NITTE MEENAKSHI INSTITUE OF TECHNOLOGY
(A Unit of Nitte Education Trust (R), Mangalore)
An Autonomous Institution

Department of Information Science and Engineering

Curriculum Handbook for M.Tech – Computer Networks and Engineering (CNE)

Vision

To build a strong research and teaching environment in the field of Information Technology to meet the ever evolving global needs and to equip students with the latest knowledge, skills and practical orientation to face challenges in IT profession.

Mission

1. To offer comprehensive educational programs in the field of Information Technology producing highly accomplished graduates.

2. To inculcate among the students, the culture of research and innovation.

3. To encourage students to participate in co-curricular and extra-curricular activities leading to enhancement of their social and professional skills.

Programme Education Objectives (PEOs)

PEO-1. Graduate will have successful professional career in computer network engineering and allied fields with in-depth knowledge and practical/interpersonal skills.
PEO-2. Graduate undertakes research work or pursues higher studies by acquiring in depth knowledge in computer network and allied fields

Programme Specific Objectives (PSOs)

PSO-1 Student will be able to analyze, design and implement the solutions for the real world problems using latest computing and network paradigms like distributed and cloud computing
PSO-2 Student will be able to develop big data applications and IOT based applications by designing network protocol stacks.

Programme Outcomes (POs)

PO-1	Acquire profound knowledge on Computer Network Engineering, analyze, distinguish and blend it for creating new knowledge.
PO-2	Make critical analysis of complex network problems and bring out the essence of analysis as a useful research problem.
PO-3	Conceptualize and solve network engineering problems using Logical, Mathematical and Stochastical concepts to arrive at feasible and optimal solutions for socitital benefits.
PO-4	Formulate research problems, solve by applying appropriate research methodologies, techniques and experiments to interpret data and demonstrate higher level skills in network engineering.
PO-5	Use modern engineering and IT tools to analyze network models and solve complex network problems.
PO-6	Undertake collaborative – multidisciplinary research to enhance the scope of research with a team spirit to achieve common goals and objectives.
PO-7	Apply network managerial skills to lead the team, manage the project efficiently focusing on financial factors.
PO-8	Communicate confidently and effectively on complex network problems, generating technical reports and presentations.
PO-9	Recognize the importance of engaging in life-long learning independently and adopt the same to update knowledge and skills to meet the global competency.
PO-10	Inculcate professional ethics, intellectual integrity, understanding problems of others and contribution to the development of the society.
PO-11	Observe and examine the outcomes of one's actions periodically and make corrective measures subsequently, and learn from mistakes without depending on external feedback.

Process of Defining Vision and Mission of the Deapartment

Developing strong vision and mission statements will help stakeholders of the college to attain their respective goals.

The process of defining vision and mission statements for department was started with formation of Program Assessment Committee with Head of the Department, being the chair person for the entire process.

Committee comprises of

- All faculty members.
- Distinguished students of 1nd &2nd years.

Functionality

- Formulate few Vision & Mission Statements
- Refine selected Vision and Mission statement according to the suggestions of Departmental Advisory Committee

Department Advisory Committee comprising of

- Distinguished academicians
- Experts from industry
- Alumni
- Dean- Academic
- Senior faculty members
- Distinguished students from final year

Department Advisory Committee Functionalities

- Formulate few Vision & Mission Statements by program assessment committee.
- Presented in the advisory committee for suggestions.
- Refine selected Vision and Mission according to the suggestions of advisory committee.
- Finalize the Vision & Mission statements in consultation with departmental advisory committee.

Process used for establishing the PEOs

Program Coordinator, PAC and DAC are involved in establishing the PEOs.

The process of establishing PEOs are as follows:

- PAC will refer the guidelines of NBA while establishing PEOs.
- PAC will formulate few PEOs which are in line with departmental mission statement.
- PAC will discuss about the attainment levels in terms of percentage.
- PAC will refer NASCOM and Government reports for further refinement of PEOs
- Formulated PEOs are Presented to DAC
- DAC will go through the PEO Statements, approve/suggest modifications.
- PAC will refine the selected PEOs according to the suggestions given by the DAC.
- Finalized PEOs with their target attainment level are presented to IQAC
- PAC will publish finalized PEO statements.

Establish consistency of the PEOs with the Mission of the department.

Mission PEO	Comprehensive Educational Programs	Research and Innovation	Co-curricular and Extra-curricular Activities
PEO1	**X**		**X**
PEO2	**X**	**X**	**X**
PEO3	**X**		**X**

Our Mission statement can be disseminated into three parts. They are Comprehensive Educational Programs, Research/Innovation and Co-curricular activities.

PEO 1 is about professional career which can be accomplished through comprehensive education programs.

PEO 2 is about higher studies and research, which can be accomplished through comprehensive education and research& innovation.

PEO3 is about leadership, ethics and communication skills, which can be accomplished through comprehensive education and co-curricular activities.

Appropriateness of credit allotment.

SEMESTER: I

Sl No	Subject Code	Subject Name	Course Type	.	Teaching Hours/week			Examination			Credits
					L#	T#	P#	CIE*	SEE**	Total	
1	16CNE101	Mathematical Foundation of Computer Network	PC		4	0	0	50	50	100	4
2	16CNE102	Wireless Communications	PC		4	0	2	50	50	100	5
3	16CNE103	Network Security	PC		4	0	0	50	50	100	4
4	16CNE104	Advanced Computer Networks	PE		4	0	2	50	50	100	5
5	16CNE105EX	PROGRAM ELECTIVE – GROUP -A	PE		4	0	2	50	50	100	5
6	16CNE106P	MINI PROJECT	PC		0	0	4	50	50	100	3
7	16CNE107S	Technical Seminar	PC		0	0	3	50	50	100	2
							TOTAL	350	350	700	28

EMESTER: II

Sl No	Subject Code	Subject Name	Course Type		Teaching Hours/week			Examination			Credits
					L#	T#	P#	CIE*	SEE**	Total	
1	16CNE201	Wireless Sensor & Adhoc Networking	PC		4	0	2	50	50	100	5
2	16CNE202	Network Programming	PC		4	0	2	50	50	100	5
3	16CNE203	High Speed Networking	PC		4	0	0	50	50	100	4
4	16CNE204	Analytical Approach in Data Network	PC		4	0	0	50	50	100	4
5	16CNE205EX	PROGRAM ELECTIVE – GROUP B	PE		4	0	2	50	50	100	5
7	16CNE206P	MINI PROJECT	PC		0	0	4	50	50	100	3
	16CNE207S	Technical Seminar	PC		0	0	3	50	50	100	2
		TOTAL						35	350	700	28

SEMESTER: III

Sl No	Subject Code	Subject Name	Course Type		Teaching Hours/week			Examination			Credits
					L#	T#	P#	CIE*	SEE**	Total	
1	16CNE301	FIELD WORK/INTERNSHIP / SELF STUDY	PC		-	-	8	50	50	100	4
2	16CNE302P	PROJECT PHASE -I Assessment	PC		-	-	32	50	50	100	16
							TOTAL	150	150	300	20

SEMESTER: IV

Sl No	Subject Code	Subject Name	Course Type	.	Teaching Hours/week			Examination			Credits
					L#	T#	P#	CIE*	SEE**	Total	
1	16CNE401P	PROJECT PHASE -II- Thesis Evaluation	PC		-	-	16	100$	100#	200	8
2	16CNE402P	PROJECT PHASE - III- Assessment & Viva Voce	PC		-	-	32	100	100	200	16
							TOTAL	250	250	500	24

* Continuous Internal Evaluation
** Semester End Exam
$ - Internal evaluation by the guide
# - External Examiner Evaluation (Thesis)

Group – A (Semester –I)

Sl No	Subject Code	Subject Name
1	16CNE105E1	Internet of Things
2	16CNE105E2	Cloud Computing
3	16CNE105E3	Distributed Computing

Group – B (Semester –II)

Sl No	Subject Code	Subject Name
1	16CNE205E1	Big Data and Data Analytics
2	16CNE205E2	Applied Parallel Computing
3	16CNE205E3	Machine Learning

Department:*Information Science & Engineering*	***Course Type:*** *Core*
Course Title*: Mathematical Foundations of Computer Networks*	***CourseCode:****16CNE101*
L-T-P:*4-0-0*	***Credits:****04*
TotalContactHours*:48hrs*	***DurationofSEE:****3hrs*
SEEMarks:*50*	***CIEMarks:****50*

Prerequisite

- Knowledge of Engineering mathematics, fundamentals of Statistics & Probability.
- Fundamentals of Computer Network.

Course Outcomes

- Student will be able to describe advanced mathematical, statistical and probabilistic concepts and theories.
- Student will be able to apply Eigen values, Eigen vectors and probability theory in the analysis of web page ranking algorithm and in the evaluation of performance of networks.
- Student will be able to design network models for optimal use of network resources.
- Students will be able to plan for the quality of services in networks and solve complex network problems using Markov chain and queuing theory.

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Teaching Methodology

- Lectures
- Power Point Presentations
- Assignments
- Case study

Assessment Methods

- Three internals assessment tests for 30 marks each will be conducted and the average of best two performances will be considered.
- Rubrics of assignment for 10 marks.
- Rubrics of case study 10 marks.
- Final examination will be conducted for 100 Marks and will be reduced to weight of 50 marks.
- Post-assesment feedback on student

COs to POs Mapping

POs/COs	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2
CO1	3		3						1				
CO2	3		3						1				
CO3	3		3						1				
CO4	3	2	3						1				
C.Level	3	2	3						1				

Course Contents

Unit-I: Linear algebra **10 hrs**

Eigen values and eigenvectors, Importance of Eigen values, The role of the principal Eigen value, finding Eigen values and eigenvectors, Power method to compute the dominant Eigen value and Eigen vector, Principal Component Analysis (PCA), Eigen decomposition of a matrix, LU Decomposition, QR Decomposition/Factorization, Symmetric Matrices, Orthogonalization & Orthonormalization, Vector Spaces and Norms, Computing state transitions using a stochastic matrix, Eigen values of a stochastic matrix, GOOGLE Page Rank Algorithm.

Unit-II: Probability theory and statistics **10 hrs**

Combinatorics, Probability Rules & Axioms, Bayes' Theorem, Random Variables, Variance and Expectation, Conditional and Joint Distributions, Standard Distributions (Bernoulli, Binomial, Multinomial, Uniform and Gaussian), Moment Generating Functions, Maximum Likelihood Estimation (MLE), Prior and Posterior, Maximum a Posteriori Estimation (MAP).

Unit-III: Optimisation **10 hrs**

System modelling and optimization, An introduction to optimization-Optimising a system with two control parameters, Optimising a system with three variables, Optimizing linear systems (Resource allocation models),Graphical method, Simplex method- maximisation model and minimisation model. Dynamic programming- Fibonacci computation, Floyd-Warshall algorithm for all pairs of shortest path.

Unit-IV: Markov process and Queuing theory **10 hrs**

Markov chain, $P^{(n)}$ for a two state Markov chain, Three state Markov chain, Markov property, Absorption probabilities, Gambler's Ruin survival probability for birth-death chains, Discrete time Markov chain, discrete time birth-death process, continuous time Markov chain, the birth-death process, the M/M/1 queue, M/M/queue, M/M/1/K queue.

