



KERALA TECHNOLOGICAL UNIVERSITY

---

ERNAKULAM – I CLUSTER

SCHEME AND SYLLABI  
FOR  
M. Tech. DEGREE PROGRAMME  
IN  
NETWORK ENGINEERING  
(2015 ADMISSION ONWARDS)

SCHEME AND SYLLABI FOR M. Tech. DEGREE PROGRAMME IN  
NETWORK ENGINEERING  
SEMESTER-1

Exam Slot	Course No	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06NE6011	Theoretical Foundation in Computer Networking	4-0-0	50	50	3	4
B	06NE6021	Advanced Computer Networks	4-0-0	50	50	3	4
C	06NE6031	Wireless & Adhoc Networks	4-0-0	50	50	3	4
D	06NE6041	Cloud Computing Concepts	3-0-0	50	50	3	3
E	06NE6X51	Elective I	3-0-0	50	50	3	3
	06NE6061	Research methodology*	1-1-0	100	0	0	2
	06NE6071	Seminar I	0-0-2	100	0	0	2
	06NE6081	Network Systems Lab	0-0-3	100	0	0	1
Total Credits							23

Elective – I	
06NE6151	Web and Rich Internet Applications
06NE6251	Internetworking Technologies
06NE6351	Multicore Architecture & Programming
06NE6451	Linux Shell Scripting

\* - Common to M.Tech. Computer Science & Engineering/Computer Science & Information Systems

## SEMESTER-2

Exam Slot	Course No	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06NE6012	Design of Computer Networks	4-0-0	50	50	3	4
B	06NE6022	Foundations in Big Data Processing	3-0-0	50	50	3	3
C	06NE6032	Enterprise Devices & Networks	3-0-0	50	50	3	3
D	06NE6X42	Elective II	3-0-0	50	50	3	3
E	06NE6X52	Elective III	3-0-0	50	50	3	3
	06NE6062	Mini Project	0-0-4	100	0	0	2
	06NE6072	Network Simulation Lab	0-0-3	100	0	0	1
Credits							19

	Elective – II		Elective – III
06NE6142	Modern Concurrent Programming Paradigm	06NE6152	Cyber Physical Systems
06NE6242	Distributed Algorithms	06NE6252	Network Security
06NE6342	High Performance Networks	06NE6352	Advances in Storage Area Networks
06NE6442	Internet Routing Design	06NE6452	Next Generation Internetworking Protocol

## SEMESTER-III

Exam Slot	Course No	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06NE7X11	Elective IV	3-0-0	50	50	3	3
B	06NE7X21	Elective V	3-0-0	50	50	3	3
	06NE7031	Seminar II	0-0-2	100	0	0	2
	06NE7041	Project(Phase 1)	0-0-8	50	0	0	6
Credits							14

Elective – IV		Elective – V	
06NE7111	Big Data Analytics	06NE7121	Software Defined Networking
06NE7211	Concurrent Algorithms and Data Structures	06NE7221	Network Forensics
06NE7311	Social Network Analysis	06NE7321	Cloud Security
06NE7411	Intrusion Detection Systems	06NE7421	Green Computing

## SEMESTER-IV

Exam Slot	Course No	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
	06NE7012	Project(Phase 2)	0-0-21	100	0	0	12
Credits							12
Total Credits for all semesters							68

