITECTURE AND DESIGN CONCEPTS

UNIT IV SOFTWARE QUALITY AND TESTING

UNIT V DEVOPS

TOTAL: 45 PERIODS

REFERENCES
COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Select Appropriate Process Model for Software Development.
CO2: Analyze user requirements and design S/W using object-oriented methodology in UML
CO3: Apply the various design patterns in software development
CO4: Incorporate appropriate quality factors and standards during Software Development
CO5: Apply software testing techniques in various software development stages

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CP3072 PARALLEL ALGORITHMS

UNIT I INTRODUCTION

UNIT II PROCESSOR ORGANISATION
Mesh -Binary Tree Network-Hyper Tree Network- Pyramid – Butterfly- Hypercube –Shuffle- Exchange Networks – Multiprocessor- Multicomputer- Data Mapping

UNIT III SORTING & SEARCHING
Sorting Networks – Sorting on a Linear Array – Sorting on CRCW, CREW, EREW – Searching a sorted sequence – Searching a random sequence – Bitonic Sort

UNIT IV ALGEBRAIC PROBLEMS

UNIT V GRAPH ALGORITHMS

TOTAL: 45 PERIODS

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Understand the difference between sequential and parallel algorithms.
CO2: Design parallel algorithms in various models of parallel computation.
CO3: Understand various parallel processor organizations
CO4: Design parallel searching and sorting algorithms
CO5: Design parallel graph algorithms

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CP3351   CYBER SECURITY       L T P C
                                                   3 0 0 3

UNIT I    INTRODUCTION         9
Need for Cyber security - History of Cyber security - Defining Cyberspace and Cyber security - Standards - CIA Triad – Cyber security Framework

UNIT II   ATTACKS AND COUNTERMEASURES 9

UNIT III  SECURING THE INFRASTRUCTURE 9
Infrastructure Security in the Real World - Understanding Access-Control and Monitoring Systems - Understanding Video Surveillance Systems - Understanding Intrusion-Detection and Reporting Systems

UNIT IV   SECURING LOCAL HOSTS AND NETWORKS 9
Local Host Security in the Real World - Securing Devices - Protecting the Inner Perimeter - Protecting Remote Access

UNIT V    TOOLS                9

TOTAL: 45 PERIODS
REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Analyze and evaluate the cyber security needs of an organization.
CO2: Analyze the security issues in networks and computer systems to secure an infrastructure.
CO3: Design operational cyber security strategies and policies.
CO4: Apply critical thinking and problem-solving skills to detect current and future attacks on an organization’s computer systems and networks.
CO5: Understand the functionality of cyber security tools.

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CP3065 GAME THEORY L T P C 3 0 0 3

UNIT I INTRODUCTION 8

UNIT II GAMES WITH PERFECT INFORMATION 10
Games with Perfect Information – Strategic games – prisoner’s dilemma, matching pennies- Nash equilibrium- theory and illustrations – Cournot and Bertrand models of oligopoly- auctions- mixed strategy equilibrium- zero-sum games- Extensive Games with Perfect Information-repeated games (prisoner’s dilemma)- subgame perfect Nash equilibrium; computational issues.
UNIT III  GAMES WITH IMPERFECT INFORMATION

UNIT IV  NON-COOPERATIVE GAME THEORY

UNIT V  MECHANISM DESIGN

REFERENCES
1. Thomas S. Ferguson, Game Theory, Web notes available at (https://www.cs.cmu.edu/afs/cs/academic/class/15859s05/www/ferguson/comb.pdf)

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Discuss the notion of a strategic game and equilibria and identify the characteristics of main applications of these concepts.
CO2: Discuss the use of Nash Equilibrium for other problems.
CO3: Identify key strategic aspects and based on these be able to connect them to appropriate game theoretic concepts given a real world situation.
CO4: Identify some applications that need aspects of Bayesian Games.
CO5: Implement a typical Virtual Business scenario using Game theory.

