E.G.S. PILLAY ENGINEERING COLLEGE (AUTONOMOUS)
Approved by AICTE, New Delhi
(Affiliated to Anna University, Chennai | Re-accredited by NAAC with 'A++' Grade)
Accredited by NBA (Tier-1)
NAGAPATTINAM – 611002

M.E. COMPUTER SCIENCE AND ENGINEERING

REGULATION -2024

First Year – First Semester

Course Code	Course Name	L	T	P	C	Maximum Marks			Category
						CA	ES	Total	
Theory Course									
2401CP101	Advanced Mathematics for Scientific Computing	3	2	0	4	40	60	100	FC
2402CP102	Advanced Data Structures and Algorithms	3	0	0	3	40	60	100	PCC
	Program Elective–I	3	0	0	3	40	60	100	PEC
	Program Elective–II	3	0	0	3	40	60	100	PEC
2401RMX01	Research Methodology and IPR	3	0	0	3	40	60	100	RMC
	Audit Course–I	2	0	0	0	100	0	100	AC
Laboratory Course									
2402CP103	Advanced Data Structures and Algorithms Laboratory	0	0	4	2	50	50	100	PCC
2402CP104	Networking Technologies Laboratory	0	0	4	2	50	50	100	PCC
Total		17	2	8	20	400	400	800	

L–Lecture |T–Tutorial |P– Practical |CA– Continuous Assessment |ES –End Semester

PROGRAM ELECTIVE COURSES (PEC)
SEMESTER - I, ELECTIVE–I

SL. NO.	COURSECODE	COURSETITLE	CATEGORY	PERIODSPERWEEK			TOTAL CONTACTPERIODS	CREDITS
				L	T	P		
1.	2403CP001	Ad-hoc Wireless Sensor Networks	PEC	3	0	0	3	3
2.	2403CP002	Networking Technologies	PEC	3	0	0	3	3
3.	2403CP003	Advanced Storage Area Network	PEC	3	0	0	3	3
4.	2403CP004	Mobile Applications and Pervasive Computing	PEC	3	0	0	3	3
5.	2403CP005	Full Stack Web Application Development	PEC	3	0	0	3	3

SEMESTER - I, PROGRAM ELECTIVE–II

SL. NO.	COURSECODE	COURSETITLE	CATEGORY	PERIODSPERWEEK			TOTAL CONTACTPERIODS	CREDITS
				L	T	P		
1.	2403CP006	Advanced Operating Systems	PEC	3	0	0	3	3
2.	2403CP007	Semantic Web	PEC	3	0	0	3	3
3.	2403CP008	Multicore Architectures	PEC	3	0	0	3	3
4.	2403CP009	Software Architecture Patterns	PEC	3	0	0	3	3
5.	2403CP010	Parallel Algorithms	PEC	3	0	0	3	3

L–Lecture |T–Tutorial |P– Practical |CA– Continuous Assessment |ES –End Semester

2401CP101	ADVANCED MATHEMATICS FOR SCIENTIFIC COMPUTING	L	T	P	C
		3	2	0	4

PREREQUISITE:

Basic knowledge about probability and statistics

COURSE OBJECTIVES:

1. To apply mathematical linear programming techniques to solve constrained Problems.
2. To appreciate the use of simulation techniques
3. To enable them to estimate the value of the parameters involved in the specific distribution from a possible continuum of alternatives.
4. To give an idea of testing the statistical hypothesis claimed based on a set of data points using standard sampling distributions
5. To impart knowledge of handling random vectors which represent random variables in multi-dimensional space.

COURSE OUTCOMES:

On the successful completion 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.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	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	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	3	-
CO2	2	2	-
CO3	2	3	-
CO4	2	3	-
CO5	2	3	-

COURSE CONTENTS:

MODULE I **LINEAR PROGRAMMING** **9 Hours**

The phases of OR study – formation of an L.P model – graphical solution – simplex algorithm – artificial variables technique -Big M method.

MODULE II	**SIMULATION**	**9 Hours**
Discrete Event Simulation – Monte – Carlo Simulation – Stochastic Simulation – Applications to real time problems.		
MODULE III	**ESTIMATION THEORY**	**9 Hours**
Unbiased Estimators – Method of moments – Maximum Likelihood Estimation – Curve fitting by Principle of least squares – Regression Lines.		
MODULE IV	**TESTING OF HYPOTHESIS**	**9 Hours**
Sampling distributions – Type I and Type II errors – Small and large samples – Tests based on Normal, t and F distributions for testing of mean, variance and proportions - Chi-square tests for independence of attributes and goodness of fit – Design of experiments one way and two way classification.		
MODULE V	**MULTIVARIATE ANALYSIS**	**9 Hours**
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: 45 HOURS

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, San Diego, 2002.*
5. *Taha H.A, "Operations Research: An Introduction", Prentice Hall of India Pvt. Ltd. 10 Edition, New Delhi, 2017.*
6. *Winston, W.L., "Operations Research", Thomson – Brooks/Cole, Fourth Edition, Belmont, 2003.*

2402CP102	ADVANCED DATA STRUCTURE AND ALGORITHMS	L	T	P	C
		3	0	0	3

PREREQUISITE:

Fundamentals of Data Structure and Algorithm

COURSE OBJECTIVES:

1. To understand the techniques for analysing the complexity of algorithms.
2. To learn the concepts of advanced data structures and algorithm design techniques.
3. To impart knowledge on choice of data structures and algorithm design for various problems

COURSE OUTCOMES:

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

CO1:	Analyse algorithm complexity using asymptotic notations.
CO2:	Design algorithms to perform operations using hierarchical data structures
CO3:	Develop solutions using graph algorithms.
CO4:	Apply algorithm design techniques to solve computational problems.
CO5:	Analyse the complexity classes for NP problems.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	2	2	-	-	-	-	-	-	-	-
CO2	2	2	3	2	-	-	-	-	-	-	-	-
CO3	2	2	3	3	-	-	-	-	-	-	-	-
CO4	3	3	3	3	-	-	-	-	-	-	-	-
CO5	2	1	2	2	-	-	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	-	1	-
CO2	-	1	-
CO3	-	1	-
CO4	-	1	-
CO5	-	1	-

COURSE CONTENTS:

MODULE I	ANALYSIS OF ALGORITHM EFFICIENCY	9 Hours

Role of Algorithms in Computing - Analysis Framework-Asymptotic notations - Conditional asymptotic notation- Mathematical Analysis of Recursive - Recurrence tree method for solving recurrences –Master theorem for solving recurrences- Mathematical Analysis of and Non recursive Algorithms.