# SEMESTER – I

Course No.	Course Name	L-T-P-Credits	Year
06NE6011	Theoretical Foundation in Computer Networking	4-0-0-4	2015
Prerequisites : Fundamentals of Algorithm Analysis			
Course Objectives :			
<ul style="list-style-type: none"><li>Ability to recognize and formulate network flow problems Knowledge of basic and advanced network flow algorithms</li><li>Ability to design resolution approaches to solve non-standard network flow problems</li></ul>			
Syllabus :			
Fundamentals on Graph Theory, Network flow problems, Shortest Paths, Maximum Flows, Minimum Cost flows, Minimum Spanning Trees			
Course Outcome :			
On successful completion of this course			
<ul style="list-style-type: none"><li>Know and formulate network flow problems</li><li>Model decision problems as network flow problems</li><li>Use base and advanced algorithms to solve network flow problems</li><li>Ability to identify network flow models scope</li><li>Ability to explain network flows models and algorithms</li><li>Ability to learn state-of-art algorithms for network flow problems</li></ul>			
Text Book :			
1. Ravindra K. Ahuja, Thomas L. Magnanti, James B.Orlin, Network Flows – “Theory, Algorithms and Applications”, Prentice Hall			
References :			
2. Mokhtar S. Bazaraa, John J. Jarvis, Hanif D. Sherali, “Linear Programming And Network Flows”, John Wiley & Sons, 4th Edition,			
3. Gunther Ruhe, Kluwer, “Algorithmic Aspects Of Flows In Networks”, Academic Publishers Group			
4. Michael W. Lucas, “Network Flow Analysis”, , No Starch Press			
5. Alexander Engau, Vdm Verlag Dr. Muller, “Semi-Simultaneous Flows In Multiple Networks”, Aktiengesellschaft & Co. Kg			
6. Wai-kai Che, John Wiley, “Theory Of Nets: Flows In Network”s,			
7. Ulrich Derigs, “Programming In Networks And Graphs: On The Combinatorial Background And Near-Equivalence Of Network Flow And Matching Algorithms”,			
8. Ford L. R. Jr. , Robert G. Bland, Fulkerson D. R, “Flows In Networks”, Princeton University Press.			
9. Alexander Hall, Vdm Verlag Dr. Mueller E. K, “Scheduling And Flow-Related Problems In Networks”			
10. Pioro M, Routing, “Flow And Capacity Design In Communication And Computer Networks”, Elsevier India Private Limited			
COURSE PLAN			
COURSE NO: 06NE6011	COURSE TITLE: Theoretical Foundation in Computer Networking	(L-T-P :4-0-0)	CREDITS:4
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Fundamentals on Graph Theory- Network flow problems- Network representations- Complexity Analysis- Developing Polynomial time algorithms- Search Algorithms- Flow Decomposition algorithms	12	30%
2	Shortest Paths: Label Setting Algorithms – Dijkstra’s Algorithm- Dial’s implementation- Heap Implementation- Radix Heap Implementation	6	
FIRST INTERNAL EXAMINATION			

2	Shortest Paths : Label Correcting Algorithms – Generic Label Correcting algorithms- Special implementations of the modified label correcting algorithm- detecting negative cycles- All pairs shortest path problem	6	30%
3	Maximum Flows : Generic Augmenting path algorithm- Labeling algorithm and Max- Flow Min – cut theorem- Capacity Scaling Algorithm- Distance labels and layered networks- Generic pre flow push algorithm- FIFO pre flow push algorithm	8	
SECOND INTERNAL EXAMINATION			
3	Minimum Cost flows : Optimality conditions- Cycle canceling algorithm and the integrity property- Successive shortest path algorithm- Primal – dual algorithm- Out – of Kilter Algorithm- Capacity scaling algorithm- Cost scaling algorithm	4	40%
4	Minimum Spanning Trees – Kruskal’s algorithm- Prim’s Algorithm- Sollin’s Algorithm- Convex Cost Flows – Pseudo Polynomial time algorithm- polynomial time algorithm Generalized Flows – Augmented forest structures- determining potentials and flows for an augmented forest structure- generalized network simplex algorithm	12	
END SEMESTER EXAM			