Unit-V: Information theory **08 hrs**

A mathematical model for communication, Source coding- coding digit sequence, coding letters, Optimal codes- Huffman code, Capacity of a communication channel- Noiseless channel, Noisy channel, the Gaussian channel, capacity of a Gaussian channel.

Text Books:

1. Srinivasan Keshav, Mathematical Foundations of Computer Networking, Addison-Wesley Professional Computing Series,2011.

2. Allen gut, an intermediate course in probability, Springer, 2008.

3. G.Strang, Linear Algebra and applications, Thomson-Brook, 4th Edition, 2006.

References:

1. Discrete –Event system simulation, by Jerry Banks, Fourth Edition, Pearson,2013.

2. Applied statistics and Probability for Engineers, Douglas C. Montgomery, George C.Runger, Third Edition, John Wiely& Sons, Inc. 2014.

3. Leon Garcia A, A Probability, Statistics and Random processes for Electrical Engineers, Pearson Prentice Hall, 2008.

Reference of Research Publications:

[1] Okoro Otonritse Joshua, "On Markovian Queueing Model as BirthDeath Process", Global Journal of Science Frontier Research Mathematics and Decision Sciences, 2015.

[2] Fabrice Guillemin · Bruno Sericola, "Stationary Analysis of a Fluid Queue Driven by Some Countable State Space Markov Chain", Methodol Comput Appl Probab (20014) 9:521–540, Springer.

[3] Yang Wang a , Chuang Lin, " A queueing analysis for the denial of service (DoS) attacks in computer networks", Computer Networks 51, 3564–3573, ELSEVIER, 2007.

[4] János Sztrik, "Queueing Theory and its Applications", Proceedings of the 8th International Conference on Applied Informatics Eger, Hungary, January 27–30, Vol. 1. pp. 9–30, 2010.

[5] Manuel Alberto M. Ferreira , Marina Andrade, " Statistical Queuing Theory with Some Applications", Int. J Latest Trends Fin. Eco. Sc., Vol-1 No. 4 December, 2013.

Department: *Information Science & Engineering*	***Course Type:*** *Core*
Course Title*: Wireless Communications*	***CourseCode:****16CNE102*
L-T-P:*4-0-2*	***Credits:****05*
TotalContactHours:*48hrs*	***DurationofSEE:****3hrs*
SEEMarks*:50*	***CIEMarks:****50*

Prerequisite:

- Probability, Random Processes and fundamentals of Computer Network.

Course Outcomes:

- Student will be able to describe wireless and cellular networks.
- Student will be able to analyze radio propagation and path losses.
- Student will be able to simulate different multipath fading techniques.
- Student will be able to differentiate different modulation techniques and advanced wireless technologies.

Teaching Methodology:

- Black Board Teaching
- Power Point Presentation
- Practical Component

Assessment Methods:

- Three internals, 30Markseachwill be conducted and the Average of best of two will be taken.
- Final examination, of 100 Marks will be conducted and will be evaluated for 50Marks.
- Rubrics to evaluate Practical Component – 20 Marks.
- Post-assesment feedback on student

Course Outcome to Programme Outcome Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**
CO1	3											3	
CO2	2		2	2							1	3	
CO3		1	2	2	1			1	1		1	3	
CO4	1		1	2								3	
16CNE102	3	1	2	2	1			1	1		1	3	

Course Content

Unit-I **10hrs**

Modern Wireless Communication Systems: Second Generation(2G) Cellular Networks, Third Generation (3G) Wireless Networks, Wireless Local Loop (WLL) and LMDS, Wireless Local Area Networks (WLANs), Bluetooth and Personal Area Networks (PANs), The Cellular Concept- System Design Fundamentals: Introduction, Frequency Reuse, Channel Assignment Strategies, Handoff Strategies, Interference and System Capacity, Trunking and Grade of Service, Improving Coverage & Capacity in Cellular Systems.Short range wireless Technologies –Bluetooth ,LiFi… introduction to 4G and 5G.

Unit –II **9hrs**

Mobile Radio Propagation: Large-Scale Path Loss: Introduction to Radio Wave Propagation, Free Space Propagation Model, Relating Power to Electric Field, The Three Basic Propagation Mechanism , Reflection, Ground Reflection(Two Ray) Model, Diffraction, Scattering, Practical Link Budget Design Using Path Loss Models, Outdoor Propagation Models, Indoor Propagation Models, Signal Penetration into Buildings, Ray Tracing and Site Specific Modeling

Unit-III **10hrs**

Mobile Radio Propagation: Small –Scale Fading and Multipath: Small Scale Multipath Propagation, Impulse Response Model of a Multipath Channel, Small-scale Multipath Measurements, Parameter of Mobile Multipath Channels, Types of Small-Scale Fading, Rayleigh and Ricean Distributions, Statistical Models or Multipath Fading Channels, Simulation of Clarke and Gans Fading Model, Level Crossing and Fading Statistics, Two-ray Rayleigh Fading Model, Saleh and Valenzuela Indoor Statistical Model, SIRCIM and SMRCIM indoor and outdoor Statistical models , Theory of Multipath Shape Factors for Small-Scale fading wireless channels

Unit-IV **9hrs**

Modulation Techniques for Mobile Radio: Frequency Modulation vs Amplitude Modulation, Amplitude Modulation, Angle Modulation, Digital Modulation- and Overview, Line Coding, Pulse Shaping Techniques, Geometric Representation of Modulation Signals, Linear Modulation Techniques.

Unit-V **10hrs**

Wireless Networking: Introduction to Wireless Networks, Difference Between Wireless and Fixed Telephone Networks, Development of Wireless Networks, Fixed Network Transmission Hierarchy, Traffic Routing in Wireless Networks, Wireless Data Services, Common Channel Signaling (CCS), Integrated Services Digital Network(ISDN) Signaling System No.7 (SS7), An Example o f SS7-Global Cellular Network Interpretability, Protocols for Network Access, Network Databases, Universal Mobile Telecommunication System (UMTs), Multiple Input Multiple output(MIMO) IMS,VOLET Technologies.

Practical Component (Only for CIE Evaluation)

1. Simulate a time-invariant channel using NS3.
2. Simulate a Rayleigh fading channel using NS3.
3. Simulate a frequency selective fading channel using NS3.
4. Simulate a RLS equalizer for a frequency selective fading channel using NS3.
5. Simulate a RLS beam former for a frequency selective fading channel using NS3.

Text book:

1. Wireless Communications Principles and Practice 2nd Edition by Theodore S Rappaport.2002

2. Wireless Communications by Andrea Goldsmith, Stanford University, California, Cambridge University Press.2014

Reference of Research Publications:

1. Monika Phogat#1. AnshulAnand,"An Introduction to Wireless Communication", International Journal of Engineering Trends and Technology (IJETT) – Volume 12 Number 1 - Jun 2014.
2. Saddam Hossain, "5G Wireless Communication Systems", American Journal of Engineering Research (AJER) e-ISSN : 2320-0847 p-ISSN : 2320-0936 Volume-02, Issue-10, pp-344-353.
3. V.Ramesh, Dr.T.StephenThangaraj, J.V.Prasad, "An Efficient Path loss Prediction mechanism in Wireless Communication Network Using Fuzzy Logic", International Journal of Advanced Research in Computer Science and Software Engineering, Volume 2, Issue 1, January 2012 ISSN: 2277 128X.
4. VinayakTambralli, Puneetha R, "Simulation of Multipath Fading Effects in Mobile Radio Systems", JOURNAL OF INFORMATION, KNOWLEDGE AND RESEARCH IN ELECTRONICS AND COMMUNICATION (ISSN 0975 – 6779 , GIF: 01.6890 – SIF: 02.885)

Department: *Computer Networks And Engineering*	***Course Type:*** *Core*
Course Title: *Network Security*	***CourseCode:****16CNE103*
L-T-P:*4-0-2*	***Credits:****05*
TotalContactHours:*48hrs*	***DurationofSEE:****3hrs*
SEEMarks*:50*	***CIEMarks:****50*

Pre- requisite:

- Basic knowledge of computer networks

Course Outcomes:

Students will be able to:

- Analyze the vulnerabilities in any computing system and hence be able to design a security solution.
- Identify the security issues in the network and resolve it.
- Evaluate security mechanisms using approaches like ElipticCurve ,IPS and others.
- Describe the security technologies such as firewall, Intrusion detection and Prevention system.
- Student will be able to analyze security issues and design experiments to solve the given problem & interpret the results

TeachingMethodology:

- Blackboardteaching
- PowerPoint presentations
- Programming Assignment / Case study

AssessmentMethods:

- Threeinternals, 30Marks eachwill beconductedandtheAverage ofbest of twowill be taken.
- Rubricsforevaluating Programming Assignment / Case study
- Final examination, of100 Markswill beconducted andwillbe evaluatedfor50Marks
- Post-assesment feedback on student

CO-PO&PSO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**
CO1	3	2	1	2									3
CO2	1		2	2									3
CO3			3										3
CO4	3									1			3
CO5		2	2	2	2			1	1	1	1		3
CO Relation Level	3	2	3	2	2			1	1	1	1		3

Course Contents

UNIT- I **10 hrs**

Classical Encryption Techniques: Symmetric Cipher Model, Cryptography, Cryptanalysis and Brute-Force Attack, Substitution Techniques, Caesar Cipher, Mono alphabetic Cipher, Play fair Cipher, Hill Cipher, Poly alphabetic Cipher, One Time Pad. Block Ciphers and the data encryption standard: Traditional block Cipher structure, Stream Ciphers and Block Ciphers, Motivation for the Feistel Cipher structure, the Feistel Cipher, The Data Encryption Standard, DES Encryption, DES Decryption, A DES example, results, the Avalanche effect, the Strength of DES, theUse of 56-Bit Keys, the Nature of the DES Algorithm, Timing attacks, Block Cipher Design Principles, Number of rounds, Design of Function F, Key Schedule Algorithm.

UNIT- II **10 hrs**

Public-Key Cryptography and RSA: Principles of Public-key Cryptosystems, Public-Key Cryptosystems, Applications for Public-Key Cryptosystems, Requirements for Public-Key Cryptosystems. Public-Key Cryptanalysis. The RSA Algorithm, Description of the Algorithm, Computational Aspects, the Security of RSA. Other Public-Key Cryptosystems:Diffie-Hellman Key Exchange, The Algorithm, Key exchange protocols, Man-in-the-Middle Attack, Elgamal Cryptographic system.

UNIT- III **10 hrs**

Key Management and Distribution: Symmetric key distribution using Symmetric encryption,A key distribution scenario, Hierarchical key control, Session key lifetime, a transparent key control scheme, Decentralized key control, Controlling key usage. Symmetric key distribution using asymmetric encryption, Simple secret key distribution, Secret key distribution with confidentiality and authentication, A hybrid scheme. Distribution of public keys, Public announcement of public keys, Publicly available directory, Public key authority, Public keys certificates, X.509 certificates. Certificates, X.509 version 3.Public key infrastructure, PKIX Management Functions, PKIX Management Protocols.UserAuthentication: Remote user Authentication principles, Mutual Authentication, One wayAuthentication. Remote user-Authentication using Symmetric encryption, Mutual Authentication, One way Authentication.