MODULE II	HIERARCHICAL DATA STRUCTURES	9 Hours

Binary Heap- D-Heaps -Leftist Heaps -Skew Heaps- Binomial Queues -Splay Trees -Red-Black Trees - Multi-Way Trees 2-3-4 Trees -Priority Queues -Tries.

MODULE III	GRAPH ALGORITHMS	9 Hours

Graph Traversals- All-To-All Shortest Path Problem -Union-Find Problem -Maximum Flows -Eulerian Graphs- Hamiltonian Graphs -Hamiltonian Cycle Problem -Graph Coloring -Vertex-Cover Problem.		
MODULE IV	**ALGORITHM DESIGN TECHNIQUES**	**9 Hours**
Dynamic Programming: Matrix-Chain Multiplication -Greedy Algorithms: Activity Selection Problem - Huffman Codes -Divide and Conquer: Maximum Sub-Array Problem-Strassen's Algorithm		
MODULE V	**NP COMPLETE AND NP HARD**	**9 Hours**
NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP- Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems.		
		TOTAL: 45 HOURS

REFERENCES:

1. *Anany Levitin, Introduction to the Design and Analysis of Algorithms, Third Edition, Pearson, 2014.*
2. *Alfred V. Aho, John E.Hopcroft, Jeffrey D. Ullman, Data Structures and Algorithms, Third Edition, Pearson, 2015.*
3. *Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, Introduction to Algorithms, Third Edition, Prentice Hall of India, Reprint 2012.*
4. *Mark Allen Weiss, Data Structures and Algorithms in C++, Fourth Edition, Pearson, 2014.*
5. *E. Horowitz, S. Sahni and S. Rajasekaran, Computer Algorithms, University Press, 2008.*
6. *Adam Drozdek, Data Structures and Algorithms in C++, Fourth Edition, Cengage Learning, 2013.*

2401RMX01	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

PREREQUISITE:

Skill Development

COURSE OBJECTIVES:

1.Problem formulation, analysis and solutions.

2.Technical paper writing / presentation without violating professional ethics

3.Understand that today's world is controlled by computer, information technology, but tomorrow world will be ruled by ideas, concept, and creativity

4. Patent drafting and filing patents

5.To understand about IPR and filing patents in R & D.

COURSE OUTCOMES:

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

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

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	2	2	2	-	-	-	-	-	2
CO2	3	3	3	3	2	2	-	-	-	-	-	2
CO3	3	3	3	3	2	2	-	-	-	-	-	2
CO4	3	3	3	3	2	2	-	-	-	-	-	2
CO5	3	3	3	3	2	2	-	-	-	-	-	2

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	1	3	-
CO2	1	2	-
CO3	1	3	-
CO4	1	3	-
CO5	1	3	-

COURSE CONTENTS:

MODULE I **RESEARCH PROBLEM FORMULATION** **9 Hours**

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.		
MODULE II	**RESEARCH DESIGN AND DATA COLLECTION**	**9 Hours**
Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools		
MODULE III	**DATA ANALYSIS, INTERPRETATION AND REPORTING**	**9 Hours**
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.		
MODULE IV	**INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR)**	9 Hours
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.		
MODULE V	**INTELLECTUAL PROPERTY RIGHTS (IPR)**	**9 Hours**
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.		
TOTAL: 45 HOURS		

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.*
6. *Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.*
7. *Mayall, "Industrial Design", McGraw Hill, 1992.*

2402CP103	ADVANCED DATA STRUCTURES AND ALGORITHMS LABORATORY	L	T	P	C
		0	0	4	2

PREREQUISITE:

Programming skills in c,c++

COURSE OBJECTIVES:

1. To implement the different data structures in C++
2. To introduce mathematical aspects and implement solutions for specific problem
3. To implement the different algorithmic design techniques

COURSE OUTCOMES:

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

CO1:	Design and Implement the concepts of linear and non-linear data structures for solving Problems
CO2:	Implement the concept of heap data structure
CO3:	Identify the difference between tree and heap data structure
CO4:	Analyze the time complexity and space complexity of all data structures.
CO5:	Familiar with the concept of various analysis techniques

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	3	1	-	-	-	-	-	-	-	-
CO2	2	-	3	1	-	-	-	-	-	-	-	-
CO3	2	-	2	2	-	-	-	-	-	-	-	-
CO4	2	-	2	2	-	-	-	-	-	-	-	-
CO5	2	-	2	3	-	-	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	3	-
CO2	2	2	-
CO3	2	3	-
CO4	2	3	-
CO5	2	3	-

COURSE CONTENTS:	
EXPERIMENT 1	Design and Implement the concepts of linear and non-linear data structures for solving Problems
EXPERIMENT 2	Create Min Heap and perform the operations on it
EXPERIMENT 3	Implement operations on Leftist Heap
EXPERIMENT 4	Implement merging of two Skew Heaps
EXPERIMENT 5	Perform rotations on AVL Tree
EXPERIMENT 6	Implement sorting techniques
EXPERIMENT 7	Create convex hull using divide and conquer
EXPERIMENT 8	Job sequencing with deadlines using greedy method

EXPERIMENT 9	0/1 Knapsack using dynamic programming
EXPERIMENT 10	Graph coloring using backtracking

2402CP104	NETWORKING TECHNOLOGIES LABORATORY	L	T	P	C
		0	0	4	2

PREREQUISITE:

Programming skills in C,C++, basic knowledge in NS3 Tool

COURSE OBJECTIVES:

	Demonstrate the operation of wireless networks.
	Simulate and analyze the performance of GSM, CDMA, LTE and SDN.
	To gain knowledge and work on various protocol layers.
	To explore network simulators.
	Identify the different features of integrated and differentiated services.

