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

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.

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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.

Attested

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

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
1.	3	3	3	2	2	3
2.	2	3	3	2	3	2
3.	1	2	2	2	1	2
4.	1	1	1	3	3	3
5.	1	3	2	1	1	2

Mapping of Course Outcome and Programme Outcome

			PO1	PO2	PO3	PO4	PO5	PO6
YEAR 1	SEM1	Advanced Mathematics for Scientific Computing	3	3	3	3	2	2
		Data Structures and Algorithms	2.5	-	3	2.2	-	-
		Networking Technologies	2	1	3	2.2	-	2.2
		Linear Programming and Applications	2.2	2.2	2.2	2.2	1.6	2
		Research Methodology and IPR						
		Data Structures and Algorithms Laboratory	3	3	3	2	1	2
	SEM2	Database Technologies	2	-	2.4	2.33	-	-
		Machine Learning	2.6	-	3	3	-	3
		Non-Linear Programming	2	1	3	2.2	-	2.2
		Professional Elective I	2.8	2.2	2.4	2.2	2.5	2
		Professional Elective II	2.2	2.2	2.2	2.2	1.6	2
		Machine Learning Laboratory						
		Professional Practices						
YEAR 2	SEM3	Dynamic Programming	3	2.6	2.2	2.2	3	2
		Professional Elective III						
		Professional Elective IV						
		Professional Elective V						
		Project Work I						
	SEM4	Project Work II						

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CURRICULA AND SYLLABI

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3154	Advanced Mathematics for Scientific Computing	FC	4	0	0	4	4
2.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3
3.	CP3151	Data Structures and Algorithms	PCC	3	0	0	3	3
4.	CP3153	Multicore Architectures	PCC	3	0	0	3	3
5.	CP3154	Networking Technologies	PCC	3	0	3	6	4.5
6.	OR3101	Linear Programming and Applications	PCC	3	0	2	5	4
PRACTICALS								
7.	CP3161	Data Structures and Algorithms Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**1**	**9**	**28**	**23.5**

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CP3152	Database Technologies	PCC	3	0	0	3	3
2.	CP3252	Machine Learning	PCC	3	0	3	6	4.5
3.	OR3201	Non-Linear Programming	PCC	3	0	2	5	4
4.		Professional Elective I	PEC	3	0	2	5	4
5.		Professional Elective II	PEC	3	0	0	3	3
PRACTICALS								
6.	CP3261	Professional Practices	EEC	0	0	4	4	2
			TOTAL	**15**	**0**	**11**	**26**	**20.5**

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SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
THEORY								
1.	OR3301	Dynamic Programming	PCC	3	0	0	3	3
2.		Professional Elective III	PEC	3	0	2	5	4
3.		Professional Elective IV	PEC	3	0	0	3	3
4.		Professional Elective V	PEC	3	0	0	3	3
PRACTICALS								
5.	OR3311	Project Work I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**14**	**26**	**19**

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK L	T	P	TOTAL CONTACT PERIODS	CREDITS
PRACTICALS								
1.	OR3411	Project Work II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 75

FOUNDATION COURSES (FC)

SL. NO	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1.	MA3154	Advanced Mathematics for Scientific Computing	FC	4	4	0	0	4

PROFESSIONAL CORE COURSES (PCC)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	CONTACT PERIODS	C
1.	CP3151	Data Structures and Algorithms	PCC	3	0	0	3	3
2.	CP3153	Multi Core Architectures	PCC	3	0	0	3	3
3.	CP3154	Networking Technologies	PCC	3	0	3	6	4.5
4.	OR3101	Linear Programming and Applications	PCC	3	2	0	5	4
5.	CP3161	Data Structures and Algorithms Laboratory	PCC	0	0	4	4	2
6.	CP3152	Database Technologies	PCC	3	0	0	3	3
7.	CP3252	Machine Learning	PCC	3	0	3	6	4.5
8.	OR3201	Non-Linear Programming	PCC	3	0	0	3	3

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PROFESSIONAL ELECTIVES (PE)

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	CONTACT PERIODS	C
1.	OR3001	Python Programming for Optimization Techniques	PEC	3	0	2	5	4
2.	OR3002	System Modelling and Simulation	PEC	3	0	2	5	4
3.	OR3003	Project Management with PERT/CPM	PEC	3	0	2	5	4
4.	OR3004	Network Optimization	PEC	3	0	0	3	3
5.	OR3005	Supply Chain Management	PEC	3	0	0	3	3
6.	OR3006	Convex Optimization Techniques	PEC	3	0	0	3	3
7.	OR3007	Numerical Optimization	PEC	3	0	0	3	3
8.	CP3056	Cloud Computing Technologies	PEC	3	0	2	5	4
9.	CP3063	Ethical Hacking	PEC	3	0	0	3	3
10.	CP3068	Internet of Things	PEC	3	0	2	5	4
11.	CP3052	Advanced Software Engineering	PEC	3	0	0	3	3
12.	CP3072	Parallel Algorithms	PEC	3	0	0	3	3
13.	CP3351	Cyber Security	PEC	3	0	0	3	3
14.	CP3065	Game Theory	PEC	3	0	0	3	3
15.	CP3059	Database Administration and Tuning	PEC	3	0	0	3	3
16.	CP3058	Data Warehousing and Data Mining Techniques	PEC	3	0	0	3	3
17.	BD3151	Big Data Mining and Analytics	PEC	3	0	0	3	3

RESEACH METHODOLOGY AND IPR (RMC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	RM3151	Research Methodology and IPR	RMC	2	1	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SI. No	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	CONTACT PERIODS	C
1.	CP3261	Professional Practices	EEC	0	0	4	4	2
2.	OR3311	Project Work I	EEC	0	0	12	12	6
3.	OR3411	Project Work II	EEC	0	0	24	24	12

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MA3154 ADVANCED MATHEMATICS FOR SCIENTIFIC COMPUTING **L T P C**
4 0 0 4

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

Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency – Maximum Likelihood Estimation – Method of moments.

UNIT IV TESTING OF HYPOTHESIS 12

Sampling distributions – Estimation of parameters - Statistical hypothesis – Tests based on Normal, t, Chi-square and F distributions for mean, variance and proportion, Tests for independence of attributes and goodness of fit.

UNIT V MULTIVARIATE ANALYSIS 12

Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.

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:

1. Jay L. Devore, “Probability and Statistics for Engineering and the Sciences”, Cengage Learning, 9th Edition, Boston, 2016.
2. Johnson, R.A, Irwin Miller and John Freund., “Miller and Freund’s Probability and Statistics for Engineers”, Pearson Education, 9th Edition, New York, 2016.
3. Johnson, R.A., and Wichern, D.W., “Applied Multivariate Statistical Analysis”, Pearson Education, Sixth Edition, New Delhi, 2013.
4. Ross. S.M., “Probability Models for Computer Science”, Academic Press, SanDiego, 2002.
5. Taha H.A.,, “Operations Research: An Introduction”, Prentice Hall of India Pvt. Ltd. 10th Edition, New Delhi, 2017.
6. Winston, W.L., “Operations Research”, Thomson – Brooks/Cole, Fourth Edition, Belmont, 2003.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	3	3	2	2
CO4	3	3	3	3	2	2
CO5	3	3	3	3	2	2
AVG	3	3	3	3	2	2

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

Attested

CO5: Execute patent filing and licensing

REFERENCES:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

CP3151	DATA STRUCTURES AND ALGORITHMS	L T P C
		3 0 0 3

UNIT I BASIC STRUCTURES AND ALGORITHM **9**

Stack- Queue - Linked List Implementation - Min/Max heap – Algorithm Analysis- Asymptotic Analysis- Solving Recurrence Relation – Amortized Analysis

UNIT II BALANCED TREE STRUCTURES **9**

Binary Search Trees – AVL Trees – Red-Black Trees – Multi-way Search Trees –B-Trees – Splay Trees – Tries

UNIT III MELDABLE HEAP STRUCTURES **9**

Leftist Tree- Leftist Heaps – Binomial Heaps – Fibonacci Heaps – Skew Heaps – Lazy Binomial Heaps –Deap

UNIT IV NP COMPLETENESS **9**

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

UNIT V APPROXIMATION ALGORITHMS **9**

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

TOTAL: 45 PERIODS

REFERENCES

1. Ellis Horowitz, Sartaj Sahni, Susan Anderson-Freed, “Fundamentals of Data Structures in C”, Second Edition, University Press, 2008.
2. Ellis Horowitz and Sartaj Sahni, “Fundamental of Computer Algorithms”, Galgotia, 1985.
3. R.C.T Lee, S.S Tseng, R.C Chang and Y.T Tsai, “Introduction to the Design and Analysis of Algorithms”, Tata McGraw-Hill Edition, 2012.
4. Thomas H Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, “Introduction to Algorithms”, Third Edition, Prentice Hall, 2010.

