Sri

SAI RAM ENGINEERING COLLEGE

An Autonomous Institution

West Tambaram, Chennai - 44

www.sairam.edu.in

Approved by AICTE, New Delhi
Affiliated to Anna University

DEPARTMENT OF INFORMATION TECHNOLOGY

M.E. COMPUTER SCIENCE AND ENGINEERING (With SPECIALIZATION in NETWORKS)

AUTONOMOUS

REGULATIONS 2024

Academic Year 2024-25 onwards

PG CURRICULUM AND SYLLABUS I - IV SEMESTERS

SRI SAIRAM ENGINEERING COLLEGE

VISION

To emerge as a "Centre of excellence " offering Technical Education and Research opportunities of very high standards to students, develop the total personality of the individual and instill high levels of discipline and strive to set global standards, making our students technologically superior and ethically stronger, who in turn shall contribute to the advancement of society and humankind.

MISSION

We dedicate and commit ourselves to achieve, sustain and foster unmatched excellence in Technical Education. To this end, we will pursue continuous development of infra-structure and enhance state-of-the-art equipment to provide our students a technologically up-to date and intellectually inspiring environment of learning, research, creativity, innovation and professional activity and inculcate in them ethical and moral values.

QUALITY POLICY

We at Sri Sai Ram Engineering College are committed to build a better Nation through Quality Education with team spirit. Our students are enabled to excel in all values of Life and become Good Citizens. We continually improve the System, Infrastructure and Service to satisfy the Students, Parents, Industry and Society.

DEPARTMENT OF INFORMATION TECHNOLOGY

VISION

To emerge as a "Centre of Excellence in the field of IT" offering Technological Education and Research opportunities of high standards to students, develop high degree of digital knowledge and skillset, making our students technologically superior and ethically strong, who in turn shall contribute to the advancement of society and humankind.

MISSION

Department of Information Technology, Sri Sairam Engineering College is committed to

M1 Provide quality education in Information Technology and also create technologically new and intellectually inspiring environment

M2 Focus on research and development of technologies by engaging in value added courses and on evolution of digital environment.

M3 Design and Develop state-of-the art on learning, creativity, innovation and inculcate in them ethical, social and moral values.

M4 Establish continuous Industry Institute Interaction, participation and collaboration to contribute job oriented skilled IT Engineers by improving their entrepreneurial skills.

AUTONOMOUS CURRICULA AND SYLLABI
Regulations 2024

SEMESTER I

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
THEORY							
1.	24PCSMA104	Applied Probability and Statistics	4	0	0	4	4
2.	24PCSPC101	Advanced Data Structures and Algorithms	3	0	0	3	3
3.	24PCNPC101	Advanced Computer Architecture	3	0	0	3	3
4.	24PCNPC102	Virtualization Technologies	3	0	0	3	3
5.	24PCNPC103	Advanced Computer Communication and Networking	3	0	0	3	3
6.	24PCSPW101	Advanced Machine Learning with Laboratory	2	0	2	4	3
PRACTICAL							
7.	24PCSPL101	Data Structures Laboratory	0	0	3	3	1.5
8.	24PCNTE101	Innovative Design Project - I	0	0	4	4	2
TOTAL						**27**	**22.5**

SEMESTER II

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
THEORY							
1.	24PCNPC201	Network Design and Programming	3	0	0	3	3
2.	24PCNPC202	Wireless Technologies	3	0	0	3	3
3.	240PCNELXXX	Professional Elective – I	3	0	0	3	3
4.	24PXXELXXX	Professional Elective - II	3	0	0	3	3
5.	24PXXELXXX	Professional Elective – III	3	0	0	3	3
PRACTICAL							
6.	24PCNPL201	Network Design and Programming Laboratory	0	0	3	3	1.5
7.	24PCNTE201	Innovation Design Project - II	0	0	4	4	2
TOTAL						**22**	**18.5**

SEMESTER III

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
THEORY							
1	24PXXELXXX	Professional Elective – IV	3	0	0	3	3
2	24PXXELXXX	Professional Elective – V	3	0	0	3	3
PRACTICAL							
3	24PCNPJ301	Project Work Phase – I	0	0	12	12	6
TOTAL						**18**	**12**

SEMESTER IV

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
PRACTICAL							
1	24PCNPJ401	Project Work Phase – II	0	0	24	24	12
TOTAL						**24**	**12**

SEMESTER II - PROFESSIONAL ELECTIVES - I

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
1	24PCNEL201	Image Processing and Analysis	3	0	0	3	3
2	24PCNEL202	Artificial Intelligence and Fuzzy Systems	3	0	0	3	3
3	24PCNEL203	Software Defined Networks	3	0	0	3	3
4	24PCNEL204	Protocols and Architectures for Wireless Sensor Networks	3	0	0	3	3
5	24PCNEL205	Advanced Software Engineering	3	0	0	3	3
6	24PCNEL206	Cloud Storage and Computing	3	0	0	3	3
7	24PCNEL207	Software Architecture and Design	3	0	0	3	3

SEMESTER II - PROFESSIONAL ELECTIVES - II

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
1	24PCNEL208	Multimedia Communication Networks	3	0	0	3	3
2	24PCNEL209	Mobile and Pervasive Computing	3	0	0	3	3
3	24PCNEL210	Simulation of Computer Systems and Networks	3	0	0	3	3
4	24PCNEL211	IT Security Compliance and Forensics	3	0	0	3	3
5	24PCSEL315	Bio-Informatics	3	0	0	3	3
6	24PCNEL212	Soft Computing	3	0	0	3	3
7	24PCNEL213	High Speed Switching Architecture	3	0	0	3	3

SEMESTER II - PROFESSIONAL ELECTIVES - III

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
1	24PCSPC203	Cloud Computing Technologies	3	0	0	3	3
2	24PCNEL215	IoT Architecture, Networking and Security	3	0	0	3	3
3	24PCSEL314	Mobile Application Development	3	0	0	3	3
4	24PCNEL216	High Speed Networks	3	0	0	3	3
5	24PCNEL217	Multimedia Technology and Application	3	0	0	3	3
6	24PCNEL218	Digital Forensics	3	0	0	3	3
7	24PCNEL219	Advanced Storage Area Networks	3	0	0	3	3

SEMESTER III - PROFESSIONAL ELECTIVES - IV

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
1.	24PCNEL301	Network Management	3	0	0	3	3
2.	24PCNEL302	Next Generation Networks	3	0	0	3	3
3.	24PCNEL303	Network Function Virtualization and Edge Computing	3	0	0	3	3
4.	24PCNEL304	Introduction to Research Methodology and IPR	3	0	0	3	3
5	24PCNEL305	Advanced Software Testing	3	0	0	3	3
6.	24PCNEL306	Social Network Analysis	3	0	0	3	3
7.	24PCSEL302	Web Engineering	3	0	0	3	3

SEMESTER V - PROFESSIONAL ELECTIVES - V

S. NO	COURSE CODE	COURSE TITLE	WEEK HOURS			TOTAL CONTACT HOURS	CREDITS
			L	T	P		
1.	24PCSEL308	Embedded Software Development	3	0	0	3	3
2.	24PCNEL308	Information Storage Management	3	0	0	3	3
3.	24PCSPC204	Big Data Analytics	3	0	0	3	3
4.	24PCNEL309	Cryptography and Wireless Network Security	3	0	0	3	3
5.	24PCNEL310	Advanced Database Management System	3	0	0	3	3
6.	24PCNEL311	Ethical Hacking	3	0	0	3	3
7.	24PCNEL312	Data Center Networks	3	0	0	3	3

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1 Graduates will embed with strong foundation in networking & mathematical tools and advanced knowledge in Computer Science and Engineering

PEO 2 Graduates will excel in developing computer/software/network systems by understanding the importance of technical, social, business, environmental, and human context in real life.

PEO 3 Graduates are inculcated as Network professionals and Entrepreneurs with technical and problem solving skills, to function as global leaders of engineering team with effective communication skills to pursue career

PEO 4 Graduates impart professional & ethical attitude, nurture to be an effective team member who function in their profession with ethics and values practising Corporate Social Responsibility

PEO 5 Graduates are trained to acquire professional integrityy, impart exhaustive knowledge of Networking & research considering the impact of research outcomes and an understanding of responsibility to contribute the community for sustainable development.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Information Technology Program Students will be able to:

PSO 1 Execution of Professional Engineering Solutions for the graduates to pursue research, or be successfully employed in academia / industries associated with programming and Networking, or become entrepreneurs, adapting to new technologies.

PSO 2 Pertain apt techniques and novel engineering tools for making holistic decisions and design applications by using modern computer languages, Networking tools & ethics.

PROGRAMME OUTCOMES(POs)

PO 1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 **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.

PO3 Design/development of solutions: Design solutions for complex engineering 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.

PO4 Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO 6 The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 Environment and sustainability : Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8 Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 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.

PO12 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.

SEMESTER - I

24PCSMA104 SDG NO. 4	APPLIED PROBABILITY AND STATISTICS	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To introduce the basic concepts of probability, one dimensional random variable and some standard discrete and continuous distributions.
- To gain knowledge in two dimensional random variables, correlation and regression and functions of random variables.
- To provide the basic principles of the theory of estimation and apply it in engineering problems.
- To formulate and test hypothesis based on Normal, t, F and Chi squared distributions.
- To introduce the concepts and principles of multivariate data analysis for analysing multi variate data sets.

UNIT I PROBABILITY AND RANDOM VARIABLES 12

Probability Axioms of probabilityConditional probability - Random variables - Probability functionMoments Moment generating functions and their properties Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributionsFunction of a random variable.

UNIT II TWO DIMENSIONAL RANDOM VARIABLES 12

Joint distributions - Marginal and conditional distributions- Functions of two-dimensional random variables - Regression curve Correlation.

UNIT III ESTIMATION THEORY 12

Unbiased estimators - Method of momentsMaximum likelihood estimation - Curve fitting by principle of least squares Regression lines.

UNIT IV TESTING OF HYPOTHESIS 12

Sampling distributions - Type I and Type II errors - Small and large samples -Tests based on Normal, t, Chi square and F distributions for testing of mean, variance and proportions - 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

REFERENCES:

1. Devore, J.L., "Probability and Statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, 2014.
2. Dallas E. Johnson, "Applied Multivariate Methods for Data Analysis", Thomson and Duxbury Press, 1998.
3. Gupta S.C. and Kapoor V.K., "Fundamentals of Mathematical Statistics", Sultan and Sons, New Delhi, 2001.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
5. Richard A. Johnson and Dean W. Wichern, "Applied Multivariate Statistical Analysis", 5th Edition, Pearson Education, Asia, 2002.

OUTCOMES:

Upon completion of the course, the student should be able to:

1. Apply basic probability axioms, moments of discrete and continuous random variables, discrete and continuous distributions in solving engineering problems.
2. Compute the coefficients of correlation, regression and the joint probability density function of transformation of random variables.
3. Calculate the consistency, efficiency and unbiasedness of estimators using the method of maximum likelihood estimation, fit a curve by the method of least squares and find the regression lines.
4. Use statistical tests in testing hypotheses on data.
5. Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.

CO- PO, PSO MAPPING:

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

SEMESTER - I

24PCSPC101 SDG NO. 4 & 9	ADVANCED DATA STRUCTURES AND ALGORITHMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the usage of algorithms in computing and to choose appropriate data structures for solving problems.
- To learn and use hierarchical data structures and its operations
- To learn the usage of graphs and its applications
- To study about NP Completeness of problems.

UNIT I ROLE OF ALGORITHMS IN COMPUTING 9

Algorithms – Algorithms as a technology- Insertion Sort – Analyzing Algorithms – Designing Algorithms- Growth of Functions: Asymptotic Notation – Standard Notations and Common Functions- Recurrences: The Substitution Method – The Recursion-Tree Method.

UNIT II HIERARCHICAL DATA STRUCTURES 9

Binary Search Trees: Basics – Querying a Binary search tree – Insertion and Deletion- Red-Black trees: Properties of Red-Black Trees – Rotations – Insertion – Deletion -B-Trees: Definition of B-Trees – Basic operations on B-Trees – Deleting a key from a B-Tree- Fibonacci Heaps: structure – Mergeable-heap operations- Decreasing a key and deleting a node-Bounding the maximum degree.

UNIT III GRAPHS 10

Elementary Graph Algorithms: Representations of Graphs – Breadth-First Search – Depth-First Search – Topological Sort – Strongly Connected

Components- Minimum Spanning Trees: Growing a Minimum Spanning Tree – Kruskal and Prim- Single-Source Shortest Paths: The Bellman-Ford algorithm – Single-Source Shortest paths in Directed Acyclic Graphs – Dijkstra's Algorithm; All-Pairs Shortest Paths: Shortest Paths and Matrix Multiplication – The Floyd-Warshall Algorithm.

UNIT IV ALGORITHM DESIGN TECHNIQUES 8

Dynamic Programming: Matrix-Chain Multiplication – Elements of Dynamic Programming – Longest Common Subsequence- Greedy Algorithms: An Activity-Selection Problem – Elements of the Greedy Strategy- Huffman Codes.

UNIT V NP COMPLETE AND NP HARD 9

NP-Completeness: Polynomial Time – Polynomial-Time Verification – NP-Completeness and Reducibility – NP-Completeness Proofs – NP-Complete Problems, NP Hard Problems.

TOTAL: 45 PERIODS

REFERENCES:

1. Alfred V. Aho, John E. Hopcroft, Jeffrey D. Ullman, "Data Structures and Algorithms", Pearson Education, Reprint 2006.
2. Robert Sedgewick and Kevin Wayne,"ALGORITHMS", Fourth Edition, Pearson Education.
3. S.Sridhar,"Design and Analysis of Algorithms", First Edition, Oxford University Press. 2014.
4. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein,"Introduction to Algorithms", Third Edition, Prentice-Hall, 2011.

WEB REFERENCES:

1. https://swayam.gov.in/nd1_noc20_cs10/preview
2. https://courses.csail.mit.edu/6.851/spring12/lectures/
3. https://nptel.ac.in/courses/106102064/
4. https://www.edx.org/course/algorithmic-design-and- techniques

ONLINE RESOURCES:

1. https://freevideolectures.com/course/1941/introduction-to algorithms
2. https://youtu.be/gTK9EfE7jQQ
3. http://www2.cs.uregina.ca/~mouhoubm/=postscript/=c3620/ chap10.pdf

OUTCOMES:

Upon completion of the course, the students should be able to

1. Identify suitable data structures and develop algorithms to solve computing problems.
2. Develop and analyze algorithms for hierarchical data structures.
3. Design algorithms using graph structure to solve real-life problems.
4. Develop various string matching algorithms.
5. Apply suitable design strategy for problem solving.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	33	3	3	3	1	1	1	-	1	1	1	3	3	2
CO2	3	2	3	2	-	-	-	-	-		1	2	3	2
CO3	3	3	3	3	1	1	1	1	1	1	1	3	3	2
CO4	3	3	3	2	1	1	-	-	-	-	1	2	3	2
CO5	3	3	3	3	1	1	1	1	1	1	1	3	3	2

SEMESTER - I

24PCNPC101 SDG NO. 4	ADVANCED COMPUTER ARCHITECTURE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the recent trends in the field of Computer Architecture and identify performance related parameters.
- To learn different multiprocessor issues.
- To expose different types of multicore architectures.
- To understand design of the memory hierarchy.

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 –Exposing ILP - Advanced Branch Prediction - Dynamic Scheduling - Hardware-Based Speculation - Exploiting ILP - Instruction Delivery and Speculation - Limitations of ILP - Multithreading.

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

Introduction- Centralized, Symmetric and Distributed Shared Memory Architectures –Cache Coherence Issues – Performance Issues – Synchronization – Models of Memory Consistency – Case Study- Interconnection Networks – Buses, Crossbar and Multi-stage Interconnection Networks.

UNIT IV MULTICORE ARCHITECTURES 9

Homogeneous and Heterogeneous Multi-core Architectures – Intel Multicore Architectures – SUN CMP architecture – IBM Cell Architecture. Introduction to Warehouse-scale computers Architectures- Physical Infrastructure and Costs-Cloud Computing –Case Study- Google Warehouse-Scale Computer.

UNIT V VECTOR, SIMD AND GPU ARCHITECTURES 9

Introduction-Vector Architecture – SIMD Extensions for Multimedia – Graphics Processing Units – Case Studies – GPGPU Computing – Detecting and Enhancing Loop Level Parallelism-Case Studies.

TOTAL: 45 PERIODS

REFERENCES:

1. David B. Kirk, Wen-mei W. Hwu, Morgan Kauffman, "Programming Massively Parallel Processors", 2010.
2. Darryl Gove, "Multicore Application Programming: For Windows, Linux, and Oracle Solaris", Pearson, 2011.
3. David E. Culler, Jaswinder Pal Singh, "Parallel computing architecture : A hardware/software approach" , Morgan Kaufmann /Elsevier Publishers, 1999.
4. John L. Hennessey and David A. Patterson, "Computer Architecture – A Quantitative Approach", Morgan Kaufmann / Elsevier, 5th edition, 2012.
5. Kai Hwang and Zhi.Wei Xu, "Scalable Parallel Computing", Tata McGraw Hill, NewDelhi, 2003.

WEB REFERENCES:

1. https://swayam.gov.in/nd1_noc19_cs62/
2. http://cs.baylor.edu/~maurer/aida/courses/archintro.pdf

OUTCOMES:

Upon completion of this course, the students should be able to

1. Discuss the limitations of ILP.
2. Understand the different multiprocessor and its real time applications
3. Identify issues related to multiprocessing and suggest solutions
4. Illustrate various techniques used in multicore architecture
5. Understand Vector,SIMD and GPU architecture

CO-PO,PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	2	-	-	2	2	2	3	1	2
CO2	3	3	3	2	2	2	-	-	2	2	2	3	1	2
CO3	3	3	3	2	2	2	-	-	2	2	2	3	1	2
CO4	3	3	3	2	2	2	-	-	2	2	2	3	1	2
CO5	3	3	3	2	2	2	-	-	2	2	2	3	1	2

SEMESTER - I

24PCNPC102 SDG NO. 4	VIRTUALIZATION TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To acquire knowledge of Virtualization and its basic principles
- Ability to use commercial software for Virtualization
- Ability to set up virtual networks, provisioning the memory, and I/O systems
- To apply the concepts of Virtualization techniques on applications

UNIT I INTRODUCTION **9**

Overview: Why server virtualization –History and re-emergence – Classic virtual machines; VMware, VSphere, KVM, Xen; Taxonomy and basic principles, Architectures comparison - CPU virtualization -Privileged instructions handling - Hypervisor – Para virtualization. Hardware-assisted virtualization. Booting up. Time keeping. CPU scheduling. Commercial examples.

UNIT II MEMORY MANAGEMENT IN VIRTUALIZATION 9

Memory management in virtualization: Virtual Storage, partitioning –reclamation –ballooning. Memory sharing. OS-level virtualization –VM Ware –Red Hat Enterprise Virtualization.

UNIT III I/O VIRTUALIZATION 9

I/O virtualization: Virtualizing I/O devices -Monolithic model -virtual I/O server. Virtual networking –Tunneling –overlay networks. Commercial examples. Virtual storage: Granularity –Centralized and Distributed File system, system level, Blocks level.

UNIT IV VIRTUALIZED COMPUTING 9

Virtualized computing: Virtual machine based distributed computing, Elastic cloud computing, clustering, Cold and hot migration. Commercial examples. Challenges and future trends.

UNIT V APPLICATIONS 9

Applications: In distributed computing: Grid and Cloud, Virtual Machine Provisioning, Desktop Virtualization, Application Virtualization, Security for virtualized environments, Business Continuity in virtual environments.

TOTAL: 45 PERIODS

REFERENCES:

1. Jim Smith, Ravi Nair, Morgan, Kaufmann, "Virtual Machines: Versatile Platforms for Systems and Processes "(1st Ed): (2005).
2. "Applied Virtualization Technology - Usage models for IT professionals and Software Developers" (1st Ed): Sean Campbell Intel Press (2006).
3. Robert P. Goldberg, Proc. "Architecture of Virtual Machines", Workshop on Virtual Computer Systems, Cambridge, MA, 1973, pp 74-112.
4. Gerald J. Popek, Robert P. Goldberg, "Formal Requirements for Virtualizable Third Generation Architectures", Communications of the ACM, 17(7), July 1974, pp 413-421.
5. Paul Barham, Boris Dragovic, Keir Fraser, Steven Hand, Tim Harris, Alex Ho, Rolf Neugebauer, Ian Pratt and Andrew Warfield -"Xen and the Art of Virtualization", Proceedings of the ACM Symposium on Operating Systems Principles (SOSP), October 2003.

WEB REFERENCES:

1. www.xenproject.org
2. https://nptel.ac.in/courses/106/106/106106144/

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the basic concepts of server virtualization.
2. Analyze the concepts of privileged instructions handling and hypervisor.
3. Apply commercial software for virtualization.
4. Design virtual networks, memory provisioning, and I/O systems.
5. Evaluate the concepts of Virtualization techniques on applications.

CO-PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	-	2	-	1	-	-	-	2	3	2	1
CO2	3	2	2	-	1	-	1	-	-	-	1	3	2	1
CO3	3	3	3	1	1	-	-	1	1	1	2	2	1	1
CO4	3	3	3	2	2	2	1	-	1	1	2	2	2	2
CO5	3	3	3	3	3	2	2	2	2	2	1	3	2	2

SEMESTER - I

24PCNPC103 SDG NO. 4	ADVANCED COMPUTER COMMUNICATION AND NETWORKING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To introduce the students to the basic understanding of Computer networks starting with OSI Reference Model, Protocols at different layers
- To special emphasis on IP, TCP & UDP and Routing algorithms
- To Identify the different types of network devices and their functions within a network.
- To study major topics such are TCP/IP implementation, LANs/WANs, internetworking technologies, Routing and Addressing

UNIT I INTRODUCTION, PROTOCOLS AND STANDARDS 9

Definition and Uses of Computer Network, Classification of Computer network, Network Architecture, Internet Standards, Internet Administration; Overview of reference models: The OSI model, The OSI Reference Model, TCP/IP protocol Suite, The TCP/IP Reference Model, Comparison of the OSI & the TCP/IP Reference Models, Addressing, IP versions.