COURSE OUTCOMES:

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

CO1:	Judge the emerging wireless technology standards. Configure functionalities of router and switches.
CO2:	Assess the importance of wireless ad-hoc networks. Compare and contrast various wireless technologies.
CO3:	Explain and design the considerations for deploying wireless network infrastructure
CO4:	Judge the emerging wireless technology standards. Configure functionalities of router and switches.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	1	1	-	-	-	-	-	-	1	2
CO2	2	-	1	1	-	-	-	-	-	-	1	2
CO3	2	-	1	2	-	-	-	-	-	-	1	2
CO4	2	-	1	2	-	-	-	-	-	-	1	2
CO5	2	-	1	3	-	-	-	-	-	-	1	2

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	3	-
CO2	2	2	-
CO3	2	3	-
CO4	2	3	-
CO5	2	3	-

COURSE CONTENTS:	
EXPERIMENT1	Configure networks using: a)Distance Vector Routing protocol b)Link State Vector Routing protocol

EXPERIMENT2	Implement the congestion control using Leaky bucket algorithm.
EXPERIMENT3	Installation of NS3 and execution of TCL commands/scripts.
EXPERIMENT4	Implementation Point to Point network using duplex links between the nodes. Analyze the packet transfer by varying the queue size and bandwidth. (using simulator)
EXPERIMENT5	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)
EXPERIMENT6	Create a wireless mobile ad-hoc network environment and implement the OLSR routing protocol. (using simulator)
EXPERIMENT7	Implement CDMA by assigning orthogonal code sequence for 5 stations, generate the CDMA code sequence and communicate between the stations using the generated code.
EXPERIMENT8	Create a GSM environment and implement inter and intra hand over mechanisms.(using simulator)
EXPERIMENT9	In LTE environment implement Round Robin and Token Bank Fair Queue scheduler in MAC layer.
EXPERIMENT10	Write python script to create topology in Mini net and configure Open Flow switches with POX controller to communicate between nodes.

PROGRAM ELECTIVE COURSES (PEC)
SEMESTER - I, ELECTIVE–I

2403CP001	AD-HOC WIRELESS SENSOR NETWORKS	L	T	P	C
		3	0	0	3

PREREQUISITE:

Basic knowledge on Computer Networks and Mobile computing

COURSE OBJECTIVES:

1. To introduce the characteristic features of Ad-hoc wireless networks and their applications to the students..
2. To enable the student to understand the functioning of different access and routing protocols.
3. To enable the student to understand the Mobility in MANETs

COURSE OUTCOMES:

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

CO1:	Design protocols for cellular networks. Compare the architectural designing issues of wireless ad-hoc networks with MAC
CO2:	Apply the routing mechanism on ad-hoc wireless networks.
CO3:	Analyze the challenges in maintaining QoS
CO4:	Design the protocols which energy efficient.
CO5:	Apply the classification in mobility model on MANET

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	3	1	-	-	-	1	1	2
CO2	1	2	-	-	3	-	-	-	-	-	-	2
CO3	1	1	-	3	3	-	-	3	-	1	-	2
CO4	1	2	1	2	3	-	-	3	-	-	-	2
CO5	1	1	1	2	3	1	-	2	-	1	-	1

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	3	3	-
CO2	3	3	-
CO3	3	3	-
CO4	3	2	-
CO5	3	2	-

COURSE CONTENTS:

MODULE I	**INTRODUCTION TO MANETS AND MAC LAYER PROTOCOLS**	**9 Hours**
Fundamentals of Wireless Networks– IP Limitations-Mobile Internet Protocol (IP)- Issues in Mobile IP- Differences between Cellular and Ad Hoc Wireless Networks Issues in Ad Hoc Wireless Networks- Classification of Ad-hoc Networks-MANET applications- Important Issues and the Need for Medium Access Control (MAC) Protocols.- Classification of MAC Protocols- Multiple-Channel MAC Protocols.		
MODULE II	**ROUTING PROTOCOLS FOR AD-HOC WIRELESS NETWORKS**	**9 Hours**
Design Issues of Routing Protocols for Ad Hoc Networks- Classification of Routing Protocols- Proactive Routing- WRP, DSDV, OLSR Protocol- Reactive Routing- AODV, DSR, TORA, CBRP Protocol- Hybrid Routing.- ZRP, ZHLS		
MODULE III	**QUALITY OF SERVICE (QOS) IN AD HOC NETWORKS**	**9 Hours**
Introduction to QoS-Issues and Challenges Involved in Providing QoS-Classification of QoS Solutions-Medium Access Control (MAC)-Layer QoS Solutions- Network-Layer QoS Solutions- QoS Model- QoS Frameworks- INSIGNIA Protocol Commands INSIGNIA Protocol Operations- Reservation Establishment-QoS Reporting- Flow Restoration-Flow Adaptation-Intelligent Optimization Self-Regulated adjustment (INORA)- Coarse-Feedback Scheme-Class-Based Fine Feedback Scheme.		
MODULE IV	**ENERGY MANAGEMENT SYSTEMS IN AD HOC WIRELESS NETWORKS**	**9 Hours**
MODULE V	**MOBILITY MODELS FOR MANET**	**9 Hours**
Mobility Model Classifications-Formulation of Mobility Models- Mobility Metrics -Impact of Mobility Models on MANET- **Random Walk Mobility**- Notation, Characteristics of Random Walk Mobility, Stationary Distribution of Random Walk Mobility, Limitations of Random Walk Mobility Model - **Random Waypoint Mobility**- Notation ,Random Waypoint Stochastic Process, Transition Length and Duration, Limitations- **Smooth Random Mobility**- Notation, Characteristics of Smooth Random Mobility Model, Speed Control, Direction Control, Correlation Between Direction and Speed Change.		
TOTAL: 45 HOURS		

REFERENCES:

1. *Subir Kumar Sarkar, T.G. Basavaraju, C. Puttamadappa," Ad Hoc Mobile Wireless Networks: Principles, Protocols, and Applications", Second edition, AUERBACH PUBLICATIONS, 2013.*
2. *Radhika RanjanRoy ,"Handbook of Mobile Ad HocNetworks for MobilityModels", Springer Science +Business Media, LLC 2011*
3. *Jonathan Loo, Jaime Lloret Mauri, Jesús Hamilton Ortiz, "Mobile Ad Hoc Networks: Current Status and Future Trends" CRC Press,2012.*
4. *B. V. V. S. PRASAD,"ROUTING ISSUES IN MANETs", Educreation Publishing2016*
5. *Waltenegus Dargie, Christian Poella bauer, Fundamentals of Wireless Sensor Networks Theory and Practice, John Wiley and Sons, 2010.*

2403CP002	NETWORKING TECHNOLOGIES	L	T	P	C
		3	0	0	3

PREREQUISITE:

Basic Computer Networks and Mobile computing

COURSE OBJECTIVES:

1. To learn about integrated and differentiated services architectures.
2. To understand the working of wireless network protocols.
3. To study the developments in cellular networks
4. To get familiarized with next generation networks.
5. To know the concepts behind software defined networks