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

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			3	2		
CO2				2		
CO3			3	2		
CO4	3		3	2		
CO5	2		3	3		

CP3153 MULTICORE ARCHITECTURES **L T P C**
3 0 0 3

UNIT I FUNDAMENTALS OF COMPUTER DESIGN AND ILP 9
Fundamentals of Computer Design – Measuring and Reporting Performance – Instruction Level Parallelism and its Exploitation – Concepts and Challenges – Limitations of ILP – Multithreading – SMT and CMP Architectures – The Multicore era.

UNIT II MEMORY HIERARCHY DESIGN 9
Introduction – Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – Design of Memory Hierarchies – Case Studies.

UNIT III MULTIPROCESSOR ISSUES 9
Symmetric and Distributed Shared Memory Architectures – Cache Coherence Issues – Performance Issues – Synchronization Issues – Models of Memory Consistency – Interconnection Networks – Buses, Crossbar and Multi-stage Interconnection Networks.

UNIT IV EXPLOITING DIFFERENT TYPES OF PARALLELISM 9
Homogeneous and Heterogeneous Multi-core Architectures – Intel Multicore Architectures – SUN CMP architecture – IBM Cell Architecture. Introduction to Warehouse-Scale computers, Cloud Computing – Architectures and Issues. Vector, SIMD and GPU Architectures – Vector Architecture – SIMD Extensions for Multimedia – Graphics Processing Units – Case Studies – GPGPU Computing.

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

1. John L. Hennessey and David A. Patterson, "Computer Architecture – A Quantitative Approach", Morgan Kaufmann / Elsevier, 6th edition, 2019.
2. Wen–mei W.Hwu,"GPU Computing Gems", Morgan Kaufmann / Elsevier, 2011.

Attested

3. Yan Solihin, “Fundamentals of Parallel Multicore Architecture”, Chapman & Hall/CRC Press, 2016.
4. David B. Kirk, Wen-mei W. Hwu, “Programming Massively Parallel Processors”, Morgan Kauffman, 2010.

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

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	3	3	2	1	2
CO2	3	3	3	2	1	2
CO3	3	3	3	2	1	2
CO4	3	3	3	2	1	2
CO5	3	3	3	2	1	2
CO6	3	3	3	2	1	2

CP3154 NETWORKING TECHNOLOGIES L T P C
3 0 3 4.5

UNIT I NETWORK ARCHITECTURE AND QoS 9

Overview of TCP/IP Network Architecture –High Speed Networks – Frame Relay – Asynchronous Transfer Mode – High-Speed LANs –Integrated Services Architecture – Approach – Components – Services – Queuing Discipline – FQ – PS – BRFQ – GPS – WFQ – Random Early Detection – Differentiated Services.

UNIT II CELLULAR NETWORKS 9

GSM – Mobility Management and call control – GPRS – Network Elements – Radio Resource Management – Mobility Management and Session Management – Small Screen Web Browsing over GPRS and EDGE – MMS over GPRS – UMTS – Channel Structure on the Air Interface – UTRAN – Core and Radio Network Mobility Management – UMTS Security

UNIT III WIRELESS NETWORKS 9

IEEE 802.16 and WiMAX – Security – Advanced 802.16 Functionalities – Mobile WiMAX – 802.16e – Network Infrastructure – WLAN – Configuration – Management Operation – Security – IEEE 802.11e and WMM – QoS – Comparison of WLAN and UMTS – Bluetooth –Protocol Stack – Security – Profiles.

Attested

UNIT IV 4G NETWORKS 9

LTE – Network Architecture and Interfaces – FDD Air Interface and Radio Networks –Scheduling – Mobility Management and Power Optimization – LTE Security Architecture – Interconnection with UMTS and GSM – LTE Advanced (3GPPP Release 10) – 4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G.

UNIT V 5G NETWORKS 9

Introduction – Pillars – IoT and Context Awareness – Networking Reconfiguration and Virtualization Support – Mobility – QoS Control – Approach for resource over-provisioning – Smart Cells – Capacity limits and achievable gains with densification – Mobile data demand – Next Generation Wireless Networks – Mobile clouds – Technologies and Services for Future Communication Platforms – Cognitive Radio for 5G Wireless Networks.

SUGGESTED LIST OF EXPERIMENTS: 45

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)
9. In LTE environment implement Round Robin and Token Bank Fair Queue scheduler in MAC layer.
10. Write python script to create topology in Mininet and configure OpenFlow switches with POX controller to communicate between nodes.

TOTAL: 90 PERIODS

REFERENCES

1. William Stallings, "High Speed Networks and Internets: Performance and Quality of Service", Prentice Hall, Second Edition, 2002.
2. Martin Sauter, "From GSM to LTE, An Introduction to Mobile Networks and Mobile Broadband", Wiley, 2014.
3. Savo G Glisic, "Advanced Wireless Networks – 4G Technologies", John Wiley & Sons, 2007.
4. Jonathan Rodriguez, "Fundamentals of 5G Mobile Networks", Wiley, 2015.
5. Naveen Chilamkurti, SheraliZeadally, HakimaChaouchi, "Next-Generation Wireless Technologies", Springer, 2013.
6. Martin Sauter, "Beyond 3G – Bringing Networks, Terminals and the Web Together: LTE, WiMAX, IMS, 4G Devices and the Mobile Web 2.0", Wiley, 2009.
7. Erik Dahlman, Stefan Parkvall, Johan Skold, "4G: LTE/LTE-Advanced for Mobile Broadband", Academic Press, 2013.

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	1	-	2
CO2	1	1	3	1	-	2
CO3	3	1	3	3	-	2
CO4	2	1	3	3	-	3
CO5	2	1	3	3	-	2

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

UNIT I BASIC STRUCTURES AND ALGORITHM 9

Formulation and Graphical Solutions – Solution of Maximization Model – Solution of Minimization Model – Simplex method – Degeneracy – Unbounded Solution – Infeasible Solution – Alternative Optima.

UNIT II ADVANCED LINEAR PROGRAMMING 9

BIG-M method – Two–Phase method – Special cases in the Simplex method –Transportation and Assignment Problems – Revised Simplex Method – Duality in Linear Programming Problems –Dual Simplex method – Bounded variable technique.

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

Knapsack Problem – Cutting plane algorithm – Branch and bound programming – Mixed integer Programming – travelling salesperson problem.

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.

Attested

8. Solving LP problems using dual simplex method using TORA.
9. Sensitivity & post optimality analysis using LINGO.

TOTAL: 45+30=75 PERIODS

REFERENCES

1. Hamdy A.Taha, “Operations Research-An Introduction”, Prentice Hall, Tenth Edition,2017.
2. J.K.Sharma, “Operations Research Theory and applications”, Macmillan,6th Edition,2017.
3. Frederick S. Hiller, Gerald J Liberman, Bodhibrata Nag, PreetamBasu, “Introduction to Operations Research”,10th Edition,McGrawHill,,2017.
4. Ronald L.Rardin, “Optimization in Operations Research”, 2nd Edition PearsonEducation, Asia,2018.
5. DimitrisAlevras, Manfred W. Padberg, Linear Optimization and Extension: problems and Solutions, 1st Edition, Springa-Verlag Berlin and Heidelberg 2001.

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	1	1
CO2	2	2	2	2	1	2
CO3	2	2	2	2	1	2
CO4	3	3	3	2	3	3
CO5	2	2	2	3	2	2

CP3161 DATA STRUCTURES AND ALGORITHMS LABORATORY **L T P C**
0 0 4 2

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

TOTAL: 60 PERIODS

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

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-		3	-	-	-
CO2			3	-	-	-
CO3	-		2	2	-	-
CO4	-		2	2	-	-
CO5	2		2	3	-	-

CP3152 DATABASE TECHNOLOGIES

L T P C
3 0 0 3

UNIT I RELATIONAL MODEL 9

Entity Relationship Model – Relational Data Model – Mapping Entity Relationship Model to Relational Model – Relational Algebra – Structured Query Language – Database Normalization – First Normal Form – Second Normal Form – Third Normal Form – Boyce Codd Normal Form – Fourth Normal Form – Fifth Normal Form.