Course No.	Course Title	L-T-P-Credits	Year
06NE6021	Advanced Computer Networks	4-0-0-4	2015
Prerequisites : Fundamentals of Computer Networks or Computer Networking programs			
Course Objectives :			
<ul style="list-style-type: none"><li>To uncover and understand the current directions of computer networks from literature readings.</li><li>To encourage a performance perspective towards analysis of computer and communications networks.</li><li>To “fill-in” gaps in students’ networking knowledge</li></ul>			
Syllabus :			
Internet Protocol : IPv4 , IP Datagram Formats, Routing and Forwarding, Path Vectors and Policies, End-to-End Protocols, Flow Control, Congestion Control, Congestion-Avoidance Mechanisms			
Course Outcome :			
On successful completion of this course			
<ul style="list-style-type: none"><li>Independently understand basic computer network technology.</li><li>Identify the different types of network topologies and protocols.</li><li>Enumerate the layers of TCP/IP and explain the function(s) of each layer.</li><li>Identify the different types of network devices and their functions within a network</li><li>Understand and building the skills of subnetting and routing mechanisms.</li><li>Familiarity with the basic protocols of computer networks, and how they can be used to assist in network design and implementation.</li></ul>			
Text Book :			
<ol style="list-style-type: none"><li>The Internet and Its Protocols - A Comparative Approach by ADRIAN FARREL, Elsevier</li><li>Computer Networks – A Systems Approach by Larry L. Peterson and Bruce S. Davie, The Morgan Kaufmann Series in Networking, Remote Procedure Call,</li></ol>			
References :			
<ol style="list-style-type: none"><li>Data networks by D.Berteskas and R Gallagar, Printice Hall</li><li>Design and Analysis of Communication Networks By V Ahuja , McGraw Hill</li><li>Kerchenbaum A., “Telecommunication Network Design Algorithms”, Tata McGraw Hill</li><li>James D.McCabe, Network analysis, Architecture and Design, 2<sup>nd</sup> Edition, Elsevier, 2003.</li><li>An Engineering approach to computer Networking by S.Keshav, Pearson education</li><li>Network Algorithms by George Varghese, Morgan Kaufmann</li></ol>			
COURSE PLAN			
COURSE NO: 06NE6021	COURSE TITLE: Advanced Computer Networks	(L-T-P :4-0-0)	CREDITS:4
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Internet Protocol : IPv4 - IP Datagram Formats - Data and Fragmentation - Address Masks- Prefixes- and Subnetworks - Network Address Translation (NAT) - IP Switching and Routing - Local Delivery and Loopbacks - Address Resolution Protocol - Route Control and Recording – ICMP - Discovering Routers - Path MTU Discovery – Multicast - IP Version Six.	13	30%
2	Routing and Forwarding – CIDR - Building and Using a Routing Table - Router IDs- Numbered Links- and Unnumbered Links - Distributing Routing Information - Distance Vectors - Link State Routing	5	
FIRST INTERNAL EXAMINATION			