UNIT- IV **10 hrs**

Wireless Network Security: Wireless security, Wireless network threats, Wireless network measures. Mobile device security, security threats, mobile device security strategy. IEEE 802.11 Wireless LAN overview, the Wi-Fi alliance, IEEE 802 protocol architecture. IEEE 802.11i Wireless LAN security, IEEE 802.11i services, IEEE 802.11i phases of operation, Discovery phase, Authentication phase, Key management phase, Protected data transfer phase, the IEEE 802.11i pseudorandom function.Transport-level Security, Web Security Considerations: Web Security Threats, Web Traffic Security Approaches. Secure Sockets Layer :SSL Architecture, SSL Record Protocol, Change Cipher Spec Protocol,Alert Protocol, Hand shake Protocol, Cryptographic Computations. Transport Layer Security: Version Number, Message Authentication Code, Pseudorandom Function, Alert Codes, Cipher Suites, Client Certificate Types, Certificate Verify and Finished Messages, Cryptographic Computations, and Padding. HTTPS Connection Initiation, Connection Closure. Secure Shell(SSH) Transport Layer Protocol, User Authentication Protocol, Connection Protocol.

UNIT- V **10 hrs**

Electronic Mail Security: pretty good privacy, Notation, Operational Description, S/MIME, RFC 5322, Multipurpose Internet Mail Extensions, S/MIME Functionality,S/MIME Messages, S/MIME Certificate Processing, Enhanced Security Services,Domain keys Identificatified Mail, Internet Mail Architecture, E-mail Threats, DKIM Strategy, DKIM Functional Flow

Programming Assignmenrt

(Note: Use C/C++/Java or equivalent tool to implement the following experiment)

1. Consider a file with composite data, create an encryption of the data-using substitute the content and transpose the ciphers (Caesar Cipher, Monoalphabetic Cipher, Playfair Cipher, Hill Cipher, Polyalphabetic Cipher).
2. Develop a mechanism to setup a security channel using Diffie-Hellman Key Exchange between client and server
3. Implementation of Message Authentication Code using cryptography VMAC function.
4. Implement secure hash algorithm for Data Integrity. Implement MD5 and SHA-1 algorithm, which accepts a stringinput, and produce a fixed size number - 128 bits for MD5; 160 bits for SHA-1, this number is a hash of the input.Show that a small change in the input results in a substantial change in the output
5. Using any simulation tool: demonstrate packet-filtering firewalls, create the ACL, create VLAN [Subnetting].
6. Develop a mechanism to setup(configure) a port scanner and identify the intrusion.
7. Create an attack(DoS, DDoS)launch to other system and capture all the intrusion packets

Text Books:

1. William Stallings: Cryptography and Network Security, Pearson 6th edition, 2014.
2. M. E. Whitman and Herbert J. Mattored , Principles of Information Security, Information Security Professional 4thedition, 2011.

References:

1. V k Pachghare: Cryptography and Information Security, 2008.

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Department: *Computer Networks And Engineering*	***Course Type:*** *Core*
Course Title*:* Advances in Computer Networks	***CourseCode:16CN104***
L-T-P:4-0-1	***Credits:*** *04*
TotalContactHours:48*hrs*	***DurationofSEE:4****hrs*
SEEMarks*:50*	***CIEMarks:****50*

Prerequisite:

- Students should have the basic knowledge of Computer networks.

Teaching Methodology:

- Blackboard teaching.
- PowerPoint presentations.
- Programming assignment
- Course Project.

Assessment Methods:

- Two Surprise Tests, 10 Marks each. Best of two tests will be taken.
- Three internals, 30 Marks each will be conducted and the Average of best of two will be taken.
- Rubrics for Course Project.
- Final examination, of 100 Marks will be conducted and will be evaluated for 50 Marks.
- Post-assesment feedback on student

Course outcomes:

- Student will be able to describe the various routing protocols used in computer networks.
- Student will be able to analyse and design different network protocols, traffic engineering techniques and network management techniques in computer networks.
- Student will be able to analyse the implications of interconnected communication networks.
- Student will be able to apply the knowledge of computer networks to implementations various computer network services.

Course Outcome to Programme Outcome Mapping:

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3											3	
CO2	1	2	2	2								3	
CO3		2	2	2			1	1	1			3	
CO4		2	2	2	1			1	1			3	
14SCN12	3	2	3	2	1		1	1	1			3	

Course Contents

UNIT I **10hrs**

Routing in Packet Networks; Shortest Path Routing; Traffic Management at packet level; Traffic management at flow level.

Unit II

End-to-End Protocols **10hrs**

Simple Demultiplexer (UDP), Reliable Byte Stream(TCP), End-to-End Issues, Segment Format, Connecting Establishment and Termination, Sliding Window Revisited, Triggering Transmission, Adaptive Retransmission, Record Boundaries, TCP Extensions, Queuing Disciplines, FIFO, Fair Queuing, TCP Congestion Control, Additive Increase/ Multiplicative Decrease, Slow Start, Fast Retransmit and Fast Recovery.

Unit III **09hrs**

Remote network monitoring –statistics, alarms and filters, ROM2-protocols directory group, protocol distribution group, address map group, RMON2 Host Group, RMON matrix group.
SNMPV3-cryptographic algorithms in SNMPV3, SNMPV3-architecure and applications, message processing and user based security model.

Unit IV **09hrs**

Advanced Network Architecture: Integrated Services in Internet, RSVP, Differentiated Services, MPLS, Real-time Transport Protocol.

UNIT V

DESIGN TECHNIQUES **10hrs**

Design principles and tradeoffs-End-to-End Vs Hop-by-Hop-Control Mechanisms - Design techniques-Scaling time and space-specialized hardware implementation-parallelism and pipelining-data structure optimization -latency reduction. Future trends: Changing resource tradeoffs-technology and applications.

Text books

1. Larry Peterson and Bruce S Davis “Computer Networks: A System Approach” 5th Edition, Elsevier -2014.
2. Communication Network by Alberto Leon Garcia and Indra Widjaja, 2003
3. James P.G Sterbenz and Joseph D.Touch “High Speed Networking: A Systematic approach to high-bandwidth low latency communication” Wiley, 2001.
4. SNMP, SNMPV2, SNMPV3 and RMON1 and 2 by William stalling 3rd edition

References

1. Uyless Black “Computer Networks, Protocols, Standards and Interfaces” 2nd Edition – PHI, 2009.
2. Behrouz A Forouzan “TCP/IP Protocol Suite” 4th Edition – Tata McGraw-Hill, 2010.

3. Douglas E Comer, “Internetworking with TCP/IP, Principles, Protocols and Architecture” 6th Edition, PHI – 2014.

Research related papers

[1] Vitaliy Mazur, Computer-aided design of the route network based on packet models , 14th International Conference the Experience of Designing and Application of CAD Systems in Microelectronics (CADSM), 2017.

[2] Farzaneh Abazari; Afsaneh Madani; Hossein Gharaee, Optimal response to computer network threats , 8th International Symposium on Telecommunications (IST), 2016.

[3] Thomas E. Potok; Catherine D. Schuman; Steven R. Young; Federico Spedalieri, A Study of Complex Deep Learning Networks on High Performance, Neuromorphic, and Quantum Computers, , 2nd Workshop on Machine Learning in HPC Environments (MLHPC), 2016.

[4] Klismann Raphael Santos; Iago Richard Rodrigues Silva; Roberta Andrade Araujo Fagundes ,Classifiers Comparison For Attack Detection in Computer Networks ,IEEE Latin America Transactions ,Year: 2017, Volume: 15, Issue: 1

[5] Aleksandar Jevremovic; Goran Shimic; Mladen Veinovic; Nenad Ristic , IP Addressing: Problem-Based Learning Approach on Computer Networks ,IEEE Transactions on Learning Technologies ,Year: 2016, Volume: PP, Issue: 99

Lab component

- Lab programs consists of creating simulated networks using NS3 and OMNeT++ and passing packets through them using different routing techniques.

- Using wireshark network protocol analyzer to analyze the various network related parameters.

Electives Group A

Department: *Computer Network Engineering*	***Course Type:*** *Elective*
CourseTitle*: Internet of* Things (IOT)	***CourseCode:****16CNE105E1*
L-T-P:*4-0-2*	***Credits:****05*
TotalContactHours: *48hrs*	***DurationofSEE:****3hrs*
SEEMarks*:50*	***CIEMarks:****50*

Prerequisite:

- C Language,basic knowledge of Electronics and Logic Design

Course Outcomes:

- Students will be able to describe the basic concept of IoT, protocols and IoT design Methodology for deployment.
- Students will be to design programs to solve socital problems using python.
- Students will be able illustrate the Raspberry Pi architecture, implement the embedded code to control IoT devices and communicate the data between cloud and IoT devices.
- Students will be able to perform data analytics using different analytics platforms
- Student will be able to demonstrate ethics behind the IoT Development.

Teaching Methodology:

- Black Board teaching
- Power point presentation
- Practical Components

Assessment Methods:

- Three internals, 30 Marks each will be conducted and the Average of best of two will be taken.
- Rubrics for evaluation of Practical components.
- Final examination, of 100Markswill be conducted and will be evaluated for 50Marks.
- Post-assesment feedback on student

Course Outcome to Programme Outcome Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**
CO1	3				3							2	
CO2			2		3	1							
CO3		2			3	2	1	1	1	1		1	
CO4			2	2	3								
CO5										2			
16CNE105E1	3	2	2	2	3	1	1	1	1	2		2	

Course Content

UNIT- I **09hrs**

INTRODUCTION& CONCEPTS: Introduction to Internet of Things, Definitions and Characteristics of IoT, Physical Design of IoT, Things in IoT, IoT Protocols, Logical Design of IoT, IoT Functional Blocks, IoT Communication Models, IoT Communication APIs, IoT Enabling Technologies, Wireless Sensor Networks, Cloud Computing, Big Data Analytics, Communication Protocols, Enbeedded Systems, IoT levels and Development Templates, IoT Level-1, IoT Level-2, IoT Level-3, IoT Level-4, IoT Level-5, IoT Level-6.

UNIT- II **12 hrs**

IoT and M2M, Introduction, M2M, Difference between IoT and M2M, SDN and NFV for IoT, Software Defined Networking, Network Function Virtualization, IoT Platform Design Methodology, Introduction, IoT Design Methodology, Purpose and requirement specification, Process Specification, Domain Model Specification, Information Model Specification, Service Specification, IoT Level Specification, Function View Specification, Operational View Specification, Device and Component Integration, Application Development, IoT System Logocal Design Using Python, Introduction, Installing Python, Python Data Types and Data Structures, Control Flow, Functions, Modules, Packages, File Handling, Date Time applications, Classes, Python Packages of Interest for IoT.

UNIT- III **13 hrs**

IoT Physical Devices and End Points: What is and IoT Device, Exemplary Device Raspberry Pi, About the Board, Linux on Raspberry Pi, Raspberry pi interfaces,programming raspberry pi with python, other IoT devices. IoT physical servers and cloud offerings: introduction to cloud storage models and communication Networks, wamp-autobahn for IoT, xively cloud for IoT, python web application frame work-django, designing a RESTful web API, amazon web services for IoT, SkyNetIoT messaging platforms.