UNIT II PARALLEL AND DISTRIBUTED DATABASES 9

Parallel Databases – I/O Parallelism - Inter-Query and Intra-Query Parallelism– Inter-Operation and Intra-operation Parallelism – Performance evaluation for Parallel DB Systems –Distributed Database Architecture – Distributed Data Storage – Distributed Transactions – Distributed Query Processing – Distributed Transaction Management – Load balancing tools for DDB – DDB Security.

UNIT III ADVANCED DATABASES 9

XML Data Model – DTD – XML Schema – XML Querying – Web Databases – Open Database Connectivity – Java Database Connectivity – Accessing Relational Database using PHP – Analytical Operations involved in Processing Spatial Data –Spatial Data Types and Models–Spatial Operators and Spatial Queries–Spatial Data Indexing–Multimedia Database Concepts - Introduction to Deductive Databases–Prolog/Datalog Notation– Clausal Form and Horn Clauses–Interpretations of Rules.

UNIT IV ACTIVE TEMPORAL AND DEDUCTIVE DATABASES 9

Event Condition Action Model – Design and Implementation Issues for Active Databases – Termination, Confluence, Determination and Modularization – Temporal Databases –Interpreting Time in Relational Databases – Deductive Databases – Data log Queries

UNIT V NOSQL DATABASES 9

NoSQL Database vs.SQL Databases – CAP Theorem –Migrating from RDBMS to NoSQL – MongoDB – CRUD Operations– MongoDB Sharding – MongoDB Replication – Web Application Development using MongoDB with PHP and Java.

TOTAL: 45 PERIODS

REFERENCES
1. Ramez Elmasri, Shamkant B. Navathe, Fundamentals of Database Systems, Seventh Edition, Pearson Education, 2016.
2. Abraham Silberschatz, Henry F. Korth, S. Sudarshan, Database System Concepts, Seventh Edition, McGraw Hill Education 2020.
3. Brad Dayley, “Teach Yourself NoSQL with MongoDB in 24 Hours”, Sams Publishing, 2014.
4. Thomas Cannolly and Carolyn Begg, “Database Systems, A Practical Approach to Design, Implementation and Management”, Third Edition, Pearson Education, 2007.
5. V.S.Subramanian, “Principles of Multimedia Database Systems”, Harcourt India Pvt. Ltd.,2001.
6. C.J.Date, A.KannanandS.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.
7. ShashankTiwari, ”Professional NoSQL”, Wiley, 2011.
8. David Lane, Hugh.E.Williums, 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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	1	-	2
CO2	1	1	3	1	-	2
CO3	3	1	3	3	-	2
CO4	2	1	3	3	-	3
CO5	2	1	3	3	-	2

CP3252 MACHINE LEARNING **L T P C**
3 0 3 4.5

UNIT I INTRODUCTION 9
Machine Learning–Types of Machine Learning : Supervised Learning, Unsupervised Learning – Machine Learning process- Testing machine learning algorithms - Parametric Vs non-parametric models - Mathematical Basics for Machine Learning : Probability and Statistics for Machine Learning – Probability Distributions – Decision Theory – Information theory – Bias Variance tradeoff.

UNIT II SUPERVISED LEARNING METHODS 9
Regression: Introduction - Linear Regression - Least Squares - Under fitting and Overfitting - Cross-Validation - Lasso Regression - Logistic Regression; Classification: Linear and Non-linear models - - Support Vector Machines - Kernel Methods; K-Nearest Neighbours; Learning with Trees: constructing Decision Tree using ID3 - Classification and regression trees (CART); Decision by Committee : Ensemble Methods -- Bagging -- Boosting -- Random Forest; Evaluation of Classification Algorithms.

Attested

UNIT III UNSUPERVISED AND REINFORCEMENT LEARNING 9

Clustering- K-means – Mixtures of Gaussians – Vector Quantization – The Self Organizing Feature Map- Dimensionality Reduction, Linear Discriminant Analysis, Principal Components Analysis, Independent Components Analysis - Reinforcement Learning : Q learning, Deterministic and Non-deterministic Rewards and Actions Temporal Difference Learning - Markov Decision Process.

UNIT IV PROBABILISTIC GRAPHICAL MODELS AND EVOLUTIONARY LEARNING 9

Graphical Models – Undirected Graphical Models : Markov Random Fields – Directed Graphical Models : Bayesian Networks – Conditional Independence properties – Markov Random Fields, Hidden Markov Models – Conditional Random Fields(CRFs) - Evolutionary Learning : The Genetic Algorithm , Generating offspring - Map Colouring, Punctuated Equilibrium - Knapsack problem - Limitations of the GA.

UNIT V NEURAL NETWORKS AND DEEP LEARNING 9

Neural Networks: The Brain and the Neuron - Perceptron learning algorithm; Multi-Layer Perceptron: Back propagation algorithm - Multi-layer perceptron in Practice, Deep Learning: Introduction - Convolution Neural Networks - Recurrent Neural Networks – Stochastic Neurons : the Boltzmann Machine – Deep Belief Networks.

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
10. Building and training Nueral networks using back propagation algorithm with gradient descent.
11. Image Classification using Convolutional Neural Networks with cross validation.

TOTAL: 90 PERIODS

REFERENCES

1. Stephen Marsland, “Machine Learning – An Algorithmic Perspective”, Chapman and Hall, CRC Press, Second Edition, 2014.
2. Christopher Bishop, “Pattern Recognition and Machine Learning” Springer, 2007.
3. Kevin P. Murphy, “Machine Learning: A Probabilistic Perspective”, MIT Press, 2012.
4. EthemAlpaydin, “Introduction to Machine Learning”, MIT Press, Third Edition, 2014.
5. Tom Mitchell, “Machine Learning”, McGraw-Hill, 1997.

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

CO4:Analyze importance of neural networks in machine learning and deep learning.

CO5:Identify applications suitable for different types of Machine Learning and to Implement appropriate learning algorithm for an application and to analyze the results.

CO-PO Mapping

	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	3	1	2	1	-	-
CO2	3	3	2	3	2	-
CO3	3	3	3	3	3	2
CO4	3	1	2	1	2	-
CO5	2	3	3	3	3	2

OR3201 NON-LINEAR PROGRAMMING **L T P C**
3 0 2 4

UNIT I INTRODUCTION 9

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 9

Introduction to descent methods – global convergence of decent algorithms – speed convergence – Fibonacci method – golden section search method – steepest descent – newton's method – polynomial approximation method

UNIT III MULTI-DIMENSIONAL OPTIMIZATIONS 9

Unconstrained optimizations without derivatives – conjugate directions – descent properties of the conjugate direction method- conjugate gradient method – partial conjugate gradient method – Powell's method – variable metric algorithms without derivative – quasi newton method

UNIT IV UNCONSTRAINED OPTIMIZATION FOR CONSTRAINED PROBLEMS 9

Lagrange method – inequality constraints – KKT conditions – quadratic programming – geometric programming – separable linear programming – sequential linear programming – feasible direction method

UNIT V EVOLUTIONARY PROGRAMMING 9

Genetic engineering – genetic operators – reproduction – crossover – mutation – selection – genetic local search – simulated annealing – ant colony optimization – particle swarm optimization

Attested

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

1. Singiresu S Rao, "Engineering Optimization: Theory and Practice", Wiley, 4th Edition, 2013.
2. David G.Luenberger, "Linear and Nonlinear Programming", Springer Publications, 3rd Edition, 2008.
3. Hamdy A Taha, "Operations Research – An Introduction", Pearson, 10th Edition, 2018.
4. Stephen Boyd, LievenVandenberghe, "Convex Optimization", Cambridge India, 2016.
5. Bertsekas, Dimitri P. *Nonlinear Programming*. 3rd Edition. Athena Scientific Press, 2016.