COURSE OUTCOMES:

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

CO1:	Identifythedifferentfeaturesofintegratedanddifferentiatedservices.
CO2:	Demonstrate various protocols of wireless networks
CO3:	Analyze the use of next generation networks
CO4:	Provide solutions using SDN.
CO5:	Design protocols for cellular networks.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	-	-	3	1	-	-	-	1	1	2
CO2	1	1	-	-	3	-	-	-	-	-	-	2
CO3	1	1	-	3	3	-	-	3	-	1	-	2
CO4	1	1	1	2	3	-	-	3	-	-	-	2
CO5	1	1	1	2	3	1	-	2	-	1	-	1

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	3	3	-
CO2	3	3	-
CO3	3	3	-
CO4	3	2	-
CO5	3	2	-

COURSE CONTENTS:

MODULE I **NETWORK ARCHITECTURE AND QOS** **9 Hours**

Overview of TCP/IP Network Architecture –Integrated Services Architecture–Approach–Components–Services–Multiplexing- Frequency Hopping Spread Spectrum- Coding Methods- Code Division Multiple Access- IMT -2000 3G Wireless Communication Standard, WCDMA 3G Communication Standards-Queuing Discipline–FQ –PS–BRFQ –GPS–WFQ –Random Early Detection –Differentiated Services.

MODULE II **WIRELESS NETWORKS** **9 Hours**

IEEE802.16 and WiMAX–Security–Advanced802.16 Functionalities– Mobile WiMAX–802.16e –Network Infrastructure – WLAN – Configuration – Management Operation – Security – IEEE 802.11e and WMM –

QoS –Comparison of WLAN and UMTS–Bluetooth– LiFi– Protocol Stack– Security– Profiles		
MODULE III	**CELLULAR NETWORKS**	**9 Hours**
GSM – Mobility Management and call control – GPRS – Network Elements – Radio Resource Management – Mobility Management and Session Management– UMTS – Channel Structure on the Air Interface – UTRAN –Core and Radio Network Mobility Management –UMTS Security- Introduction to 5G&XGnetworks.		
MODULE IV	**5G,6G and 7G NETWORKS**	9 Hours
LTE – Network Architecture and Interfaces – FDD Air Interface and Radio Networks –Scheduling – Mobility Management and Power Optimization – LTE Security Architecture - 5G cellular network- 6G cellular networks- 7G cellular networks- comparison of 5G,6G and 7G cellular networks – XG Networks Protocols–Green Wireless Networks.		
MODULE V	**SOFTWARE DEFINED NETWORKS**	**9 Hours**
Introduction–Centralized and Distributed Controland Data Planes–Open Flow–SDN Controllers–General Concepts – VLANs – NVGRE – Open Flow – Network Overlays – Types – Virtualization – Data Plane – I/O –Design of SDN Framework		
		TOTAL: 45 HOURS

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 Broad band",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. *Martin Sauter, "Beyond 3G–Bringing Networks, Terminals and the Web Together: LTE, WiMAX, IMS, 4G Devices and the Mobile Web2.0",Wiley,2009.*
6. *Naveen Chilamkurti, Sherali Zeadally, Hakima Chaouchi, "Next-Generation Wireless Technologies", Springer, 2013.*
7. *Erik Dahlman, Stefan Parkvall, Johan Skold, "4G: LTE/LTE-Advanced for Mobile Broadband", Academic Press, 2013.*

2403CP003	ADVANCED STORAGE AREA NETWORK	L	T	P	C
		3	0	0	3

PREREQUISITE:

Basic knowledge about Storage Area Network and File System

COURSE OBJECTIVES:

1. To expose the students to different Backup, Archive and Replication, Business Continuity, Securing Storage Infrastructure.
2. To familiarize storage visualization concept
3. To study about the NAS file system.

COURSE OUTCOMES:

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

CO1:	Identify the need for performance evaluation and the metrics used for it.
CO2:	Understand the file sharing operation on NAS and IP-SAN of the different network.
CO3:	Realize strong virtualization concepts.
CO4:	Study the hardware devices associated with SAN architecture
CO5:	Analyze the SAN management strategies.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	-	-	2	-	-	-	3	2	2
CO2	3	2	3	-	2	2	-	-	2	1	2	2
CO3	2	2	3	2	-	1	-	-	2	1	2	3
CO4	2	2	3	2	-	1	-	-	2	1	2	3
CO5	2	3	2	2	3	-	-	2	2	3	3	3

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	3	-
CO2	2	2	-
CO3	2	3	-
CO4	2	3	-
CO5	2	3	-

COURSE CONTENTS:

MODULE I **INTRODUCTION** **9 Hours**

Server Centric IT Architecture and its Limitations; Storage – Centric IT Architecture and its advantages. Case study: Replacing a server with Storage Networks The Data Storage and Data Access problem; The Battle for size and access. Intelligent Disk Subsystems: Architecture of Intelligent Disk Subsystems; Hard disks and Internal I/O Channels; JBOD, Storage virtualization using RAID and different RAID levels; Caching Acceleration of Hard Disk Access; Intelligent disk subsystems, Availability of disk subsystems.

MODULE II	**I/O TECHNIQUES**	**9 Hours**
The Physical I/O path from the CPU to the Storage System; SCSI; Fibre Channel Protocol Stack; Fibre Channel SAN; IP Storage. Network Attached Storage: The NAS Architecture, The NAS hardware Architecture, The NAS Software Architecture, Network connectivity, NAS as a storage system. File System and NAS: Local File Systems; Network file Systems and file servers; Shared Disk file systems; Comparison of fibre Channel and NAS, Case study: General Parallel File System		
MODULE III	**STORAGE VIRTUALIZATION**	**9 Hours**
Definition of Storage virtualization; Implementation Considerations; Storage virtualization on Block or file level; Storage virtualization on various levels of the storage Network; Symmetric and Asymmetric storage virtualization in the Network.		
MODULE IV	**SAN ARCHITECTURE AND HARDWARE DEVICES**	**9 Hours**
Overview, Creating a Network for storage; SAN Hardware devices; The fibre channel switch; Host Bus Adaptors; Putting the storage in SAN; Fabric operation from a Hardware perspective. Software Components of SAN: The switch's Operating system; Device Drivers; Supporting the switch's components; Configuration options for SANs.		
MODULE V	**MANAGEMENT OF STORAGE NETWORK**	**9 Hours**
System Management, Requirement of management System, Support by Management System, Management Interface, Standardized Mechanisms, Property Mechanisms, Inband Management, Use of SNMP, CIM and WBEM, Storage Management Initiative Specification (SMIS), CMIP and DMI, Optional Aspects of the Management of Storage Networks,		
		TOTAL: 45 HOURS