UNIT- IV **09hrs**

Data Analytics for IoT; Introduction AppacheHadoop, using HadoopMapReduce for Batch Data Analysis, Apache oozie, Apache Spark, Apache Storm, using Apache Storm for Real-time Data Analysis.

UNIT- V **07hrs**

Ethics: Characterizing the IoT, Privacy, Control , Distributing Control and Crowd Sourcing, Environment, Physical Thing, Electronics, Internet Service, Solutions, Internet of Things as Part of Solution, Cautious Optimizing, The Open IoT definition.

Practical Component (CIE Evaluation only):

1. LED blinking using Ardunio.
2. Fading an LED using Raspberry Pi
3. Moving Light display using Arduino
4. Automatic Switching on/off of light using Arduino and relay switches
5. Arduino Clock
6. 7 segment display on Arduino
7. File handling using python on Raspberry Pi
8. Cloud communication using thingspeak and Raspberry Pi

TextBooks:

1. **ArshdeepBahga, Vijay Madisetti,** Internet Of Things-A Hands on Approach, University of Penn, http://www.internet-of-things-book.com/
2. **Adrian McEwen & Hakim Cassimally**Designing the Internet of Things, ISBN 978-81-265-5686-1 Wiley Publication.

ReferenceBooks:

1. **OvidiuVermesan,PeterFriess**Internet of Things:ConvergingTechnologiesfor Smart Environmentsand Integrated Ecosystems. River Publishers Series in Communication.

Reference Material:

- http://www.intel.com/content/www/us/en/internet-of-things/smart-city-initiative.html
- Enabling Industrial IoT with Intel, https://www.intel.com/content/dam/www/public/us/en/documents/articles/enabling-industrial-iot-paper.pdf

Department: *Computer Networks And Engineering*	***Course Type:*** *Elective*
Course Title*: Cloud Computing*	***Course Code:****16CNE105E2*
L-T-P: *4-0-2*	***Credits:*** *05*
Total Contact Hours: *48hrs*	***Duration of SEE:*** *3 hrs*
SEE Marks*: 50*	***CIE Marks:*** *50*

Prerequisites:

- Fundamentals of Computer Networking, Engineering Management and Entrepreneurship.

Course outcomes:

- Students will describe basic principles of cloud computing.
- Students will be able to demonstrate different technologies on virtualization.
- Students will demonstrate Ubiquitous computing and Internet of Things.
- Students will be able to implement features of cloud computing for end users.

Teaching methodology:

- Black Board Teaching
- Power Point Presentation
- Course Project

Assessment methods:

- Three internals, 30 Marks each will be conducted and the Average of best of two will be taken.
- Rubrics for evaluation of Course Project.
- Final examination, of 100 Marks will be conducted and will be evaluated for 50 Marks.
- Post-assesment feedback on student

Course Outcome to Programme Outcome Mapping:

PO	1	2	3	4	5	6	7	8	9	10	11	PSO1	PSO2
CO1	**3**											**2**	
CO2	**1**	**1**		**1**	**3**			**1**	**1**		**1**		
CO3	**1**	**1**										**2**	
CO4		**2**	**2**	**2**	**2**			**1**	**1**		**1**		
16CNE105E2	**3**	**2**	**2**	**2**	**2**			**1**	**1**		**1**	**2**	

Course contents

UNIT- I **10 hrs**

Virtual Machines and Virtualization of clusters and Data centers: Implementation Levels of Virtualization, Virtualization Structures/Tools and mechanisms, virtualization of cpu, Memory and I/O devices, Virtual clusters and resource Management, Virtualization for data center automation.

UNIT- II **10 hrs**

Cloud Platform architecture over virtual data centers: Cloud Computing and service models, Data center design and interconnection networks, Architectural design of compute and storage clouds, Public cloud platforms: GAE, AWS and Azure, Inter cloud Resource Management, Cloud security and Trust Management.

UNIT- III **10 hrs**

Service Oriented Architecture for Distributed Computing: Services and Service Oriented Architecture, Message Oriented middleware, Discovery, Registries, Metadata and Databases

UNIT- IV **10 hrs**

Cloud Programming and Software Environments: Features of cloud and grid platforms, Parallel and distributed programming paradigms, programming Support for Google App Engine, Programming on Amazon AWS and Microsoft Azure, Emerging Cloud software Environments.

UNIT- V **08 hrs**

Ubiquitous Clouds and the Internet of Things: Cloud Trends in supporting Ubiquitous Computing, Enabling Technologies for the Internet of Things, Innovative Applications of the Internet of Things

Text book: 1. "Distributed and cloud computing" by Kai Hwang, Geoffrey C Fox and Jack J Dongarra.

Department: *Computer Networks and Engineering*	***Course Type:*** *Elective*
Course Title*: Distributed Systems*	***Course Code:****16CNE105E3*
L-T-P:*4-0-2*	***Credits:****05*
TotalContactHours:*60hrs*	***Duration of SEE:****3hrs*
SEEMarks*:50*	***CIEMarks:****50*

Pre-requisites:

- Fundamentals of operating system and computer networks.

Course Outcomes:

- Students will be able to describe various distributed architectural models, resource sharing and inter process communication techniques.
- Students will be able to demonstrate client server communication and remote procedure call events.
- Students will be able to analyze the detection, prevention and avoidance of distributed deadlocks.
- Students will be able to design and implement the concurrency control issues in distributed transactions using shared memory.

Teaching Methodology:

- Black board teaching
- PowerPoint presentations
- Course Project / Case Study / Programming Assignments

Assessment Methods:

- Three internals, 30 Marks each will be conducted and the Average of best of two will be taken.
- Final examination, of 100 Marks will be conducted and will be evaluated for 50Marks.
- Rubrics for evaluation of Course Project / Case Study / Programming Assignments.
- Post-assesment feedback on student

Course Outcome to Programme Outcome Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**
CO1	3											2	
CO2	1	2	1	2	1			1	1		1	1	
CO3		2											

CO4		2		2	1			1	1		1	1	
16CNE106E3	3	2	1	2	1			1	1		1	2	

Course Contents

UNIT-I **9hrs**

CHARACTERIZATION OF DISTRIBUTED SYSTEMS: Introduction, Examples of distributed systems, Trends in distributed systems, Focus on resource sharing, Challenges, Case study: The World Wide Web. **SYSTEM MODELS**: Introduction, Physical models, Architectural models, Fundamental models.

UNIT- II **10hrs**

REMOTE INVOCATION: Introduction, Request-reply protocols, Remote procedure call, Remote method invocation, Case study: Java RMI. **DISTRIBUTED OBJECTS AND COMPONENTS**: Introduction, Distributed objects, Case study: CORBA, from objects to components, Case studies: Enterprise JavaBeans and Fractal.

UNIT-III **9 hrs**

DISTRIBUTED FILE SYSTEMS: Introduction, File service architecture, Case study: Sun Network File System, Case study: The Andrew File System. **NAME SERVICES**: Introduction, Name services and the Domain Name System, Directory services. **TIME AND GLOBAL STATES**: Introduction, Clocks, events and process states, Synchronizing physical clocks, Logical time and logical clocks, Global states, distributed debugging.

UNIT-IV **10 hrs**

COORDINATION AND AGREEMENT: Introduction, Distributed mutual exclusion, Elections, Coordination and agreement in group communication, Consensus and related problems.

TRANSACTIONS AND CONCURRENCY CONTROL: Introduction, Transactions, Nested transactions, Locks, Optimistic concurrency control, Timestamp ordering, Comparison of methods for concurrency control.

UNIT- V **10 hrs**

DISTRIBUTED TRANSACTIONS: Introduction, Flat and nested distributed transactions, Atomic commit protocols, Concurrency control in distributed transactions, Distributed deadlocks, Transaction recovery. **REPLICATION**: Introduction, System model and the role of group communication, Fault-tolerant services, And Case studies of highly available services: The gossip architecture, Bayou and Coda, Transactions with replicated data.

Text Book:

1. Distributed Systems Concepts and Design: George Coulouris, Jean Dollimore, Tim Kindberg, Gordon Blair, Fifth Edition, Pearson Education, Inc., publishing as

Addison-Wesley.-2012.

Reference Book:

1. Distributed Systems : An algorithmic approach: © 2007 CRC press , Sukumar Ghosh

Practical Component:

Sl. No	Problem Statement
1	Write a program to simulate the functioning of Lamport's logical clock in 'C'.
2	Write a program to simulate the Distributed Mutual Exclusion in 'C'.
3	Write a program to implement a Distributed chat server using TCP sockets in 'C'.
4	Implement RPC mechanism for a file transfer across a network in 'C'.
5	Write a JAVA code to implement 'Java RMI' mechanism for accessing methods of remote systems.
6	Write a code in 'C' to implement sliding window protocol

2nd Semester Syllabus

Department: *Computer Networks and Engineering*	***Course Type:*** *Core*
Course Title*: Wireless Sensor & Adhoc Networking*	***CourseCode:16CNE201***
L-T-P:4-0-2	***Credits:****05*
TotalContactHours:*48hrs*	***DurationofSEE:****3hrs*
SEEMarks*:50*	***CIEMarks:****50*

Prerequisites:

- Statistics, Probability and fundamentals of Computer Networks.

Course outcomes:

- Students will be able to describe the performance of ad-hoc , sensor networks, and associated protocols.
- Students will be able to analyze the performance of various unicast and multicast routing protocols.
- Students will be able to simulate different MAC layer protocols .
- Students will be able to describe the problems of MAC and network layer to provide QoS.

Teaching Methodology:

- Blackboard teaching
- PowerPoint presentations
- Practical Component

Assessment Methods:

- Three internals, 30 Marks each will be conducted and the Average of best of two will be taken.
- Rubrics for evaluation of practical component 20 Marks
- Final examination, of 100 Marks will be conducted and will be evaluated for 50 Marks.
- Post-assesment feedback on student

Course Outcome to Programme Outcome Mapping:

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO2**
CO1	3											3	
CO2	2	1										3	
CO3		2		2	1			1		1	1	3	
CO4	3											3	
16CN201	3	2		2	1			1		1	1	3	

Course Contents

UNIT - I **10 hrs**

Introduction & Ad Hoc Wireless Networks: Introduction: Fundamentals of Wireless Communication Technology, The Electromagnetic Spectrum, Radio Propagation Mechanisms, Characteristics of the Wireless Channel, Modulation Techniques, Multiple Access Techniques, Voice Coding, Error Control, IEEE 802 Networking Standard, Ad hoc Wireless Networks: Introduction, Issues in Ad Hoc Wireless Networks, Ad Hoc Wireless Internet.

UNIT - II **10 hrs**

Energy management in Adhoc Wireless Networks: Introduction, Need for energy management in adhoc wireless networks, Classification of Energy management schemes, Battery Management schemes, Transmission power management schemes, System power management schemes.

UNIT - III **10 hrs**

Wireless Sensor Networks: Introduction, Sensor Network architecture, Data dissemination, Data gathering, MAC protocols for sensor networks, Location discovery, Quality of a sensor network, Evolution standards, other issues.