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	1	1
CO2	2	2	2	2	1	2
CO3	2	2	2	2	1	2
CO4	3	3	3	2	3	3
CO5	2	2	2	3	2	2

1 : low, 2 : medium, 3 : high

Attested

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CP3261 **PROFESSIONAL PRACTICES** **L T P C**
0 0 4 2

UNIT I EVOLUTION OF IT ORGANIZATIONS 12

Governance Structure-Decentralized and Ad Hoc Governance – Centralized Governance Agile and DevOps- Digital Transformation and Cloud Computing- Continuous Governance andAutomation – Vision, mission, and goals- Business verticals – 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) 12

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 12

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 12

Water Fall, Agile, Incremental – Scrum Framework – Clauses in contracts – SDLC – Roles and Responsibilities – Industry 4.0 – Quality Requirements and Quality Management – NFR – Software Estimation – Research and Innovation – Risk Assessment and Risk Management-Code of Ethics.

UNIT V INDUSTRY STANDARDS 12

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	3	2
CO2	3	2	2	3	2	3
CO3	3	3	3	3	2	2
CO4	3	2	3	3	3	3
CO5	3	2	3	3	2	2

Attested

OR3301 DYNAMIC PROGRAMMING

	L	T	P	C
	3	0	0	3

UNIT I INTRODUCTION 9

Characteristics of Dynamic Programming Problems – Formulation – Examples – Disadvantages of Dynamic Programming – Bellman's Principal of Optimality of Dynamic Programming – Applications of Dynamic Programming – Capital Budgeting Problem – Reliability Improvement Problem (Shortest path Problem) – Minimizing Scheduling problem – Optimal Subdividing Problem solution of LPP through Dynamic Programming.

UNIT II DETERMINISTIC DYNAMIC PROGRAMMING 9

Introduction – Mathematical description – Principal of Optimality – Recursive computation – Multistage Forward and Backward Recursion – Selected Dynamic Programming Applications – Cargo loading model – workforce size model – equipment replacement model – investment model – inventory models – Problem of Dimensionality.

UNIT III PROBABILISTIC DYNAMIC PROGRAMMING 9

Introduction – Distribution of effort example – New product introduction – Elementary inventory model – optimal Batch size model – Stochastic regeneration Model – Equipment Replacement –Sales Forecasting problem – Applicability and Computational feasibility.

UNIT IV DYNAMIC PROGRAMMING IN MARKOV CHAINS 9

Introduction – Stochastic Shortest – Route Model – Unbounded horizon with discounting equivalent Average Return – Linear Programming Approach – Computational considerations – Markov chain version of the equipment replacement model.

UNIT V RISK AND UNCERTAINTY 9

Terminology and Classification – Decision making under risk – Multistage Optimization under Risk Markovian Decision Processes – A variable stage Stochastic Problem – Uncertainty and Adaptive Optimization – Gambling with unknown Probabilities – Two-Person – Zero-Sum Games – Games in Extensive

TOTAL : 45 PERIODS

REFERENCES

1. HamdyA.Taha, "Operations Research – An Introduction", Prentice Hall, HI Learning Private Limited, Tenth Edition, 2017.
2. Harvey M.Wagner, "Principles of Operations Research with applications to Managerial Decisions", PHI Learning Private Limited, 2nd Edition, 2009.
3. RonaldL.Rardin, "Optimization in Operations Research", 2ndEdition Pearson Education, Asia 2018.

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.

Attested

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			3	2			2		2
CO2				2			3		
CO3			3	2			2	1	2
CO4	3		3	2				2	3
CO5	2		3	3				2	3

OR3001 PYTHON PROGRAMMING FOR OPTIMIZATION TECHNIQUES **L T P C**
3 0 2 4

UNIT I INTRODUCTION TO PYTHON 9+6

Introduction to Python language – Using the interpreter – Python datatypes and functions – Working with Data – List, Dictionary and Set – Processing Primitives – List comprehensions – File Handling – Object model including Variables, Reference counting, Copying, and Type checking – Error handling – Control structures

UNIT II PROGRAM ORGANIZATION AND FUNCTIONS 9+6

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 9+6

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 9+6

Solving optimization problems using SciPy.optimize : Unconstrained and constrained minimization of multivariate scalar functions– Global optimization routines – Least-square minimization and curve fitting algorithms – Scalar univariate functions minimizers and root finders – Multivariate equation system solvers - Multidimensional general nonlinear solvers – General linear programming solver

UNIT V MATHEMATICAL MODELING AND SOLVING USING PYOMO 9+6

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

1. Mark Lutz, "Learning Python, Powerful OOPs,O'reilly,2011.
2. Guttag, John. Introduction to Computation and Programming Using Python. MIT Press, 2013.
3. Zelle, John M. Python Programming: An Introduction to Computer Science. 1st ed. Franklin Beedle& Associates, 2003.
4. Budd, Timothy. Exploring Python. McGraw- Hill Science, 2009.
5. W.E. Hart, C. Laird, J.-P. Watson, and D.L. Woodruff, Pyomo - Optimization Modeling in

Attested

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			3	2			2		2
CO2				2			3		
CO3			3	2			2	1	2
CO4	3		3	2	4			2	3
CO5	2		3	3				2	3

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-Markovianmodel - 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 - Output1ZX 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

Attested

1. Jerry Banks “Discrete-event system simulation”, Pearson Education, 2009.

2. Fitzgerald, John, Larsen, PeterGorm, “Modeling Systems; Practical Tools and Techniques in software development”, Cambridge University Press, 2009.
3. Hopcroft, John E, Motwani, Rajeev, Ullman, Seffrey D, “Introduction to automata theory, languages and computation”, Pearson/Addison Wesley, 3rd Edition, 2007.
4. Donald Gross and Carl M. Harris, “Fundamentals of Queuing theory”, 2nd Edition, John Wiley and Sons, New York (1985).
5. Hamdy A Taha, “Operations Research an Introduction”, Prentice Hall, Eighth Edition, 2007.
6. Jeofrey Gordon “System Simulation”, Prentice Hall of India, 2009.

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			3	2			2		2
CO2				2			3		
CO3			3	2			2	1	2
CO4	3		3	2				2	3
CO5	2		3	3				2	3

OR3003 PROJECT MANAGEMENT WITH PERT/CPM L T P C
3 0 2 4

UNIT I INTRODUCTION 9+6
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 9+6
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 9+6
The PERT model – The problem of uncertainty – Expected times for activities – variability of activity times – The expected length of a critical path – Probability of completing a project by a given date – Effects of a near critical path - other methods for calculating project length and variance – Simulation of a network-criticality index - PERT’s Event orientation - The PERT assumptions – The CPM model - Schedule-Related project Costs - The lowest cost schedule - stretching jobs - The problem of large projects - solutions by computers - cost optimization-L.P.Models - Non linear cost-time trade-off curves - non convex and discontinuous cost-time trade off curves.

Attested

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

1. Chandra, P., “Projects”, Tata McGraw-Hill Education, 2009.
2. Levy, F. K. and Wiest, J. D., “A Management Guide to PERT/CPM”, Prentice Hall, 1969.
3. Lewis, R., “Project Management”, McGraw-Hill, 2006.
4. Moder, J. J. and Phillips, “C. R., Project Management With CPM, PERT and Precedence Diagramming”, Van Nostrand Reinhold,1983.
5. Morris, P. W. G., and Pinto, J. K., “The Wiley Guide to Managing Projects”, JohnWiley& Sons, 2004.
6. Phillips, J., “PMP Project Management Professional Study Guide”, McGraw-Hill, 2003.
7. Pritsker, A. A. B., “Modeling and analysis using Q-GERT networks”, John Wiley & Sons Inc, 1979.

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			3	2			2		2
CO2				2			3		
CO3			3	2			2	1	2
CO4	3		3	2				2	3
CO5	2		3	3				2	3

Attested

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OR3004 **NETWORK OPTIMIZATION** **L T P C**
3 0 0 3

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
Nonlinear network optimization - Convex separable network problems - Algorithms for differentiable dual problems.

UNIT IV INTEGER CONTRAINTS NETWORK PROBLEMS 9
Network problems with integer constraints - Formulation of integer - constrained problems - Branch-and-bound - Lagrangian relaxation - Rollout algorithms.