REFERENCES:

1. *Storage Networks Explained Ulf Troppens, Rainer Erkens and Wolfgang Muller Wiley India 2013*
2. *Storage Networks The Complete Reference Robert Spalding Tata McGrawHill 2011*
3. *Storage Networking Fundamentals – An Introduction to Storage Devices, Subsystems, Applications, Management, and File Systems Marc Farley Cisco Press, 2005*
4. *Storage Area Network Essentials A Complete Guide to understanding and Implementing SANs Richard Barker and Paul Massiglia Wiley India, 2006*

2403CP004	MOBILE APPLICATIONS AND PERVASIVE COMPUTING	L	T	P	C
		3	0	0	3

PREREQUISITE:

Knowledge on Basic Concepts of OS, Distributed Systems and Computer Architecture

COURSE OBJECTIVES:

1. To introduce the characteristics, basic concepts and systems issues in mobile and pervasive computing
2. To illustrate architecture and protocols in pervasive computing and to identify the trends and latest development of the technologies in the area.
3. To design successful mobile and pervasive computing applications and services

COURSE OUTCOMES:

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

CO1:	Explicate emerging technologies in wireless networks.
CO2:	Illustrate about architecture and routing in GSM.
CO3:	Apply the services in Mobile Computing.
CO4:	Apply the principles of pervasive computing.
CO5:	Outline the characteristics of pervasive computing applications including the major system components and architectures of the systems.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	3	1	-	-	-	-	-	-
CO2	3	3	2	2	2	2	-	-	-	-	-	-
CO3	3	3	3	1	3	1	-	-	-	-	-	-
CO4	3	2	2	3	1	1	-	-	-	-	-	-
CO5	3	2	2	3	3	3	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	3	-
CO2	2	2	-
CO3	2	3	-
CO4	2	3	-
CO5	2	3	-

COURSE CONTENTS:

MODULE I **INTRODUCTION** **9 Hours**

Wireless networks- emerging technologies- Blue tooth, WiFi, WiMAX, 3G ,WATM.-Mobile IP protocols-a survey on mobile operating systems- Mobile applications development and protocols: Mobile devices as web clients-WAP –J2ME- Android Application development

MODULE II	**MOBILE COMPUTING**	**9 Hours**
Mobile Computing Architecture: Architecture for Mobile Computing – Three-Tier Architecture – Design Considerations for Mobile Computing- Global System for Mobile Communications – GSM Architecture – GSM Entities - Call Routing in GSM – GSM Addresses and Identifiers – Network Aspects in GSM – GSM Frequency Allocation – Authentication and Security.		
MODULE III	**SERVICES IN MOBILE COMPUTING**	**9 Hours**
Short Message Service (SMS)- Value Added Services through SMS – GPRS- GPRS and Packet Data Network – GPRS Network Architecture – GPRS Network Operations –Data Services in GPRS- Applications for GPRS – Limitations of GPRS.		
MODULE IV	**PERVASIVE COMPUTING**	**9 Hours**
Pervasive Computing: Past, Present and Future Pervasive Computing - Pervasive Computing Market – m-Business – Application Examples: Retail, Airline check-in and booking – Sales force automation – Health care – Tracking – Car information system – E-mail access via WAP.		
MODULE V	**SERVICE DISCOVERY**	**9 Hours**
Open protocols- Service discovery technologies- SDP, Jini, SLP, UpnP protocols-data synchronization-SyncML framework - Context aware mobile services -Context aware sensor networks, addressing and communications- Context aware security.		
		TOTAL: 45 HOURS

REFERENCES:

1. *Ashok K.Talukder and Roopa R.Yuvagal, "Mobile Computing", 2nd Edition, Tata McGraw Hill, 2010.*
2. *Pattnaik, Prasant kumar, Mall, Rajib , "Fundamentals of Mobile Computing", Second Edition, India: PHI Learning Private Limited, 2015.*
3. *Jochen Burkhardt, Horst Henn, Stefan Heper, Klaus Rindtorff and Thomas Schack, "Pervasive Computing Technology and Architecture of Mobile Internet Applications" Addison Wesley, 2002.*
4. *UweHansmann, L. Merk, M. Nicllous, T. Stober and U.Hansmann, "Pervasive Computing", Springer Verlag, 2003.Johcehn H.Schiller, "Mobile Communications", Addison-Wesley, 2003.*
5. *SengLoke, Context-Aware Computing Pervasive Systems, Auerbach Pub., NewYork, 2007.*
6. *Frank Adelstein Sandeep K. S. Gupta Golden G. Richard III Loren Schwiebert, "Fundamentals of Mobile and Pervasive Computing", McGraw-Hill,2005.*

2403CP005	FULL STACK WEB APPLICATION DEVELOPMENT	L	T	P	C
		3	0	0	3

PREREQUISITE:

Basic Knowledge on front end technologies, back end technologies and Database Programming Technologies

COURSE OBJECTIVES:

1. To become knowledgeable about the most recent web development technologies.
2. Idea for creating two tier and three tier architectural web applications
3. Design and Analyze real time web applications.
4. Constructing suitable client and server side applications.
5. To learn core concept of both front end and back end programming.

COURSE OUTCOMES:

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

CO1:	Use Java script and its libraries for building front-end applications
CO2:	Use React.js to build client-side applications
CO3:	Develop Spring Boot based web applications
CO4:	Integrate web applications with MongoDB
CO5:	Develop Web applications, RESTful web services and Micro Services using full stack

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	-	3	2	-	-	-	-	-	-	-	-
CO2	1	-	3	2	-	-	-	-	-	-	-	-
CO3	1	-	3	2	-	-	-	-	-	-	-	-
CO4	1	-	3	2	-	-	-	-	-	-	-	-
CO5	1	-	3	2	-	-	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	1	2	-
CO2	1	2	-
CO3	1	3	-
CO4	1	3	-
CO5	2	3	-

COURSE CONTENTS:

MODULE I	OVERVIEW OF FULL STACK	9 Hours

Understanding the Basic Web Development Framework - Browser – JavaScript – functions, arrays, objects, strings, Web Server –- Backend Services – MVC Architecture – Full stack with JAVA Spring Boot, React, MongoDB- Simple programs using Java script functions