UNIT - IV **09 hrs**

Hybrid Wireless Networks: Introduction, Next-generation Hybrid wireless architectures, routing in hybrid wireless networks, Pricing in Multi-Hop wireless networks, Power control schemes in Hybrid wireless networks, Load balancing in Hybrid wireless networks.

UNIT - V **09 hrs**

Quality Of Service In Ad Hoc Wireless Networks: Introduction, Issues and Challenges in Providing QoS in Ad Hoc Wireless Networks, Classifications of QoS Solutions, MAC Layer Solutions, Network Layer Solutions.

Practical Component (CIE Evaluation Only)

1.Develop unicast routing protocols using any suitable Network Simulator for (Mobile Ad hoc Networks) MANET to find the best route using the any one of routing protocols from each category from table-driven (e.g., link state or DSDV) on demand (e.g., DSR, AODV, TORA), hybrid (e.g., ZRP, contact-based architectures) and hierarchical (e.g., cluster based.) The efficient path/route should be established for source and destination data transmission using routing protocols. Understand the advantages and disadvantages of each routing protocol types by observing the performance metrics of the routing protocol. In that way the best application/environment suitable routing protocol can be identified in each category.

2. Develop multicast routing protocols using any suitable Network Simulator for MANET in which session nodes are connecting through either tree(MAODV, MCEDAR) or mesh (ODMRP, CAMP, FGMP) structure. Analyze the performance metrics of multicast routing protocols with unicast routing protocols.

3. Develop MAC Protocol using any suitable Network Simulator for MANETs to send the packet without any contention through wireless link using the following MAC protocols; (CSMA/CA (802.11), MACA, MACAW, PAMAS, SMAC). Analyze its performance with increasing node density and mobility.

4. Develop and analyze the performance of TCP connection when it is used for wireless networks. You will find performance of TCP decreases dramatically when a TCP connection traverses a wireless link on which packets may be lost due to wireless transmission errors. Make use of Active Queue Management Technique to control congestion on Wireless Networks. Evaluate the performance of FIFO, RED and WFQ over wireless networks using suitable Network Simulator.

5. Simulate MANET environment using suitable Network Simulator and test with various mobility model such as Random way point, group mobility, highway model, Manhattan model, hybrid models) (Spatial correlation, temporal correlation, relative speed, link durations). Analyze throughput, PDR and delay with respect to different mobility models.

Text books:

1. Ad Hoc Wireless Networks Architecture and Protocols: C. Siva Ram Murthy, B. S Manoj, 2nd edition, Pearson education (Chapters of the book: 1, 5, 6, 7, 9, and 10)

Reference Books:

1. Guide to Wireless Adhoc networks, Misra,sudip, Woungang, Isaac, Springer publisher
2. Adhoc Networking, C E Perkins, Addison Wesley,2001.
3. Wireless Communications, Principles and Practice, second edition, Theodore S Rappaport, Pearson Education Asia, 2002.

Department: *Information Science and Engineering(CNE)*	***Course Type:*** *Core*
Course Title*: Network Programming*	***Course Code:***16CNE202
L-T-P: *4-0-2*	***Credits:5***
Total Contact Hours: *48 hrs*	***Duration of SEE:*** *3 hrs*
SEE Marks*: 50*	***CIE Marks:*** *50*

Pre-requisites:

- Knowledge on Computer Networks.

Course Outcomes:

Students will be able to

- Describe transport layer protocols which provides end-to-end service.
- Implement the socket level programming for initiation and termination of data transmission services.
- Apply socket level programming for I/O multiplexing using pselect and poll functions.
- Demonstrate TCP & UDP applications on iterative and concurrent servers.

Teaching Methodology:

- Blackboard teaching
- Power point presentation
- Practical component

Assessment Methods:

- Rubrics for evaluation of practical components 20 marks.
- Three internals, 30 Marks each will be conducted and the Average of best of two will be taken.
- Final examination, of 100 Marks will be conducted and will be evaluated for 50 Marks.
- Post-assesment feedback on student

- **CO-PO Mapping:**

	PO 1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	3											**3**	
CO2		2	1	2	2			1	1		1	**3**	
CO3		2	1	2	2			1	1		1	**3**	

CO4		2	1	2	2			1	1		1	**3**	
16CNE202	3	2	1	2	2			1	1		1	**3**	

Course Contents

Unit-I **10 hrs**

Introduction: Introduction, A simple Daytime Client, Protocol Independence, Error handling, A simple Daytime Server, OSI model, BSD Networking History, Test networks and Hosts, Unix Standards, 64-bit Architecture. **The Transport Layer: TCP, UDP and SCTP:** Introduction, The Big Picture, User Datagram Protocol(UDP), Transmission Control Protocol(TCP), Stream Control Transmission Protocol(SCTP), TCP connection establishment and termination, TIME_WAIT state, SCTP association establishment and termination, Port Numbers, TCP Port Number and Concurrent Servers, Buffer Sizes and Limitations, Standard internet services.

Unit- II **10 hrs**

Elementary Sockets: Sockets Introduction: Introduction, Socket Address Structures, Value Result Arguments, Byte Ordering Functions, Byte Manipulation Functions, inet_aton, inet_addr and inet_ntoa, inet_pton and inet_ntop Functions, sock_ntop Functions, readn, written and readline Functions. **Elementary TCP Sockets:** Introduction, socket, connect, bind, listen, accept, fork, exec, close, getsockname and getpeername Functions, Concurrent Server.

Unit- III **10 hrs**

I/O Multiplexing: The select **and** poll **Functions:** Intoduction, I/O Models, select Function, str_cli Function, Batch Input and Buffering, shutdown Function, str_cli Function, TCP Echo Server, pselect Function, poll Function, TCP Echo Server. **Socket Options:** Introduction, getsockopt and setsockopt Functions, Checking if an Option is supported and obtained the default, Socket States, Generic Socket Options, IPv4 Socket Options, ICMPv6 Socket Option, IPv6 Socket Options, TCP Socket Options, SCTP Socket Options, fcntl Function

Unit IV **09 hrs**

Elementary UDP Sockets: Introduction, recvfrom and sendto Functions, UDP Echo Server: main, dg_echo Function, UDP Echo Client: main, dg_cli Function, Lost Datagrams, Verifying Received Response, Server Not Running, connect Function with UDP, dg_cli Function, Lack of Flow Control with UDP, Determining Outgoing interface with UDP, TCP and UDP Echo Server using select. **Advanced Sockets: IPv4 and IPv6 Interoperability:**Introduction, IPv4 Client, IPv6 Server, IPv6 Client, IPv4 Server. **Daemon Processes and the** inetd **Superserver:** Introduction, syslogd Daemon, syslog Function, inetd Daemon, daemon_inetd Function.

Unit- V **09 hrs**

Advanced I/O Functions: Introduction, Socket Timeouts, recv, send, readv, writev, recvmsg and sendmsg Functions, Ancillary Data, How much data is Queued?, Sockets and Standard I/O, Advanced Polling. **Client/Server Design Alternatives:** Introduction, TCP Client Alternatives, TCP Test Client, TCP Iterative Server, TCP Concurrent Server, One Child per Client, TCP Preforked Server, No

Locking Around accepy, File Locking Around accept, Thread Locking Around accept, Descriptor Passing, TCP Concurrent Server, One Thread per Client, TCP Prethreaded Server, per-Thread accept, Main Thread accept.

Text Book:

1.Stevens. R.W, "Unix Network Programming, Vol-I Networking APIS: Sockets and XTI", Prentice- Hall of India, 3rd Edition, 2004

Reference Book:

1. Douglase E Comer, "Internetworking with TCP/IP", Principle, Protocol and Architecture.

LABORATORY WORK

1. Design, develop, and execute a program in C under UNIX / LINUX environment to implement a simple echo server and demonstrate its working. Both the server and client are to be connection-oriented and use TCP. The system works as follows: Client reads a line from the standard input and writes the line to the server; the server reads a line from its network input and echoes the line back to the client; the client reads the echoed line and prints it on its standard output.

2. Repeat the above experiment using UDP instead of TCP.

3. Modify the above program such that the client sends an integer value supposed to represent the radius of a circle and the server is to compute and return the corresponding area.

4. Extend the above program such that the server responds to multiple clients.

5.Design, develop, and execute a program in C under UNIX / LINUX environment to implement a simple Day / Time Server and demonstrate its functioning.

6..Design TCP Client and Server application to transfer file.

7. Design UDP Client Server to transfer a file.

Department: *Computer Networks And Engineering*	***Course Type:*** *Core*
Course Title*: Software Defined Networks*	***CourseCode:****16CNE203*
L-T-P:*4-0-2*	***Credits:****05*
TotalContactHours:*48hrs*	***DurationofSEE:****3hrs*
SEEMarks*:50*	***CIEMarks:****50*

Prerequisite:

- knowledge on Computer networks,C++, JAVA and Python.
- Experience with virtual machines and other virtual networking environments is added advantages.

Course Outcomes:

- Student will be able to describe virtualized Software defined networks.
- Students will be able to analyse the technology evolution leading to SDN as well as Open Source role in SDN.
- Students will be able to apply OpenFlow specifications to build Software defined networks.
- Investigate and synthesize information, concepts and theories relating to Network Management and SDN.
- Demonstrate knowledge of software defined networking and its applications, including network programmability and virtualization.

Teaching Methodology:

- Black board teaching
- Power point presentation
- Practical component

Assessment Methods:

- Three internals, 30 Marks each will be conducted and the Average of best of two will be taken.
- Rubrics for evaluation of Practical component .
- Final examination, of 100 Markswill be conducted and will be evaluated for 50Marks.
- Post-assesment feedback on student

Course Outcome to Programme Outcome Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**
CO1	3											3	
CO2	1	2			1							3	
CO3		2		2	2			1	1		1	1	
CO4	2	1										2	
CO5	3											3	
16CNE104	3	2		2	2			1	1		1	3	

Course Contents

Unit-I **10hrs**

Virtualization: Introduction, Virtual Memory, Virtual Memory Operation, Virtual and Physical Memory Mapping, Server Virtualization, Importance of Virtualizing Servers, Hypervisor Role in Server Virtualization, Types of Virtualization, Server Virtualization in Operation, Storage Virtualization, Computer Storage Operation, Network-Attached Storage, Storage-Area Networks, Server-Based Storage Virtualization, Storage-Network-Based Storage Virtualization Storage-Controller-Based Storage Virtualization.

Unit -II **10hrs**

Software DefinedNetworking: Introduction, Network Limitations, Network Control Plane, Forwarding Function, Network State Function, Configuration Function, Separation of Functionality, Applications.**SDN Implementation:**Introduction, SDN Design, Separation of the Control and Data Planes, Edge-Oriented Networking, SDN Operation.

Unit -III **8 hrs**

Service Providers and SDN: Introduction, Telecommunication SDN Attributes, elecommunication SDN Services.**SDN Development:**Introduction, Existing Network Limitations, Programmable Networks, Network/Application Information, Legacy to SDN, SDN Application Services, Service-Engineered Path, Service Appliance Pooling, Content Request Routing, Bandwidth Calendaring, Social Networking.