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

TOTAL : 45 PERIODS

REFERENCES

1. Dimitri P. Bertsekas, "Network Optimization: Continuous and Discrete Models", 1998.
2. "Operations Research – An Introduction", Hamdy A. Taha, 10th Edition, Pearson Education Inc., 2017.
3. K.S. Trivedi, "Probability and Statistics with Reliability, Queueing and Computer Science Applications", Wiley Publications, 2016.
4. Anurag Kumar, D.Manjunath, Joy Kuri, "Communication Networking: An analytical approach", Morgan Kaufmann Publishers, 2011.
5. Mahbub Hassan, Raj Jain, "High Performance TCP/IP Networking: Concepts, Issues and Solutions", 1st Edition, Pearson Education Inc., 2015.
6. Xin-She Yang, "Nature-Inspired Optimization Algorithms", Elsevier Inc., First edition 2014

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			3	2			2		2
CO2				2			3		
CO3			3	2			2	1	2
CO4	3		3	2				2	3
CO5	2		3	3				2	3

OR3005 SUPPLY CHAIN MANAGEMENT L T P C
3 0 0 3

UNIT I INTRODUCTION 9
Introduction to SCM – Development chain – Global Optimization – Managing uncertainty and risk – Evolution of SCM – Issues in SCM – Decision phase – Supply chain drivers and obstacles – SCM complexity.

UNIT II FORECASTING 9
Demand forecasting – Role of forecasting-Characteristics – Basic Approach – Time series method – Measures of forecast error – Aggregate planning in SCM – Aggregate planning using Linear Programming – Excel – Supply and demand planning in supply chain – Managing supply – Demand – Implementing solution.

UNIT III INVENTORY MANAGEMENT AND RISK POOLING 9
Introduction to inventory – Forms of inventory – Single stage control – Economic Order Quantity (EOQ)– Lot size model – Demand uncertainty – Single period model – Review Policies – Risk Pooling – Centralized v/s Decentralized systems – Practical issues – Approaches for future demand.

UNIT IV NETWORK PLANNING AND PROCUREMENT STRATEGY 9
Network design – Inventory positioning and logistics and logistics co-ordination – Resource allocation – Transportation in a supply chain – Outsourcing benefits and risks – Buy/make Decisions – Procurement strategy – E-Procurement.

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

1. Sunil Chopra, Peter Mendil, “Supply chain Management – Strategy, Planning and Operation”, Pearson, 5th Edition, 2012.
2. HartmatStadtler, ChristoperKilger, “Supply Chain Management and Advanced Planning Concepts, Models, Software and Case Studies”, 5th edition, Springer, 2015.
3. Simchi-Levi David, Kaminsky Philip, Simchi-Levi Edith, “Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies”, McGraw Hill, 3rd edition, 2008.
4. Handfield R.B, Nicholas E.L, “Introduction to Supply Chain Management”, PHI, 1999.
5. Shapiro, J.F, “Modelling the Supply Chain”, Dubury, 2nd Edition 2006.

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			3	2			2		2
CO2				2			3		
CO3			3	2			2	1	2
CO4	3		3	2				2	3
CO5	2		3	3				2	3

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

UNIT I INTRODUCTION 9
Convex sets: affine sets – operations that preserve convexity – generalized inequalities – separating and supporting hyper planes – dual cones and generalized inequalities. Convex functions: basic properties and examples – operations that preserve convexity – conjugate functions – log concave and log convex functions – convexity with respect to generalized inequalities

UNIT II CONVEX OPTIMIZATION PROBLEMS 9
Optimization problems – convex optimization – linear optimization problems -quadratic optimization problems – geometric programming – generalized inequality constraints – vector optimization

UNIT III DUALITY 9
Lagrange dual function – Lagrange dual problem – geometric interpretation – saddle point interpretation – optimality conditions – perturbation and sensitivity analysis – generalized inequalities

UNIT IV UNCONSTRAINED AND EQUALITY CONSTRAINED MINIMIZATION 9
Unconstrained minimization problems – descent methods- gradient descent method - steepest descent method – newton's method – self concordance – Equality constrained minimization problems – newton's method with equality constraints – infeasible start newton method

UNIT V INTERIOR POINT METHODS 9
Inequality constrained minimization problems – logarithmic barrier function and central path – barrier method – feasibility and phase I methods – complexity analysis via self-concordance – problems with generalized inequalities – primal dual interior point methods

TOTAL : 45 PERIODS

Attested

REFERENCES

1. Singiresu S Rao, “Engineering Optimization: Theory and Practice”, Wiley, 4th Edition, 2013.
2. David G.Luenberger, “Linear and Nonlinear Programming”, Springer Publications, 3rd Edition, 2008.
3. Hamdy A Taha, “Operations Research - An Introduction”, Pearson, 10th Edition, 2018.
4. Stephen Boyd, LievenVandenberghe, “Convex Optimization”, Cambridge India, 2016.
5. Bertsekas, Dimitri P. *Nonlinear Programming*. 3rd Edition. Athena Scientific Press, 2016.

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			3	2			2		2
CO2				2			3		
CO3			3	2			2	1	2
CO4	3		3	2				2	3
CO5	2		3	3				2	3

OR3007 NUMERICAL OPTIMIZATION **L T P C**
3 0 0 3

UNIT I INTRODUCTION 9

Mathematical Formulation – Categories of optimizations – Local and Global Optimality - Existence of an Optimal Solution - Level Sets – Gradients - Convex Sets.

UNIT II COMPLEXITY ISSUES 9

Algorithms and Complexity – Average Running Time - Randomized Algorithms - Basics of Computational Complexity Theory - Complexity of Local Optimization - Optimal Methods for Nonlinear Optimization – To teach the solution to unconstrained optimal problems.

UNIT III UNCONSTRAINED OPTIMIZATION 9

Fundamentals – Search directions – Rates of convergence – Linear search method – Conjugate gradient method – Quasi newton methods – Non-linear equations.

UNIT IV CONSTRAINED OPTIMIZATION 9

Local and Global Solutions – Smoothness - First-Order Optimality Conditions - Derivation of the First-Order Conditions - Second-Order Conditions - Other Constraint Qualifications – Quadratic Programming - Active set methods, Gradient Projection and sequential quadratic programming.

Attested

UNIT V CASE STUDIES 9

Case Studies – Transportation problem - Network flow problem - Portfolio Optimization – Optimal trajectory problem – Chemical process optimization.

TOTAL : 45 PERIODS

REFERENCES

1. Jorge Nocedal, Stephen J Wright, "Numerical Optimization", Springer Series in Operations Research, Springer, 1999.
2. M. S. Bazaraa, J. J. Jarvis, and H. D. Sherali, "Linear Programming and Network Flows", John Wiley & Sons, 4th edition, 2010.
3. D. Bertsimas and J. N. Tsitsiklis, "Introduction to Linear Optimization", Athena Scientific,Belmont, MA, 1997.
4. S. Boyd and L. Vandenberghe, "Convex Optimization", Cambridge University Press, 2004.

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

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			3	2			2		2
CO2				2			3		
CO3			3	2			2	1	2
CO4	3		3	2				2	3
CO5	2		3	3				2	3

CP3056 CLOUD COMPUTING TECHNOLOGIES

L T P C
3 0 2 4

UNIT I DISTRIBUTED SYSTEMS AND ENABLING TECHNOLOGIES 9

Technologies for network based systems - System Models for Distributed and Cloud Computing - Clustering for Massive Parallelism - Design Principles of Computer Clusters - Cluster Job and Resource Management.

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.

Attested

UNIT III CLOUD COMPUTING 9

Characteristics - Service Models: IaaS, PaaS, SaaS - Deployment Models: Public, Private, Community, Hybrid Clouds - Data-Center Design and Interconnection Networks - Architectural Design.

UNIT IV EXPLORING CLOUD PLATFORMS AND SERVICES 9

Compute Services – Storage Services – Database Services – Application Services – Content Delivery Services – Analytics Services – Deployment and Management Services – Identity and Access Management Services – Open Source Private Cloud Softwares.

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

1. Kai Hwang, Geoffrey C Fox, Jack J Dongarra, “Distributed and Cloud Computing From Parallel Processing to the Internet of Things”, Morgan Kauffman imprint of Elsevier, 2012.
2. Arshdeep Bahga, Vijay Madisetti, “Cloud Computing: A Hands-On Approach”, Universities Press (India) Private Limited, 2014.
3. James E Smith and Ravi Nair, “Virtual Machines”, Elsevier, 2005.
4. Thomas Erl, Zaigham Mahood, Ricardo Puttini, “Cloud Computing, Concept, Technology & Architecture”, Prentice Hall, 2013.
5. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, “Mastering Cloud Computing”, Tata McGraw-Hill, 2013.
6. Toby Velte, Anthony Velte, Robert C. Elsenpeter, “Cloud Computing, A Practical Approach”,Tata McGraw-Hill Edition, 2010.
7. Tom White, “Hadoop: The Definitive Guide”, O’Reilly Media, 4th Edition, 2015.
8. John Rittinghouse and James Ransome, “Cloud Computing Implementation, Management and Security”, CRC Press, 2010.