UNIT II MULTIPLEXING AND LOCAL AREA NETWORKS 9

Multiplexing, Types of Multiplexing- FDM, TDM, SM; - Ethernet, token ring, FDDI; switching - circuit switching, packet switching, multicasting. Connectors, Transceivers and Media converters, Network interface cards and PC cards, Repeaters, Hubs, Bridges, Switches, Routers and Gateways etc. H/W selection. , Telephone networks, networking principles.

UNIT III PACKET SWITCHING PROTOCOL AND ROUTING PROTOCOL 9

X.25, theory of Operation and Network Layer functions, X.75, Internetworking protocols, SMDS, Subscriber Interface and Access Protocol, Addressing and Traffic Control Common Protocols, Routing Protocols: RIP, OSPF, BGP; Multicast Routing Protocols: MOSPF, DVMRP, Drawbacks of traditional routing methods, Idea of TE, TE and Different Traffic classes.

UNIT IV WEB SECURITY AND TRAFFIC MANAGEMENT BASICS 9

Introduction, Web Security Requirements, Secure Socket Layer (SSL), Traffic Management, Quality characteristics and requirements. Introduction, Applications and Quality of service, Queue Analysis, Queue Management Algorithms.

UNIT V ENTERPRISE NETWORK SECURITY 9

DMZ, NAT, SNAT, DNAT, Port Forwarding, Proxy, Transparent Proxy, Packet Filtering and Layer 7 Filtering. Backbone Network Design: Backbone Requirements, Network Capacities Topologies, Topologies Strategies, Tuning Network

TOTAL : 45 PERIODS

REFERENCES :

1. L. Peterson and B. Davie, Morgan Kaufman, "Computer Networks, A Systems Approach", Fifth Edition,, 2012.
2. A. Tanenbaum and David Wetherall, "Computer Networks", Fifth Edition, Pearson Prentice-Hall, 2011.
3. W.S. Stallings, "Data and Computer Communications", Ninth Edition,, Pearson Prentice-Hall, 2011.
4. J. Kurose and K. Ross, "Computer Networking, A Top-Down Approach", Addison Wesley, 2010.
5. Y-D. Lin, R-H. Hwang and F. Baker, "Computer Networks, An Open Source Approach", McGraw Hill, 2012.
6. Morgan Kaufman,"The Illustrated Network, How TCP Works in a Modern Network", 2009.
7. A. Leon-Garcia and I. Widjaja," Communication Networks, Fundamental Concepts and Key Architectures", Second Edition, McGraw-Hill, 2003.

8. D.E. Comer, "Computer Networks and Internets", Fifth Edition, Pearson Prentice-Hall, 2009.
9. F. Halsall, "Computer Networking and the Internet', Fifth Edition, Addison Wesley, 2005.
10. D. Bertsekas and R. Gallager,"Data Networks, Second Edition", Prentice-Hall, 1992.

WEB REFERENCES :

1. https://www.coursera.org/specializations/computer-communications
2. https://www.systems.ethz.ch/node/489
3. https://courses.engr.illinois.edu/cs538/sp2018/

OUTCOMES:

Upon completion of this course, the students should be able to

1. Illustrate reference models with layers, protocols and interfaces.
2. Describe and Analysis of basic protocols of computer networks, and how they can be used to assist in network design and implementation.
3. Describe Subnetting and Addressing of IP V4.
4. Identify the different types of network devices and their functions within a network.
5. Diagnose and resolve problems of a LAN and WAN.

CO-PO,PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	2	2	0	0	2	3	3	3	1	3
CO2	3	3	3	3	2	2	0	0	2	3	3	3	1	3
CO3	3	3	3	3	2	2	0	0	2	3	3	3	1	3
CO4	3	3	3	3	2	2	0	0	2	3	3	3	1	3
CO5	3	3	3	3	2	2	0	0	2	3	3	3	1	3

SEMESTER - I

24PCSPW101 SDG NO. 4 & 9	ADVANCED MACHINE LEARNING WITH LABORATORY	L	T	P	C
		2	0	2	3

OBJECTIVES:

- To understand the basic concepts and techniques of Machine Learning.
- To implement the concepts of Supervised and Unsupervised learning techniques
- To study the various probability based learning techniques
- To understand graphical models of machine learning algorithms

UNIT I INTRODUCTION 9

Learning – Types of Machine Learning – Supervised Learning – The Brain and the Neuron – Design a Learning System – Perspectives and Issues in Machine Learning – Concept Learning Task – Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Regression.

UNIT II LINEAR AND GRAPHICAL MODEL 9

Multi-layer Perceptron –Deriving Back-Propagation– Radial Basis Functions and Splines – RBF Network – Curse of Dimensionality – Interpolations and Basis Functions – Support Vector Machines- Markov Chain Monte Carlo Methods – Sampling – Proposal Distribution - Graphical Models –Bayesian Networks – Markov Random Fields – Hidden Markov Models.

UNIT III TREE AND PROBABILISTIC MODELS 9

Learning with Trees – Decision Trees – Classification and Regression Trees – Ensemble Learning – Boosting – Bagging – Different ways to Combine Classifiers – Probability and Learning – Data into Probabilities – Basic Statistics – Gaussian Mixture Models – Nearest Neighbor Methods – Unsupervised Learning – K means Algorithms – Vector Quantization – Self Organizing Feature Map.

UNIT IV DIMENSIONALITY REDUCTION AND EVOLUTIONARY MODELS 9

Dimensionality Reduction – Linear Discriminant Analysis – Principal Component Analysis – Factor Analysis – Independent Component Analysis – Locally Linear Embedding – Isomap – Least Squares Optimization – Evolutionary Learning – Genetic algorithms – Genetic Offspring: - Genetic Operators – Using Genetic Algorithms –Reinforcement Learning – Overview –

Getting Lost Example – Markov Decision Process.

UNIT V LAB COMPONENT – LIST OF EXPERIMENTS 9

1. Demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.
2. Build an Artificial Neural Network by implementing the Back propagation algorithm and test the same using appropriate data sets.
3. Write a program to implement k-Nearest Neighbour algorithm to classify the iris data set. Print both correct and wrong predictions.
4. Apply k-Means algorithm to cluster a set of data stored in a .CSV file and comment on the quality of clustering.
5. Interpret the results of PCA analysis .
6. Implement the naïve Bayesian classifier for a sample training data set stored as a .CSV file. Compute the accuracy of the classifier, considering few test data sets..

TOTAL: 45 PERIODS

TEXT BOOK:

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (India) Private Limited, 2013.

REFERENCES:

1. Ethem Alpaydin, "Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series)", Third Edition, MIT Press,2014
2. Jason Bell, "Machine learning – Hands on for Developers and Technical Professionals", First Edition, Wiley, 2014
3. Peter Flach, "Machine Learning: The Art and Science of Algorithms that Make Sense of Data", First Edition, Cambridge University Press, 2012.
4. Stephen Marsland, "Machine Learning – An Algorithmic Perspective", Second Edition, Chapman and Hall/CRC Machine Learning and Pattern Recognition Series,2014.

WEB REFERENCES:

1. http://mitpress.mit.edu/catalog/item/default.asp?ttype=2&tid=12012.
2. http://www.amazon.com/Machine-Learning-Algorithmic-Perspective-Recognition/dp/1420067184
3. http://research.microsoft.com/en-us/um/people/cmbishop/prml/

4. http://www.cs.cmu.edu/~tom/mlbook.html

ONLINE RESOURCES:

1. http://calla.rnet.missouri.edu/cheng_courses/mlbioinfo/heckerman_bn.pdf
2. https://link.springer.com/chapter/10.1007/3-540-26888-X_5

DATASETS:

Data sets can be taken from standard repositories

- SNAP: Stanford Large Network Dataset Collection
- The UCI Machine Learning Repository
- The UCI Network Data Repository
- The Koblenz Network Collection

Or constructed by the students.

OUTCOMES:

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

1. Understand the concept of machine learning fundamentals
2. Apply the appropriate machine learning strategy for linear and graphical model
3. Apply the tree and probabilistic approach in learning
4. Analyze the evolutionary model in machine learning
5. Design and develop machine learning applications using the following Tools : SAS / NumPy, Software: Weka, TensorFlow, RapidMiner.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	1	3	1	1	2	1	2	3	3
CO2	2	2	3	2	2	-	2	-	1	-	-	-	3	3
CO3	2	3	2	2	2	-	2	2	-	-	1	-	2	2
CO4	3	2	2	3	2	-	3	1	-	2	1	2	2	2
CO5	3	2	2	3	2	1	2	1	1	2	1	2	3	3

SEMESTER - I

24PCSPL101 SDG NO. 4 & 9	DATA STRUCTURES LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To acquire the knowledge of using advanced tree structures.
- To learn the usage of heap structures.
- To understand the usage of graph structures and spanning trees.
- To learn about Huffman Coding

LIST OF EXPERIMENTS:

1. Implementation of Merge Sort and Quick Sort-Analysis
2. Implementation of a Binary Search Tree
3. Red-Black Tree Implementation
4. Heap Implementation
5. Fibonacci Heap Implementation
6. Graph Traversals
7. Spanning Tree Implementation
8. Shortest Path Algorithms (Dijkstra's algorithm, Bellman Ford Algorithm)
9. Implementation of Matrix Chain Multiplication
10. Activity Selection and Huffman Coding Implementation

TOTAL: 45 PERIODS

LAB REQUIREMENT FOR A BATCH OF 30 STUDENTS

Hardware Requirements:

- Desktop Systems - Pentium IV with 2 GB RAM
- 160 GB HARD Disk
- Monitor 1024 x 768 color

Software Requirements:

- Windows Operating System.
- Dev C++/C/Equivalent Compiler.
- JDK 1.8

OUTCOMES:

Upon Completion of this course, the students should be able to

1. Design and implement basic data structures.
2. Implement advanced data structures extensively

3. Design algorithms using graph structures.
4. Design and develop efficient algorithms with minimum complexity using design techniques.
5. Understand and develop Dynamic programming algorithms.

CO-PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3	2	1	-	1	3	3	1	1	3	2
CO2	3	3	3	3	2	-	1	1	3	2	1	1	3	2
CO3	3	2	3	2	3	1	-	-	2	2	2	-	3	2
CO4	3	3	3	3	3	1	1	1	3	3	2	1	3	2
CO5	3	3	3	3	3	1	1	-	3	3	2	1	3	2

SEMESTER - I

24PCNTE101 SDG NO. 4 & 9	INNOVATIVE DESIGN PROJECT - I	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To encourage in identifying problems with social relevance
- To think of an innovative solution for the problem
- To design and conduct suitable experiment with modern tool
- To develop a cost effective prototype of the innovative design
- To understand the practical aspects and associated challenges in implementing the design

METHODOLOGY:

1. Student should do it individually.
2. Student should submit / present his/her ideas to the Faculty-in-Charge for approval.
3. Student should submit proposal with system/ technical details and cost implications.
4. Student should periodically demonstrate his/her progress.

EVALUATION: Evaluation will be based on:

1. The social relevance of the work.
2. The utility of the system developed.
3. The Level of proof of concept.
4. Industry support if obtained.etc.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Conduct literature survey to identify the gap and an application oriented research problem in the specific domain
2. Design and validate the proposed system using simulation
3. Prototype the proposed system
4. Analyze the obtained results and prepare a technical report
5. Publish the work in journals and apply for the patents.

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	2	2	2	3	2	2	3	3	3
CO2	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO3	2	2	2	1	2	1	1	1	3	2	3	3	3	2
CO4	2	2	2	1	2	1	1	1	3	2	3	3	3	2
CO5	2	2	2	1	2	1	1	1	3	2	3	3	3	2

SEMESTER - II

24PCNPC201 SDG NO. 4 & 9	NETWORK DESIGN AND PROGRAMMING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To explore various networking devices and protocols required for network design and management
- To study two novel networking technologies: SDN and DTN
- To Configure the networking devices and routing protocols
- To learn network programming in UNIX C

UNIT I NETWORKING PRINCIPLES **9**

Advanced multiplexing – Code Division Multiplexing, DWDM and OFDM – Shared media networks – Collision detection and collision avoidance-Hidden and Exposed Terminals – Switched networks – Datagrams, Virtual circuits, Cell switching and Label switching – Wireless Networks – Infrastructure based, ad hoc and hybrid – End to end semantics – Connectionless, Connection oriented, Wireless Scenarios –Applications, Quality of Service – End to end level and network level solutions.

UNIT II PHYSICAL NETWORK DESIGN **9**

LAN cabling topologies – Ethernet Switches – High speed and Gigabit and 10Gbps – Building cabling topologies and Campus cabling topologies – Routers, Firewalls and L3 switches –Remote Access Technologies and Devices – Modems and DSLs – SLIP and PPP - WAN Design and Enterprise Networks – Core networks, Distribution networks and access networks.

UNIT III LOGICAL DESIGN AND MANAGEMENT **9**

IPv4 and IPv6 Dynamic Addressing –Hierarchical routing – VLSM and CIDR – Transition from IPv4 to IPv6 – NAT and DHCP – Static and Dynamic routes – RIP, OSPF and BGP – VPN –RMON and SNMP.

UNIT IV INNOVATIVE NETWORKS **9**

Software Defined Networks – Evolution of switches and control planes – Centralized and distributed data and control planes – OpenFlow and SDN Controllers – Network Function Virtualization – Needs of the Data Centres – SDN solutions for data centres - Delay Tolerant Networks – Overlay architecture – Bundle Protocol – Opportunistic routing and Epidemic routing.

UNIT V NETWORK PROGRAMMING IN UNIX C 9

Socket address structures – Byte ordering and byte manipulation functions – Elementary TCP sockets – socket, connect, bind, listen, accept and close functions – TCP client and server – Elementary UDP sockets –recvfrom and sendto functions , connect function with UDP – Raw sockets – Client-Server design alternatives – Iterative and Concurrent servers.

TOTAL: 45 PERIODS

REFERENCES:

1. Larry Peterson and Bruce Davie, "Computer Networks: A Systems Approach", 5th edition, Morgan Kauffman, 2011.
2. Paul Goransson, Chuck Black, "Software Defined Networks: A Comprehensive Approach", Morgan Kauffman, 2014.
3. W.Richard Stevens, Bill Fenner and Andrew M Rudoff, "Unix Network Programming: The Sockets Networking API: Volume 1", 3rd Edition, Addison Wesley, 2003.

WEB REFERENCES:

1. https://nptel.ac.in/courses/106/105/106105183/

ONLINE RESOURCES:

1. ParitoshPuri, M.P.Singh, "A Survey paper on routing in delay tolerant networks", International Conference on Information and Computer Networks (ISCON), 2013, DOI:10.1109/ICISCON 2013.6524206.
2. https://www.opennetworking.org/sdn-definition.
3. https://ivypanda.com/essays/networking-basics.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the networking principles to design a network.
2. Study of various Physical Network Design concepts.
3. Apply SDN in computing paradigms like Cloud Computing and Internet of Things.
4. Configure the networking devices and routing protocols.
5. Develop network applications in various platforms.

CO-PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	2	3	-	-	-	-	-	-	1	-	1	2	2
CO2	1	-	3	2	-	-	-	-	-	2	-	1	2	2
CO3	-	-	1	-	3	-	-	-	-	-	-	1	2	2
CO4	-	2	3	2	-	-	-	-	-	3	-	2	2	2
CO5	-	2	1	1	-	-	-	-	-	-	-	1	2	2

SEMESTER - II

24PCNPC202 SDG NO. 4	WIRELESS TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concepts of wireless technology
- To implement the working of MVC and MIMO.
- To analyze various waveforms and channel modes
- To apply networking via wireless medium

UNIT I INTRODUCTION AND ROADMAP TO 5G **9**

Historical trend and evolution of LTE technology to beyond 4G – Key building blocks of 5G – 5G use cases and System Concepts – The 5G Architecture – IoT Relation to 5G.

UNIT II RF FRONT END FOR 5G **9**

Millimeter Wave Communications: Hardware technologies for mmW systems – Architecture and Mobility – Massive MIMO: Resource allocation and transceiver algorithms for massive MIMO - Fundamentals of baseband and RF implementations in massive MIMO - Beamforming.

UNIT III 5G WAVEFORMS AND CHANNEL MODELS **9**

5G Radio Access Technologies: Design principles - Multi-carrier with filtering - Non Orthogonal Multiple Access - Radio access for dense deployments – Radio Access for V2X Communication - Radio access for massive machine-type communication - 5G wireless propagation channel models - Modelling requirements and scenarios - The METIS channel models.

UNIT IV NETWORKING IN 5G **9**

Coordinated multi-point transmission in 5G: Joint Transmission CoMP enablers - Distributed cooperative transmission - JT CoMP with advanced receivers - Relaying and network coding in 5G: Multi-flow wireless backhauling - Bufferaided relaying.

UNIT V EVALUATION OF 5G AND 5G APPLICATIONS **9**

Machine-type communications: Fundamental techniques for MTC - Massive MTC - Ultra-reliable low-latency MTC - Device-to-Device (D2D) Communications - Multi-hop D2D communications - Multi-operator D2D communication - Simulation methodology: Evaluation methodology – Calibration - New challenges in the 5G modelling.

TOTAL: 45 PERIODS

REFERENCES:

1. Wei Xiang, Kan Zheng, Xuemin (Sherman) Shen, "5G Mobile Communications", Springer, 2017.
2. AfifOsseiran, Jose F. Monserrat and Patrick Marsch, "5G Mobile and Wireless Communications Technology", Cambridge University Press, 2016.
3. Jonathan rodriguez, "Fundamentals of 5G mobile networks", John Wiley & Sons, Ltd, 2015.

WEB REFERENCES:

1. https://www.geeksforgeeks.org/what-is-5g-wireless-technology-and-how-it-works/
2. https://www.tutorialspoint.com/5g/5g_technology.htm

OUTCOMES:

Upon Completion of the course, the students should be able to

1. Understand and discuss the cellular system design and technical challenges.
2. Analyze the 5G radio propagation, fading, diversity concepts.
3. Examine wave forms and channel modeling.
4. Evaluate the networking and related parameters.
5. Apply the 5G schemes and its application.

CO-PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	3	1	1	2	1	1	1	1	-	-	3	1
CO2	1	2	3	1	1	2	1	1	-	1	-	1	3	1
CO3	2	2	3	1	1	2	1	1	1	1	3	1	3	-
CO4	1	2	3	1	1	2	1	1	1	1	1	2	3	1
CO5	1	2	3	1	1	2	1	1	-	-	-	2	3	1

SEMESTER - II

24PCNPL201 SDG NO. 4	NETWORK DESIGN AND PROGRAMMING LABORATORY	L	T	P	C
		0	0	3	1.5

OBJECTIVES:

- To practice LAN and WAN design
- To learn network programming in UNIX C and Python
- Establish a LAN with a switch/hub with 3 PCs and check the connectivity and configuration
- Establish a internetwork with 2 routers and two or more LANs using static routes and check the connectivity and configuration

LIST OF EXPERIMENTS:

1. Develop a C Program that demonstrates inter process communication.
2. Develop a TCP client/server application.
3. Develop a UDP client/server application.
4. Develop an Iterative UDP server with 2 or 3 clients.
5. Develop a concurrent TCP server with 2 or 3 clients.
6. Develop a multiprotocol server with TCP and UDP and 2 clients.
7. Develop simple python programs that use frequently used syntactic constructs.
8. Develop a Socket based application in Python.
9. Build client applications for major APIs (Amazon S3, Twitter etc) in Python.
10. Develop an application that interacts with e-mail servers in python.
11. Develop applications that work with remote servers using SSH, FTP etc., in Python.

TOTAL: 45 PERIODS

LAB REQUIREMENTS :

- Linux OS
- GCC Compiler
- Python IDE
- Network Simulator like Packet Tracer, NS2 etc

OUTCOMES :

On completion of this laboratory course, the student should be able to

1. Design and implement LANs and internetworks.
2. Establish LAN with a switch and check connectivity and configuration.
3. Checking the connectivity and connection of an internetwork with 2 routers and two or more LANs.
4. Create a dynamic routing internetwork with 2 routers using RIP/OSPF protocol.
5. Develop network based applications in Unix C and Python.

CO-PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	2	1	1	1	1	2	1	2	3	3
CO2	3	3	3	3	3	2	2	2	2	2	2	2	3	3
CO3	3	3	3	3	3	1	2	1	3	2	2	3	3	3
CO4	3	2	2	2	2	1	1	1	2	1	1	2	3	3
CO5	3	2	2	2	2	1	1	1	2	1	1	2	3	3

SEMESTER - II

24PCNTE201 SDG NO. 4 & 9	INNOVATIVE DESIGN PROJECT - II	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To encourage in identifying problems with social relevance
- To think of an innovative solution for the problem
- To design and conduct suitable experiment with modern tool
- To develop a cost effective prototype of the innovative design
- To understand the practical aspects and associated challenges in implementing the design

METHODOLOGY:

1. Student should do it individually.
2. Student should submit / present his/her ideas to the Faculty-in-Charge for approval.
3. Student should submit proposal with system/ technical details and cost implications.
4. Student should periodically demonstrate his/her progress.

EVALUATION:

Evaluation will be based on:

1. The social relevance of the work.
2. The utility of the system developed.
3. The Level of proof of concept.
4. Industry support if obtained.etc.

WEB REFERENCES:

1. https://www.mathworks.com/academia/books.html
2. http://www.mathcs.emory.edu/~cheung/Courses/455/Syllabus/A3-NS/Book/Introduction-to- Network-Simulator-NS2-2012.pdf

ONLINE REFERENCES:

1. http://www.jgyan.com/ns2/
2. https://matlabacademy.mathworks.com/

OUTCOMES:

Upon completion of the course, the student should be able to

1. Conduct literature survey to identify the gap and an application oriented research problem in the specific domain
2. Design and validate the proposed system using simulation
3. Prototype the proposed system
4. Analyze the obtained results and prepare a technical report
5. Publish the work in journals and apply for the patents.