Unit -IV **10 hrs**

Network Vendors and SDN: Introduction, Cisco, VMware, Juniper, OpenDaylight, Big Switch Networks. Google and SDN: Introduction, Earlier Network Management, Motivation for Solution, Network Testing, Simulating the Google WAN, Google and SDN, Google's G-Scale Network, Google's G-Scale Network Hardware, Google SDN Deployment, Implementation Challenges Lessons Learned.

Unit -V **10 hrs**

OpenFlow: Introduction, Overview of the OpenFlow Switch Specification, OpenFlow Ports, OpenFlow Packet-Processing Pipeline, OpenFlow Channel, Message Handling, OpenFlow Channel Connections, Controller Modes, Auxiliary Connection Use for Performance and Reliability, Flow Table Synchronization, Bundle Messages, OpenFlow Configuration-and-Management Protocol, Remote Configuration, Connection Establishment Between Switch and Controller.OF-CONFIG Transport Protocol.The Conformance Test Specification for OpenFlow Switch Specification 1.0.1, The OpenFlow™ Conformance Testing Program.

Practical component (CIE Evaluation Only)

1. Program to SDN floodlight using north bound REST APIs.
2. Create virtual machines in Hyper-V Manager.
3. Programs using the OpenDaylight SDN Controller with the Mininet Network Emulator.

Text books:

1. Software Defined Networking: Design and Deployment by Patricia A. Morreale,James M. Anderson , CRC Press,2014 .
2. SDN: Software Defined Networks, An Authoritative Review of Network Programmability
   Technologies, By Thomas D. Nadeau, Ken Gray Publisher: O'Reilly Media, August 2013.

Reference books:

1. Software Defined Networks: A Comprehensive Approach, by Paul Goransson and Chuck Black, Morgan Kaufmann, June 2014, Print Book ISBN: 9780124166752, eBook ISBN: 9780124166844.
2. SDN and Open Flow for Beginners by Vivek Tiwari, Sold by: Amazon Digital Services, Inc., ASIN:, 2013.
3. Network Innovation through Open Flow and SDN: Principles and Design, Edited by Fei Hu, CRC Press, ISBN-10: 1466572094, 2014.

Reference of Research Publications:

[1] Software-Defined Networking: A Comprehensive Survey By Diego Kreutz, Member IEEE, Fernando M. V. Ramos, Member IEEE, Paulo Esteves Verı´ssimo, Fellow IEEE, Christian Esteve Rothenberg, Member IEEE, Siamak Azodolmolky, Senior Member IEEE, and Steve Uhlig, Member IEEE, 2016 2nd IEEE International Conference on Computer and Communications,Vol. 103, No. 1, January 2015.

[2] The controller placement problem for software-definednetworks by Hu Bo; Wu Youke; Wang Chuan'an; Wang Ying, 2016 2nd IEEE International Conference on Computer and Communications (ICCC)Year: 2016Pages: 2435 - 2439, DOI: 10.1109/CompComm.2016.7925136

[3] A greedy power-aware routing algorithm for software-definednetworks by Mohamad Khattar Awad; Yousef Rafique; Sarah Alhadlaq; Dunya Hassoun; Asmaa Alabdulhadi; Sheikha Thani2016 IEEE International Symposium on Signal Processing and Information Technology (ISSPIT)Year: 2016Pages: 268 - 273, DOI: 10.1109/ISSPIT.2016.7886047

[4] Inferring OpenFlow rules by active probing in software-definednetworksPo-Ching Lin; Ping-Chung Li; Van Linh Nguyen2017 19th International Conference on Advanced Communication Technology (ICACT)Year: 2017Pages: 415 - 420, DOI: 10.23919/ICACT.2017.7890123.
[5] Toward Highly Available and Scalable SoftwareDefinedNetworks for Service Providers
Dongeun Suh; Seokwon Jang; Sol Han; Sangheon Pack; Myung-Sup Kim; Taehong Kim; Chang-Gyu LimIEEE Communications MagazineYear: 2017, Volume: 55, Issue: 4 ,Pages: 100 - 107, DOI: 10.1109/MCOM.2017.1600170.
[6] Topology Discovery in SoftwareDefinedNetworks: Threats, Taxonomy, and State-of-the-ArtSuleman Khan; Abdullah Gani; Ainuddin Wahid Abdul Wahab; Mohsen Guizani; Muhammad Khurram KhanIEEE Communications Surveys & Tutorials.Year: 2017, Volume: 19, Issue: 1Pages: 303 - 324, DOI: 10.1109/COMST.2016.2597193.

Department: *Information Science & Engineering*	***Course Type:*** *Core*
Course Title*:* Analytical Approach in Data Networks	***Course Code:*** 16CNE204
L-T-P:4-0-0	***Credits:*** *04*
Total Contact Hours:*48hrs*	***Duration of SEE:*** *3hrs*
SEE Marks*:50*	***CIE Marks:*** *50*

Prerequisite:

- Knowledge of Statistics, Probability, Queuing theory, Markov chain.
- Knowledge of Wired and wireless Networks.

Course Outcomes:

Student will be able to

- Apply probability theory, deterministic and stochastic processes in the study of network traffic engineering.
- Develop the models to evaluate the performance of networks parameters and packet parameters.
- Analyze the network traffic and resolve issues related to congestion and transmissions.
- Evaluate the use of network resources optimally and enhance the quality of service.

Teaching Methodology:

- Black Board Teaching
- Power Point presentations
- Assignments
- Case Study involving modeling a wired/wireless networks scenario and performance analysis

Assessment Method:

- Three internals assessment tests for 30 marks each will be conducted and the average of best of two performances will be considered.
- Rubrics for evaluating Assignment for 10 marks.
- Rubrics for evaluating case study, 10 marks.
- Final examination will be conducted for 100 marks and will be calculated for weight of 50 marks.
- Post-assesment feedback on student

Course Outcome to Programme Outcome Mapping:

-

POs	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**
CO1	3		3					1	1		1	3	
CO2	1	1	2	1				1	1		1	3	
CO3		2	2					1	1		1	3	
CO4		1	2					1	1		1	3	
16CNE204	3	2	3	1				1	1		1	3	

Course Contents

Unit-I: Networking functional elements 10 hrs

Multiplexing, Switching, Routing, network management, traffic controls and time scale, Two types of traffic- Elastic traffic, stream traffic, Network delay, Delay jitter, playout delay, QoS objectives, Elastic transfer in a packet network- Feedback control, the file transfer abstraction, congestion control, feedback, and bandwidth sharing, Packet multiplexing over wireless networks. Sessions- Deterministic network analysis- Notations and general results, Deterministic traffic models and network calculus, Reich's equation and the convolution operator, Service curves for network elements, latency rate service elements.

Unit-II: Stream Session- Stochastic analysis 10 hrs

stochastic traffic models, models for a single stream source, superposition of several streams, discrete time Markovian batch arrival model, morkov modulated Poisson process, sum of time-varying number of deterministic processes, Additional notation, performance measures, Little's theorem, Invariance of mean system time, Brumelle's theorem, the M/G/1 model: formulation for mean number of bits in a buffer,Multiplexed Networks:Introduction and sample applications, Multiclass traffic on a single link, Theorem 6.1, the Kaufman-Roberts recursion, the Erlang blocking model.

Unit-III: Adaptive Bandwidth sharing for elastic traffic 10 hrs

Elastic transfer in networks, Network parameters and performance objectives, propagation delay and round-trip time, performance measures-transfer throughput, sharing a control link, Control objectives, rate-based control, explicit-rate-feedback, queue-length based-based feedback, a simple rate adaptation, additive increase, multiplicative decrease ODE model, Window-based control- general principles.TCP: the Internet's adaptive window protocol. Slow-Start and congestion avoidance, relative buffer and cumulative acknowledgements.

Unit-IV: Congestion Control 10 hrs

packet loss recovery and congestion control, single connection-analysis with buffer overflow, analysis of slow-start phase, short transfer throughput, slow start- evaluation after buffer overflow, analysis of congestion avoidance phase, Congestion avoidance: Evolution after buffer overflow, Congestion avoidance- timeout based recovery, congestion avoidance- fast recovery, Stochastic model for a wide area TCP connection, TCP with explicit feedback (RED and ECN), a dynamic system model, Random marking, randomly arriving finite –volume transfers.

Unit-V: Multiple Access -Wireless Networks 08 hrs

Bits over a wireless link, principles, issues, and trade-offs, simple binary modulation, and detection, Getting higher bit rates, Channel coding and fundamental limit, delay, path loss, shadowing and fading, characterization of the signal attenuation, BER and channel capacity with fading, Bits over a wireless network, TCP performance over wireless links, Performance analysis of wired and wireless networks.

Text Books:

1. Communication Networking an analytical approach by Anurag Kumar, D.Manjunath, Joy Kuri, Margan Kaufmann publisher, an imprint of ELSEVIER, 2012.
2. R.Srikanthand Y.Ling, Communication networks: An Optimisation, Control and Stochastic networks perspective, Cambridge University press, 2014.

References:

1. Larry Peterson and Bruce S Davis "Computer Networks : A System Approach" 5th Edition , Elsevier -2014.
2. Analysis of Computer Networks: Fayez Gebali, 2nd edition.

Reference of Research Publications:

[1] Pavlos Sermpezis and Thrasyvoulos Spyropoulos, "Modeling and analysis of communication traffic heterogeneity in opportunistic networks", Department of Mobile Communications, EURECOM, France,2015.

[2] Rabie Barhoun, Abdelwahed Namir and Anas Barhoun, "Analysis of hierarchical scheduling for heterogeneous traffic over network", International Journal of Computer Networks & Communications, Vol.5, No.3, 2013.

[3] Ruogu Li, AtillaEryilmaz, Lei Ying and Ness B. Shroff, "A Unified Approach to Optimizing Performance in Networks Serving Heterogeneous Flows", IEEE/ACM Transactions on Networking, 1063-6692, 2010.

[4] Mehri Mehrjoo, Mohamad KhattarAwad, Mehrdad Dianati and Xuemin Shen, "Design of Fair Weights for Heterogeneous Traffic Scheduling in Multichannel Wireless Networks", IEEE Transactions on Communications, Vol. 58, No. 10, 2010.

[5] Meisam Mirahsan, Rainer Schoenen and Halim Yanikomeroglu,"HetNets: Heterogeneous traffic distribution in heterogeneous wireless cellular networks", IEEE Global Communications Conference (Globecom), 2015.

[6] Biswajit Bhowmik, "A comparison study on selective traffic models with handoff management schemes for wireless mobile network infrastructure", International journal of technology and computer science, vol.02, pp. 66-72, 2013.

[7] Biswajit Bhowmik, et al " Modeling prioritized hard handoff management scheme for wireless mobile networks", International journal of computer networks and information security , vol.8, pp. 21-32, 2012.

[8] Michael J. Neely, "Delay analysis for maximal scheduling with flow control in wireless networks with bursty traffic", IEEE Transactions on networking, Vol.17, No.4, pp.1146-1159, 2009.

[9] N.G.Goudru and B.P.Vijaya Kumar, "Performance analysis and enhancement of TCP in presence of jitter in wireless networks", International Journal of Computer Network and Information Security, Hong Kong, MECS,Vol.8, No.6, PP: 9-21, ISSN: 2074-9090 (Print), 2016.