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. Attested
CO4:Choose the appropriate technologies, algorithms and approaches for the related issues.

CO5:Set up and use cloud platforms and services.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	1	1	2
CO2	3	1	3	2	1	2
CO3	3	1	3	2	1	2
CO4	3	1	3	3	1	3
CO5	1	1	3	2	1	3

CP3063 ETHICAL HACKING L T P C
3 0 0 3

UNIT I INTRODUCTION TO HACKING 9

Penetration Test – Vulnerability Assessments versus Penetration Test – Pre-Engagement – Rules of Engagement –Penetration Testing Methodologies – OSSTMM – NIST – OWASP – Categories of Penetration Test – Types of Penetration Tests – Vulnerability Assessment Summary –Reports.

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

Information Gathering Techniques – Active Information Gathering – Passive Information Gathering – Sources of Information Gathering – Tracing the Location – Traceroute – ICMP Traceroute – TCP Traceroute – Usage – UDP Traceroute – Enumerating and Fingerprinting the Webservers – Google Hacking – DNS Enumeration – Enumerating SNMP – SMTP Enumeration – Target Enumeration and Port Scanning Techniques – Advanced Firewall/IDS Evading Techniques.

UNIT IV EXPLOITATION 9

Introduction to Metasploit – Reconnaissance with Metasploit – Port Scanning with Metasploit – Compromising a Windows Host with Metasploit – Client Side Exploitation Methods – E–Mails with Malicious Attachments – Creating a Custom Executable – Creating a Backdoor with SET – PDF Hacking – Social Engineering Toolkit – Browser Exploitation – Post–Exploitation – Acquiring Situation Awareness – Hashing Algorithms – Windows Hashing Methods – Cracking the Hashes – Brute force Dictionary Attacks – Password Salts –Rainbow Tables – John the Ripper – Gathering OS Information – Harvesting Stored Credentials.

UNIT V ENTERPRISE SECURITY 9

Gaining and Maintaining Access : Systems hacking – Windows and Linux – Metasploit and Kali Linux, Keylogging, Buffer Overflows, Privilege Escalation, Network hacking - ARP Poisoning, Password Cracking, WEP Vulnerabilities, MAC Spoofing, MAC Flooding, IPSpoofing, SYN Flooding, Smurf attack, Applications hacking : SMTP/Email-based attacks, VOIP vulnerabilities, Directory traversal, Input Manipulation, Brute force attack, Unsecured login mechanisms, SQL injection, XSS, Mobile apps security, Malware analysis : Netcat Trojan, wrapping definition, reverse engineering, Additional Security Mechanisms : IDS/IPS, Honeypots and evasion techniques, Secure Code Reviews (Fortify tool, OWASP Secure Coding Guidelines)

TOTAL: 45 PERIODS

REFERENCES

1. Rafay Baloch, “Ethical Hacking and Penetration Testing Guide”, CRC Press, 2014.
2. Certified Ethical Hacker Study Guide v9, Sean-Philip Oriyano, Sybex; Study Guide Edition,2016
3. CEH official Certified Ethical Hacking Review Guide, Wiley India Edition, 2007
4. Patrick Engebretson, “The Basics of Hacking and Penetration Testing – Ethical Hacking and Penetration Testing Made Easy”, Syngress Media, Second Revised Edition, 2013
5. Michael T. Simpson, Kent Backman, James E. Corley, “Hands-On Ethical Hacking and Network Defense”, Cengage Learning, 2012
6. Kevin Beaver, “Ethical Hacking for Dummies”, Sixth Edition, Wiley, 2018.
7. Jon Erickson , “Hacking: The Art of Exploitation”, Second Edition, Rogunix, 2007

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	-	2	-
CO2	3	2	3	-	-	-
CO3	3	3	2	-	-	3
CO4	3	3	2	3	2	3
CO5	3	2	3	2	3	-

CP3068 INTERNET OF THINGS L T P C
3 0 2 4

UNIT I ARCHITECTURES AND MODELS 9+6

Introduction to IoT – Sensor networks- M2M to IoT, IoT Architectures –Core IoT Functional Stack, Sensors and Actuators Layer, Communications Network Layer, Applications and Analytics Layer – IoT Data Management and Compute Stack, Fog Computing, Edge Computing, Cloud Computing.

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

Data Analytics for IoT –Big Data Analytics Tools and Technology –Cloud of Things-Edge Streaming Analytics –Network Analytics, Applications. Security history, challenges, variations –Risk Analysis Structures –Application in Operational Environment.

UNIT V IoT IN INDUSTRY 9+6

Introduction to Industrial Automation, Architecture, Protocols –Utilities, Grid Blocks-Smart Cities, Architecture, Use cases –Transportation, UAV, Health care, Architecture.

TOTAL: 75 PERIODS

REFERENCES

1. David Hanes, Gonzalo Salgueiro, Patrick Grossetete, Rob Barton and Jerome Henry, "IoT Fundamentals: Networking Technologies, Protocols and Use Cases for Internet of Things", Cisco Press, 2017
2. Olivier Hersent, David Boswarthick, Omar Elloum, "The Internet of Things Key applications and Protocols", Wiley, 2012.
3. Michael Miller, "The Internet of Things", Pearson Education, 2015.
4. ArshdeepBahga, Vijay Madisetti, "Internet of Things –A hands-on approach", Universities Press, 2015.
5. Jan Ho¨ller, VlasiosTsiatsis, Catherine Mulligan, Stamatis, Karnouskos, Stefan Avesand. David Boyle,"From Machine -to-Machine to the Internet of Things – Introduction to a New Age of Intelligence", Elsevier, 2014.
6. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
7. Matt Richardson & Shawn Wallace, Getting Started with Raspberry Pi, O'Reilly(SPD), 2014
8. Sudip Misra, Chandana Royand Anandarup Mukherjee, "Introduction to Industrial Internet of Things and Industry 4.0", CRC Press.

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	4	5	6
CO2	3	-	3	2	-	-
CO3	3	-	3	2	-	-
CO4	3	3	2	3	-	
CO5	3	2	2	2	-	3

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

CP3052 ADVANCED SOFTWARE ENGINEERING L T P C
3 0 0 3

UNIT I PROCESS MODELS 9
Prescriptive process models – Specialized process models –The Unified Process – Personal and Team Software process – Product and Process – Agile development – Extreme Programming – Other Agile process models – Human aspects of Software Engineering

UNIT II REQUIREMENTS MODELING 9
Requirement analysis and specification – Requirements gathering and analysis – Software Requirement Specification – Formal system specification – Finite State Machines – Petrinets – Object modelling using UML – Use case Model –Scenario based methods–Class based methods–Behaviour, Patterns and Web/Mobile Apps

UNIT III ARCHITECTURE AND DESIGN CONCEPTS 9
Software design – Design process – Design concepts – Coupling – Cohesion – Functional independence – Design patterns – Model-view-controller – Publish-subscribe – Adapter – Command – Strategy – Observer – Proxy – Facade – Architectural styles – Layered - Client- server - Tiered - Pipe and filter.- User interface design

UNIT IV SOFTWARE QUALITY AND TESTING 9
Garvin's Quality dimensions–McCall's Quality factors– Review Techniques–Elements of Software Quality Assurance–SQA Processes and Product Characteristics–SQA Tasks, Goals, and Metrics–Statistical Software Quality Assurance–Software Reliability–The ISO 9000 Quality Standards–SQA Plan Software Testing Strategies - Testing Conventional Applications–Testing Object Oriented Applications–Testing Web applications–Testing Mobile Apps

UNIT V DEVOPS 9
DevOps: Motivation-Cloud as a platform-Operations- Deployment Pipeline: Overall Architecture - Building and Testing-Deployment- Case study: Migrating to Microservices.