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	2	2	2	3	2	2	3	3	3
CO2	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO3	2	2	2	1	2	1	1	1	3	2	3	3	3	2
CO4	2	2	2	1	2	1	1	1	3	2	3	3	3	2
CO5	2	2	2	1	2	1	1	1	3	2	3	3	3	2

SEMESTER - III

24PCNPJ301 SDG NO. 4, 6, 7, 8, 9, 1,12,13, 17	PROJECT WORK PHASE - I	L	T	P	C
		0	0	12	6

OBJECTIVES:

- Identify and describe the problem and scope of project
- Collect, analyze and present data into meaningful information using relevant tools
- Select, plan and execute a proper methodology in problem solving, work independently and ethically
- Present the results in written and oral format effectively and identify basic entrepreneurship skills in project management.

GUIDELINES TO BE FOLLOWED:

A student should work under a project supervisor, a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department. The Project Work Phase-I will follow the following Sequence:

I. Problem Identification

1. A statement of system / process specifications proposed to be developed (Block Diagram / Concept tree)
2. List of possible solutions including alternatives and constraints
3. Cost benefit analysis
4. Timeline of activities

II. A report highlighting the design finalization [based on functional requirements and standards (if any)]

III. A presentation including the following:

1. Implementation Phase (Hardware / Software / both)
2. Testing and Validation of the developed system
3. Learning in the Project

IV. Consolidated report preparation

TOTAL: 90 PERIODS

OUTCOMES:

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

1. Comprehend and identify an industrial or real life problem with solution.
2. Execute a proper methodology in problem solving
3. Review the literature and design a setup of equipment and complete the analysis
4. Write a project report based on the findings.
5. Demonstrate an ability to present and defend their work to a panel of experts.

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	2	2	2	3	2	2	3	3	3
CO2	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO3	2	2	2	1	2	1	1	1	3	2	3	3	3	2
CO4	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO5	2	2	2	1	2	1	1	1	3	2	3	3	3	2

SEMESTER - IV

24PCNPJ401 SDG NO. 4, 6, 7, 8, 9, 1,12,13, 17	PROJECT WORK PHASE - II	L	T	P	C
		0	0	12	6

OBJECTIVES:

- Identify and describe the problem and scope of project
- Collect, analyze and present data into meaningful information using relevant tools
- Select, plan and execute a proper methodology in problem solving, work independently and ethically
- Present the results in written and oral format effectively and identify basic entrepreneurship skills in project management.

GUIDELINES TO BE FOLLOWED:

A student should work under a project supervisor, a faculty member and prepare a comprehensive project report after completing the work to the satisfaction of the supervisor. The progress of the project is evaluated based on a minimum of three reviews. The review committee may be constituted by the

Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department. The Project Work Phase-I will follow the following Sequence:

I. Problem Identification

1. A statement of system / process specifications proposed to be developed (Block Diagram / Concept tree)
2. List of possible solutions including alternatives and constraints
3. Cost benefit analysis
4. Timeline of activities

II. A report highlighting the design finalization [based on functional requirements and standards (if any)]

III. A presentation including the following:

1. Implementation Phase (Hardware / Software / both)
2. Testing and Validation of the developed system
3. Learning in the Project

IV. Consolidated report preparation

TOTAL: 180 PERIODS

OUTCOMES:

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

1. Comprehend and identify an industrial or real life problem with solution.
2. Execute a proper methodology in problem solving
3. Review the literature and design a setup of equipment and complete the analysis
4. Write a project report based on the findings.
5. Demonstrate an ability to present and defend their work to a panel of experts.

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	2	2	2	2	3	2	2	3	3	3
CO2	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO3	2	2	2	1	2	1	1	1	3	2	3	3	3	2
CO4	3	3	3	2	3	3	2	2	3	3	3	3	3	3
CO5	2	2	2	1	2	1	1	1	3	2	3	3	3	2

PROFESSIONAL ELECTIVES - I

24PCNEL201 SDG NO. 4	IMAGE PROCESSING AND ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the Image Processing Concepts and Analysis
- To understand the Image Processing Techniques
- To familiarize the Image Processing Environment and their applications
- To use Image Processing in various applications

UNIT I IMAGE PROCESSING FUNDAMENTALS 9

Introduction – Elements of visual perception - Steps in Image Processing Systems – Digital Imaging System - Image Acquisition – Sampling and Quantization – Pixel Relationships – File Formats – Colour Images and Models - Image Operations – Arithmetic - Logical- Statistical and Spatial Operations.

UNIT II IMAGE ENHANCEMENT AND RESTORATION 9

Image Transforms - Discrete and Fast Fourier Transform and Discrete Cosine Transform - Spatial Domain - Gray Level Transformations - Histogram Processing - Spatial Filtering – Smoothing and Sharpening. Frequency Domain - Filtering in Frequency Domain – Smoothing and Sharpening Filters – Homomorphic Filtering - Noise Models - Constrained and Unconstrained Restoration Models.

UNIT III IMAGE SEGMENTATION AND MORPHOLOGY 9

Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region Based Segmentation – Motion Segmentation - Image Morphology - Binary and Gray level Morphology Operations - Erosion-Dilation - Opening and Closing Operations - Distance Transforms - Basic Morphological Algorithms. Features – Textures - Boundary Representations and Descriptions - Component Labeling – Regional Descriptors and Feature Selection Techniques.

UNIT IV IMAGE ANALYSIS AND CLASSIFICATION 9

Image Segmentation - Pixel Based - Edge Based - Region Based Segmentation - Active Contour Models and Level Sets for Medical Image Segmentation - Image Representation and Analysis - Feature Extraction and Representation - Statistical - Shape - Texture - Feature and Statistical Image Classification.

UNIT V IMAGE REGISTRATION AND VISUALIZATION 9

Rigid Body Visualization - Principal Axis Registration - Interactive Principal

Axis Registration - Feature Based Registration - Elastic Deformation Based Registration - Image Visualization – 2D Display Methods - 3D Display Methods - Virtual Reality Based Interactive Visualization.

TOTAL : 45 PERIODS

REFERENCES:

1. Rafeal C. Gonzalez, Richard E. Woods,"Digital Image Processing"- 3rd Edition, Pearson, 2008.
2. Alasdair McAndrew, "Introduction to Digital Image Processing with Matlab", Cengage Learning 2011,India.
3. Anil J Jain, "Fundamentals of Digital Image Processing", PHI, 2006.
4. Kavyan Najarian and Robert Splerstor, "Biomedical signals and Image Processing", CRC – Taylor and Francis, New York, 2006.
5. S.Sridhar,"Digital Image Processing", Oxford University Press, 2011.

WEB REFERENCES:

1. http://eeweb.poly.edu/~onur/lectures/lectures.html
2. http://www.caen.uiowa.edu/~dip/LECTURE/lecture.html
3. https://nptel.ac.in/courses/117105135/
4. https://nptel.ac.in/courses/106105032/

OUTCOMES:

Upon successful completion of this course, a student should be able to

1. Understand the basic concepts of Image Processing.
2. Apply algorithms for Image Processing Applications that incorporate different concepts of Medical Image Processing.
3. Identify the possibility of applying Image Processing concepts in various Applications.
4. Analyze different approaches to Image Processing Applications.
5. Design Image Processing Applications.

CO-PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	1	2	1	1	2	3	3
CO2	3	3	3	3	3	1	1	1	2	1	1	2	3	3
CO3	3	3	3	3	3	1	1	1	2	1	1	2	3	3
CO4	3	3	3	3	3	1	1	1	2	1	1	2	3	3
CO5	3	3	3	3	3	1	1	1	2	1	1	2	3	3

PROFESSIONAL ELECTIVES - I

24PCNEL202 SDG NO. 4 & 9	ARTIFICIAL INTELLIGENCE AND FUZZY SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To study the concepts of Artificial Intelligence
- To learn the methods of solving problems using Artificial Intelligence
- To learn the concept of Knowledge Inference
- To impact knowledge on fuzzy logic principles

UNIT I INTRODUCTION TO Al AND PRODUCTION SYSTEMS 9

Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies - Problem characteristics - Production system characteristics - Specialized production system - Problem solving methods – Problem graphs – Matching -Indexing and Heuristic functions - Hill Climbing - Depth first and Breath first - Constraints satisfaction – Related algorithms - Measure of performance and analysis of search algorithms.

UNIT II REPRESENTATION OF KNOWLEDGE 9

Game playing – Knowledge representation - Knowledge representation using Predicate logic - Introduction to predicate calculus - Resolution - Use of predicate calculus - Knowledge representation using other logic -Structured representation of knowledge.

UNIT III KNOWLEDGE INFERENCE 9

Knowledge representation - Production based system - Frame based system - Inference – Backward chaining - Forward chaining - Rule value approach - Fuzzy reasoning – Certainty factors - Bayesian Theory-Bayesian Network-Dempster – Shafer theory.

UNIT IV INTRODUCTION TO FUZZY LOGIC PRINCIPLES 9

Basic Concepts Of Fuzzy Set Theory – Operations Of Fuzzy Sets – Properties Of Fuzzy Sets – Crisp Relations – Fuzzy Relational Equations – Operations on Fuzzy Relations – Fuzzy Systems – Propositional Logic – Inference – Predicate Logic – Inference In Predicate Logic – Fuzzy Logic Principles – Fuzzy Quantifiers – Fuzzy Inference – Fuzzy Rule Based Systems – Fuzzification And Defuzzification – Types.

UNIT V ADVANCED FUZZY LOGIC APPLICATIONS 9

Fuzzy Logic Controllers – Principles – Review of Control Systems Theory –

Various Industrial Applications of Flc Adaptive Fuzzy Systems – Fuzzy Decision Making – Multiobjective Decision Making – Fuzzy Classification – Means Clustering – Fuzzy Pattern Recognition – Image Processing Applications – Systactic Recognition – Fuzzy Optimization.

TOTAL: 45 PERIODS

REFERENCES:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", Mc Graw Hill- 2008.
2. Rajasekaran. S.. Vijayalakshmi Pai. G.A. "Neural Networks, Fuzzy Logic and Genetic Algorithms", Prentice Hall of India Private Limited, 2003.
3. Timothy J.Ross, "Fuzzy logic with Engineering Applications", McGraw Hill, 1995.
4. Zurada J.M. "Introduction to Artificial Neural Systems", Jaico publishing house, 1994.
5. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.
6. Klir.G, Yuan B.B. "Fuzzy sets and Fuzzy Logic" Prentice Hall of India private limited, 1997.
7. LauranceFausett, "Fundamentals of Neural Networks", Prentice Hall, 1992.
8. Gen, M. and Cheng R. "Genetic Algorithm and Engineering Design", John Wiley 1997.

WEB REFERENCES:

1. https://eecs.wsu.edu/~cook/ai/lectures/p.html.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/106105077/
2. https://nptel.ac.in/courses/111102130/.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Identify problems that are amenable to solution by AI methods.
2. Identify appropriate AI methods to solve a given problem.
3. Formalise a given problem in the language/framework of different AI methods.
4. Develop the skill in basic understanding on fuzzy and neural networks.

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	1	-	1	-	-	2	-	3	1	1	1	2
CO2	1	-	-	3	2	-	1	-	-	3	-	2	1	1
CO3	2	2	2	3	3	-	1	-	-	-	1	-	1	2
CO4	1	-	-	-	1	1	-	-	-	3	-	2	1	1
CO5	1	3	2	-	-	1	1	-	-	-	1	1	2	3

PROFESSIONAL ELECTIVES - I

24PCNEL203 SDG NO. 4	SOFTWARE DEFINED NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concepts of software defined networks
- To learn the interface between networking devices and the software controlling them
- To know about SDN in data centers
- To explore modern approaches like openflow, openstack

UNIT I SDN INTRODUCTION **9**

Basic packet-Switching terminology - Historical background - The modern Data Center - Traditional switch architecture - Autonomous and dynamic forwarding Tables- Open source and technological shifts.- Evolution of switches and Control plane – Cost- SDN Implications for research and innovation- Data Center Innovation- Data Center needs -The evolution of networking technology - Forerunners of SDN- Sustaining SDN interoperability - Open Source contributions- Legacy mechanisms evolve towards SDN- Network virtualization.

UNIT II SDN AND OPEN FLOW SPECIFICATION **9**

Fundamental characteristics of SDN - SDN operation - SDN Devices- SDN Controller - SDN applications- Alternate SDN methods - OpenFlow Overview - OpenFlow 1.0 and OpenFlow basics- OpenFlow 1.1 additions - OpenFlow 1.2 additions - OpenFlow 1.3 additions - OpenFlow limitations.

UNIT III SDN IN DATA CENTERS AND OTHER ENVIRONMENT 9

Data Center definition - Data Center demands- Tunneling technologies for the Data Center- Path technologies in the Data Center - Ethernet fabrics in the Data Center- SDN Use Cases in the Data Center- Open SDN vs Overlays in the Data Center- Real World Data Center implementations- SDN in other environments - Wide Area Networks - Service provider and carrier networks - Campus networks- Hospitality networks- Mobile network - In-Line network functions- Optical Networks - SDN vs P2P/Overlay Networks.

UNIT IV SDN APPLICATIONS AND OPEN SOURCE PERSPECTIVES 9

Reactive versus proactive applications - Analyzing simple SDN Applications- A simple reactive Java application - Background on controllers - Using the Floodlight controller - Using the Open Daylight controller - Using the Cisco XNC Controller - Switch considerations- Creating network virtualization tunnels - Offloading flows in the Data Center- Access control for the campus- Traffic engineering for service providers - Open source licensing issues - Profiles of SDN Open Source users- OpenFlow source code- Switch implementations - Controller implementations - SDN applications - Orchestration and network virtualization - Simulation and testing - Tools- OpenStack.

UNIT V SDN SECURITY CHALLENGES 9

Characteristics of SDN - Security analysis and potential attacks in SDN - Solutions to the security issues in SDN - Network security enhancement using the SDN Framework - Issues and Challenges.

TOTAL: 45 PERIODS

REFERENCES:

1. Paul Goransson and Chuck Black, “Software Defined Networks: A Comprehensive Approach”, Morgan Kaufmann Publications, First Edition , 2014.
2. S. Scott-Hayward, S. Natarajan and S. Sezer, "A Survey of Security in Software Defined Networks," in IEEE Communications Surveys & Tutorials, vol. 18, no. 1, pp. 623-654, First quarter 2016.
3. Thomas D. Nadeau and Ken Gray, “SDN - Software Defined Networks” O'Reilly Media , 2013.
4. Siamak Azodolmolky, “Software Defined Networking with OpenFlow”, Packt Publishing, 2013.
5. Feamster, Nick, Jennifer Rexford, and Ellen Zegura, "The road to SDN: an intellectual history of programmable networks." ACM SIGCOMM Computer Communication Review , Volume 44, Number 2, 2014, Pages 87-98.

WEB REFERENCES:

1. Kreutz, Diego, et al. "Software-defined networking: A comprehensive survey." Proceedings of the IEEE 103.1 (2015): 14-76.
2. Nunes, Bruno AA, et al. "A survey of software-defined networking: Past, present, and future of programmable networks." Communications Surveys & Tutorials, IEEE 16.3 (2014): 1617-1634.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Differentiate between traditional networks and software defined networks.
2. Understand advanced and emerging networking technologies.
3. Learn how to use SDN controllers to perform complex networking tasks.
4. Demonstrate the skills to do advanced networking research and programming.
5. Apply the knowledge on SDN and security measures to solve real world problems.

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	-	-	1	-	-	-	-	-	-	-	2	1	3
CO2	3	2	2	-	-	-	1	-	-	-	1	3	2	3
CO3	3	3	3	1	3	-	-	-	1	1	2	2	1	3
CO4	3	3	3	2	3	2	2	-	-	1	1	2	2	3
CO5	3	3	3	3	3	2	2	1	2	2	3	3	2	3

PROFESSIONAL ELECTIVES - I

24PCNEL204 SDG NO. 4	PROTOCOLS AND ARCHITECTURES FOR WIRELESS SENSOR NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Learn about the basics and protocols in Wireless sensor networks
- Understand the layered protocol stack
- Analyze the performance in network applications
- Learn about the layered approach in sensor networks

UNIT I WIRELESS SENSOR NETWORK ARCHITECTURE 9

Introduction to wireless sensor networks- Challenges- Comparison with ad hoc network - Node architecture and Network architecture - Design principles - Service interfaces - Gateway - Short range radio communication standards - IEEE 802.15.4 - Zigbee and Bluetooth - Physical layer and Transceiver design considerations.

UNIT II DATA LINK LAYER 9

Mac Protocols - Fundamentals - Low Duty Cycle Protocols and Wakeup Concepts - Contention-based Protocols - Schedule-based Protocols - SMAC - BMAC - TRAMA - Link Layer Protocols - Fundamentals Task and Requirements - Error Control - Framing - Link Management - Naming and Addressing - Address Assignment - Unique - Content-based and Geographical Addressing.

UNIT III NETWORK LAYER 9

Routing protocols - Requirements - Taxonomy - Data-centric routing - SPIN Directed Diffusion Energy aware routing - Gradient-based routing - COUGAR - ACQUIRE - Hierarchical Routing - LEACH - PEGASIS - Location Based Routing - GAF - GEAR - Data aggregation - Various aggregation techniques - Localization and positioning - Properties - Approaches - Mathematical basics for single hop and multi-hop environment.

UNIT IV TRANSPORT LAYER 9

Transport Protocol - Coverage and deployments - Sensing models - Coverage measures - Random deployments - Poisson model - Boolean sensing model - general sensing model - Coverage determination - Grid deployment - Reliable data transport - Single packet delivery - Block delivery - Congestion control and rate control - Time synchronization - Issues and protocol - Sender/Receiver - Security - Protocols and Key Distribution Techniques.

UNIT V TOOLS FOR WSN 9

TinyOS - Introduction - NesC - Interfaces - Modules - Configuration - Programming in TinyOS using NesC - TOSSIM - Contiki - Structure - Communication Stack - Simulation environment - Cooja simulator - Programming.

TOTAL: 45 PERIODS

REFERENCES:

1. Anna Hac, "Wireless Sensor Network Design, John Wiley & Sons", 2003.
2. Siva Ram Murthy C and Manoj B S, "Ad Hoc Wireless Networks: Architectures and Protocols", Prentice Hall, 2004.
3. C.S.Raghavendra Krishna, M.Sivalingam and Taribznati, "Wireless Sensor Networks", Springer Publication, 2004.

4. Holger Karl , Andreas Willig, "Protocol and Architecture for Wireless Sensor Networks", John Wiley Publication, 2006.
5. KazemSohraby, Daniel Minoli and TaiebZnati, "Wireless Sensor Networks TechnologyProtocols and Applications", John Wiley & Sons, 2007.
6. Paolo Santi, "Topology Control in Wireless Ad Hoc and Sensor Networks", John Wiley & Sons, 2005.
7. Philip Levis, David Gay,"TinyOS Programming", Cambridge University Press, 2009.

WEB REFERENCES:

1. https://nptel.ac.in/courses/106105160/

ONLINE RESOURCES:

1. Contiki - Open Source Operating System for IOT - http://www.contiki-os.org/
2. https://epdf.pub/wireless-sensor-network-designs9998.html.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the basic concepts of wireless sensor networks.
2. Study the protocols for WSN.
3. Get exposure to the WSN environment with TinyOS.
4. Learn about the layered approach in sensor networks.
5. Analyze the performance of WSN in various applications.

CO-PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	-	-	-	-	-	-	-	-	2	2	2
CO2	3	1	1	-	-	-	-	-	-	-	-	-	2	2
CO3	3	1	1	-	3	-	-	-	-	-	-	-	2	2
CO4	3	1	1	-	-	-	-	-	-	-	-	-	2	2
CO5	3	3	2	1	3	-	-	-	-	-	-	-	2	2

PROFESSIONAL ELECTIVES - I

24PCNEL205 SDG NO. 4	ADVANCED SOFTWARE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand Software Engineering Lifecycle Models, Project Management and Cost Estimation
- To gain knowledge of the System Analysis and Design concepts
- To learn various Software Testing approaches
- To explore Software Development with DevOps practices

UNIT I INTRODUCTION **9**

Software engineering concepts – Development activities – Software lifecycle models - Classical waterfall - Iterative waterfall – Prototyping – Evolutionary - Spiral – Software project management – Project planning – Estimation – Scheduling – Risk management – Software configuration management.

UNIT II SOFTWARE REQUIREMENT SPECIFICATION **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 – Class diagrams – Interaction diagrams – Activity diagrams – State chart diagrams – Functional modelling – Data Flow Diagram.

UNIT III ARCHITECTURE AND DESIGN **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 TESTING **9**

Testing – Unit testing – Black box testing– White box testing – Integration and System testing–Regression testing – Debugging - Program analysis – Symbolic execution – Model Checking.

UNIT V DeVOps **9**

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

TOTAL: 45 PERIODS

REFERENCES:

1. Bernd Bruegge, Alan H Dutoit, "Object-Oriented Software Engineering", Second edition, Pearson Education, 2004.
2. Len Bass, Ingo Weber and Liming Zhu, "DevOps: A Software Architect's Perspective", Pearson Education, 2016.
3. Carlo Ghezzi, Mehdi Jazayeri, Dino Mandrioli, "Fundamentals of Software Engineering", Second edition, PHI Learning Pvt. Ltd., 2010.
4. Craig Larman, "Applying UML and Patterns", Third Edition, Pearson Education, 2005.
5. Rajib Mall, "Fundamentals of Software Engineering", Third edition, PHI Learning Pvt. Ltd., 2009.

WEB REFERENCES:

1. https://swayam.gov.in/nd1_noc19_cs69/
2. https://www.udacity.com/course/intro-to-devops--ud611.

ONLINE REFERENCES:

1. https://www.ece.rutgers.edu/~marsic/books/SE/

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the advantages of various Software Development Lifecycle Models.
2. Gain knowledge on project management approaches as well as cost and schedule estimation strategies.
3. Evaluate software design using different architectural styles and design patterns.
4. Understand software testing approaches.
5. Implement software development using DevOps practices.