MODULE II	FRONT-END DEVELOPMENT	9 Hours

REACT - Virtual DOM, components, props, JSX, Events, conditionals, lists, forms, Routing, Hooks, Redux, Client-server communication, material-UI- Implementation of simple UI using REACT class.		
MODULE III	**JAVA SPRING BOOT**	**9 Hours**
Spring Boot core features, architecture - auto configuration, dependency management, application, component scan, starters-starter web, data JPA, actuators, annotation, POM file- Creating Spring Boot and Implementation of a simple web applications.		
MODULE IV	**MONGO DB**	**9 Hours**
Understanding NoSQL and MongoDB – Building MongoDB Environment – User accounts – Access control – Administering databases – Managing collections – Connecting to MongoDB from Spring Boot Spring Data MongoDB, CRUD operations- Create a CRUD applications using MongoDB		
MODULE V	**BUILDING WEBAPPS, WEB SERVICES AND MICROSERVICES WITH SPRING BOOT**	**9 Hours**
Building simple web applications, creating RESTful web service, Micro services architecture, Principles of Micro services and its advantages, Service register & API Gateway, Admin Server & Client, Inter service communication, External API communication, Distributed logging.		
		TOTAL: 45 HOURS

REFERENCES:

1. *John Carnell, Illary Huaylupo Sánchez, "Spring Microservices in Action", 2nd Edition, Manning Publications, 2021.*
2. *Greg L. Turn quist, Learning Spring Boot 3.0, 3rd Edition, Packt Publishing, 2022.*
3. *David Herron, Node.js Web Development, Packt Publishing Limited, 5th edition, 2020.*
4. *David Flanagan, Java script The Definitive Guide, Oreilly, 7th Edition, 2020.*
5. *K. Siva Prasad Reddy, Sai Upadhyayula, Beginning Spring Boot 3: Build Dynamic Cloud Native Java Applications and Microservices, A Press, 2022*
6. *Craig Walls, Spring Boot in Action, Manning Publications, 2016.*

SEMESTER - I, PROGRAM ELECTIVE–II

2403CP006	ADVANCED OPERATING SYSTEMS	L	T	P	C
		3	0	0	3

PREREQUISITE:

Knowledge on Basic Concepts of OS

COURSE OBJECTIVES:

1. To gain knowledge on Distributed operating system concepts.
2. To get insight on to the distributed resource management components
3. To know the components and management aspects of Real time, Mobile operating systems.
4. To gain knowledge on the design concepts of Real Time operating systems
5. To analyze the memory management policies of cluster machines

COURSE OUTCOMES:

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

CO1:	Identify the features of distributed operating systems.
CO2:	Demonstrate the various protocols of distributed operating systems.
CO3:	Identify the different features of real time operating systems.
CO4:	Discuss the features of Mobile and Cloud Operating System
CO5:	Describe and analyze the memory management and its allocation policies in cluster machines

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	3	2	-	-	-	-	-	-	-	-
CO2	3	-	2	2	2	-	-	-	-	-	-	-
CO3	3	-	2	2	-	-	-	-	-	-	-	-
CO4	3	2	2	3	-	-	-	-	-	-	-	-
CO5	3	2	2	3	-	-	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	1	2	-
CO2	2	2	-
CO3	2	3	-
CO4	2	3	-
CO5	2	3	-

COURSE CONTENTS:

MODULE I	DISTRIBUTED OPERATING SYSTEMS	9 Hours

Distributed Operating Systems – Communication Primitives –-Issues in Distributed Operating System - Architecture - Communication Primitives -Lamport's Logical clocks -Causal Ordering of Messages - Distributed Mutual Exclusion Algorithms - Centralized and Distributed Deadlock Detection Algorithms - Agreement Protocols.		
MODULE II	**DISTRIBUTED RESOURCE MANAGEMENT**	**9 Hours**
Distributed File Systems -Design Issues - Distributed Shared Memory -Algorithms for implementing Distributed Shared memory-Issues in Load Distributing - Scheduling Algorithms - Synchronous and Asynchronous Check Pointing and Recovery - Fault Tolerance -Two-Phase Commit Protocol - Non blocking Commit Protocol -Security and Protection.		
MODULE III	**REAL TIME OPERATING SYSTEMS**	**9 Hours**
Basic Model of Real Time Systems - Characteristics- Applications of Real Time Systems –Real Time Task Scheduling - Handling Resource Sharing and Dependencies in real time tasks- Scheduling real time task in Multiprocessor and Distributed systems.		
MODULE IV	**MOBILE AND CLOUD OPERATING SYSTEMS**	**9 Hours**
Android – Overall Architecture – Linux Kernel – Hardware Support – Native User-Space – Dalvik and Android's Java – System Services – Introduction to Cloud Operating Systems-Virtualization –Machine virtualization, binary virtualization, VMware Design.		
MODULE V	**MEMORY MANAGEMENT**	**9 Hours**
Memory Management: virtual memory, NUMA machines, memory allocators – Hoard Scalable Memory Allocator, Memory Resource Management in VMware, Global Memory Management in Cluster machines.		
		TOTAL: 45 HOURS

REFERENCES:

1. *Mukesh Singhal, Niranjan Shivaratri, "Advanced Concepts in Operating Systems: Distributed, Database and Multiprocessor Operating Systems", McGraw Hill, 2017.*
2. *Andrew S Tanenbaum, "Modern Operating Systems", Pearson, 2021.*
3. *Mukesh Singhal , "Advanced concepts in operating systems", McGraw Hill, 2017.*
4. *Rajib Mall, "Real-Time Systems: Theory and Practice", Prentice Hall, 2006*
5. *Karim Yaghmour, "Embedded Android", O'Reilly, First Edition, 2013.*
6. *Nikolay Elenkov, "Android Security Internals: An In-Depth Guide to Android's Security Architecture", No Starch Press, 2014.*

2403CP007	SEMANTIC WEB	L	T	P	C
		3	0	0	3

PREREQUISITE:

Basic Knowledge about Agents, Ontology

COURSE OBJECTIVES:

1. To understand the importance of Resource Description Framework in semantic web
2. To study the scope of ontology for semantic web
3. To know the applications of semantic web

COURSE OUTCOMES:

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

CO1:	Understand the standards related to semantic web.
CO2:	Develop an application using ontology languages and tools.
CO3:	Analyze various methods of evaluating Ontologies.
CO4:	Use ontology related tools and technologies for application creation
CO5:	Design and develop applications using semantic web.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	3	1	2	3	-	-	-	-	-	-
CO2	3	-	3	2	3	3	-	-	-	-	-	-
CO3	2	2	3	2	-	1	-	-	-	-	-	-
CO4	3	-	2	3	2	3	-	-	-	-	-	-
CO5	3	-	3	2	3	3	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	3	-
CO2	2	2	-
CO3	2	3	-
CO4	2	3	-
CO5	2	3	-

COURSE CONTENTS:

MODULE I **THE QUEST FOR SEMANTICS** **9 Hours**

Building Models – Calculating with Knowledge – Exchanging Information – Semantic Web Technologies – Layers – Architecture – Components – Types – Ontological Commitments – Ontological Categories – Philosophical Background – Sample Knowledge Representation Ontologies –

Top Level Ontologies – Linguistic Ontologies – Domain Ontologies – Semantic Web – Need – Foundation.		
MODULE II	**LANGUAGES FOR SEMANTIC WEB AND ONTOLOGIES**	**9 Hours**
Web Documents in XML – RDF – Schema – Web Resource Description using RDF – RDF Properties – Topic Maps and RDF – Overview – Syntax Structure – Semantics – Pragmatics – Traditional Ontology Languages – LOOM – OKBC – OCML – Flogic Ontology Markup Languages – SHOE – OIL – DAML+OIL – OWL.		
MODULE III	**ONTOLOGY LEARNING FOR SEMANTIC WEB**	**9 Hours**
Taxonomy for Ontology Learning – Layered Approach – Phases of Ontology Learning –Importing and Processing Ontologies and Documents – Ontology Learning Algorithms –Methods for evaluating Ontologies		
MODULE IV	**ONTOLOGY MANAGEMENT AND TOOL**	**9 Hours**
Overview – Need for management – Development process – Target Ontology – Ontology mapping – Skills management system – Ontological class – Constraints – Issues – Evolution –Development of Tools and Tool Suites – Ontology Merge Tools – Ontology based Annotation Tools		
MODULE V	**APPLICATIONS**	**9 Hours**
Web Services – Semantic Web Services – Case Study for specific domain – Security issues – Web Data Exchange and Syndication – Semantic Wikis – Semantic Portals – Semantic Metadata in Data Formats – Semantic Web in Life Sciences – Ontologies for Standardizations – Rule Interchange Format.		
		TOTAL: 45 HOURS

REFERENCES:

1. *Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph, "Foundations of Semantic Web Technologies", Chapman & Hall/CRC, 2009.*
2. *Asuncion Gomez-Perez, Oscar Corcho, Mariano Fernandez-Lopez, "Ontological Engineering: with Examples from the Areas of Knowledge Management, e-Commerce and the Semantic Web", Springer, 2004.*
3. *Grigoris Antoniou, Frank van Harmelen, "A Semantic Web Primer (Cooperative Information Systems)", MIT Press, 2004.*
4. *Alexander Maedche, "Ontology Learning for the Semantic Web", First Edition, Springer. 2002.*
5. *John Davies, Dieter Fensel, Frank Van Harmelen, "Towards the Semantic Web: Ontology Driven Knowledge Management", John Wiley, 2003.*
6. *John Davies, Rudi Studer, Paul Warren, (Editor), "Semantic Web Technologies: Trends and Research in Ontology-Based Systems", Wiley, 2006.*

2403CP008	MULTICORE ARCHITECTURES	L	T	P	C
		3	0	0	3

PREREQUISITE:

Knowledge about basic concepts of computer organization and architecture

COURSE OBJECTIVES:

1. To identify the limitations of ILP and the need for multicore architectures.
2. To define fundamental concepts of parallel programming and its design issues.
3. To solve the issues related to multiprocessing and suggest solutions.
4. To make out the salient features of different multicore architectures and how they exploit parallelism.

COURSE OUTCOMES:

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

CO1:	Discuss and evaluate the performance of computer
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:	Point out the salient features of different multicore architectures and how they exploit different types of parallelism
CO5:	Point out the salient features of different example domain specific architectures

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
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	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	3	-
CO2	2	2	-
CO3	2	3	-

	CO4	2	3	-
	CO5	2	3	-

COURSE CONTENTS:

MODULE I	**FUNDAMENTALS OF COMPUTER DESIGN AND ILP**	**9 Hours**

Fundamentals of Computer Design – Measuring and Reporting Performance – Instruction Level Parallelism and its Exploitation – Concepts and Challenges – Limitations of ILP-Evolution of Processor Architecture– Multithreading – SMT and CMP Architectures – Introduction to Multi-core Architecture.

MODULE II	**MEMORY HIERARCHY DESIGN**	**9 Hours**

Introduction – Optimizations of Cache Performance – Memory Technology and Optimizations – Protection: Virtual Memory and Virtual Machines – Design of Memory Hierarchies – Memory Level Parallelism- Case Studies.

MODULE III	**MULTIPROCESSOR ISSUES**	**9 Hours**

Symmetric and Distributed Shared Memory Architectures – Cache Coherence Issues – optimizing shared memory performance- Performance Issues – Synchronization Issues – Models of Memory Consistency – Interconnection Networks – Buses, Crossbar and Multi-stage Interconnection Networks.

MODULE IV	**EXPLOITING DIFFERENT TYPES OF PARALLELISM**	**9 Hours**

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.

MODULE V	**DOMAIN SPECIFIC ARCHITECTURES**	**9 Hours**

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 HOURS

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.*
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.*
5. *https://archive.nptel.ac.in/courses/106/104/106104025.*

2403CP009	SOFTWARE ARCHITECTURE PATTERNS	L	T	P	C
		3	0	0	3

PREREQUISITE:

Knowledge about the basic concepts of architecture styles.