ELECTIVE GROUP - B

Department:*Information Science and Engineering*	***CourseType:*** *Elective*
CourseTitle*:* ***Big Data Analytics***	***CourseCode:****16CNE205E1*
L-T-P:*4-0-2*	***Credits:****05*
TotalContactHours:*48 hrs*	***DurationofSEE:****3hrs*
SEEMarks*:50*	***CIEMarks:****50*

Prerequisite:

- Knowledge of Data Pre-processing, Data Mining and SQL

Course Outcomes:

- Student will be able to Describe big data and use cases from selected business domains, Health Care, Fraud Detection and Advertising
- Student will be able to apply query languages like Hive and Pig for managing unstructured data.
- Student will be able to implement map-reduce program on Hadoop framework for the module of real world applications.
- Student will be able to use related tools for big data analytics.

Teaching Methodology:

- Power Point Presentation
- Black Board Teaching
- Practical component.

Assessment Methods:

- Three internals – 30 Marks each will be conducted and the Average of best of two will be considered.
- Rubrics for evaluation of Practical components..
- Final examination - 100 Marks will be conducted and will be evaluated for 50 Marks.
- Post-assesment feedback on student

Course Outcome to Programme Outcome Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**
CO1	3	1											
CO2		2	1		3			1	1		1		
CO3		2	1		3			1	1		1		
CO4		2	1		3			1	1		1		
16CNE205E1	3	2			3			1	1		1		

Course Contents

UNIT –I **10 Hrs**

Big Data Analytics Applications: Social media center, Product knowledge hub, infrastructure and operations studies, Product selection, Design and Engineering, Location Based services, Micro-segmentation and Next Best action, online advertising, improved risk management. **Architecture Components**: Massively parallel Processing(MPP) platforms, Unstructured Data Analytics and Reporting- Search & count, Context-sensitive & Domain specific searches, Categories and ontology, Qualitative comparisons, focus on specific Time Slice or Using other Dimensions, Big data & Single view of customer/Product, Data privacy protection, Real-Time Adaptive Analytics and Decision Engines. **Advanced Analytics platform:** Real-Time Architecture for conversations, Orchestration & Synthesis Using Analytics Engines- Entity Resolution, Model Management, Command center, Analytics Engine, Discovery using Data at Rest, Integration Strategies.

UNIT -II **10 Hrs**

NOSQL DATA MANAGEMENT: Introduction to NoSQL–aggregate data models–aggregates–key-value and document data models – relationships – graph databases – schema less databases – materialized views – distribution models – sharding — version – Map reduce – partitioning and combining – composing map-reduce calculations

UNIT -III **10 Hrs**

BASICS OF HADOOP: Data format–analyzing data with Hadoop–scaling out–Hadoop streaming– Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface– data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures

UNIT –IV **10 Hrs**

MAPREDUCE APPLICATIONS: MapReduce workflows–unit tests with MRUnit–test data andlocal tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats

UNIT -V **8 Hrs**

HADOOP RELATED TOOLS: Hbase–data model and implementations–Hbase clients–Hbaseexamples –praxis. Cassandra – Cassandra data model – cassandra examples – cassandra clients – Hadoop integration. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.

Practical Component(CIE Evaluation Only)

Exercise 1 --- HDFS

Start by reviewing HDFS. You will find that its composition is similar to your local Linux file system. You will use the hadoopfs command when interacting with HDFS.

1. Review the commands available for the Hadoop Distributed File System:

2. Copy file foo.txt from local disk to the user's directory in HDFS

3. Get a directory listing of the user's home directory in HDFS

4. Get a directory listing of the HDFS root directory

5. Display the contents of the HDFS file user/fred/bar.txt

6. Move that file to the local disk, named as baz.txt

7. Create a directory called input under the user's home directory

8. Delete the directory input old and all its contents

9. Verify the copy by listing the directory contents in HDFS:

Exercise 2 --- MapReduce

1. Create a JOB and submit to cluster

2. Track the job information

3. Terminate the job

4. Counters in MR Jobs with example

5. Map only Jobs and generic map examples

6. Distributed cache example

7. Combiners, Secondary sorting and Job chain examples

Exercise 3 --- MapReduce (Programs)

Using movie lens data

1. List all the movies and the number of ratings

2. List all the users and the number of ratings they have done for a movie

3. List all the Movie IDs which have been rated (Movie Id with at least one user rating it)

4. List all the Users who have rated the movies (Users who have rated at least one movie)

5. List of all the User with the max, min, average ratings they have given against any movie

6. List all the Movies with the max, min, average ratings given by any user.

Exercise4 – Extract facts using Hive

Hive allows for the manipulation of data in HDFS using a variant of SQL. This makes it excellent for transforming and consolidating data for load into a relational database. In this exercise you will use HiveQL to filter and aggregate click data to build facts about user's movie preferences. The query results will be saved in a staging table used to populate the Oracle Database.

The moveapp_log_json table contains an activity column. Activity states are as follows:

1. RATE_MOVIE

2. COMPLETED_MOVIE

3. PAUSE_MOVIE

4. START_MOVIE

5. BROWSE_MOVIE

6. LIST_MOVIE

7. SEARCH_MOVIE

8. LOGIN

9. LOGOUT

10. INCOMPLETE_MOVIE

hive> SELECT * FROM movieapp_log_json LIMIT 5;

hive> drop table movieapp_log_json;

hive> CREATE EXTERNAL TABLE movieapp_log_json (custId INT, movieId INT, genreId INT, time STRING, recommended STRING, activity INT, rating INT, price FLOAT)

ROW FORMAT SERDE 'org.apache.hadoop.hive.contrib.serde2.JsonSerde'

LOCATION '/user/oracle/moviework/applog/';

hive> SELECT * FROM movieapp_log_json LIMIT 20;

hive> SELECT MIN(time), MAX(time) FROM movieapp_log_json

1. PURCHASE_MOVIE Hive maps queries into Map Reduce jobs, simplifying the process of querying large datasets in HDFS. HiveQL statements can be mapped to phases of the Map Reduce framework. As illustrated in the following figure, selection and transformation operations occur in map tasks, while aggregation is handled by reducers. Join operations are flexible: they can be performed in the reducer or mappers depending on the size of the leftmost table. 1. Write a query to select only those clicks which correspond to starting, browsing, completing, or purchasing movies. Use a CASE statement to transform the RECOMMENDED column into integers where 'Y' is 1 and 'N' is 0. Also, ensure GENREID is not null. Only include the first 25 rows.

2. Write a query to select the customer ID, movie ID, recommended state and most recent rating for each movie.

3. Load the results of the previous two queries into a staging table. First, create the staging table: 4. Next, load the results of the queries into the staging table.

Exercise 5 Extract sessions using Pig

While the SQL semantics of HiveQL are useful for aggregation and projection, some analysis is better described as the flow of data through a series of sequential operations. For these situations, Pig Latin provides a convenient way of implementing data flows over data stored in HDFS. Pig Latin statements are translated into a sequence of Map Reduce jobs on the execution of any STORE or DUMP command. Job construction is optimized to exploit as much parallelism as possible, and much like Hive, temporary storage is used to hold intermediate results. As with Hive, aggregation occurs largely in the reduce tasks. Map tasks handle Pig's FOREACH and LOAD, and GENERATE statements. The EXPLAIN command will show the execution plan for any Pig Latin script. As of Pig 0.10, the ILLUSTRATE command will provide sample results for each stage of the execution plan.

In this exercise you will learn basic Pig Latin semantics and about the fundamental types in Pig Latin, Data Bags and Tuples.

1. Start the Grunt shell and execute the following statements to set up a dataflow with the click stream data. Note: Pig Latin statements are assembled into Map Reduce jobs which are launched at execution of a DUMP or STORE statement.

2. Group the log sample by movie and dump the resulting bag.

3. Add a GROUP BY statement to the sessionize.pig script to process the click stream data into user sessions.

Text Books:

1. Dr. Arvind Sathi, "Big Data Analytics: Disruptive Technologies for Changing the Game", copyright © 2012 IBM Corporation, MC Press.
2. P. J. Sadalage and M. Fowler, "NoSQL Distilled: A Brief Guide to the Emerging World of Polyglot Persistence", Copyright © 2013 Pearson Education, Inc. 2012.
3. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012.
4. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.

Reference Books:

1. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
2. Eben Hewitt, "Cassandra: The Definitive Guide", O'Reilley, 2010.
3. Alan Gates, "Programming Pig", O'Reilley, 2011

Department: *Computer Networks And Engineering*	***Course Type:*** *Elective*
Course Title*: Parallel Computing*	***CourseCode:*** *16CNE205E2*
L-T-P:4-0-2	***Credits:****05*
TotalContactHours:48*hrs*	***DurationofSEE:****3hrs*
SEEMarks*:50*	***CIEMarks:****50*

Prerequisite:
Knowledge of Data Communications Networks.

Course Outcomes:

- Student will be Able to describe fundamentals of parallel computing.
- Ability to use PThreads /OpenMP/MPI to build parallel application.
- Ability to analyse the given problem, identify the hotspot and parallelize the given application.
- Ability to communicate and present the work effectively.

Teaching Methodology:

- Black board teaching
- Power Point presentations (if needed)
- Course Project

Assessment Methods:

- Three internals, 30Marks each will be conducted and the Average of best of two will be taken.
- Rubrics evaluation for the Course Project.
- Final examination, of100 Marks will be conducted and will be evaluatedfor50Marks.
- Post-assesment feedback on student

Course Outcome to Programme Outcome Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**
CO1	3												
CO2		2		2	2			1	1		1		
CO3		2		2	2			1	1		1		
CO4								2					
16CNE205E2	3	2		2	2			1	1		1		

Course Content

UNIT-1 **10hrs**

Parallel Hardware and Parallel Software: Some background, Modifications to the von Neumann model, Parallel Hardware, Parallel Software, Input and Output, Performance, (Text Book 1)

UNIT-II **10hrs**

Principles of Parallel Algorithm Design: Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for Load Balancing, Methods for Containing Interaction Overheads, Parallel Algorithm Models. (Text Book 2)

UNIT-III **10hurs**

Distributed Memory Programming with MPI: Getting Started, The trapezoidal rule in MPI, Dealing with I/O, Collective Communication, Derived Data types, Performance evaluation of MPI programs, A Parallel Sorting Algorithm. (Text Book 1)

UNIT-IV **09hrs**

Shared Memory Programming with PThreads: Process, threads and Pthreads, Hello world, Matrix vector multiplication, Critical Sections, Busy waitings, Mutexes, Producer consumer synchronization and semaphores, Barrier and conditional variables, read-write locks, Caches, cache coherence and conditional locks. (Text Book 1)

UNIT-V **09hrs**

Shared Memory Programming with OpenMP: Getting started, The trapezoidal rule, Scope of Variables, The reduction clause, The parallel for directive, More about loops in OpenMP, Scheduling loops, Producer and Consumers.(Text Book 1)

TEXTBOOKS

1. Peter Pacheco, "An Introduction to Parallel Programming", Morgan Koufman Publishers in an imprint of Elsvier, 2011
2. Anantha Grama, Anshul Gupta, George, Vipin. "Introduction to Parallel Computing", Pearson 2.
3. Web materials for practices.