CO- PO,PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	1	1	1	2	1	2	2	2
CO2	3	3	3	3	3	3	1	1	1	2	1	2	2	2
CO3	3	3	3	3	3	3	1	1	1	2	1	2	2	2
CO4	3	3	3	3	3	3	1	1	1	2	1	2	2	2
CO5	3	3	3	3	3	3	1	1	1	2	1	2	2	2

PROFESSIONAL ELECTIVES - I

24PCNEL206 SDG NO. 4 & 9	CLOUD STORAGE AND COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concepts of virtualization and virtual machines
- To gain expertise in server, network and storage virtualization
- To understand and deploy practical virtualization solutions and enterprise solutions
- To gain knowledge on the concept of virtualization that is fundamental to cloud computing

UNIT I VIRTUALIZATION **9**

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation –Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –ManagementVirtualization –– Hardware Maximization – Architectures – Virtualization Management – StorageVirtualization – Network Virtualization.

UNIT II VIRTUALIZATION INFRASTRUCTURE **9**

Comprehensive Analysis – Resource Pool – Testing Environment –Server Virtualization – Virtual Workloads – Provision Virtual Machines – Desktop Virtualization – Application Virtualization -Implementation levels of virtualization – Virtualization structure – Virtualization of CPU, Memory and I/O devices – Virtual clusters and Resource Management – Virtualization for data center automation.

UNIT III CLOUD PLATFORM ARCHITECTURE **9**

Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software - A Generic Cloud Architecture Design –Layered cloud Architectural Development – Virtualization Support and Disaster Recovery –Architectural Design Challenges - Public Cloud Platforms : GAE,AWS – Inter-cloud Resource Management.

UNIT IV PROGRAMMING MODEL **9**

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions,Specifying input and output parameters, Configuring and running a job –Developing Map ReduceApplications - Design of Hadoop file system –Setting up Hadoop Cluster - Cloud SoftwareEnvironments - Eucalyptus, Open Nebula, Open Stack, Nimbus.

UNIT V CLOUD SECURITY **9**

Cloud Infrastructure security: network, host and application level – Aspects of data security, Provider data and its security, Identity and access management architecture, IAM practices in the cloud, SaaS, PaaS, IaaS availability in the cloud - Key privacy issues in the cloud –Cloud Security and Trust Management.

TOTAL : 45 PERIODS

REFERENCES:

1. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
2. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
3. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner‟s Guide||, McGraw-Hill Osborne Media, 2009.
4. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
5. Tim Mather, Subra Kumaraswamy, and Shahed Latif ,"Cloud Security and Privacy", O‘Reilly Media, Inc.,2009.
6. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw- Hill Osborne Media, 2009.
7. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

WEB REFERENCES:

1. https://nptel.ac.in/courses/106/105/106105167/
2. https://swayam.gov.in/nd1_noc20_cs20/preview.

ONLINE RESOURCES:

1. https://www.ubuntupit.com/best-cloud-computing-books-available-online/
2. https://azure.microsoft.com/en-in/overview/what-is-cloud-computing/
3. https://www.simplilearn.com/what-is-cloud-computing-article.
4. https://www.youtube.com/watch?v=_fGrYN5rxhs.

OUTCOMES:

Upon completion of this course, the students should be able to

1. Employ the concepts of storage virtualization, network virtualization and its management.
2. Apply the concept of virtualization in the cloud computing.

3. Identify the architecture, infrastructure and delivery models of cloud computing.
4. Develop services using Cloud computing.
5. Apply the security models in the cloud environment.

CO-PO,PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	1	-	2	1	1	1	-	-	1	1	3	2
CO2	2	1	2	1	3	2	1	1	2	-	1	1	3	2
CO3	3	2	2	3	3	2	1	1	2	1	1	3	3	3
CO4	2	2	3	3	3	1	1	1	3	2	1	3	3	3
CO5	3	2	2	2	3	1	1	1	2	2	1	3	3	3

PROFESSIONAL ELECTIVES - I

24PCNEL207 SDG NO. 4 & 7	SOFTWARE ARCHITECTURE AND DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the need, design approaches for software architecture to bridge the dynamic requirements and implementation
- To learn the design principles and to apply for large scale systems
- To design architectures for distributed heterogeneous systems, environment through brokerage interaction
- To build design knowledge on service oriented and model driven architectures and the aspect oriented architecture

UNIT I INTRODUCTION TO SOFTWARE ARCHITECTURE 9

Introduction to Software Architecture-Bridging Requirements and Implementation - Design Guidelines - Software Quality attributes - Software Architecture Design Space - Agile Approach to Software Architecture Design - Models for Software Architecture Description Languages (ADL).

UNIT II OBJECT-ORIENTED PARADIGM 9

Design Principles - Data-Centered Software Architecture - Repository Architecture - Blackboard Architecture. Hierarchical Architecture Main – Subroutine - Master-Slave, Layered - Virtual Machine - Interaction-Oriented

Software Architectures: Model View Controller (MVC) – Presentation Abstraction Control (PAC).

UNIT III DISTRIBUTED ARCHITECTURE 9

Client-Server – Middleware - Multi-tiers - Broker Architecture – MOM,CORBA - Message Broker Architecture- Service Oriented Architecture (SOA) –SOAP – UDDI - SOA Implementation in Web Services - Grid/cloud Service Computing - Heterogeneous Architecture - Methodology of Architecture Decision- Quality Attributes.

UNIT IV USE CASE AND USER INTERFACE PATTERNS FOR DATA ORIENTED APPLICATIONS 9

Architecture of User Interfaces containers, case study -Web service - Product Line Architectures – methodologies - Processes and tools. Software Reuse and Product Lines - Product Line Analysis - Design and implementation - Configuration Models - Model Driven Architectures (MDA) –Why MDA-Model transformation and software architecture - SOA and MDA- Eclipse modeling framework.

UNIT V ASPECT ORIENTED ARCHITECTURES 9

Aspect Oriented Architectures - AOP in UML - AOP tools - Architectural aspects and middleware Selection of Architectures - Evaluation of Architecture Designs - Case Study - Online Computer Vendor - Order Processing, Manufacture & Shipping inventory - Supply Chain Cloud Service Management - Semantic Web Services.

TOTAL: 45 PERIODS

REFERENCES:

1. Ion Gorton, "Essentials of software Architecture", Second Edition, Springer- Verlag, 2011.
2. "Software Architecture Design Illuminated", Kai Qian Jones and Bartlett Publishers Canada, 2010.
3. Tanenbaum A.S., Van Steen M., "Distributed Systems: Principles and Paradigms", Pearson Education, 2007.

WEB REFERENCES:

1. https://cosmolearning.org/courses/software-architecture-design/video-lectures/.

ONLINE RESOURCES:

1. https://nptel.ac.in/courses/106101061/

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the need of software architecture for sustainable dynamic systems.
2. Identify a sound knowledge on design principles and to apply for large scale systems.
3. Ability to design architectures for distributed heterogeneous systems.
4. Develop a good knowledge on service oriented and model driven architectures.
5. Design a good knowledge on aspect oriented architecture.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	I	2	1	2	1	-	-	1	-	3	1	1	I	1
CO2	2	1	1	3	2	-	1	-	-	3	-	2	I	2
CO3	2	3	2	3	3	-	1	3	-	-	2	-	2	2
CO4	2	1	1	1	1	1	-	-	-	3	-	3	1	1
CO5	1	1	2	2	3	1	1	1	-	-	1	1	2	1

PROFESSIONAL ELECTIVES - II

24PCNEL208 SDG NO. 4	MULTIMEDIA COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the multimedia communication models
- To study multimedia transport in wireless networks
- To explore real-time multimedia network applications
- To apply various wireless standards to provide QoS

UNIT I MULTIMEDIA COMMUNICATION MODELS **9**

Common Multimedia applications – VoIP - Video Conferencing - Military Surveillance - Interactive TV Video on Demand - Smartphone - Requirements and Design challenges of multimedia communications-Architecture of Internet Multimedia Communication - Protocol Stack - H.323.

UNIT II BEST EFFORT AND GUARANTEED SERVICE MODEL 9

Best effort service model and its limitations - Resource allocation – Metrics - Max and Min fair sharing Queuing - FIFO - Priority queue - Fair queue - Waited fair queue - Traffic policing - Token bucket - Leaky bucket - Admission control - Packet classification and scheduling.

UNIT III MULTIMEDIA ON IP NETWORKS 9

QoS aware routing - RSVP - Integrated and Differentiated services - MPLS - Multicasting - IGMP - PIM - DVMRP.

UNIT IV TRANSPORT LAYER SUPPORT FOR MULTIMEDIA 9

Multimedia over TCP - Significance of UDP - Multimedia Streaming - Audio and Video Streaming Interactive and Non Interactive Multimedia - RTP/RTCP - SIP - RTSP.

UNIT V MULTIMEDIA IN WIRELESS NETWORKS 9

IEEE 802.11e - IEEE 802.16 - 3G networks - UMTS - 3GPP - 4G networks - LTE - IMS.

TOTAL:45 PERIODS

REFERENCES:

1. James F. Kurose and Keith W. Ross, "Computer Networking-A Top-Down Approach Featuring the Internet", Pearson, 2012.
2. Larry L. Peterson and Bruce S. Davie, "Computer Networks - A Systems Approach", Morgan Kaufmann Publishers, 2007.
3. Mario Marques da Silva, "Multimedia Communications and Networking", CRC Press, 2012.
4. Mark Wuthnow, Jerry Shih, Matthew Stafford, "IMS: A New Model for Blending Applications", Auerbach Publications, 2019.

ONLINE RESOURCES:

1. https://tools.ietf.org/html/rfc1075
2. https://www.akeneo.com/what-is-a-pim/
3. http://www.networksorcery.com/enp/protocol/igmp.htm
4. https://www.cisco.com/c/en/us/td/docs/ios-xml/ios/voice/H-323/configuration/15-mt/voi-h323-overview.html
5. https://www.ericsson.com/en/blog/2019/12/3gpp-rel-17
6. https://www.digitaltrends.com/mobile/4g-vs-lte/

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand various multimedia communication models.
2. Describe various internet protocols and standards used in multimedia.
3. Deploy the right Multimedia Communication model for required application.
4. Understand various wireless multimedia network applications with efficient routing techniques.
5. Develop the real-time multimedia network applications.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	1	1	1	1	1	1	3	3	2
CO2	3	3	3	2	3	1	1	1	1	1	1	3	3	2
CO3	3	3	3	2	3	1	1	1	1	1	1	3	3	2
CO4	3	3	3	2	3	1	1	1	1	1	1	3	3	2
CO5	3	3	3	2	3	1	1	1	1	1	1	3	3	2

PROFESSIONAL ELECTIVES - II

24PCNEL209 SDG NO. 4	MOBILE AND PERVASIVE COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Study the emerging technologies in the context of wireless networks.
- Understand the mobile computing environment
- Learning the concepts of tracking management schemes wireless mobile networks
- Learn about a pervasive computing environment

UNIT I EMERGING TECHNOLOGIES 9

Wireless networks - Emerging technologies - Bluetooth, WiFi, WiMAX, 3G, WATM. - Mobile IP protocols – WAP push architecture-Wml scripts and applications.

UNIT II MOBILE COMPUTING ENVIRONMENT AND SECURITY 9

Mobile computing environment - Functions -Architecture- Design considerations- Content architecture -CC/PP exchange protocol - Context manager - Data management in WAE- Coda file system- Caching schemes- Mobility QOS - Security in mobile computing.

UNIT III HANDOFF AND TRACKING MANAGEMENT SCHEMES 9

Handoff in wireless mobile networks-Reference model-Handoff schemes- Location management in cellular networks - Mobility models- Location and tracking management schemes- Time, movement, profile and distance based update strategies - ALI technologies.

UNIT IV PERVASIVE COMPUTING 9

Pervasive Computing- Principles, Characteristics- Interaction transparency - Context aware - Automated experience capture - Architecture for pervasive computing- Pervasive devices - Embedded controls.- Smart sensors and actuators -Context communication and access services.

UNIT V OPEN PROTOCOLS AND CONTEXT AWARE SENSOR NETWORKS 9

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 PERIODS

REFERENCES:

1. Ivan Stojmenovic , "Handbook of Wireless Networks and Mobile Computing", John Wiley & sons Inc, Canada, 2002
2. Asoke K Taukder,Roopa R Yavagal, "Mobile Computing", Tata McGraw Hill Pub Co. , New Delhi, 2005.
3. Seng Loke, "Context-Aware Computing Pervasive Systems" Auerbach Pub., New York, 2007.
4. Uwe Hansmannetl , "Pervasive Computing", Springer, New York, 2001.
5. Frank Adelstein, Sandeep KS Gupta, "Fundamentals of Mobile and Pervasive Computing", Golden Richard, McGraw-Hill 2005.
6. Jochen Burkhardt, "Pervasive Computing: Technology and Architecture of Mobile Internet Applications", Addison-Wesley Professional; 3rd edition, 2007.

6. John Krumm, "Ubiquitous Computing Fundamentals", CRC Press,2010.
7. Stefan Poslad, "Ubiquitous Computing: Smart Devices, Environments and Interactions", Wiley, 2009.
8. Jochen Schiller, "Mobile Communications", PHI, Second Edition, 2008.
9. Debashis Saha, "Networking Infrastructure for Pervasive Computing: Enabling Technologies", Kluwer Academic Publisher, Springer; First Edition, 2011.
10. Agrawal and Zeng "Introduction to Wireless and Mobile Systems", Brooks / Cole (Thomson Learning), First Edition, 2006.
12. Uwe Hansmann, Lothar Merk, Martin S. Nicklons and Thomas Stober, "Principles of Mobile Computing", Springer, New York, 2006.

WEB REFERENCES:

1. http://nptel.ac.in/courses/108102045/37
2. http://nptel.ac.in/video.php?subjectId=117102062
3. http://nptel.ac.in/video.php?subjectId=117102062.

ONLINE RESOURCES:

1. https://www.morganclaypool.com/toc/mpc/1/1.
2. http://mpc.ece.utexas.edu/research.html.
3. https://www.cs.cmu.edu/~15-821/.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understanding the fundamentals of Wireless Networks and Mobile Computing.
2. Study the basics of Mobile computing environment and security.
3. Learning the concepts of tracking management schemes wireless mobile networks.
4. Apply the concepts of Pervasive Computing.
5. Analyse the open protocols and context aware sensor networks.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	-	3	-	-	-	-	-	-	-	-	-	1	1
CO2	1	1	2	-	-	-	-	-	-	-	-	-	1	1
CO3	2	-	-	-	3	1	-	-	-	-	-	1	3	2
CO4	-	1	2	-	-	2	-	-	-	-	-	1	1	1
CO5	2	2	2	-	-	3	-	-	-	-	-	3	2	2

PROFESSIONAL ELECTIVES - II

24PCNEL210 SDG NO. 4 & 9	SIMULATION OF COMPUTER SYSTEMS AND NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand how simulators are built
- To study the statistical models used in simulations
- To know different ways of generating random numbers
- To learn modelling of the data given as input to simulators

UNIT I STATISTICAL AND QUEUING MODELS 9

Statistical models – Discrete, continuous and empirical distributions – Characteristics of Queuing systems – Measures of performance of queuing systems – Markovian models.

UNIT II RANDOM NUMBER AND RANDOM VARIATE GENERATION 9

Properties of random numbers – Generating uniform random numbers – Generating non uniform random numbers - Tests for random numbers – Random-variate generation.

UNIT III ANALYSIS OF SIMULATION DATA 9

Input modeling – Identifying the distribution – Parameter estimation – Goodness-of-fit tests – Multivariate and time-series input models – Verification and validation of simulation models.

UNIT IV SIMULATION OF COMPUTER NETWORKS 9

Introduction – Performance modeling – Modeling Techniques – Protocol modeling – Workload modeling – Network Topology modeling – Performance

metrics in computer network simulation – Validation and verification – Discrete event simulation – GPU-based simulations – Multi-agent-based simulations –Network simulators.

UNIT V CASE STUDIES OF NETWORK SIMULATORS 9

NS-3 based Simulative Platform - Evolved packet system – Differentiated services domain – NS-3 simulator – Simulation techniques for next generation wireless heterogeneous networks - Features of common network simulators – OpNet- Mininet.

TOTAL: 45 PERIODS

REFERENCES:

1. J. B. Sinclair, "Simulation of Computer Systems and Computer Networks: A Process-Oriented Approach", 2004.
2. Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol, "Discrete-event System Simulation", Fifth Edition, Pearson, 2010.
3. Law, Averill, "Simulation Modeling and Analysis with Expert Software", Mc Graw Hill, 2006.
4. Mohammad S. Obaidat, PetrosNicopolitidis, FaouziZarai, "Modeling and Simulation of Computer Networks and Systems – Methodologies and Applications", Morgan Kaufmann, 2015.
5. Sheldon M. Ross, "Simulation", Fifth Edition, Elsevier, 2013.

WEB REFERENCES:

1. https://www.informs-sim.org/wsc97papers/0103.PDF.

ONLINE RESOURCES:

1. https://onl.kmi.open.ac.uk/
2. https://www.tetcos.com/netsim-acad.html.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the modeling and development of simulations and simulators.
2. Differentiate the different ways in which simulators are designed.
3. Analyze how computer networks are simulated.
4. Use simulators like NS-3.
5. Compare the features of different simulators.

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	-	-	-	-	-	-	3	3
CO2	3	3	3	3	3	1	1	1	2	1	1	2	3	3
CO3	3	3	3	3	3	1	1	1	2	1	1	2	3	3
CO4	3	3	3	3	3	1	1	1	2	1	1	2	3	3
CO5	3	3	3	3	3	1	1	1	2	1	1	2	3	3

PROFESSIONAL ELECTIVES - II

24PCNEL211 SDG NO. 4	IT SECURITY COMPLIANCE AND FORENSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the current security landscape, including the nature of threat and vulnerabilities
- To justify the need for appropriate strategies and processes for disaster recovery and fault tolerance
- To Know about the emerging security solutions for Web and Email
- To assess the current information security compliance and network forensics security tools, evidence and investigations

UNIT I INFORMATION SECURITY FUNDAMENTALS 9

Importance of Computer and Network Security – Confidentiality – Integrity-Availability-Accountability –Non-repudiation - Threats and Countermeasures - Policies and Standards – Authentication overview – Authentication credentials & protocols – Authentication services : LDAP, RADIUS, TACACS – Best practices for secure authentication – Authorization and access control models – Implementing access control on Windows and Unix.

UNIT II NETWORK SECURITY & SERVER SECURITY 9

Best Practices for Network Security - Securing Network Transmission - Analyzing Security Requirements for Network Traffic- Defining Network Perimeters - Data Transmission Protection Protocols - Server Roles and Baselines - Securing Network Infrastructure Servers- Securing Domain Controllers - Securing File , Print and Application Servers.

UNIT III APPLICATION SECURITY AND DISASTER RECOVERY ASSURANCE 7

Web Browser Security - Email Security – Planning for the worst - Creating a Backup Strategy - Designing for Fault Tolerance.

UNIT IV INFORMATION SECURITY COMPLIANCE 9

Develop an Information System Strategy - Integrate security into an organization – Security compliance management and auditing – Information security program metrics.

UNIT V FORENSICS AND SECURITY 9

Managing Updates - Auditing and Logging- Secure Remote Administration - Intrusion Detection - Honeypots – Forensics: Understanding Evidence - Gathering Evidence on a Live System - Preparing a Hard Drive Image - Searching for Data on a Hard Drive – Forensic Laboratories – Forensics Tools – Network Forensics : Network Security Tools – Incidence response – Network evidence and investigation.

TOTAL: 45 PERIODS

REFERENCES:

1. Cole, Eric, Rachelle Reese, Ronald L. Krutz, and James Conley, "Network Security Fundamentals", United Kingdom: Wiley, John Sons, 2008. (ISBN No.: 978-0-470-10192-6).
2. Jason Andress, Mark Leary, "Building a Practical Information Security Program", Syngress Publication ,2017,
3. John Sommons, "The Basics of DigitalForensics - The Primer for Getting Started in Digital Forensics", SyngressPublication , 2012.
4. Joshi, James, Bruce S. Davie, and Saurabh Bagchi, "Network Security: Know It All" , United States: Morgan Kaufmann Publishers In, 2008. (ISBN No.: 978-0-12-374463-0).
5. Ciampa, Mark. "Security Guide to Network Security Fundamentals". 4th edition, Boston, MA:Course Technology, Cengage Learning, 2011. (ISBN No. : 978-1-111-64012-5)
6. Thomas R, "Information Security Fundamentals", 2nd edition, CRC Press. Boca Raton, FL: Auerbach Publications, 2014. (ISBN No.: 978-1-4398-1063-7)
7. Vacca, John R., ed. "Network and System Security" UnitedStates: SyngressMedia,U.S., 2010. (ISBN No. : 978-1-59749-535-6).

WEB REFERENCES :

1. https://resources.infosecinstitute.com/security-plus-authentication-services-radius-tacacs-ldap-etc-sy0-401/#gref
2. https://www.cgi.com/sites/default/files/2019-08/cgi-understanding-cybersecurity-standards-white-paper.pdf
3. https://www.dni.gov/files/NCSC/documents/campaign/NSA-guide-Keeping-Home-Network-Secure.pdf.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Learn various vulnerabilities of computer network systems, as well as the different modes of attack.
2. Explore and design techniques to prevent security attacks.
3. Know about the emerging security solutions for Web and Email.
4. Develop the disaster recovery and fault tolerance systems.
5. Identify the need of information security compliance, forensics and security.

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	3	2	-	2	1	-	1	3	2	2
CO2	3	2	1	1	3	2	-	1	1	-	1	3	3	1
CO3	3	3	3	3	3	3	-	2	3	-	3	3	3	3
CO4	3	3	3	3	3	3	-	2	3	-	3	3	3	3
CO5	3	1	2	2	3	2	-	2	1	-	2	3	2	2

PROFESSIONAL ELECTIVES - II

24PCSEL315 SDG NO. 3 & 4	BIO INFORMATICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To get exposed to the fundamentals of bioinformatics.
- To analyze DNA sequencing data and detection of genomic variants.
- To learn and understand open problems, issues in replication, assemble genome, various clustering and multiple pattern matching.
- To study and be exposed to the domain of animal genomics.

UNIT I INTRODUCTION AND FUNDAMENTALS 9

Fundamentals of Genes, Genomics, Molecular Evolution – Genomic Technologies –Beginning of Bioinformatics - Genetic Data –Sequence Data Formats – Secondary Database – Examples – Data Retrieval Systems – Genome Browsers - Biomedical Data –Their Acquisition, Storage and Use, Electronic Health Records (EHR), Information Retrieval From Digital Libraries.