TOTAL: 45 PERIODS

REFERENCES

1. Roger S. Pressman, "Software Engineering – A Practioner's Approach", MC Graw Hill, 8th edition.
2. Ian Sommerville, "Software Engineering", Addison-Wesley, 9th Edition, 2010
3. Len Bass, Ingo Weber and Liming Zhu, "DevOps: A Software Architect's Perspective", Pearson Education, 2016.
4. Bernd Bruegge, Allen H. Dutoit, "Object-Oriented Software Engineering", Prentice Hall,Third Edition, 2009.
5. Robert E. Filman, Tzilla Elrad, Siobhán Clarke, Mehmet Aksit, "Aspect-Oriented Software Development", Addison-Wesley Professional, 2004.
6. Renu Rajni, Pradeep Oak, "Software Testing: Effective Methods, Tools and Techniques",Tata McGraw Hill, 2004.
7. Jonathan Bowen, "Formal Specification and Documentation using Z – A Case Study Approach", Intl Thomson Computer Press, 1996.
8. Antoni Diller, "Z: An Introduction to Formal Methods", Wiley, 1994.
9. James Shore, Shane Warden "The Art of Agile Development – Pragmatic guide to agile software development", O'Reilly Media, October 2007.
10. Ken Schwaber, "Agile Project Management with SCRUM", Microsoft Press, 2004.

Attested

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	-	2
CO2	2	1	3	2	-	2
CO3	1	1	3	2	-	2
CO4	3	1	3	3	-	2
CO5	1	1	3	1	-	1

CP3072 PARALLEL ALGORITHMS L T P C
3 0 0 3

UNIT I INTRODUCTION 10
Introduction to Parallel Algorithms – Principles of Parallel Algorithm Design- Parallel Algorithm Models - Analyzing Parallel Algorithms- PRAM Algorithms: PRAM Model of Computation – Parallel Reduction – Prefix Sum-List ranking- Merging Sorted lists

UNIT II PROCESSOR ORGANISATION 8
Mesh -Binary Tree Network-Hyper Tree Network- Pyramid – Butterfly- Hypercube –Shuffle-Exchange Networks – Multiprocessor- Multicomputer- Data Mapping

UNIT III SORTING & SEARCHING 9
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 9
Permutations and Combinations – Matrix Transpositions – Matrix by Matrix Multiplications – Matrix by Vector Multiplication.

UNIT V GRAPH ALGORITHMS 9
Connectivity Matrix – Connected Components – All Pair Shortest Paths – Single Source Shortest Path - Minimum Spanning Trees – Sollin's Algorithm - Kruskal's Algorithm-Algorithms for Sparse Graphs

TOTAL: 45 PERIODS

REFERENCES

1. Michael J. Quinn, "Parallel Computing: Theory & Practice", Tata McGraw Hill Edition, 2003.
2. Ananth Grama, Anshul Gupta, George Karypis, Vipin Kumar, "Introduction to Parallel Computing", Pearson, 2012
3. Selim G. Akl, "The Design and Analysis of Parallel Algorithms", Prentice Hall, New Jercy, 1989

Attested

4. Joseph JaJa, “Introduction to Parallel Algorithms”, Addison-Wesley, 1992.

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

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	-	1	-	-	-
CO2	-	-	3	2	-	-
CO3	1	-	2	-	-	-
CO4	3	-	3	3	-	-
CO5	2	-	3	3	-	-

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

Malicious Attacks, Threats, and Vulnerabilities – Scope of cyber-attacks – Tools used to attack computer systems – security breach – Risks, vulnerabilities and threats. Malware – malicious software attack – social engineering attack – wireless network attack – web application attack
Access control - Audit – Authentication - Biometrics - Denial of Service Filters - Ethical Hacking – Firewalls - Scanning, Security policy, Threat Management - Applying software update and patches - Intrusion Detection Systems -Virtual Private Networks –Cryptographic Techniques

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
Local Network Security in the Real World - Networking Basics - Understanding Networking Protocols - Understanding Network Servers - Understanding Network Connectivity Devices - Understanding Network Transmission Media Security

UNIT V TOOLS 9

Zenmap – Hydra –Kismet – John the Ripper – Airgeddon – Deauther Board – Aircrack-ng – EvilOSX

TOTAL: 45 PERIODS

REFERENCES

1. William Stallings, Effective Cybersecurity: A Guide to Using Best Practices and Standards, 1st edition, 2019.
2. Charles J. Brooks, Christopher Grow, Philip A. Craig, Donald Short, Cybersecurity Essentials, Wiley Publisher, 2018.
3. Yuri Diogenes, ErdalOzkaya, Cyber security - Attack and Defense Strategies, Packt Publishers, 2018.
4. Carol C. Woody, Nancy R. Mead, Cyber Security Engineering: A Practical Approach forSystems and Software Assurance, Addison-Wesley, 2016.
5. Thomas A. Johnson Cyber Security- Protecting Critical Infrastructures from Cyber Attack andCyber Warfare, CRC Press, 2015.

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	2	-	2
CO2	2	3	2	3	2	2
CO3	2	2	2	2	-	2
CO4	3	3	2	2	2	2
CO5	3	2	2	2	2	2

CP3065 GAME THEORY L T P C
3 0 0 3

UNIT I INTRODUCTION 8

Introduction – Making rational choices: basics of Games – strategy – preferences – payoffs – Mathematical basics –Game theory –Rational Choice – Basic solution concepts-non-cooperative versus cooperative games – Basic computational issues – finding equilibria and learning in games- Typical application areas for game theory (e.g. Google's sponsored search, eBay auctions, electricity trading markets).

UNIT II GAMES WITH PERFECT INFORMATION 10

Games with Perfect Information – Strategic games – prisoner's dilemma, matching pennies- Nash equilibria- 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.

Attested

UNIT III GAMES WITH IMPERFECT INFORMATION 9

Games with Imperfect Information – Bayesian Games – Motivational Examples – General Definitions –Information aspects – Illustrations – Extensive Games with Imperfect –Information – Strategies-Nash Equilibrium – Beliefs and sequential equilibrium – Illustrations – Repeated Games – The Prisoner's Dilemma – Bargaining

UNIT IV NON-COOPERATIVE GAME THEORY 9

Non-cooperative Game Theory – Self-interested agents- Games in normal form – Analyzing games: from optimality to equilibrium – Computing Solution Concepts of Normal-Form Games – Computing Nash equilibria of two-player, zero-sum games –Computing Nash equilibria of two- player, general-sum games – Identifying dominated strategies

UNIT V MECHANISM DESIGN 9

Aggregating Preferences-Social Choice – Formal Model- Voting – Existence of social functions – Ranking systems – Protocols for Strategic Agents: Mechanism Design – Mechanism design with unrestricted preferences- Efficient mechanisms – Vickrey and VCG mechanisms (shortest paths) – Combinatorial auctions – profit maximization Computational applications of mechanism design – applications in Computer Science – Google's sponsored search – eBay auctions – K-armed bandits.

TOTAL: 45 PERIODS

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*)
2. M. J. Osborne," An Introduction to Game Theory", Oxford University Press, 2012.
3. M. Machler, E. Solan, S. Zamir, "Game Theory", Cambridge University Press, 2013.
4. N. Nisan, T. Roughgarden, E. Tardos, and V. V. Vazirani (Editors), "Algorithmic Game Theory" Cambridge University Press, 2007.
5. A.Dixit and S. Skeath, "Games of Strategy", Second Edition, W W Norton & Co Inc, 2004.
6. Yoav Shoham, Kevin Leyton-Brown, "Multiagent Systems: Algorithmic, Game-Theoretic, and Logical Foundations", Cambridge University Press, 2008.
7. Zhu Han, Dusit Niyato, Walid Saad, Tamer Basar and Hjorungnes, "Game Theory in Wireless and Communication Networks", Cambridge University Press, 2012.
8. Y.Narahari, "Game Theory and Mechanism Design", IISC Press, World Scientific, 2015.
9. Anna R. Karlin and Yuval Peres, Game Theory, Alive, AMS, 2016 (E-book available online from the author at (https://homes.cs.washington.edu/~karlin/GameTheoryBook.pdf)
10. Ivan Pastine, Tuvana Pastine, Tom Humberstone, Introducing Game Theory: A Graphic Guide, Icon Books, 2017.
11. Steven Tadelis, Game Theory: An Introduction, Princeton University Press, 2013.

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.

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CO4:Identify some applications that need aspects of Bayesian Games.