COURSE OBJECTIVES:

1. Interpret the introductory concepts of Architecture patterns to define the basic characteristics and behavior of a Software application.
2. Apply the methodologies involved in choosing the best architecture pattern to meet the specific business needs and goals.
3. Summarize the architecture reconstruction to recover undocumented architectures

COURSE OUTCOMES:

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

CO1:	Analyze the characteristics of software Architecture Patterns for design consideration.
CO2:	Demonstrate the layered architecture to produce highly scalable applications.
CO3:	Recognize and Classify the microkernel &Micro service architecture pattern based on the custom processing logic.
CO4:	Demonstrate the event-driven architecture to produce highly scalable application.
CO5:	Predict the factors of Space based architecture to limit application scaling.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	3	1	2	3	-	-	-	-	-	-
CO2	3	-	3	2	3	3	-	-	-	-	-	-
CO3	2	2	3	2	-	1	-	-	-	-	-	-
CO4	3	-	2	3	2	3	-	-	-	-	-	-
CO5	3	-	3	2	3	3	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	3	-
CO2	2	2	-
CO3	2	3	-
CO4	2	3	-
CO5	2	3	-

COURSE CONTENTS:

MODULE I	**FUNDAMENTAL OF ARCHITECTURE**	**9 Hours**
Software Architecture- Architecture Vs Design-Measuring Modularity- Architectural Characteristics Defined-Identifying Architectural Characteristics-Measuring and Governing Architectural Characteristics-Architecture Partitioning- Case Study: Silicon sand witches: Partitioning.		
MODULE II	**LAYERED AND PIPELINE ARCHITECTURE**	**9 Hours**
Layered Architecture: Topology- Layers of Isolation- Adding Layers- Other Considerations- Architecture Characteristics Ratings. Pipeline Architecture: Topology- Pipes-Filters-Example-Architecture Characteristics Ratings.		
MODULE III	**MICROKERNEL ARCHITECTURE**	**9 Hours**
Microkernel Architecture: Topology - Core System- Plug-In Components – Registry- Contracts- Examples and Use Cases- Architecture Characteristics Ratings Service based Architecture: Topology-Topology Variants- Service Design and Granularity- Database Partitioning- Example Architecture- Architecture Characteristics Ratings		
MODULE IV	**EVENT DRIVEN ARCHITECTURE**	**9 Hours**
Event-Driven Architecture Style- Topology- Broker Topology- Mediator Topology- Asynchronous Capabilities- Error Handling- Preventing Data Loss- Broadcast Capabilities- Request-Reply- Choosing Between Request-Based and Event-Based- Hybrid Event-Driven Architectures- Architecture Characteristics Ratings.		
MODULE V	**SPACE BASED ARCHITECTURE**	**9 Hours**
Space Based Architecture General Topology- Processing Unit- Virtualized Middleware- Data Pumps- Data Writers- Data Readers- Data Collisions- Cloud Versus On-Premises Implementations- Replicated Versus Distributed Caching- Near-Cache Considerations- Implementation Examples- Online Auction System-Architecture Characteristics Ratings.		
		TOTAL: 45 HOURS

REFERENCES:

1. *Mark Richards & Neal Ford, "Fundamental of Software Architecture:An engineering approach", O'Reilly Media,2020*
2. *Mark Richards, "Software Architecture Patterns", O'Reilly Media, Third Edition, 2017.*
3. *Len Bass, Paul Clements, Rick Kazman, Software Architecture in Practice, Second Edition, Pearson, 2013.*
4. *Erich Gamma, Design Patterns: Elements of Reusable Object-Oriented Software, First Edition, Pearson, 2011.*
5. *George H. Fairbanks, Just Enough Software Architecture: A Risk-Driven Approach, First Edition, Marshall & Brainerd, 2010.*

2403CP010	PARALLEL ALGORITHMS	L	T	P	C
		3	0	0	3

PREREQUISITE:

Knowledge about Data structures and Design and Analysis of algorithms

COURSE OBJECTIVES:

1. To analyze the parallel algorithms using parallel models
2. To discuss the various types of processor organization.
3. To understand the various methodology for sorting, searching, multiplication and matrix operations.
4. To summarize the parallel graph algorithms.

COURSE OUTCOMES:

On the successful completion of the course, 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.

COs Vs POs MAPPING:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	1	-	-	-	-	-	-	-	-	-
CO2	-	-	3	2	-	-	-	-	-	-	-	-
CO3	1	-	2	-	-	-	-	-	-	-	-	-
CO4	3	-	3	3			-	-	-	-	-	-
CO5	2	-	3	3	-	-	-	-	-	-	-	-

COs Vs PSOs MAPPING:

COs	PSO1	PSO2	PSO3
CO1	2	3	-
CO2	2	2	-
CO3	2	3	-
CO4	2	3	-
CO5	2	3	-

COURSE CONTENTS:

MODULE I	**INTRODUCTION**	**9 Hours**
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		
MODULE II	**PROCESSOR ORGANISATION**	**9 Hours**
Mesh -Binary Tree Network-Hyper Tree Network- Pyramid – Butterfly- Hypercube –Shuffle- Exchange Networks – Multiprocessor- Multicomputer- Data Mapping		
MODULE III	**SORTING & SEARCHING**	**9 Hours**
Sorting Networks – Sorting on a Linear Array – Sorting on CRCW, CREW, EREW – Searching a sorted sequence – Searching a random sequence – Bitonic Sort		
MODULE IV	**ALGEBRAIC PROBLEMS**	**9 Hours**
Permutations and Combinations – Matrix Transpositions – Matrix by Matrix Multiplications – Matrix by Vector Multiplication		
MODULE V	**GRAPH ALGORITHMS**	**9 Hours**
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 HOURS

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*
4. *Joseph JaJa, "Introduction to Parallel Algorithms", Addison-Wesley, 1992.*

Audit Course–I

2101AU005	CONSTITUTION OF INDIA	L	T	P	C
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PREREQUISITE:

COURSE OBJECTIVES:

	1.Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective
	2. To address the growth of Indian opinion regarding modern Indian intellectuals‟ constitutional
	3. Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
	4.To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

COURSE OUTCOMES:

CO1:	Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
CO2:	Discuss the intellectual origins of informed the conceptualization the framework of argument that
CO3:	of social reforms leading to revolution in India.
CO4:	Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
CO5:	Discuss the passage of the Hindu Code Bill of 1956.

COURSE CONTENTS:

MODULE I	**HISTORY OF MAKING OF THE INDIAN CONSTITUTION:**	**5 Hours**
History, Drafting Committee, (Composition & Working)		
MODULE II	**PHILOSOPHY OF THE INDIAN CONSTITUTION:**	**5 Hours**
Preamble, Salient Features		
MODULE III	**CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:**	**5 Hours**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.		
MODULE IV	**ORGANS OF GOVERNANCE:**	**9 Hours**
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.		
MODULE V		**9 Hours**
District‟s Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.		
TOTAL: 45 HOURS		

REFERENCES:

1.The Constitution of India,1950 (Bare Act),Government Publication.

2.Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.

3.M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.

4.D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.