UNIT II GENOMICS AND EPIGENOMICS 9

Genomic Variants Detection and Genotyping - Computational approaches for Finding Long Insertions and Deletions with NGS Data- Computational Approaches in Next-Generation Sequencing Data Analysis for Genome-Wide DNA Methylation Studies- Bisulfite-Conversion-Based Methods for DNA Methylation Sequencing Data Analysis

UNIT III DNA REPLICATION AND ASSEMBLE GENOME 9

Beginning of DNA Replication – Open Problems – Multiple Replication and Finding Replication – Computing Probabilities of Patterns in a String-The Frequency Array-Converting Patterns-Solving Problems- Finding Frequents Words-Big-O Notation –Case Study-The Tower Of Hanoi Problem-Assemble Genome-String Reconstruction Problem-Assembling Genomes from Read Pairs.

UNIT IV BIOINFORMATICS CLUSTERING AND PATTERN MATCHING 9

Introduction to Clustering- Good Clustering Principle-K-Means Clustering-Lloyd Algorithm-Making Soft Decisions in Coin Flipping-Clustering Tumor Samples-Introduction to Multiple Pattern Matching-Burrows-Wheeler Transform-Pattern Matching with the Burrows-Wheeler Transform-Epilogue: Mismatch-Tolerant Read Mapping.

UNIT V ANIMAL GENOME 9

Human and Mouse Genomes-Random Breakage Model of Chromosome Evolution – Sorting by Reversals – Greedy Heuristic Approach – Break Points Graphs-Neighbor-Joining Algorithm-Character Based Tree Reconstruction.

TOTAL: 45 PERIODS

REFERENCES:

1. Philip Compeau and Pavel Pevzner, "Bioinformatics Algorithms: An Active Learning Approach" Second Edition Volume I , Coursera, 2015.
2. Supratim Choudhuri, "Bioinformatics For Beginners", Elsevier, 2014.
3. Biomedical Informatics: Computer applications in Health care and Biomedicine (3rd ed), by Shortliffe EH, Ciminio JJ., 2000, New York

Springer-Verlag, ISBN 0-387-28986-0.
4. Ion Mandoiu and Alexander Zelikovsky , "Computational Methods for Next Generation Sequencing Data Analysis " Wiley series 2016.
5. Robert F.Coughlin, Istvan Miklos,Renyi Institute, "Introduction to algorithms in Bioinformatics",Springer 2016.

WEB REFERENCES:

1. https://www.bits.vib.be/index.php/training/122-basic-bioinformatics
2. http://bioinfo.mbb.yale.edu/mbb452a/intro/
3. http://pages.cs.wisc.edu/~bsettles/ibs08/lectures/01-intro.pdf

ONLINE RESOURCE:

1. https://www.youtube.com/user/NCBINLM

OUTCOMES:

Upon Completion of this course, the students should be able to

1. Deploy the Genomics Technologies in Bioinformatics.
2. Able to distinguish Epigenomics and Genomics.
3. Deploy the replication and molecular clocks in Bioinformatics.
4. Implement various Clustering and Pattern Matching techniques
5. Use the Breakpoint Graphs for Genome Expression.

CO-PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	1	-	-	-	2	1	-	1	2	-	1	2	2
CO2	1	-	2	2	-	2	2	-	-	-	-	1	2	2
CO3	2	2	2	1	-	2	1	-	-	-	-	1	2	1
CO4	2	2	2	1	1	2	1	-	-	-	-	1	2	2
CO5	2	2	2	2	-	2	1	-	-	-	-	1	2	2

PROFESSIONAL ELECTIVES - II

24PCNEL212 SDG NO. 4	SOFT COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To classify the various soft computing frameworks
- To be familiar with the design of neural networks, fuzzy logic and fuzzy systems
- To learn a mathematical background for optimized genetic programming
- To be exposed to neuro-fuzzy hybrid systems and its applications

UNIT I INTRODUCTION TO SOFT COMPUTING **9**

Soft Computing Constituents - From Conventional AI to Computational Intelligence - Artificial Neural Network- Introduction- Characteristics- Learning Methods – Taxonomy – Evolution of Neural Networks - Basic Models - Important Technologies - Applications- Fuzzy Logic- Introduction - Crisp Sets- Fuzzy Sets - Crisp Relations and Fuzzy Relations- Cartesian Product of Relation - Classical Relation, Fuzzy Relations, Tolerance and Equivalence Relations, Non-iterative Fuzzy Sets- Genetic Algorithm- Introduction - Biological Background - Traditional Optimization and Search Techniques – Genetic Basic Concepts.

UNIT II NEURAL NETWORKS **9**

Mcculloch-pitts Neuron - Linear Separability - Hebb Network - Supervised Learning Network - Perceptron Networks - Adaptive Linear Neuron - Multiple Adaptive Linear Neuron - BPN - RBF - TDNN Associative Memory Network - Auto-associative Memory Network- Hetero-associative Memory Network- BAM - Hopfield Networks- Iterative Auto Associative Memory Network - Iterative Associative Memory Network – Unsupervised Learning Networks- Kohonen Self-organizing Feature Maps- LVQ – CP Networks- ART Network.

UNIT III FUZZY LOGIC **9**

Membership Functions - Features- Fuzzification - Methods of Membership Value Assignments - Defuzzification - Lambda Cuts - Methods - Fuzzy Arithmetic and Fuzzy Measures- Fuzzy Arithmetic - Extension Principle - Fuzzy Measures - Measures of Fuzziness - Fuzzy Integrals.

UNIT IV FUZZY REASONING AND DECISION MAKING **9**

Fuzzy Rule Base and Approximate Reasoning- Truth Values and Tables- Fuzzy Propositions- Formation of Rules - Decomposition of Rules- Aggregation of

Fuzzy Rules- Fuzzy Reasoning - Fuzzy Inference Systems – Overview of Fuzzy Expert System-Fuzzy Decision Making.

UNIT V GENETIC ALGORITHM **9**

Genetic Algorithm- Introduction - Biological Background - Traditional Optimization and Search Techniques - Genetic Basic Concepts - Operators – Encoding Scheme – Fitness Evaluation – Crossover - Mutation - Genetic Programming – Multilevel Optimization – Real Life Problem - Advances in GA .

TOTAL: 45 PERIODS

REFERENCES:

1. S.N.Sivanandam and S.N.Deepa, "Principles of Soft Computing", Wiley India Pvt Ltd, 2011.
2. J.S.R.Jang, C.T. Sun and E.Mizutani, “Neuro-Fuzzy and Soft Computing”, PHI / Pearson Education 2004.
3. S.Rajasekaran and G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm: Synthesis & Applications", Prentice-Hall of India Pvt. Ltd., 2006.
4. George J. Klir, Ute St. Clair, Bo Yuan, “Fuzzy Set Theory: Foundations and Applications” Prentice Hall, 1997.
5. James A. Freeman, David M. Skapura, “Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Education India, 1991.
6. Simon Haykin, “Neural Networks Comprehensive Foundation” Second Edition, Pearson Education, 2005.
7. SDF David E. Goldberg, “Genetic Algorithm in Search Optimization and Machine Learning” Pearson Education India, 2013.

WEB REFERENCES:

1. https://nptel.ac.in/courses/106105173/.

ONLINE RESOURCES:

1. https://cse.iitkgp.ac.in/~dsamanta/courses/sca/index.html.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Apply various soft computing concepts for practical applications.
2. Understand and design suitable neural networks for real time problems.
3. Use fuzzy rules and reasoning to develop decision making and expert system.

4. Explain the importance of optimization techniques and genetic programming.
5. Analyze the various hybrid soft computing techniques and apply in real time problems.

CO-PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3	3	3	3	-	-	1	3	1	-	1	3	2
CO2	2	2	3	3	3	-	-	1	3	1	-	1	3	2
CO3	2	2	3	3	3	-	-	1	2	1	-	1	3	2
CO4	1	2	2	3	2	-	-	1	2	1	-	1	3	2
CO5	2	3	3	3	3	-	-	1	3	1	-	1	3	2

PROFESSIONAL ELECTIVES - II

24PCNEL213 SDG NO. 4 & 9	HIGH SPEED SWITCHING ARCHITECTURE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the basics of switching
- To explore the various space division switches
- To evaluate the performance of various switching architectures
- To analyze the architecture of IP routers

UNIT I SWITCHING BASICS 9

Circuit switching - Message switching - Packet switching – Datagrams and Virtual circuits – Cell switching – Label Switching – L2 switching Vs L3 switching – VLANs – Switching and Bridging – Loop resolution - Spanning tree algorithms – Cut through and Store and forward switches – Head of line blocking – Back pressure – Switch design goals.

UNIT II SWITCHING ARCHITECTURES 9

Shared medium switches – Shared memory switches – Space division switches – Crossbar based switching architecture – Input queued - Output queued and Combined input- Output queued switches – Non blocking and blocking crossbar switches – Banyan networks – Batcher Banyan networks – Optical switches – Unbuffered and buffered switches – Buffering strategies – Optical packet switches and Optical burst switches – MEMS optical switches.

UNIT III PACKET QUEUES AND DELAY ANALYSIS 9

Little's theorem – Birth and death processes – Queuing disciplines – Markovian FIFO queuing – Non Markovian – Pollaczek Khinchine formula –M/M/1models- M/G/1 models - M/D/1 models – Self similar models - Batch arrivals models – Network of queues – Burkes theorem - Jackson theorem.

UNIT IV ROUTER ARCHITECTURE 9

Bus based router architecture with single processor and multiple processors – Architecture with multiple parallel forwarding engines – Switch based router architecture with multiple processors – Switch based router architecture with multiple processors – Switch based architecture with fully distributed processors – Critical and non critical data path processing – Fast and slow path.

UNIT V MPLS ROUTERS 9

MPLS – Layer 2.5 - Labels – Switching and Distribution –Label Switched Path – Label Forwarding Instance Base – Label Stacking - IP Lookup vs Label lookup – Label Distribution Protocol – MPLS based VPNs– Label switching – Label switched path – Comparison with ATM technology.

TOTAL: 45 PERIODS

REFERENCES:

1. Damitri P Bertsekas and Gallager, "Data Networks", 2nd edition, PHI, 1992.
2. Elhanany, Itamar, Hamdi and Mounir, "High Performance Packet Switching Architectures", Springer, 2007.
3. H.Jonathan Chao and Bin Liu, "High Performance Switches and Routers", John Wiley and Sons, 2007.
4. Howard C Berkowitz, "Designing Routing and Switching Architectures for Enterprise Networks||", Sams, 1999.
5. Luc De Ghein, "MPLS Fundamentals", Cisco Press 2014.

WEB REFERENCES:

1. https://www.researchgate.net/publication/221243923_Isochronets_A_HighSpeed_Network_Switching_Architecture
2. https://ieeexplore.ieee.org/document/1590169.

ONLINE RESOURCES:

1. https://www.udemy.com/course/ccnpswitchv2/
2. https://www.udemy.com/course/ccnpswitchv2/.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Apply switching concepts to build networks.
2. Deploy the network with appropriate types of switches.
3. Analyze delays in packet routing.
4. Select and configure the appropriate type of IP router.
5. Design and implement MPLS networks.

CO - PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	1	2	1	1	2	3	2
CO2	3	3	3	3	3	1	1	1	2	1	1	2	3	2
CO3	3	3	3	3	3	1	1	1	2	1	1	2	3	2
CO4	3	3	3	3	3	1	1	1	2	1	1	2	3	2
CO5	3	3	3	3	3	1	1	1	2	1	1	2	3	2

PROFESSIONAL ELECTIVES - III

24PCSPC203 SDG NO. 4 & 9	CLOUD COMPUTING TECHNOLOGIES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the concepts of virtualization and virtual machines
- To gain expertise in server, network and storage virtualization
- To understand and deploy practical virtualization solutions and enterprise solutions
- To understand the security issues in the grid and the cloud environment

UNIT I VIRTUALIZATION **9**

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines –Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization - Management Virtualization-Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization

UNIT II VIRTUALIZATION INFRASTRUCTURE **9**

Comprehensive Analysis – Resource Pool – Testing Environment –Server

Virtualization – Virtual Workloads – Provision Virtual Machines – Desktop Virtualization – Application Virtualization -Implementation levels of Virtualization – Virtualization structure – Virtualization of CPU, Memory and I/O devices – Virtual clusters and Resource Management – Virtualization for Data center automation.

UNIT III CLOUD PLATFORM ARCHITECTURE 9

Cloud deployment models: Public, Private, Hybrid, Community – Categories of Cloud computing: Everything as a Service: Infrastructure, Platform, Software- A Generic Cloud Architecture Design – Layered Cloud Architectural Development – Virtualization Support and Disaster Recovery – Architectural Design Challenges - Public Cloud Platforms : GAE,AWS – Inter-Cloud Resource Management.

UNIT IV PROGRAMMING MODEL 9

Introduction to Hadoop Framework - MapReduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing MapReduce Applications - Design of Hadoop File System –Setting up Hadoop Cluster - Cloud Software Environments - Eucalyptus, OpenNebula, OpenStack, Nimbus.

UNIT V CLOUD SECURITY 9

Cloud Infrastructure Security: Network, Host and Application level – Aspects of Data security, provider data and its security, Identity and access management architecture, IAM practices in the cloud, SaaS, PaaS, IaaS availability in the cloud - Key privacy issues in the cloud –Cloud Security and Trust Management.

TOTAL : 45 PERIODS

TEXT BOOKS:

1. Kai Hwang, Geoffrey C Fox, Jack G Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.

REFERENCES:

1. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005
2. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
3. Danielle Ruest, Nelson Ruest, "Virtualization: A Beginner‟s Guide", McGraw-Hill Osborne Media, 2009.
4. Tim Mather, Subra Kumaraswamy, and Shahed Latif ,"Cloud Security and Privacy", O'Reilly Media, Inc.,2009.

5. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
6. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

WEB REFERENCES:

1. https://nptel.ac.in/courses/106/105/106105167/
2. https://swayam.gov.in/nd1_noc20_cs20/preview

ONLINE RESOURCES:

1. https://www.ubuntupit.com/best-cloud-computing-books-available-online/
2. https://azure.microsoft.com/en-in/overview/what-is-cloud-computing/
3. https://www.simplilearn.com/what-is-cloud-computing-article
4. https://www.youtube.com/watch?v=_fGrYN5rxhs
5. https://cutepooji.files.wordpress.com/2017/01/distributed-and-cloud-computing-from-parallel-processing-to-the-internet-of-things.pdf

OUTCOMES:

Upon completion of the course, the students should be able to

1. Employ the concepts of storage virtualization, network virtualization and its management
2. Apply the concept of virtualization in the cloud computing
3. Identify the architecture, infrastructure and delivery models of cloud computing
4. Develop services using Cloud computing
5. Apply the security models in the cloud environment

CO - PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	1	1	1	2	1	2	2	2
CO2	2	2	2	3	3	2	1	1	2	2	2	2	2	2
CO3	2	2	2	3	3	2	1	1	1	2	1	1	3	3
CO4	2	2	2	3	3	3	1	1	1	2	2	2	3	3
CO5	3	2	3	3	3	2	1	1	1	2	2	2	3	3

PROFESSIONAL ELECTIVES - III

24PCNEL215 SDG NO. 4	IOT ARCHITECTURE, NETWORKING AND SECURITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the fundamentals of Internet of Things.
- Learn about the basics of IOT protocols
- Build a small low cost embedded system using Raspberry Pi.
- Apply the concept of Internet of Things in the real

UNIT I INTRODUCTION TO IoT **9**

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology.

UNIT II IoT ARCHITECTURE **9**

M2M High-level ETSI Architecture - IETF Architecture for IoT - OGC Architecture - IoT Reference Model - Domain Model - Information Model - Functional Model - Communication Model - IoT Reference Architecture.

UNIT III IoT PROTOCOLS **9**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LoWPAN - CoAP – Security.

UNIT IV BUILDING IoT WITH RASPBERRY PI & ARDUINO **9**

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

UNIT V IOT REAL-WORLD APPLICATIONS AND TOOLS **9**

Real World Design Constraints - Applications - Asset Management, Industrial Automation, Smart Grid, Commercial Building Automation, Smart Cities - Participatory Sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT - Amazon Web Services for IoT.

TOTAL:45 PERIODS

REFERENCES:

1. Arshdeep Bahga, Vijay Madisetti, "Internet of Things – A hands-on approach", Universities Press, 2015.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
3. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.
4. Jan Ho¨ ller, Vlasios Tsiatsis , 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.
5. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012.

WEB REFERENCES:

1. https://www.springer.com/gp/book/9783319697147
2. http://ptgmedia.pearsoncmg.com/images/9781587144561/samplepages/9781587144561_CH08.pdf.

ONLINE RESOURCES:

1. https://books.google.co.in/books.
2. https://www.elsevier.com/books
3. https://www.ieee.org/publications/books.

OUTCOMES :

Upon completion of the course, the student should be able to

1. Analyze various protocols for IoT.
2. Develop web services to access/control IoT devices.
3. Design a portable IoT using Raspberry Pi
4. Deploy an IoT application and connect to the cloud.
5. Analyze applications of IoT in real time scenarios.

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	3	3	3	2	2	1	3	3	3
CO2	3	3	3	3	3	3	3	2	3	3	1	3	3	3
CO3	3	3	3	3	3	3	3	2	3	3	2	3	3	3
CO4	3	3	3	3	3	3	2	2	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	2	3	3	3	3	3	3

PROFESSIONAL ELECTIVES - III

24PCSEL314 SDG NO. 4 & 9	MOBILE APPLICATION DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand system requirements for mobile applications
- Generate suitable design using specific mobile development frameworks
- Generate mobile application design and implement the design using specific mobile development frameworks
- Deploy the mobile applications in marketplace for distribution

UNIT I INTRODUCTION **9**

Introduction to Mobile applications – Embedded systems - Market and Business drivers for Mobile applications – Publishing and Delivery of Mobile applications – Requirements gathering and Validation for Mobile applications

UNIT II BASIC DESIGN **9**

Introduction – Basics of Embedded systems design – Embedded OS - Design constraints for Mobile applications - Both Hardware and Software related – Architecting mobile applications – User interfaces for mobile applications – Touch events and Gestures – Achieving quality constraints – Performance, Usability, Security, Availability and Modifiability.

UNIT III ADVANCED DESIGN **9**

Designing applications with Multimedia and Web access capabilities – Integration with GPS and Social media networking applications – Accessing applications hosted in a Cloud Computing environment – Design patterns for mobile applications.

UNIT IV TECHNOLOGY I - ANDROID **9**

Introduction – Establishing the development environment – Android architecture – Activities and views – Interacting with UI – Persisting data using SQLite – Packaging and deployment – Interaction with Server Side applications using Google Maps, GPS and Wifi – Integration with Social Media applications.

UNIT V TECHNOLOGY II - IOS **9**

Introduction to Objective C – iOS features – UI implementation – Touch frameworks – Data persistence using Core Data and SQLite – Location aware applications using Core Location and Map Kit – Integrating calendar and

address book with social media application using Wifi - iPhone marketplace.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Jeff McWherter and Scott Gowell, "Professional Mobile Application Development", Wrox, 2012.
2. Charlie Collins, Michael Galpin and Matthias Kappler, "Android in Practice", DreamTech, 2012.

REFERENCES:

1. James Dovey and Ash Furrow, "Beginning Objective C", Apress, 2012
2. David Mark, Jack Nutting, Jeff LaMarche and Frederic Olsson, "Beginning iOS 6 Development: Exploring the iOS SDK", Apress, 2013.

ONLINE RESOURCE:

1. https://nptel.ac.in/courses/106/106/106106147/

WEB REFERENCE

1. http://developer.android.com/develop/index.html

OUTCOMES:

Upon completion of the course, the students should be able to

1. Describe the requirements for mobile applications.
2. Explain the challenges in mobile application design and development.
3. Develop and design mobile applications for specific requirements.
4. Implement the design using Android SDK.
5. Implement the design using Objective C and iOS and deploy mobile applications in Android and iPhone marketplace for distribution.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	2	-	-	1	1	2	2	3	2
CO2	3	3	3	2	1	2	-	-	1	1	2	2	3	2
CO3	3	3	3	2	1	2	-	-	1	1	2	2	3	2
CO4	3	3	3	2	3	2	-	-	1	1	2	2	3	2
CO5	3	3	3	2	3	2	-	-	2	3	2	2	3	2

PROFESSIONAL ELECTIVES - III

24PCNEL216 SDG NO. 4	HIGH SPEED NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the ATM and wireless LAN applications in High Speed networks
- To be familiar with the working of queuing, Congestion control and traffic management
- To learn the TCP congestion control techniques
- To explore the QoS and Network Management Protocols and Technologies

UNIT I HIGH SPEED NETWORKS **9**

Frame Relay Networks – Asynchronous transfer mode – ATM Protocol Architecture, ATM logical Connection, ATM Cell – ATM Service Categories – AAL, High Speed LANs: Fast Ethernet, Gigabit Ethernet, Fiber Channel – Wireless LANs: applications, requirements – Architecture of 802.11.

UNIT II CONGESTION AND TRAFFIC MANAGEMENT **9**

Queuing Analysis- Queuing Models – Single Server Queues – Effects of Congestion – Congestion Control – Traffic Management – Congestion Control in Packet Switching Networks – Frame Relay Congestion Control.

UNIT III TCP AND ATM CONGESTION CONTROL **9**

TCP Flow control – TCP Congestion Control – Retransmission – Timer Management – Exponential RTO backoff – KARN's Algorithm – Window Management – Performance of TCP over ATM. Traffic and Congestion control in ATM – Requirements – Attributes – Traffic Management Frame work, Traffic Control – ABR traffic Management – ABR rate control, RM cell formats, ABR Capacity allocations – GFR traffic management.

UNIT IV PROTOCOLS FOR QOS SUPPORT **9**

RSVP – Goals & Characteristics, Data Flow, RSVP operations, Protocol Mechanisms – Multiprotocol Label Switching – Operations, Label Stacking, Protocol details – RTP – Protocol Architecture, Data Transfer Protocol, RTCP.