REFERENCEBOOKS

1. *J.Ja'Ja'*: **An introduction to parallel algorithms**, Addison-Wesley, 1992, ISBN 0-201-54856-9
2. *T.Leighton*: Introduction to parallel algorithms and architectures. Morgan Kaufmann Publ., 1992, ISBN 1-55860-117-1

Department:*Information Science and Engineering*	***CourseType:*** *Elective*
CourseTitle*: **Machine Learning***	***CourseCode:****16CNE205E3*
L-T-P:*4-0-2*	***Credits:****05*
TotalContactHours:*48 hrs*	***DurationofSEE:****3hrs*
SEEMarks*:50*	***CIEMarks:****50*

Prerequisite:

- Students should have knowledge of Databases and how they are managed.
- Students should have basic knowledge about graphs, trees and basic mathematical concepts.

Course Outcomes:

Students will be able to:

- Describe the basics of machine learning concepts.
- Analyze the concepts of neural networks, regression models and artificial intelligence.
- Design and inplement PCA for Neural networks.
- Apply SVM for building the mathematical models.
- Apply different modalities in ML framework

Teaching Methodology:

- Black board teaching
- Power Point presentations (if needed)
- Assignment
- Course Project

Assessment Methods:

- Three internals, 30Marks each will be conducted and the Average of best of two will be taken.
- Rubrics for Course Project
- Rubric Evaluation for Assignments
- Final examination, of100 Marks will be conducted and will be evaluatedfor50Marks.Post-assesment feedback on student

Course Outcome to Programme Outcome Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**PSO1**	**PSO2**
CO1	**3**												
CO2	**2**		2									1	
CO3		**2**		2	1			1	1		1		
CO4	1		**3**										
CO5		**2**		2	1			1	1		1		
16CNE205E3	3	2	2	2	1			1	1		1	1	

Course Contents

Unit-I **10 hrs**

Machine learning basics: Introduction. Linear algebra basics. Probability. Python basics – numpy, scipy. Overview of machine learning problems.

Unit-II **10 hrs**

Supervised Machine Learning: Introduction with logistic regression; Neural networks**,** Artificial neural networks. Logistic regression. Cost function. Gradient descent and back-propagation. Decision boundaries.

Unit-III **10 hrs**

Unsupervised machine Learning: Basics of unsupervised learning. Clustering. Dimensionality reduction. PCA.

Unit-IV **09 hrs**

Support Vector machine: Over fitting. Bias / Variance. Support Vector machines intuition and formulation.

Unit-V **09 hrs**

Feature engineering: Images and Text: How to represent different modalities like images and text in an ML framework? Case studies: Digit classification. Text classification

Text Books:

1. Tom Mitchell, "Machine Learning", McGraw Hill, 1997.

2. Christopher M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2007.

Reference Books:

1. Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani, "An Introduction to Statistical Learning: with Applications in R", Springer, 2016.

2. Trevor Hastie, Robert Tibshirani and Jerome Friedman, "The Elements of Statistical Learning: Data Mining, Inference, and Prediction", Springer, 2016

3. Andreas Muller, "Introduction to Machine Learning with Python: A Guide for Data Scientists", Shroff/O'Reilly; First edition (2016)

Online Materials:

1. Andrew NG's online Course

SEMINAR

Topics should be chosen from IEEE/ACM/Elsevier/Springer/any Refereed - Journals/Transactions. Encourage students to convert these seminar topics into a good survey paper or technical paper.

PROJECT

- Project can be done in-house or externally in any reputed industry/institution.
- Students are instructed to meet their Guides at the department every week.

Component	Timeline	Assessment
Project phase-I	End of 3rd semester-12th week	Interim Progress Assessment
Project phase-II	Mid of 4th semester -8th week	Design Development and Solution
Evaluation-1		
Project phase-II	End of 4th semester -13th week	Written Report
Evaluation-2		Final Presentation

Guidelines for External projects

- The company/organization has to give an acceptance letter permitting the students to carry out their project work in their premises prior to the conduction (Third Semester Project Phase I).
- Students are free to carry out their project work in the Company premises, but should meet their guides at the department every week for updates.
- Demonstration of the project is a must at the College during the final Viva Voce.
- A project guide (external guide) shall be allotted by the company/organization for supervising the progress of the project work (Third Semester Project Phase I).
- An internal guide will be allotted by the department for every external project also. In consultation with the external guide, the internal guide must be permitted to oversee the progress of the project work at the company premises at suitable times.
- Students carrying out external projects will have to submit synopsis / functional specification of the project work duly signed by the external guide before the deadline (Third Semester Project Phase I).
- The project guides are responsible for approving the progress of their respective wards.
- In case the project guide requires a committee to approve their status of the work, he/she can convey the same to the project coordinator at regular intervals. An expert committee will be then formed to review the work on request from the project guide. The committee will finalize the work by end of the semester.

- Students are required to maintain a project diary wherein all the student-guide meetings must be recorded.
- The Project Phase II will be reviewed in two stages.

Project Phase II- Evaluation-I: to be done after six (6) weeks from the start of the semester. The evaluation should be done by the guide and two co-examiners. The students are required to submit the work on the System Design, Detailed Design and further course of action of their work.

Project Phase II- Evaluation-II: The same team that conducted the Evaluation-I must do the Evaluation- II after twelve (12) weeks from the start of the semester. Students must complete the implementation and testing by this time. They are required to demonstrate the implementation, testing & results.

The faculty should also visit the Industry (in case it is an external project) to interact with the mentors so as to monitor the progress of their respective students.

A draft version of the complete project report must also be submitted at the end of twelve (12) weeks.

The CIE marks will be cumulative sum of the two evaluations done for a total of 100 marks.

The student should prepare a consolidated report in IEEE Format and should submit it for possible publication in National/International Conferences/Journals before the submission of the Thesis

A final project viva-voce will be conducted at the end of the semester (SEE) with an internal examiner and an external examiner.

Typical Project Activities and Timelines:

The project activities includes

1. Deciding the project subject area (Third Semester Project Phase I).
2. Establishing relevance and importance of the project (Third Semester Project Phase I).
3. Identifying requirements (Third Semester Project Phase I).
4. Feasibility study and freezing of project scope/objectives (Third Semester Project Phase I).
5. General design inputs: requirements analysis (Third Semester Project Phase I).
6. System and subsystem level design: design(Fourth Semester Project Phase II)
7. Convert all designs into programs: implementation(Fourth Semester Project Phase II)

8. Performance evaluation at system/subsystem level testing (Fourth Semester Project Phase II)
9. Documentation of all above activities into a project report (Third Semester Project Phase I & Fourth Semester Project Phase II)

Suggested Timelines for Activities and Deliverables:

1. **Start time + 6 weeks**

Write very clearly scope/objective set for the project. The objectives must reflect as to what exactly is proposed to implement. Freeze the title and scope/ objectives and this will not change under normal situation.

System design: Understand the overall system functioning, identify and draw a system level block schematic identifying all identified subsystems and their input/output need. Prepare a list of hardware systems, computing and network environment. Similarly identify the software – operating systems, application software, case tools, simulators, databases, etc. Highlight what is already available and what will be newly created or required for the project.

Deliverable: System design document

2. **Start time + 8 weeks**

Detailed Design: Design from the conceptual level block schematic, a detailed architectural layout, indicate every subsystem and within that identify input/output and design for every small entity. Draw functional block schematics, data flow diagrams for every small entity and subsystem.

Formulate a test plan: list the test data at the inputs, type of tests to be performed during development and making of subsystems, and tests required during runtime or execution.

Deliverable: Detailed design document

3. **Start time + 10 weeks**

Write the algorithms, the pseudo code for every function call, the subroutines and the recursions. Implement the design; execute the programs step by step for each module. Debug, evaluate the performance and validate the design. Integrate all modules/subsystems to realize the over system.

Perform all system level tests, evaluate the results and compare the project scope/objects and the requirements.

Deliverable: Implementation and testing document, demo of working code

4. <u>Start time + 13 weeks</u>

Complete all documentation and make the project report ready for submission.

Deliverable: ***Complete project report***

The Students need to also consolidate their work into an IEEE and publish the same in a reputed Journal or an International Conference.

GUIDELINES FOR THE PREPARATION OF PG IV Semester (Project Phase-II) PROJECT REPORTS:

1. Project reports should be typed neatly only on one side of the paper with 1.5 or double line spacing on a A4 size paper. The margins should be: Left - 1.25", Right - 1", Top and Bottom -0.75".
2. The total number of reports to be prepared is 5 (4+1)
    - Four (4) Copies to be submitted to the department
    - One (1) copy to the student.
3. Before taking the final printout, the approval of the concerned guide(s) is mandatory and suggested corrections, if any, must be incorporated.

4. The organization of the report should be as follows:
    - Inner title page
    - Certificate from the guide and department
    - Declaration by candidate
    - Abstract or Synopsis
    - Acknowledgments
    - Table of Contents
    - List of table & figures (optional)-All the above pages Starting from **abstract** must be numbered in roman (i, ii,iii, iv, v, …) Chapters (page numbers in Arabic i.e. 1, 2, 3).

    o Main body of the report divided appropriately into chapters, sections and subsections.References or bibliography

5. Numbering : The chapters, sections and subsections may be numbered in the decimal form for e.g. Chapter 2, sections as 2.1, 2.2 etc., and subsections as 2.2.3, 2.5.1 etc.

6. Fonts sizes:

a. The chapter number must be left or right justified (font size 16).
b. Followed by the title of chapter centered (font size 18),
c. Section/subsection numbers along with their headings must be left justified with
    i. Section number and its heading in font size 16
    ii. Subsection and its heading in font size 14.
    iii. The body or the text of the report should have font size 12.

7. The figures and tables must be numbered chapter wise for e.g.: Fig. 2.1 Block diagram of a serial binary adder, Table 3.1 Primitive flow table, etc. Figure captions must be placed below the figure and centred. Table captions must be above the table and centred.

8. **Reference or Bibliography**: The references should be numbered serially in the order of their occurrencein the text and their numbers should be indicated within square brackets for e.g. [3]. The section on references should list them in serial order in the following format.

    For textbooks –

    [1] A.V. Oppenheim and R.W. Schafer, Digital Signal Processing, Englewood, N.J., Prentice Hall, 3 Edition, 1975.

    [2]Devid, Insulation design to combat pollution problem, Proc of IEEE, PAS, Vol 71, Aug 1981, pp 1901 - 1907.Bibliography need not be numbered and need not be cited.

9. Only SI units are to be used in the report. Important equations must be numbered in decimal form for e.g.

    V = IR..... (3.2)

10. The project report should be clearly written and include descriptions of work carried out by others only to the minimum extent necessary. Verbatim reproduction of material available elsewhere should be strictly avoided. If short excerpts from published work are desired to be included, they should be within quotation marks and appropriately referenced.
11. Proper attention is to be paid not only to the technical contents but also to the organization and clarity of the report. Due care should be taken to avoid spelling and typing errors. The student should note that report-write-up forms the important component in the overall evaluation of the project.
12. The color of the cover page for Computer Science PG projects is CREAM.
13. The Report should be plagiarism checked in Main Library by paying 300/- and plagiarism check should be less than 20%. If it's more than 20% the thesis is liable for rejection.