CO5:Implement a typical Virtual Business scenario using Game theory.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	-	3	3	-	-
CO2	3	-	3	3	-	3
CO3	3	-	3	3	3	3
CO4	3	-	3	3	-	3
CO5	3	-	-	3	-	3

CP3059 DATABASE ADMINISTRATION AND TUNING **L T P C**
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UNIT I FUNDAMENTALS OF DATABASE ADMINISTRATION 9

The Management Discipline of Database Administration- Database, Data, and System Administration- Database Design- OODBMS-Persistence-DBA Tasks- Types of DBAs- Working as a DBA- Multiplatform DBA Issues- Test and Production- DBMS Release Migration - Creating the Database Environment - Choosing a DBMS - DBMS Architectures - DBMS Clustering - DBMS Proliferation - Hardware Issues - Installing the DBMS -Storage and Memory Requirements-Configuring the DBMS

UNIT II DATABASE SECURITY, BACKUP AND RECOVERY 9

Different Security Issues- Security Models- threats to databases- Database Users – Grant and Revoke - Types of Privileges - Privileges - Security Reporting - Authorization Roles and Groups - Using Views for Security - Using Stored Procedures for Security Auditing - SQL Injection Prevention - External Security - Job Scheduling and Security – Types of Failures- Image Copy Backups - Full vs. Incremental Backups - Database Objects and Backups-Concurrent Access Issues - Backup Consistency - Log Archiving and Backup.

UNIT III PERFORMANCE MANAGEMENT 7

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 10

Introduction to Tuning- Tuning and Relational Databases – Relational Algebra – Concurrency control goals- Locking and Concurrency Control – Correctness Consideration – Lock Tuning – Logging and the Recovery Subsystem – Principles of Recovery – Tuning the Recovery Subsystem – Operating Systems Considerations – Hardware Tuning- Types of Queries – B tree – B+ Tree - Bit Map Indexes – Clustering Indexes – Non Clustering Indexes – Composite Indexes – Hot Tables – Comparison of Indexing and Hashing Techniques.

UNIT V OPTIMIZATION AND TROUBLESHOOTING 10

Optimization Techniques -- Normalization – Tuning Denormalization – Clustering Two Tables – Aggregate Maintenance – Record Layout – Query Cache – Parameter Cache - Query Tuning – Transaction chopping -Triggers - Query Plan Explainers – Performance Monitors – Event Monitors.

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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

1. Craig S. Mullins, "Database Administration: The Complete Guide to Practices and Procedures", Addison-Wesley Professional, 2nd edition, 2013.
2. Dennis Shasha and Philippe Bonnet, "Database Tuning, Principles, Experiments and Troubleshooting Techniques", Elsevier Reprint, 2005.
3. C.J.Date, A.Kannan, S.Swamynathan, —An Introduction to Database Systems‖, Eighth Edition, Pearson Education, 2006.
4. R. Elmasri, S.B. Navathe, —Fundamentals of Database Systems‖, Sixth Edition, Pearson Education/Addison Wesley, 2010.
5. Craig S. Mullins. "DB2 Developer's Guide A Solutions-Oriented Approach to Learning the Foundation and Capabilities of DB2 for Z/OS", IBM Press, 6th edition, 2012.
6. Henry F Korth, Abraham Silberschatz, S. Sudharshan, —Database System Concepts, Seventh Edition, McGraw Hill, 2019
7. Thomas Connoly and Carlolyn Begg, "Database Systems, A Practical Approach to Design, Implementation and Management", Fourth Edition, Pearson Education, 2008

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	2	1	0	1
CO2	1	1	2	3	2	1
CO3	2	1	3	3	1	1
CO4	3	2	3	3	1	1
CO5	2	3	3	2	1	1

CP3058 DATA WAREHOUSING AND DATA MINING TECHNIQUES **L T P C**
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UNIT I INTRODUCTION TO DATA WAREHOUSING 9

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

A Business Analysis Framework for Data Warehouse Design - Data Warehouse Design Process - Data Warehouse Usage for Information Processing - Data Warehouse Implementation: Efficient Data Cube Computation: Efficient Processing of OLAP, OLAP Server Architectures: ROLAP versus MOLAP versus HOLAP - tuning and testing of data warehouse - data warehouse visualization, Data Warehouse Deployment, Maintenance. Data Warehousing and Business Intelligence Trends.

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

Decision Tree Induction - Bayesian Classification – Rule Based Classification – Classification by Back propagation – Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods(Genetic Algorithms, Rough Set Approach, Fuzzy Set Approaches) – Semi-Supervised Classification - Clustering techniques – Partitioning methods : k-means- Hierarchical Methods : distance based agglomerative and divisible clustering, Probabilistic hierarchical Clustering Density-Based Methods : DBSCAN, DENCLUE – Expectation Maximization -Grid Based Methods – Clustering High-Dimensional Data - Clustering Graph and Network Data - Outlier Analysis.

UNIT V TRENDS IN DATA MINING 9

Big Data - Mining complex data objects – Spatial databases – Temporal databases – Visual and Audio Data Mining – Time series and sequence data – Text mining – Web mining – Data mining Applications.

TOTAL: 45 PERIODS

REFERENCES

1. Jiawei Han, Micheline Kamber and Jian Pei“Data Mining Concepts and Techniques”, Third Edition, Elsevier, 2011.
2. Alex Berson, Stephen J. Smith, “Data Warehousing, Data Mining & OLAP”, Tata McGraw Hill, Tenth Reprint, 2007.
3. G. K. Gupta, “Introduction to Data Mining with Case Studies”, Eastern Economy Edition, Prentice Hall of India, Third Edition, 2014.
4. Ian.H.Witten, Eibe Frank and Mark.A.Hall, “Data Mining: Practical Machine Learning Tools and Techniques”, Morgan Kaufmann, Third edition, 2011.
5. Bruce Ratner, “Statistical and Machine - Learning Data Mining: Techniques for Better Predictive Modeling and Analysis of Big Data”, CRC Press, Second Edition, 2012.
6. Mehmed kantardzic, “Data mining: Concepts, Models, Methods, and Algorithms”, WileyBlackwell, Second Edition, 2011.

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	1	1	-
CO2	3	3	3	3	3	1
CO3	3	2	2	3	1	-
CO4	3	3	3	3	3	1
CO5	3	3	3	3	3	1

BD3151 BIG DATA MINING AND ANALYTICS L T P C
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UNIT I DATA MINING AND LARGE SCALE FILES 9

Introduction to Statistical modeling – Machine Learning – Computational approaches to modeling – Summarization – Feature Extraction – Statistical Limits on Data Mining – Distributed File Systems– Map-reduce – Algorithms using Map Reduce – Efficiency of Cluster Computing Techniques.

UNIT II SIMILAR ITEMS 9

Nearest Neighbor Search – Shingling of Documents – Similarity preserving summaries – Locality sensitive hashing for documents – Distance Measures – Theory of Locality Sensitive Functions – LSH Families – Applications of Locality-Sensitive Hashing - Methods for High Degree of Similarities.

UNIT III MINING DATA STREAMS 9

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 9

Page Rank –Efficient Computation – Topic Sensitive Page Rank – Link Spam – Hubs and Authorities - Market Basket Model – Apriori algorithm – Handling Larger Datasets in Main Memory – Limited Pass Algorithm – Counting Frequent Items.

UNIT V CLUSTERING 9

Introduction to Clustering Techniques – Hierarchical Clustering –Algorithms – K-Means – CURE – Clustering in Non–Euclidean Spaces – Streams and Parallelism – Case Study: Advertising on the Web – Recommendation Systems

TOTAL: 45 PERIODS

REFERENCES

1. Jure Leskovec, AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, Second Edition, 2014.

2. Jiawei Han, MichelineKamber, Jian Pei, “Data Mining Concepts and Techniques”, Morgan Kaufman Publications, Third Edition, 2011.
3. Ian H.Witten, Eibe Frank “Data Mining – Practical Machine Learning Tools and Techniques”, Morgan Kaufman Publications, Third Edition, 2011.
4. David Hand, HeikkiMannila and Padhraic Smyth, “Principles of Data Mining”, MIT Press,2001.

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.

CO-PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	2	2	2
CO3	3	3	3	3	3	3
CO4	3	3	3	2	2	2
CO5	3	3	3	3	3	3

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