UNIT V NETWORK MANAGEMENT AND APPLICATION **9**

Managing Network - Choosing a Configuration Method - Command Line Interfaces - Graphical User Interfaces - Standardized Data Representations and Access - Making the Choice - Management Information Base (MIB) -

Representing Managed Objects - Simple Network Management Protocol (SNMP) - Extensible Markup Language (XML) - Common Object Request Broker Architecture (CORBA) - Choosing a Configuration Protocol - Choosing to Collect Statistics -Common Open Policy Service Protocol (COPS).

TOTAL: 45 PERIODS

REFERENCES:

1. William Stallings, "HIGH SPEED NETWORKS AND INTERNET", Pearson Education, Second Edition, 2002.
2. Adrian Farrel,"The Internet And Its Protocols", Elsevier Publications, 2011.
3. Warland, Pravin Varaiya, "High performance communication networks", Second Edition, Jean Harcourt Asia Pvt. Ltd., , 2001.
4. Irvan Pepelnjk, Jim Guichard, Jeff Apcar, "MPLS and VPN architecture", Cisco Press, Volume 1 and 2, 2003.
5. Abhijit S. Pandya, Ercan Sea, "ATM Technology for Broad Band Telecommunication Networks", CRC Press, New York, 2004.
6. Behrouz A. Forouzan, "Data Communication And Computer Networking", 4th, 2011.
7. Larry L. Peterson and Bruce S.Davie,"Computer Networks",3rd edition, Elsevier Publications, 2003.

WEB REFERENCES:

1. www.utdallas.edu/~metin/SUNet.
2. www.rivier.edu/faculty/vricbov.

ONLINE RESOURCES:

1. http://pages.cpsc.ucalgary.ca/~carey/CPSC641/archive/Sept2005/.
2. http://www.williamstallings.com/HsNet2e.html.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the principles of High speed networks.
2. Learn the implementation of Traffic and congestion management.
3. Explain the concepts of TCP and ATM Congestion Control.
4. Explore the importance of QOS support Protocols.
5. Learn various network management and its protocols.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	2	2	1	2	1	2	3	3
CO2	2	2	2	3	3	2	2	2	2	2	2	2	3	3
CO3	2	2	2	3	3	2	1	1	1	2	1	1	3	3
CO4	2	2	2	3	3	3	1	1	1	2	2	2	3	3
CO5	3	2	3	3	3	2	1	1	1	2	2	2	3	3

PROFESSIONAL ELECTIVES - III

24PCNEL217 SDG NO. 4	MULTIMEDIA TECHNOLOGY AND APPLICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the basic multimedia objects
- To know about the need of multimedia applications
- Explore real-time multimedia digital audio and video standards
- To understand the various compression techniques of multimedia

UNIT I INTRODUCTION **9**

Introduction - Media and Data Streams - Sound - Audio - Image and Graphics - Computer Image Processing - Video and Animation - Television - Computer-based Animation.

UNIT II MULTIMEDIA APPLICATIONS **9**

Introduction - Media Preparation - Media Composition - Media Integration - Media Communication - Media Consumption - Media Entertainment – Trends.

UNIT III DIGITAL AUDIO AND VIDEO **9**

Digital audio - Analog to digital conversion techniques - Nyquist's theorem - PCM - DPCM - ADPCM - Compression techniques - IBM PC sound cards - Anatomy - Installing - MIDI - Digital video - Building a digital picture - Frames and interlacing - Digital to analog conversion - VGA and SVGA standards - Mixing video and graphics - Color keying.

UNIT IV DIGITAL PICTURE AND VIDEO COMPRESSION 9

Digital picture compression - Compression techniques - Data compression through coding - Human eye response - RGB color space model - Luma/Croma representation, DCT - JPEG and MPEG - File format - JPEG modes - Video compression techniques - MPEG1 - MPEG2 - MPEG4.

UNIT V MULTIMEDIA OPERATING SYSTEMS 9

Introduction - Real-Time Resource Management - Process Management - File Systems - Additional Operating System Issues - System Architecture.

TOTAL: 45 PERIODS

REFERENCES:

1. Ralf Steinmetz, Klara Nahrstedt , "Multimedia:Computing, Communications and Applications" Pearson Publishers, 1995.
2. Steve Heath, "Multimedia and Communications Technology", O'Reilly Media Inc., 2nd Edition 2015
3. John Billamil, Louis Molina, "Multimedia: An Introduction", PHI, 2002.
4. David Hillman, "Multimedia Technology and Applications", Galgotia Publications Pvt Ltd, 2013.

ONLINE RESOURCES:

1. https://www.instructables.com/id/What-is-MIDI/
2. https://www.midiator.com/sound-cards/evolution-of-pc-sound-cards/
3. https://www.vocal.com/video/video-compression-technology/
4. https://www.cknow.com/cms/ref/video-display-standards.html

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand various multimedia objects.
2. Describe the need of multimedia applications.
3. Apply different digital and audio compression techniques.
4. Understand different audio and video standards.
5. Develop the real-time multimedia OS.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	2	3	1	1	1	1	1	1	3	3	2
CO2	3	2	3	2	3	1	1	1	1	1	1	3	3	2
CO3	3	2	3	2	3	1	1	1	1	1	1	3	3	2
CO4	3	2	3	2	3	1	1	1	1	1	1	3	3	2
CO5	3	2	3	2	3	1	1	1	1	1	1	3	3	2

PROFESSIONAL ELECTIVES - III

24PCNEL218 SDG NO. 4	DIGITAL FORENSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the fundamental concepts of forensic science
- To understand the application of forensic science principles to digital evidence examinations.
- To articulate the steps of the forensic process as applied to digital evidence
- To analyze and validate the computer forensics data

UNIT I INTRODUCTION **9**

Introduction - Digital Forensics - Digital Evidence - Increasing Awareness of Digital Evidence - Digital Forensics: Past, Present, and Future – Principles - Challenging Aspects of Digital Evidence – Cyber trail - Language of Computer Crime Investigation - Role of Computers in Crime .

UNIT II EVIDENCE AND INVESTIGATIONS **9**

Evidence in the Courtroom - Duty of Experts – Admissibility - Levels of Certainty in Digital Forensics - Direct versus circumstantial evidence - Scientific Evidence - Presenting Digital Evidence - Conducting Digital Investigations - Digital Investigation Process Models - Scaffolding for Digital Investigations - Applying the Scientific Method in Digital Investigations - Investigative Scenario - Security Breach

UNIT III DISK AND FILE SYSTEM ANALYSIS **9**

Imaging- Internet Artifacts- Browser & Mail Artifacts- File Analysis- Image- Audio- Video- Archives- Documents- Graphical Investigation Environments-

PyFLAG- Fiwalk- Forensic Ballistics and Photography- Face, Iris and Fingerprint Recognition.

UNIT IV LAWS AND ACTS **9**

Laws and Ethics- Digital Evidence Controls- Evidence Handling Procedures- Basics of Indian Evidence- ACT IPC and CrPC - Electronic Communication Privacy ACT- Legal Policies.

UNIT V NETWORK FORENSICS **9**

Network Basics for Digital Investigators- Applying Forensic Science to Networks- Digital Evidence on the Internet- Digital Evidence on Physical and Data-Link Layers- Digital Evidence at the Network and Transport Layers .

TOTAL: 45 PERIODS

REFERENCES:

1. Eoghan Casey ,"Digital Evidence and Computer Crime, Forensic Science, Computers, and the Internet", Elsevier, 3rd Edition, 2011
2. Adrian Farrel," The Internet And Its Protocols", Elsevier Publications, 2011.
3. Cory Altheide and Harlan Carvey,"Digital Forensics with Open Source Tools" Elsevier publication, 3rd Edition, April 2011.
4. Kevin Mandia, Chris Prosise, Matt Pepe,"Incident Response and Computer Forensics", TataMcGraw -Hill, New Delhi, 2006.
5. Nelson Phillips and Enfinger Steuart, "Computer Forensics and Investigations", Cengage Learning, New Delhi, 2009
6. Robert M Slade," Software Forensics", Tata McGraw - Hill, New Delhi, 2005.

WEB REFERENCES:

1. https://www.forensicnotes.com/dfir-articles-software/
2. https://www.ncjrs.gov/app/publications/alphalist.aspx.

ONLINE RESOURCES:

1. https://resources.infosecinstitute.com/category/computerforensics/introduction/online-resources/#gref.
2. https://www.udemy.com/course/digital-forensics-and-electronic-evidence/
3. https://www.classcentral.com/course/edx-computer-forensics-7857.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the basics and principles of digital forensics.
2. Learn the implementation of digital investigations and collecting evidence.
3. Implement the forensic concepts in an open platform.
4. Apply the Standard Operating Procedure.
5. Explore the techniques and technologies in Network Forensics.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	-	-	2	3	3	2	3	3	3
CO2	3	3	3	2	3	-	-	2	3	3	3	3	3	3
CO3	3	3	3	2	3	-	-	2	3	3	2	3	3	3
CO4	3	3	3	-	3	-	2	2	3	3	3	3	3	3
CO5	3	3	3	-	3	-	2	2	3	3	3	3	3	3

PROFESSIONAL ELECTIVES - III

24PCNEL219 SDG NO. 4	ADVANCED STORAGE AREA NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the fundamentals of storage centric and server centric systems
- To identify and analyze the metrics used for Designing storage area networks
- To infer and implement the RAID concepts
- To examine how data center's maintain the data with the concepts of backup mainly remote mirroring concepts for both simple and complex systems

UNIT I INTRODUCTION TO STORAGE TECHNOLOGY 9

Information storage - Evolution of storage technology and architecture - Data center infrastructure - Key challenges in Managing information - Information lifecycle - Storage system Environments - Components of storage system environment - Disk Drive component - Disk Drive Performance - Fundamental laws governing disk performance - Logical components of the host -

Application requirements and disk performance.

UNIT II INTELLIGENT DISK SUBSYSTEMS 9

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 - The Physical I/O path from the CPU to the Storage System - SCSI.

UNIT III NETWORK ATTACHED STORAGE & FILE SYSTEM 10

Fiber Channel Protocol Stack - Fiber Channel SAN - IP Storage - The NAS Architecture - The NAS hardware Architecture - The NAS Software Architecture - Network connectivity - NAS as a storage system - Local File Systems - Network file Systems and file servers - Shared Disk file systems - Comparison of fiber Channel and NAS.

UNIT IV STORAGE VIRTUALIZATION 8

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

UNIT V SAN HARDWARE DEVICES & SOFTWARE COMPONENTS OF SAN 9

Overview - Creating a Network for storage - SAN Hardware devices - The Fiber channel switch - Host Bus adapters - Putting the storage in SAN - Fabric operation from a Hardware perspective - The switch's Operating system - Device Drivers - The Supporting the switch's components - Configuration options for SANs - Planning for business continuity.

TOTAL: 45 PERIODS

REFERENCES

1. Ulf Troppens, Rainer Erkens, Wolfgang Müller, "Storage Networks Explained, Wiley & Sons, 2003.
2. Robert Spalding, "Storage Networks: The Complete Reference" , Tata McGraw Hill, 2003
3. Richard Barker and Paul Massiglia, "Storage Area Network Essentials: A Complete Guide to understanding and Implementing SANs", John Wiley India, 2002.
4. Marc Farley, "Storage Networking Fundamentals", Cisco Press, 2005

WEB REFERENCES:

1. https://nptel.ac.in/courses/106108058/
2. https://www.snia.org/education/storage_networking_primer/san/what_san

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the limitations of the client-server architecture and evaluate the need for data protection and storage centric architectures such as Intelligent storage system.
2. Examine and interpret various SAN technologies.
3. Apply the techniques used for data maintenance and realize storage virtualization concept.
4. Classify the applications as per their requirements and select relevant SAN solutions.
5. Evaluate different SAN management strategies to fulfill business continuity requirements.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	-	1	1	-	1	1	1	3	3
CO2	3	3	3	3	3	-	1	1	-	1	2	1	3	3
CO3	3	3	3	3	3	1	2	2	-	1	1	2	3	3
CO4	3	3	3	3	3	-	1	1	-	1	2	1	3	3
CO5	3	3	3	3	3	1	2	2	-	1	2	2	3	3

PROFESSIONAL ELECTIVES - IV

24PCNEL301 SDG NO. 4	NETWORK MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the need for interoperable network management as a typical distributed application
- To familiarize concepts and terminology associated with SNMP
- To be aware of current trends in network management technologies
- To implement and experiment the routine management tasks using network management tools

UNIT I OSI NETWORK MANAGEMENT 8

OSI Network management model - Organizational model - Information model - Communication model - Abstract Syntax Notation - Encoding Structure - Macros Functional Model CMIP/CMIS.

UNIT II BROADBAND NETWORK MANAGEMENT 9

Broadband networks and services - ATM Technology – VP – VC - ATM Packet - Integrated service - ATM LAN emulation - Virtual LAN - ATM Network Management - ATM Network reference model - Integrated local Management Interface - ATM Management Information base - Role of SNMP and ILMI in ATM Management - M1 - M2 - M3 - M4 interface - ATM Digital Exchange Interface Management.

UNIT III SIMPLE NETWORK MANAGEMENT PROTOCOL 10

SNMPv1 Network Management: Communication and Functional Models - The SNMP Communication Model - Functional model - SNMP Management SNMPv2 - Major Changes in SNMPv2 - SNMPv2 System Architecture - SNMPv2 Structure of Management Information - The SNMPv2 Management Information Base - SNMPv2 Protocol - Compatibility with SNMPv1 - Configuration management - Fault management - Performance management - Event Correlation Techniques 168 security management - Accounting management - Report Management - Policy Based Management - Services Level Management.

UNIT IV NETWORK MANAGEMENT SYSTEMS 9

Network Management Tools - Network Statistics Measurement Systems - History of Enterprise Management - Commercial Network management Systems - System Management and Enterprise Management Solutions.

UNIT V WEB-BASED MANAGEMENT 9

NMS with Web Interface and Web-Based Management - Web Interface to SNMP Management - Embedded Web-Based Management - Desktop management Interface – Web-Based Enterprise Management - WBEM: Windows Management Instrumentation - Java management Extensions - Management of a Storage Area Network.

TOTAL: 45 PERIODS

REFERENCES:

1. Lakshmi G Raman, "Fundamentals of Telecommunication Network Management", Eastern Economy Edition IEEE Press, New Delhi, 1999.
2. Mani Subramanian, "Network Management - Principles and Practice", Pearson Education, Second edition, 2010.
3. Mani Subramanian, "Network Management Principles and Practice", Addison Wesley, Second edition, 2010.
4. Mark Burges, "Principles of Network System Administration", Wiley, 2000.
5. Salah Aiidarons and Thomas Plevayk, "Telecommunications Network Technologies and Implementations||, Eastern Economy Edition IEEE press, New Delhi, 1998.
6. Stephen Morris, "Network Management, MIBs and MPLS - Principles, Design and Implementation", Pearson Education, 2003.

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1. http://www.apps.ietf.org/rfc/rfc1095.html
2. ycchen.im.ncnu.edu.tw/nm/ch_5x.ppt
3. en.wikipedia.org/wiki/Systems_management
4. www.rivier.edu/faculty/vriabov/NWM_ch_14.ppt 169

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand general concepts and architecture behind network management.
2. Design a simple network management protocol.
3. Demonstrate how to correctly maintain LAN computer systems.
4. Manage the network by performing routine maintenance tasks.
5. Articulate and Implement network management tools.

CO- PO, PSO MAPPING :

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	1	1	1	-	1	-	-	-	-	1	3	3
CO2	3	3	3	3	3	-	1	1	-	1	2	2	3	3
CO3	3	2	3	2	3	-	1	1	-	1	1	2	3	3
CO4	3	3	3	2	3	-	1	1	-	1	2	2	3	3
CO5	3	3	3	2	3	-	1	1	-	-	2	2	3	3

PROFESSIONAL ELECTIVES - IV

24PCNEL302 SDG NO. 4,7 & 9	NEXT GENERATION NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the technical, economic and service advantages of next generation networks
- To learn the evolution of technologies of 4G and beyond
- To learn Software defined Mobile Network issues and integrating challenges with LTE
- To explore the NGN framework catering the services of end user with QoS provisioning

UNIT I INTRODUCTION **9**

Evolution of public mobile services -Motivations for IP based services, Wireless IP network architecture –3GPP packet data network architecture. Introduction to next generation networks-Opportunities and Challenges, Technologies-Networks and Services-Next Generation Society-Future Trends.

UNIT II 4G and BEYOND **9**

Introduction to LTE -Requirements and Challenges-Network architectures – EPC - E-UTRAN architecture-Mobility management - Resourcemanagement-Services-Channel -Logical and Transport channel mapping-Downlink/uplink data transfer-MAC control element-PDU packet formats-scheduling services-random access procedure.

UNIT III SDMN-LTE INTEGRATION **9**

SDN paradigm and applications, SDN for wireless-challenges-Leveraging SDN

for 5G networks ubiquitousconnectivity-Mobile cloud-Cooperative cellular network-Restructuring mobile networks to SDN-SDN/LTE integration benefits.

UNIT IV NGN ARCHITECTURE **9**

Evolution towards NGN-Technology requirements-NGN functional architecture- Transport stratum-Service stratum-Service/ content layer and customer terminal equipment function. NGN entities- Network and Service evolution -Fixed-Mobile-Cable and internet evolution towards NGN.

UNIT V NGN MANAGEMENT AND STANDARDIZATION **9**

NGN requirements on Management-Customer-Third party- Configuration-Accounting-Performance-Device and information management. Service and Control management- End-to-End QoS and security. ITU and GSI-NGN releases-ETSI-NGN concept and releases- NGMN alliance and NGMN.

TOTAL: 45 PERIODS

REFERENCES:

1. Jingming Li Salina, Pascal Salina "Next Generation Networks-perspectives and potentials" Wiley, January 2008.
2. Madhusanga Liyanage, Andrei Gurtov, Mika Ylianttila, "Software Defined Mobile Networks beyond LTE Network Architecture", Wiley, June 2015.
3. Martin Sauter, "3G,4G and Beyond bringing networks, devices and web together", Wiley, 2nd edition-2013.
4. Savo G Glisic, "Advanced Wireless Networks- Technology and Business models", Wiley, 3rd edition- 2016
5. Thomas Plavyk, “Next generation Telecommunication Networks, Services and Management”, Wiley & IEEE Press Publications, 2010.

WEB REFERENCES:

1. http://www.hit.bme.hu/~jakab/edu/litr/NGN/Architecture/ITU_NGN_Module1.pdf
2. https://www.etsi.org/deliver/etsi_sr/080001_080099/080005/03.01.01_60/sr_080005v030101p.pdf.
3. http://www.oecd.org/internet/ieconomy/40761101.pdf.

ONLINE RESOURCES:

1. https://www.itu.int/ITU-D/tech/NGN/CaseStudies/NGN_CaseStudy_IND_PHIL_SLKA_V2.pdf
2. http://www.freebookcentre.net/mobile-technology/4G-LTE-Books.html.

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OUTCOMES:

Upon completion of this course, the students should be able to

1. Employ the issues and challenges of wireless domain in future generation· network design.
2. Understand the 4G and its challenges.
3. Explore the LTE concepts and technologies.
4. Understand the integration of SDN with LTE.
5. Understand the NGN management and standardizations.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	1	2	2	1	2	1	2	3	3
CO2	2	2	2	3	3	2	2	2	2	2	2	2	3	3
CO3	2	2	2	3	3	2	1	1	1	2	1	1	3	3
CO4	2	2	2	3	3	3	1	1	1	2	2	2	3	3
CO5	3	2	3	3	3	2	1	1	1	2	2	2	3	3

PROFESSIONAL ELECTIVES - IV

24PCNEL303 SDG NO. 4	NETWORK FUNCTION VIRTUALIZATION AND EDGE COMPUTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn network virtualization and tools.
- To explore modern approaches like vmware, openflow, openstack
- To understand the security process of virtualization
- To understand the basics of Edge Computing

UNIT I NETWORK FUNCTIONS VIRTUALIZED 8

Virtualize a Network- Virtualizing Appliances - Virtualizing Core Networking Functions - Scalability and Performance.

UNIT II MODERN NETWORKING APPROACHES 9

Openflow - VMware NSX - OpenDayLight Project - ODL Architecture & Controller Platform - Control Network - Business case for SDN.

UNIT III SECURITY AND VISIBILITY **9**

Security - Preventing Data leakage - Logging and Auditing - Encryption in Virtual Networks Visibility - Overlay Networks - Network Management Tools - Monitoring Traffic.

UNIT IV BASICS OF EDGE COMPUTING **10**

Introduction - Hierarchy - Business Models - Opportunities and Challenges - Addressing the Challenges in Federating Edge Resources - Management and Orchestration of Network Slices - Optimization Problems.

UNIT V MIDDLEWARES AND CLASSIFICATION **9**

Middlewares - Lightweight Container Middleware for Edge Cloud Architectures – Classification to Edge Application - Modeling and Simulation of Edge Computing Environments.

TOTAL : 45 PERIODS

REFERENCE:

1. Jim Doherty,"SDN and NFV Simplified",Addison Wesley, 2016.
2. Rajkumar Buyya (Editor), Satish Narayana Srirama (Editor),"Fog and Edge Computing: Principles and Paradigms", John Wiley & Sons.
3. Ken Gray Thomas Nadeau,"Network Function Virtualization"1st Edition,Morgan Kaufmann.
4. Rajendra Chayapathi, Syed F. Hassan, Paresh Shah,"Network Functions Virtualization (NFV) with a Touch of SDN",1st Edition,Addison-Wesley Professional.

WEB REFERENCES:

1. https://books.google.co.in/books/about/Fog_and_Edge_Computing.html?id=zdWCDwAAQBAJ&printsec=frontcover&source=kp_read_button&redir_esc=y
2. https://en.wikipedia.org/wiki/Network_virtualization
3. https://www.slideshare.net/SatishChavan4/network-function-virtualization-69960465
4. https://www.coursera.org/lecture/network-transformation-101/network-functions-virtualization-nfv-introduction-3x2J8.

OUTCOMES:

Upon successful completion of this course, a student should be able to

1. Design and deploy network virtualization.
2. Implement various network security measures and tackle.
3. Understand the business and challenges in Edge Computing.