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CP3059 DATABASE ADMINISTRATION AND TUNING

UNIT I FUNDAMENTALS OF DATABASE ADMINISTRATION


UNIT II DATABASE SECURITY, BACKUP AND RECOVERY


UNIT III PERFORMANCE MANAGEMENT

Designing the DBMS Environment for Recovery - Types of Recovery - DBA Tools - Monitoring Vs Management - Service level management - Performance parameters - Performance Tuning Tools - Techniques for Optimizing Databases - Database reorganization - Files and datasets - space management - Loading and unloading data - bulk data movement - Client server computing

UNIT IV DATABASES AND INDEX TUNING


UNIT V OPTIMIZATION AND TROUBLESHOOTING

Finding 'Suspicious' Queries – Analysing Query’s Access Plan – Profiling Query Execution. Tuning DBMS Subsystems - Disk Subsystem - Buffer Manager - Logging Subsystem - Locking Subsystem. Troubleshooting CPU, Disks and Controllers, Memory, and Networks

TOTAL: 45 PERIODS

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: An ability to understand various DBA roles, tasks and tools
CO2: Apply various Database recovery, backup and security privileges and
CO3: Differentiate between monitoring and management in the context of database administration and explain their respective roles in ensuring database performance and availability.
CO4: Effectively tune and optimize relational databases, including query optimization, concurrency control, recovery subsystem tuning, index selection, and hardware considerations.
CO5: Possess the skills to effectively optimize and tune database systems by employing techniques such as normalization, denormalization, clustering, query tuning, performance monitoring, and troubleshooting various subsystems.

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CP3058 DATA WAREHOUSING AND DATA MINING TECHNIQUES L T P C
3 0 0 3

UNIT I INTRODUCTION TO DATA WAREHOUSING
Data Warehouse: Basic Concepts - Differences between Operational Database Systems and Data Warehouses- Data warehousing Components – Data Warehousing: A Multi-tiered Architecture –
Data Warehouse Models: Enterprise Warehouse, Data Mart, distributed and virtual data warehouses - Building a Data warehouse - Data Warehouse and DBMS, - Data Extraction, Cleanup, and Transformation Tools - Data marts, Metadata, Multidimensional data model, Data Warehouse Modeling: Data Cube and OLAP , OLAP operations, Schemas for Multidimensional Database – Metadata.

UNIT II DATA WAREHOUSE PROCESS AND ARCHITECTURE 9

UNIT III INTRODUCTION TO DATA MINING 9
Data Objects and Attribute Types - Basic Statistical Descriptions of Data - Measuring Data Similarity and Dissimilarity - KDD versus data mining, Stages of the Data Mining Process-task primitives, Data Mining Techniques - Data preprocessing – Data cleaning, Data Integration, Data Transformation and Data Discretization, Data reduction - Association Rule Mining: Frequent Item set Mining Methods – Pattern Evaluation Methods – Association Mining to Correlation Analysis.

UNIT IV CLASSIFICATION AND CLUSTERING 9

UNIT V TRENDS IN DATA MINING 9

TOTAL: 45 PERIODS

REFERENCES
COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Evolve multidimensional intelligent model from typical system.
CO2: Design and implement data warehouse and to do Business Analytics.
CO3: Acquire knowledge on data and to prepare data for mining
CO4: Design and deploy classification and clustering techniques.
CO5: Evaluate various mining techniques on complex data objects.

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BD3151 BIG DATA MINING AND ANALYTICS

UNIT I DATA MINING AND LARGE SCALE FILES

UNIT II SIMILAR ITEMS

UNIT III 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

UNIT IV LINK ANALYSIS AND FREQUENT ITEMSETS

UNIT V CLUSTERING

TOTAL: 45 PERIODS

REFERENCES

COURSE OUTCOMES:
Upon completion of the course, the students will be able to
CO1: Design algorithms by employing Map Reduce technique for solving Big Data problems.
CO2: Identify similarities using appropriate measures.
CO3: Point out problems associated with streaming data and handle them.
CO4: Discuss algorithms for link analysis and frequent itemset mining.
CO5: Design solutions for problems in Big Data by suggesting appropriate clustering techniques.

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Attested

DIRECTOR
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