4. Understand the classification in Edge Computing.
5. Design Middlewares and Simulation for Edge Computing.

CO – PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	3	3	1	1	1	1	2	3	3
CO2	3	3	3	3	3	3	3	1	1	1	1	2	3	3
CO3	3	3	3	3	3	3	3	1	1	1	1	2	3	3
CO4	3	3	3	3	3	3	3	1	1	1	1	2	3	3
CO5	3	3	3	3	3	3	3	1	1	1	1	2	3	3

PROFESSIONAL ELECTIVES - IV

24PCNEL304 SDG NO. 4	INTRODUCTION TO RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Identify an appropriate research problem in their interesting domain
- Study ethical issues and understand the Preparation of a research project thesis report
- Learn the law of patent and copyrights
- Gain adequate knowledge on IPR

UNIT I MEANING OF RESEARCH PROBLEM **10**

Meaning of research problem- Sources of research problem- Criteria - Characteristics of a good research problem- Errors in selecting a research problem- Scope and objectives of research problem- Approaches of investigation of solutions for research problem- Data collection - Analysis - Interpretation - Necessary instrumentations.

UNIT II LITERATURE STUDIES **7**

Effective literature studies approaches- Analysis-
Plagiarism, and Research ethics.

UNIT III TECHNICAL WRITING **9**

Effective technical writing, How to write report- Developing a Research Proposal- Format of research proposal- Presentation and assessment by a review committee.

UNIT IV RESEARCH PROPOSAL **9**

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.

UNIT V PATENT RIGHTS AND NEW DEVELOPMENTS IN IPR **10**

Scope of Patent Rights- Licensing and transfer of technology-Patent information and databases-Geographical Indications- New Developments in IPR: Administration of Patent System-New developments in IPR - IPR of Biological Systems - Computer Software -Traditional knowledge Case Studies

TOTAL: 45 PERIODS

REFERENCES:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students", Publisher: Kenwyn, South Africa: Juta & Co . Ltd.,1996.
2. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners", SAGE Publications., 2018.
3. Bordens, K. S. and Abbott, B. B., "Research Design and Methods – A Process Approach", 8th Edition, McGraw-Hill, 2011.
4. C. R. Kothari, "Research Methodology – Methods and Techniques", 2nd Edition, New Age International Publishers
5. Davis, M., Davis K., and Dunagan M., "Scientific Papers and Presentations", 3rd Edition, Elsevier Inc.
6. Michael P. Marder," Research Methods for Science", Cambridge University Press, 2011
7. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New Technological Age". Aspen Law & Business; 6 edition July 2012.

WEB REFERENCES :

1. https://nptel.ac.in/courses/110105139/
2. https://nptel.ac.in/courses/121/106/121106007/

ONLINE RESOURCES:

1. https://iare.ac.in/sites/default/files/MTECH-CAD.CAM-R18-RM-IP-NOTES.pdf.
2. https://lecturenotes.in/subject/448/intellectual-property-rights-ipr
3. http://ignca.gov.in/short-term-certification-course/research-methodology/.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the research problem and research process.
2. Learn research ethics.
3. Prepare a well-structured research paper and scientific presentations.
4. Explore on various IPR components and process of filing.
5. Examine about steps in getting patent and rights.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	1	2	2	1	1	2	1	1	1	2	2	3	-	-
CO2	1	1	2	-	-	1	3	3	-	2	-	3	-	1
CO3	2	2	3	2	2	2	1	1	1	2	2	3	-	-
CO4	2	2	3	2	2	2	2	1	1	2	1	3	-	-
CO5	2	2	2	2	1	3	1	-	1	2	1	-	-	1

PROFESSIONAL ELECTIVES - IV

24PCNEL305 SDG NO. 4	ADVANCED SOFTWARE TESTING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To Learn the fundamentals of software Testing and principles
- To Evaluate the essentials of Software Engineering concepts
- To Comprehend the process of generating effective test cases for dynamic testing
- To Understand testing techniques for testing specialized systems

UNIT I TESTING FUNDAMENTALS 8

Fundamental Test Process - Software Testing Principles - The Tester's Role in a Software Development Organization - Overview of Testing Techniques - Creating Test Plans and Test Cases - Test Scenarios - Test Data - Test Scripts - Test Requirements Specification and gathering - Creating TRS and Test Procedure.

UNIT II SOFTWARE TEST PLAN AND MANAGEMENT 8

Pre-Planning Activities - Success Criteria / Acceptance Criteria - Test Objectives - Assumptions - Entrance Criteria / Exit Criteria - Test Planning - Test Plan – Requirements / Traceability - Estimating - Scheduling - Staffing - Approach - Test Check Procedures Post -Planning Activities - Change Management - Versioning-Change Management - Configuration Management -Software Test Management - Risk and Testing - Test Organization - Test progress monitoring and control.

UNIT III TEST CASE DESIGN TECHNIQUES AND LEVELS OF TESTING 12

Test Planning – Strategies - Functional Testing - White Box Test Case Design Techniques - Coverage and Control Flow Graphs - Cyclomatic Complexity - Basis path Testing - Data Flow Testing - Black Box Test Case Design Techniques - Formal Specifications - Random Testing - Requirements Based Testing - Decision Tables - State-based Testing - Cause-Effect Graphing - Error Guessing - Non-Functional Testing - Performance testing - Load Testing - Endurance Testing - Scalability Testing - Regression Testing - Internationalization Testing - Ad-hoc Testing – Alpha & Beta Tests - Compatibility Testing - Volume Testing - Stress Testing -Scalability Testing - Recovery Testing Usability and Accessibility Testing - Configuration Testing - Testing the Documentation - Website Testing - Testing OO Systems - Fault-based Testing - Scenario Based Testing - Levels of Testing - Unit Testing - Integration Testing - System Testing - Acceptance Testing - Case Study.

UNIT IV TOOLS AND ITS APPLICATION IN SPECIFIC TESTINGS 9

Automated Testing Tools – Functional Testing - Rational Functional Tester – Selenium – Cucumber - JUnit- Performance Testing Tools - Rational Performance Tester – HP Loadrunner- Test Management Tools - Quality Center, Performance Center Reports and Control Issues – Types of Review – Component of Review Plans – Reporting Review Results – Evaluation of Software Quality.

UNIT V ADVANCED CONCEPTS IN SOFTWARE TESTING 8

Test Process Optimization - Empirical Software Testing and Analysis - Mobile Testing - SOA Testing - Data Warehouse Testing - Cloud Testing - Big Data Testing - WebApps Testing- IoT Testing.

TOTAL: 45 PERIODS.

REFERENCE BOOKS:

1. NareshChauhan, "Software Testing Principles and Practices",Oxford University Press, 2010.
2. Glenford J. Myers, Corey Sandler, Tom Badgett, "The Art of Software Testing", 3rd Edition, 2011.
3. Srinivasan Desikan, Gopalaswamy Ramesh "Software Testing – Principles and practices",Pearson Education, 2006
4. Nick Jenkins, "A Software Testing Primer – An Introduction to Software Testing" 2008.
5. Rex Black, Jamie L Mitchell, " Advanced Software Testing - Vol. 3", 2nd Edition, Rocky Nook, March 2015 ,ISBN: 9781457189074
6. "Software Testing – An ISTQB-BCS Certified Tester Foundation Guide", Third Edition,BCS,2015.

WEB REFERENCES:

1. https://nptel.ac.in/courses/106101163/
2. https://swayam.gov.in/nd1_noc19_cs71/preview

ONLINE RESOURCES:

1. https://www.testbytes.net/blog/top-10-websites-to-learn-software-testing/
2. http://www.testingreferences.com/testingliterature.php

OUTCOMES:

Upon completion of the course, the student should be able to

1. Apply software testing knowledge and engineering methods.
2. Examine and solve various functionality problems by designing and selecting testing models and methods.
3. Ability to Design and conduct various types and levels of software testing.
4. Automate the Testing process by using several Testing tools.
5. Establish a Quality Environment as specified in standards for developing Quality Software.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	2	1	1	1	1	1	1	2	3
CO2	3	3	3	3	3	2	1	1	1	1	2	2	2	3
CO3	3	3	3	3	3	2	1	1	1	1	1	2	2	3
CO4	3	3	3	3	3	2	1	1	1	1	2	2	2	3
CO5	3	3	3	3	3	2	1	1	1	1	2	2	2	3

PROFESSIONAL ELECTIVES - IV

24PCNEL306 SDG NO. 4	SOCIAL NETWORK ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the components of the social network
- To model and visualize the social network
- To analyze the users in the social network
- To comprehend the evolution of the social network

UNIT I INTRODUCTION **9**

Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Statistical Properties of Social Networks - Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks.

UNIT II MODELING AND VISUALIZATION **9**

Visualizing Online Social Networks - A Taxonomy of Visualizations - Graph Representation - Centrality- Clustering - Node-Edge Diagrams - Visualizing Social Networks with Matrix-Based Representations- Node-Link Diagrams - Hybrid Representations - Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce - Ontological representation of social individuals and relationships.

UNIT III MINING COMMUNITIES **9**

Aggregating and reasoning with social network data- Advanced Representations – Extracting evolution of Web Community from a Series of Web Archive - Detecting Communities in Social Networks - Evaluating

Communities – Core Methods for Community Detection and Mining - Applications of Community Mining Algorithms - Node Classification in Social Networks.

UNIT IV EVOLUTION **9**

Evolution in Social Networks – Framework - Tracing Smoothly Evolving Communities - Models and Algorithms for Social Influence Analysis - Influence Related Statistics - Social Similarity and Influence - Influence Maximization in Viral Marketing - Algorithms and Systems for Expert Location in Social Networks - Expert Location - Without Graph Constraints - With Score Propagation – Expert Team Formation - Link Prediction in Social Networks - Feature based Link Prediction – Bayesian Probabilistic Models - Probabilistic Relational Models.

UNIT V APPLICATIONS **9**

Learning Based Approach for Real Time Emotion Classification of Tweets - New Linguistic Approach to assess the Opinion of Users in Social Network Environments - Explaining Scientific and Technical Emergence Forecasting - Social Network Analysis for Biometric Template Protection.

TOTAL: 45 PERIODS

REFERENCES:

1. Ajith Abraham, Aboul Ella Hassanien, Vaclav Snasel ,"Computational Social Network Analysis: Trends, Tools and Research Advances", Springer, 2012
2. Borko Furht, "Handbook of Social Network Technologies and Applications", Springer, 1 st edition, 2011
3. Charu C. Aggarwal, "Social Network Data Analytics", Springer; 2014
4. Giles, Mark Smith, John Yen, "Advances in Social Network Mining and Analysis", Springer, 2010.
5. Guandong Xu , Yanchun Zhang and Lin Li, "Web Mining and Social Networking – Techniques and applications", Springer, 1st edition, 2012
6. Peter Mika, "Social Networks and the Semantic Web", Springer, 1st edition, 2007.
7. Przemyslaw Kazienko, Nitesh Chawla,"Applications of Social Media and Social Network Analysis", Springer,2015

WEB REFERENCES:

1. https://learnengineering.in/cs6010-social-network-analysis/
2. https://ocw.mit.edu/courses/sloan-school-of-management/15-599-workshop-in-it-collaborative-innovation-networks-fall-2011/lecture-

notes/MIT15_599F11_lec04.pdf

3. https://www.scribd.com/document/390705690/CS6010-SOCIAL-NETWORK-ANALYSIS-Unit-1-Notes.

OUTCOMES:

Upon Completion of the course, the students should be able to

1. Understand the working on the internals components of the social network.
2. Analyze the model and visualize the social network.
3. Apply various network and mine the behaviour of the users in the social network
4. Predict the possible next outcome of the social network.
5. Implement social network in real time applications.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	2	2	1	-	1	-	-	3	1	2	1	1
CO2	3	3	2	2	1	-	1	-	-	3	2	2	1	1
CO3	3	3	3	2	2	-	2	2	-	3	2	3	1	1
CO4	3	3	2	2	1	-	1	1	-	3	1	2	1	1
CO5	3	3	2	2	3	3	2	1	0	3	3	3	3	3

PROFESSIONAL ELECTIVES - IV

24PCSEL302 SDG NO. 4 & 9	WEB ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the characteristics of web applications
- Learn to Model web applications
- Be aware of Systematic design methods
- Be familiar with the testing techniques for web applications

UNIT I INTRODUCTION TO WEB ENGINEERING 9

Motivation, Categories of Web Applications, Characteristics of Web Applications. Requirements of Engineering in Web Applications- Web

Engineering-Components of Web Engineering-Web Engineering Process-Communication-Planning.

UNIT II WEB APPLICATION ARCHITECTURES & MODELLING WEB APPLICATIONS 9

Introduction- Categorizing Architectures- Specifics of Web Application Architectures, Components of a Generic Web Application Architecture-Layered Architectures, 2-Layer Architectures, N-Layer Architectures- Data-aspect Architectures, Database-Centric Architectures- Architectures for Web Document Management- Architectures for Multimedia Data- Modeling Specifics in Web Engineering, Levels, Aspects, Phases Customization, Modeling Requirements, Hypertext Modeling, Hypertext Structure Modeling Concepts, Access Modeling Concepts, Relation to Content Modeling, Presentation Modeling

UNIT III WEB APPLICATION DESIGN 9

Design for WebApps- Goals-Design Process-Interactive Design- Principles and Guidelines- Workflow-Preliminaries-Design Steps- Usability- Issues-Information Design- Information Architecture- Structuring- Accessing Information-Navigation Design- Functional Design-WebApp Functionality-Design Process- Functional Architecture- Detailed Functional Design - Case Study on UI Design.

UNIT IV TESTING WEB APPLICATIONS 9

Introduction-Fundamentals-Test Specifics in Web Engineering-Test Approaches- Conventional Approaches, Agile Approaches- Testing concepts-Testing Process -Test Scheme- Test Methods and Techniques- Link Testing-Browser Testing-Usability Testing- Load, Stress, and Continuous Testing, Testing Security, Test-driven Development, -Content Testing-User Interface testing-Usability Testing-Compatibility Testing-Component Level Testing-Navigation Testing-Configuration testing-Security and Performance Testing-Test Automation

UNIT V PROMOTING WEB APPLICATIONS AND WEB PROJECT MANAGEMENT 9

Introduction-Challenges in launching the Web Application-Promoting Web Application- Content Management-Usage Analysis-Web Project Management-Challenges in Web Project Management-Managing Web Team- Managing the Development Process of a Web Application- Risk, Developing a Schedule, Managing Quality, Managing Change, Tracking the Project. Introduction to Node JS - Web sockets. Case Study: Evolving Framework.

TOTAL: 45 PERIODS

TEXT BOOK:

1. Roger S. Pressman, David Lowe, "Web Engineering", Tata McGraw Hill Publication, 2007.

REFERENCES:

1. Chris Bates,"Web Programming: Building Internet Applications", Third Edition,Wiley India Edition, 2007.
2. Gerti Kappel, Birgit Proll, "Web Engineering, John Wiley and Sons" Ltd, 2006.
3. Guy W. Lecky-Thompson, "Web Programming, Cengage Learning", 2008.
4. John Paul Mueller, "Web Development with Microsoft Visual Studio 2005", Wiley Dream tech, 2006.

WEB REFERENCES:

1. https://www.elegantthemes.com/blog/tipstricks/learn-web-development-online
2. https://web-engineering.info/
3. https://www.mockplus.com/blog/post/web-design-resource

ONLINE RESOURCES:

1. https://www.coursera.org/specializations/web-design
2. https://nptel.ac.in/courses/106/106/106106222/
3. https://link.springer.com/content/pdf/10.1007/978-3-540-27834-4_64.pdf

OUTCOMES:

On Successful completion of the course, students should be able to:

1. Explain the characteristics of Web applications.
2. Model Web applications.
3. Design Web applications.
4. Test Web applications.
5. Promote Web Project Management

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	2	2	3	-	-	3	3	-	2	3	2
CO2	2	2	3	2	2	-	2	-	2	3	2	-	2	3
CO3	3	3	2	-	3	3	-	-	-	-	-	2	2	2
CO4	2	2	2	2	2	2	-	-	-	2	2	2	3	2
CO5	3	3	3	2	2	-	2	-	2	2	1	-	2	3

PROFESSIONAL ELECTIVES - V

24PCSEL308 SDG NO. 4 & 9	EMBEDDED SOFTWARE DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the architecture of embedded processor, microcontroller and peripheral devices.
- To interface memory and peripherals with embedded systems.
- To study the embedded network environment.
- To understand challenges in Real time operating systems.

UNIT I EMBEDDED PROCESSORS 9

Embedded Computers - Characteristics of Embedded Computing Applications - Challenges in Embedded Computing System Design - Embedded System Design Process- Formalism for System Design - Structural Description - Behavioral Description - ARM Processor – Intel ATOM Processor.

UNIT II EMBEDDED COMPUTING PLATFORM 9

CPU Bus Configuration - Memory Devices and Interfacing - Input/Output Devices and Interfacing - System Design - Development and Debugging – Emulator – Simulator - JTAG Design Example – Alarm Clock - Analysis and Optimization of Performance - Power and Program Size.

UNIT III EMBEDDED NETWORK ENVIRONMENT 9

Distributed Embedded Architecture - Hardware And Software Architectures - Networks for Embedded Systems - I2C - CAN Bus - SHARC Link Supports – Ethernet – Myrinet – Internet - Network-based Design - Communication

Analysis - System Performance Analysis - Hardware Platform Design - Allocation and Scheduling - Design Example - Elevator Controller.

UNIT IV REAL-TIME CHARACTERISTICS 9

Clock Driven Approach - Weighted Round Robin Approach - Priority Driven Approach - Dynamic versus Static Systems - Effective Release Times and Deadlines - Optimality of the Earliest Deadline First (EDF) Algorithm - Challenges in Validating Timing Constraints in Priority Driven Systems - Off-Line versus On-Line Scheduling.

UNIT V SYSTEM DESIGN TECHNIQUES 9

Design Methodologies - Requirement Analysis - Specification - System Analysis and Architecture Design - Quality Assurance - Design Examples - Telephone PBX - Ink jet printer - Personal Digital Assistants - Set-Top Boxes.

TOTAL: 45 PERIODS

REFERENCES:

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things" Wiley Publication, First edition, 2013
2. Andrew N Sloss, D. Symes, C. Wright, “Arm system developers guide”, Morgan Kauffman/Elsevier, 2006.
3. Arshdeep Bahga, Vijay Madisetti, "Internet of Things: A Hands-on-Approach" VPT First Edition, 2014
4. C. M. Krishna and K. G. Shin, “Real-Time Systems”, McGraw-Hill, 1997
5. Frank Vahid and Tony Givargis, “Embedded System Design: A Unified Hardware/Software Introduction”, John Wiley & Sons.
6. Jane.W.S. Liu, “Real-Time systems”, Pearson Education Asia.
7. Michael J. Pont, “Embedded C”, Pearson Education , 2007.
8. Muhammad Ali Mazidi, Sarmad Naimi, Sepehr Naimi, "The AVR Microcontroller and Embedded Systems: Using Assembly and C" Pearson Education, First edition, 2014
9. Steve Heath, “Embedded System Design”, Elsevier, 2005
10. Wayne Wolf, “Computers as Components: Principles of Embedded Computer System Design”, Elsevier, 2006.

WEB REFERENCES:

1. https://nptel.ac.in/courses/117/106/117106112/

ONLINE RESOURCES:

1. https://freevideolectures.com/search/embedded-/
2. https://e-box.co.in/embedded-systems-course.shtml

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand different architectures of embedded processor, microcontroller and peripheral devices interface memory and peripherals with embedded systems.
2. Work with embedded network environment.
3. Understand challenges in Real time operating systems.
4. Design and analyze applications on embedded systems
5. Promoting embedded system

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	1	2	2	-	2	1	-	1	1	2	2	3	2
CO2	2	2	3	1	1	-	-	-	-	-	2	-	2	3
CO3	2	1	2	2	-	2	1	-	1	2	-	2	3	2
CO4	3	2	3	1	3	1	-	1	-	-	2	1	2	3
CO5	3	1	2	2	3	2	-	2	2	3	2	2	3	2

PROFESSIONAL ELECTIVES - V

24PCNEL308 SDG NO. 4	INFORMATION STORAGE MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the storage architecture and technologies in Information management
- Learn to establish and manage a data center
- Learn various storage technologies for the required application
- Apply security measures to the data center

UNIT I STORAGE TECHNOLOGY 9

Review data creation - Amount of data being created - Understand the value of data to a business - Challenges in data storage and data management -

Solutions available for data storage - Core elements of a data center infrastructure - Role of each element in supporting business activities.

UNIT II STORAGE SYSTEM ARCHITECTURE 9

Hardware and software components of the host environment - Key protocols and concepts used by each component - Physical and logical components of a connectivity environment - Major physical components of a disk drive and their function - Logical constructs of a physical disk - Access characteristics - Performance Implications - Concept of RAID and its components - Different RAID levels and their suitability for different application environments - Compare and contrast integrated and modular storage systems - High-level architecture and working of an intelligent storage system.

UNIT III INTRODUCTION TO NETWORKED STORAGE 9

Evolution of networked storage - Architecture - Components - Topologies of FC-SAN - NAS - IP-SAN - Benefits of the different networked storage options - Understand the need for long-Term archiving solutions - Describe how CAS fullfill the need - Understand the appropriateness - Different networked storage options - Different application environments.

UNIT IV INFORMATION AVAILABILITY, MONITORING & MANAGING DATA CENTERS 9

List reasons for planned or unplanned outages - Impact of downtime - Business continuity (BC) - Disaster recovery (DR) - RTO - RPO - Identify single points of failure - List solutions to mitigate failures - Architecture of backup/recovery - Different backup or recovery topologies - Replication technologies - Role in ensuring information availability and business continuity - Remote replication technologies - Role in providing disaster recovery and business continuity capabilities - Identify key areas to monitor in a data center - Industry standards for data center monitoring and management - Key metrics - Key management tasks.

UNIT V SECURING STORAGE AND STORAGE VIRTUALIZATION 9

Information security - Critical security attributes - Storage security domains - List and analyze the common threats in each domain - Virtualization technologies - Block-level and file-level virtualization technologies and processes.

TOTAL: 45 PERIODS

REFERENCES:

1. EMC Corporation, "Information Storage and Management: Storing, Managing, and Protecting Digital Information", Wiley, India, 2010.

2. Marc Farley, "Building Storage Networks", Tata McGraw Hill" ,Osborne, 2001.
3. Robert Spalding, "Storage Networks: The Complete Reference", Tata McGraw Hill , Osborne, 2003.

WEB REFERENCES:

1. https://nptel.ac.in/courses/106108058/.

ONLINE RESOURCES:

1. https://dokumen.tips/engineering/cp7029-information-storage-management-notes-58f9ada4e0e17.html.

OUTCOMES:

Upon completion of the course, the student should be able to:

1. Understand the basics of storage management for Information maintenance.
2. Study the requirements and strategies for the data center.
3. Learn various storage technologies for the required application.
4. Apply security measures to data center.
5. Analyze Quality of Service in Storage.

CO- PO,PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	2	-	-	-	-	1	-	-	-	2	2	2
CO2	3	2	2	-	-	-	-	2	-	-	-	2	2	2
CO3	3	3	3	-	-	-	-	1	-	-	-	-	2	2
CO4	3	3	3	-	-	-	-	1	-	-	-	-	2	2
CO5	3	3	3	-	-	-	-	1	-	-	-	-	2	2

PROFESSIONAL ELECTIVES - V

24PCSPC204 SDG NO. 4 & 9	BIG DATA ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To describe the basic concepts of Big Data characteristics and Analytics.
- To examine the Hadoop and MapReduce framework for processing large volume of data sets and various data analysis methods.
- To store and retrieve the data effectively using MongoDB and report generation.
- To analyze the big data for useful business applications and familiar with the Visualization.

UNIT I INTRODUCTION TO BIG DATA ANALYTICS 9

Classification of Digital Data - Introduction to Big Data: Characteristics – Evolution – Definition - Challenges with Big Data - Other Characteristics of Data - Why Big Data - Traditional Business Intelligence versus Big Data - Data Warehouse and Hadoop Environment - Big Data Analytics: Classification of Analytics – Challenges - Big Data Analytics importance - Data Science - Data Scientist - Terminologies used in Big Data Environments - Soft State Eventual Consistency - Top Analytics Tools.

UNIT II HADOOP AND MAPREDUCE PROGRAMMING 9

Hadoop: Features – Advantages – Versions – Ecosystems – Distributions – Hadoop Versus RDBMS - Distributed Computing Challenges – History - Hadoop Overview - Use Case of Hadoop - Hadoop Distributors - Hadoop Distributed File System - Processing Data with Hadoop - Managing Resources and Applications with Hadoop YARN - Interacting with Hadoop Ecosystem – MapReduce: Mapper – Reducer – Combiner – Partitioner – Searching – Sorting – Compression.

UNIT III DATA ANALYSIS 9

Statistical Methods: Regression modeling, Multivariate Analysis - Classification: SVM - Rule Mining - Cluster Analysis, Types of Data in Cluster Analysis, Partitioning Methods, Hierarchical Methods, Density Based Methods, Grid Based Methods, Model Based Clustering Methods, Clustering High Dimensional Data - Data analysis using R.

UNIT IV NoSQL: MongoDB AND JASPER REPORTS 9

NoSQL Databases: Advantages – Usage – Vendors – New SQL – Comparison of SQL, NoSQL and NewSQL -MongoDB: Why MongoDB - Terms used in RDBMS

and MongoDB - Data Types - MongoDB Query Language Methods: Insert – Save – Update – Remove - Find – NULL – Count – Limit – Sort – Skip – Arrays – Aggregate – MapReduce – Cursors in MongoDB – Indexes – Import and Export - JasperReport using Jaspersoft – Connecting to MongoDB, NoSQL Database.

UNIT V FRAMEWORKS AND VISUALIZATION 9

Apache Hbase – Architecture/Storage – Features – Data Model – Shell and Implementation – Hbase vs RDBMS - Zookeeper – Installation and Configuration - Running Zookeeper - Sqoop – Architecture - Import and Export Data – Sqoop Job – Flume – Log Collection – Working with Twitter Stream - Oozie – Simple and Complex Flow – Components – Service/Scheduler – Workflow – Apache Spark – Lambda Architecture – Spark Streaming – Spark Processing – Apache Kafka – Operations – Visualizations – Visual Data Analysis Techniques – Interaction Techniques.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Seema Acharya, Subhashini Chellappan, "Big Data and Analytics", Wiley Publications, First Edition, 2015.
2. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, Second Edition, 2007.

REFERENCES:

1. Seema Acharya, "Data Analytics using R", McGraw Hill Publications, New Edition, 2018.
2. Judith Huruwitz, Alan Nugent, Fern Halper, Marcia Kaufman, "Big data for dummies", John Wiley & Sons, Inc., 2013.
3. Tom White, "Hadoop, the Definitive guide", O'Reilly Media, 2010.
4. Donald Miner, "Map Reduce Design Patterns: Building Effective Algorithms and Analytics for Hadoop and other Systems", O'Reilly Media, 2012.

WEB REFERENCES:

1. https://www.mongodb.org
2. http://cassandra.apache.org
3. http://apache.bytenet.in/hadoop/common/hadoop-2.6.0
4. https://community.jaspersoft.com

OUTCOMES:

Upon completion of the course, the students should be able to

1. Identify the characteristics and challenges of big data analytics.

2. Implement the Hadoop and MapReduce framework for processing massive volume of data.
3. Analyze data by utilizing various statistical and data mining approaches.
4. Implement CRUD operations effectively using MongoDB and Report generation using Jaspersoft studio.
5. Explore the usage of Hadoop and its integration tools to manage Big Data and use Visualization Techniques.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	2
CO2	3	3	3	1	3	-	-	-	-	3	-	-	2	2
CO3	3	3	3	3	3	2	-	-	2	3	1	2	3	2
CO4	3	3	3	3	3	2	-	-	2	-	-	-	3	2
CO5	3	3	3	3	3	2	-	-	2	2	2	2	3	2

PROFESSIONAL ELECTIVES - V

24PCNEL309 SDG NO. 4	CRYPTOGRAPHY AND WIRELESS NETWORK SECURITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand and acquire knowledge in security mechanism of wireless systems/ networks
- To emphasis on knowledge-building for solving problems in communication systems
- To provide a complete understanding on network security concepts
- To identify how the algorithm is designed to provide security, as well as what are its pros and cons

UNIT I INTRODUCTION TO CRYPTOSYSTEMS 9

Security Services - Mechanisms and Attacks - Network Security Model - Classical Encryption Techniques – Steganography - Data Encryption Standard (DES).

UNIT II PUBLIC-KEY CRYPTOSYSTEM 9

Public Key Crypto System – Principles- RSA Algorithm - Key Management - Diffie Hellman Key Exchange - Message Authentication - Hash Functions - Digital Signature - Digital Signature Standard.

UNIT III NETWORK SECURITY APPLICATION 9

Kerberos - X.509 Authentication Service - Electronic Mail Security – PGP – IPSec -Web Security - Considerations – SSL and TLS – SET - System Security – Intruders - Intruder detection - Viruses and Related Threats - Firewalls – Design Principles - Trusted Systems.

UNIT IV WLAN/ WPAN SECURITY 9

Security in Wireless Environment - Mobile Network Environment – Limitations - Attacks and security issues in mobile environment – WLAN – IEEE 802.11 Architecture - Wireless LAN Components - Security of 802.11 Wireless LANs - Security Requirements and Threats - Risk Mitigation - Emerging Security Standards and Technologies - WPAN - Bluetooth Overview - Security of Bluetooth - Security Requirements and Threats - Risk Mitigation - Wireless Handheld Device – Benefits - Security Requirements – Threats and Counter measures.

UNIT V SECURITY IN 2G, 3G AND 4G SYSTEMS 9

Security in 2G Systems - GSM Overview – Architecture - GSM Security - I-Mode - Security in 3G & 4G Systems - 3G Wireless Communication systems - 3GPP Objectives - 3G Security Architecture - Authentication and Key Agreement in 3GPP - Confidentiality and Data Integrity - 4G Communication Systems.

TOTAL: 45 PERIODS

REFERENCES:

1. William Stallings, "Cryptography and Network Security", 8th Edition, Pearson Education, 2019.
2. Atul Kahate, "Cryptography and Network Security", Tata McGraw Hill, 2006.
3. B.A. Forouzan, "Cryptography & Network Security", Tata McGraw Hill, 2007.
4. Hideki Imai, Mohammad Ghulam Rahman and Kazukuni Kobara, "Wireless Communication s Security", Artech House Universal Personal Communication, 2006.
5. Tom Karygiannis, Les Owens,"Wireless Network Security 802.11, Bluetooth and Handheld Devices", National Institute of Standards and Technology, US Dept. of Commerce Special Publication 800-48, 2002.

6. Bruce Schneier and Neils Ferguson, "Practical Cryptography", First Edition, Wiley Dream Tech India Pvt Ltd, 2003.
7. Charles P Fleeger, "Security in Computing", 4th Edition, Prentice Hall of India, 2006.
8. Charlie Kaufman and Radia Perlman, Mike Speciner, "Network Security", Second Edition, Private Communication in Public World, PHI 2002.
9. Man Young Rhee, "Internet Security: Cryptographic Principles, Algorithms and Protocols", Wiley Publications, 2003.

WEB REFERENCES:

1. https://nptel.ac.in.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Compare various Security Techniques and Design Secure applications.
2. Implement basic security algorithms and formulate research problems in the computer security field.
3. Analyse the vulnerabilities in any computing system and hence be able to design a security solution.
4. Identify the possible security attacks in complex real time systems and their effective countermeasures.
5. Apply the security issues in the network and evaluate security mechanisms using various approaches.

CO- PO,PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	2	3	3	1	2	2	2	2	3	3
CO2	3	3	3	2	2	3	3	2	2	2	1	2	3	3
CO3	3	3	3	2	3	2	1	1	2	2	2	3	3	3
CO4	2	3	3	3	3	2	2	1	2	2	2	3	3	3
CO5	3	3	3	3	3	2	2	2	3	3	3	3	3	3

PROFESSIONAL ELECTIVES - V

24PCNEL310 SDG NO. 4	ADVANCED DATABASE MANAGEMENT SYSTEM	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To elucidate a general introduction to conceptual model
- To provide a general introduction to relational model
- To understand Normalization and query processing
- To learn about Query processing and Transaction Processing
- To analyze Advanced Modeling
-

UNIT I INTRODUCTION AND CONCEPTUAL MODELING 9

Database and database users – Database system concepts and architecture – Data modeling using Entity- Relationship model – Enhanced Entity-Relationship model.

UNIT II THE RELATIONAL DATAMODEL 9

Relational model- Concepts - Constraints - Languages- Design and Programming – Relational data model and relational database constraints – Relational algebra - relational database design by ER - EER-to-relational mapping – SQL – Schema definition - Constraints - Queries - Views.

UNIT III NORMALIZATION, DATA STORAGE, INDEXING AND QUERY PROCESSING 9

Functional Dependencies and Normalization Of Relational Databases – Relational Database Design Algorithms and Further Dependencies - Disk Storage-Indexing - Query Processing and Physical Design – Disk Storage - Basic File Structures and Hashing – Indexing Structures for Files – Algorithms for Query Processing and Optimization.

UNIT IV TRANSACTION PROCESSING AND OBJECT RELATIONAL DATABASES 9

Transaction processing concepts – Introduction – concurrency control and database recovery techniques- Concepts for Object databases – Object database standards - Object database languages - Object database design - Object relational and extended- Relational systems.

UNIT V ADVANCED MODELING 9

Database security - Enhanced data models for advanced applications – Distributed databases and client-server architecture – Web database

programming using PHP – XML – Extensible markup language.

TOTAL: 45 PERIODS

REFERENCES:

1. RamezElmasri and ShamkantB.Navathe, "Fundamentals of Database Systems", Fifth Edition, Pearson, 2008.
2. Silberschatz, H. Korth and S. Sudarshan, "Database System Concepts", 6th Edition, McGraw-Hill International, 2011.
3. Hector Garcia-Molina, Jeffrey D.Ullman, Jennifer Widom, "Database System The Complete Book", 2nd Edition, Pearson 2008.
4. Raghurama Krishnan, Johannes Gehrke,"Database Management Systems", TATA McGraw Hill, 3rd Edition.
5. Peter Rob & Carlos Coronel ,"Database Systems design, Implementation, and Management",7th Edition.

WEB REFERENCES:

1. http://www.exploredatabase.com/p/blog-page.html.

ONLINE RESOURCES:

1. https://www.udemy.com/courses/search/?q=Advanced%20 Data bases% 20and%20SQL%20Querying&src=sac&kw=ADVANCED%20 DATABASE.
2. https://www.udemy.com/course/advanced-database-design.

OUTCOMES:

Upon completion of the course, the student should be able to

1. Elucidate a general introduction to conceptual model.
2. Provide a general introduction to relational model.
3. Understand Normalization and query processing.
4. Learn about Query processing and Transaction Processing.
5. Analyze the Advanced Modeling.

CO- PO, PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	3	3	3	-	-	-	1	2	-	2	1	2
CO2	3	2	3	3	3	-	-	-	1	2	-	2	1	2
CO3	3	2	3	3	3	-	-	-	1	2	-	2	1	2
CO4	3	2	3	3	3	-	-	-	1	2	-	2	1	2
CO5	3	2	3	3	3	-	-	-	1	2	-	2	1	2

PROFESSIONAL ELECTIVES - V

24PCNEL311 SDG NO. 4	ETHICAL HACKING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand and analyse Information security threats and counter measures
- To perform security auditing & testing
- To understand issues relating to ethical hacking
- To study & employ network defense measures

UNIT I ETHICAL HACKING OVERVIEW & VULNERABILITIES 9

Understanding the importance of security-Concept of ethical hacking and essential TerminologiesThreat- Attack- Vulnerabilities- Target of Evaluation-Exploit. Phases involved in hacking.

UNIT II FOOTPRINTING & PORT SCANNING 9

Footprinting - Introduction to foot printing- Understanding the information gathering methodology of the hackers-Tools used for the reconnaissance phase.Port Scanning - Introduction- using port scanning tools- Ping sweeps-Scripting Enumeration-Introduction- Enumerating windows OS & Linux OS.

UNIT III SYSTEM HACKING 9

Aspect of remote password guessing- Role of eavesdropping -Various methods of password cracking- Keystroke Loggers- Understanding Sniffers - Comprehending Active and Passive Sniffing- ARP Spoofing and Redirection-DNS and IP Sniffing- HTTPS Sniffing.

UNIT IV HACKING WEB SERVICES & SESSION HIJACKING 9

Web application vulnerabilities- Application coding errors- SQL injection into Back-end Databases- Cross-site scripting- cross-Site request forging-Authentication bypass- Web services and related flaws- Protective http headers Understanding Session Hijacking- Phases involved in Session Hijacking-Types of Session Hijacking- Session Hijacking Tools

UNIT V HACKING WIRELESS NETWORKS 9

Introduction to 802.11-Role of WEP- Cracking WEP Keys- SniffingTraffic-WirelessDOSattacks-WLANScanners-WLANSniffers-HackingTools-Securing Wireless Networks.

TOTAL: 45 PERIODS

REFERENCES:

1. Kimberly Graves, "Certified Ethical Hacker", Wiley India Pvt Ltd, 2010.
2. Michael T. Simpson, "Hands-on Ethical Hacking & Network Defense", Course Technology, 2010.
3. Ramachandran V, BackTrack5 Wireless Penetration Testing Beginner's Guide (3rd ed.). Packt Publishing, 2011
4. Thomas Mathew, "Ethical Hacking", OSB publishers, 2003.
5. Patrick Engebretson, "The Basics of Hacking and Penetration Testing" Ethical Hacking and Penetration Testing Made Easy, Syngress Media, Second Revised Edition, 2013.
6. RajatKhare, "Network Security and Ethical Hacking", Luniver Press, 2006.
7. Thomas Mathew, "Ethical Hacking", OSB publishers, 2003.

WEB REFERENCES:

1. https://www.elsevier.com/books/
2. https://www.elsevier.com/books/cyber-security-awareness-for-lawyers
3. https://books.google.co.in/books

ONLINE RESOURCES:

1. https://www.coursera.org/specializations/ethical-hacking
2. https://nptel.ac.in/courses

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand and identify the vulnerabilities/threats/attacks.
2. Understand penetration & security testing.
3. Use safe penetration techniques on the World Wide Web.
4. Design a computer against a variety of security attacks using various tools.
5. Become a professional ethical hacker.

CO- PO, PSO MAPPING:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	2	3	2	1	3	3	2	2	3	3	2
CO2	2	3	3	3	3	2	1	3	3	2	2	3	3	3
CO3	2	3	3	2	3	2	2	3	3	3	2	3	3	3
CO4	2	3	3	3	3	2	1	3	3	3	2	3	3	3
CO5	3	3	3	3	3	2	2	3	3	3	2	3	3	3

PROFESSIONAL ELECTIVES - V

24PCNEL312 SDG NO. 4 & 9	DATA CENTER NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To build robust and scalable data centers
- To understand current data center architectures, new technologies have been adopted to create modern data centers
- To examine new technologies and demonstrate data center network consolidation

UNIT I MOTIVATION FOR A NEW NETWORK ARCHITECTURE 6

The Application - Network Shuffle - The Network Design From The Turn of the Century - The Charms of Building Scalable Bridging Networks - The Trouble With the Access - Aggregation - Core Network Unscalability - Complexity - Failure Domain- Unpredictability - Lack of Agility.

UNIT II NETWORK TOPOLOGY AND NETWORK DISAGGREGATION 10

Clos topology - A deeper dive into the Clos topology scaling the Clos topology - Implications of the Clos topology - Some best practices for a Clos network - Host attach models - Network disaggregation - What and Why is network disaggregation important - What made network disaggregation possible now - Difference in network operations with disaggregation - Open Network Installer Environment (ONIE) - The players in network disaggregation - Hardware - Common myths about network disaggregation.

UNIT III NETWORK OPERATING SYSTEM AND ROUTING PROTOCOLS 8

Requirements of a network device - The rise of SDN and Openflow - NOS design models - Comparing the NOS models with cloud - native NOS requirements -

Routing protocol choices - Routing overview - Routing protocols overview - Distance vector protocols versus Link state protocols - Routing protocols in Clos networks - Requirements of a routing protocol in the Data Center - Choosing the routing protocol for your network.

UNIT IV NETWORK VIRTUALIZATION AND AUTOMATION 12

Network virtualization - Uses of Network virtualization in the Data Center - Network virtualization Models- Network Tunnels - Network virtualization solutions for the Data Center - Practical limits on the number of Virtual networks - Packet forwarding control protocol for Network virtualization - Illustrating VXLAN bridging and routing - Network automation - Introduction - Network operators - Tools for Network automation.

UNIT V INTERCONNECTING DATA CENTERS 9

Data Center Layer 2 Interconnect - Overview of high availability clusters - Data center interconnect - Legacy deployment models - Problems associated with extended layer2 networks - Data center interconnect - Architecture alternatives - Ensuring a loop free global topology - Data center interconnect design alternatives - Case studies- Large government organization - Large outsourcer for server migration and clustering.

TOTAL: 45 PERIODS

REFERENCES:

1. Dinesh G. Dutt, "Cloud-Native Data Center Networking". O'Reilly Media Inc. ISBN: 9781492045601.
2. Nash Darukhanawalla, Patrice Bellagamba, "Interconnecting Data Centers Using VPLS" Cisco Press; 1 edition, [ISBN: 9781587059926], 2009
3. Silvano Gai, Tommi Salli, Roger Andersson, "Cisco Unified Computing System", Cisco Press; 1 edition, [ISBN: 9781587141935], 2010.
4. Robert W. Kembel, Roger Cummings (Introduction), "The Fibre Channel Consultant" Northwest Learning Assoc;3rd edition, [ISBN: 0931836840], 1998.
5. Robert W Kembal,"Fiber Channel Switched Fabric"Northwest Learning Associates, inc.[ISBN: 0931836719],2009.
6. John L. Hufferd, "ISCSI", Addison-Wesley Boston [ISBN: 978-0201784190], 2003.

WEB REFERENCES:

1. https://datatracker.ietf.org/meeting/82/materials/slides-82-armd-1
2. https://queue.acm.org/detail.cfm?id=2208919

ONLINE RESOURCES:

1. https://www.cisco.com/c/en/us/solutions/data-center-virtualization/what-is-a-data-center.html
2. https://www.youtube.com/watch?v=ZPiTcWdNo6c

OUTCOMES:

Upon completion of the course, the student should be able to

1. Understand the reasons for the network architecture for cloud-native data centers.
2. Discuss the new trend in networking, the rise of network disaggregation and open networking.
3. Study the behaviour of link state and BGP routing protocols in the data center.
4. Learn about virtual networks and technologies that are used to build the data center
5. Interpret the methods for interconnecting data centers.

CO- PO, PSO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	-	-	-	-	-	2	2	2
CO2	3	3	3	3	3	-	-	-	-	1	-	2	3	2
CO3	3	3	3	3	3	-	-	-	-	1	-	2	2	2
CO4	3	3	3	3	3	-	-	-	-	1	-	2	3	3
CO5	3	3	3	3	3	-	-	-	-	1	-	2	2	2

Imagine the Future and

Make it happen!

Together let's build a better world where there is NO POVERTY and ZERO HUNGER.

We have GOOD HEALTH AND WELL BEING QUALITY EDUCATION and full GENDER EQUALITY everywhere.

There is CLEAN WATER AND SANITATION for everyone. AFFORDABLE AND CLEAN ENERGY

which will help to create DECENT WORK AND ECONOMIC GROWTH. Our prosperity shall be fuelled

by investments in INDUSTRY, INNOVATION AND INFRASTRUCTURE that will help us to

REDUCE INEQUALITIES by all means. We will live in SUSTAINABLE CITIES AND COMMUNITIES.

RESPONSIBLE CONSUMPTION AND PRODUCTION will help in healing our planet.

CLIMATE ACTION will reduce global warming and we will have abundant,

flourishing LIFE BELOW WATER, rich and diverse LIFE ON LAND.

We will enjoy PEACE AND JUSTICE through STRONG INSTITUTIONS

and will build long term PARTNERSHIPS FOR THE GOALS.

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