2	Path Vectors and Policies - Computing Paths- Routing Information Protocol – OSPF - OSPF – Intermediate System to Intermediate System - Border Gateway Protocol - Multicast Routing - Inter-Gateway Routing Protocol - Inter-Domain Routing Protocol	8	30%
3	End-to-End Protocols : Ports and Addresses - User Datagram Protocol - UDP Message Format - Transmission Control Protocol - Segment Format - Connection Establishment and Termination - Flow Control - Triggering Transmission	9	
SECOND INTERNAL EXAMINATION			
3	Silly Window Syndrome - Nagle’s Algorithm - Adaptive Retransmission - Karn/Partridge Algorithm - Remote Procedure Call – BLAST – CHAN – SELECT – SunRPC- Stream Control Transmission Protocol - Real-time Transport Protocol.	7	40%
4	Congestion Control : Packet-Switched Network - Connectionless Flows - Issues in Resource Allocation - Fair Resource Allocation - Queuing Disciplines – FIFO - Fair Queuing - TCP Congestion Control - Additive Increase/Multiplicative Decrease - Slow Start - Fast Retransmit and Fast Recovery - Congestion-Avoidance Mechanisms – DECbit - Random Early Detection - Source-Based Congestion Avoidance – Tahoe- Reno- and Vegas- QoS Application Requirements - Real-Time Audio - Taxonomy of Real-Time Applications - Approaches to QoS Support.	13	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6031	Wireless & Adhoc Networks	4-0-0-4	2015
Prerequisites : Fundamentals of Wireless Network			
<p>Course Objectives :</p> <ul style="list-style-type: none"> <li>To develop an understanding of modern network architectures from a design and performance perspective.</li> <li>To introduce the student to the major concepts involved in wide-area networks (WANs), local area networks (LANs) and Wireless LANs (WLANS).</li> <li>To clarify network terminology.</li> </ul>			
<p>Syllabus :</p> <p>Ad hoc Wireless Networks, Routing Protocols for Ad Hoc Wireless Networks, Multicast Routing in Ad hoc Wireless Networks, Transport Layer and Security Protocols, Security in Ad hoc Wireless Networks, Quality of Service and Energy Management in Ad hoc Wireless Networks</p>			
<p>Course Outcome :</p> <p>On successful completion of this course</p> <ul style="list-style-type: none"> <li>Describe the unique issues in ad-hoc/sensor networks.</li> <li>Describe current technology trends for the implementation and deployment of wireless ad-hoc/sensor networks.</li> <li>Discuss the challenges in designing MAC, routing and transport protocols for wireless ad-hoc/sensor networks.</li> <li>Discuss the challenges in designing routing and transport protocols for wireless Adhoc/sensor networks.</li> <li>Comprehend the various sensor network Platforms, tools and applications</li> </ul>			
<p>Text Books :</p> <ol style="list-style-type: none"> <li>C. Siva Ram Murthy &amp; B. S. Manoj: Ad hoc Wireless Networks, 2nd Edition, Pearson Education, 2011</li> </ol>			
<p>References :</p> <ol style="list-style-type: none"> <li>Imielinski T. and Korth H.F., "Mobile Computing", Kluwer Academic Publishers, 1996.</li> <li>William Stallings, "Wireless Communications and Networks", Prentice Hall, 2004.</li> <li>Clint Smith. P.E., and Daniel Collins, "3G Wireless Networks", 2nd Edition, Tata McGraw Hill, 2007.</li> <li>Carlos de Moraes Cordeiro and Dharma Prakash Agrawal, "Ad Hoc &amp; Sensor Networks: Theory and Applications", World Scientific, 2007.</li> <li>Toh C. K., "Ad Hoc Mobile Wireless Networks Protocols and Systems", Prentice Hall, PTR, 2001.</li> <li>Yi-Bing and Imrich Chlamtac, "Wireless and Mobile Networks Architectures", John Wiley &amp; Sons, 2001.</li> <li>Vijay. K. Garg, "Wireless Communication and Networking", Morgan Kaufmann Publishers</li> <li>Ian F. Akyildiz and Mehmet Can Vuran, Wirless Sensor Networks, Wiley</li> </ol>			

COURSE PLAN			
COURSE NO: 06NE6031	COURSE TITLE: Wireless & Adhoc Networks	(L-T-P : 4-0-0)	CREDITS:4
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Ad hoc Wireless Networks: Introduction- Issues in Ad hoc Wireless Networks- Ad hoc Wireless Internet; MAC Protocols for Ad hoc Wireless Networks: Introduction- Issues in Designing a MAC Protocol- Design Goals of MAC Protocols- Classification of MAC protocols- Contention-Based Protocols- Contention-Based Protocols with Reservation Mechanisms- Contention-Based Protocols with Scheduling Mechanisms- MAC Protocols that Use Directional Antennas	13	30%
2	Routing Protocols for Ad Hoc Wireless Networks: Introduction- Issues in Designing a Routing Protocol for Ad hoc Wireless Networks; Classification of Routing Protocols; Table Driven Routing Protocols; On- Demand Routing Protocols- Hybrid Routing Protocols- Hierarchical Routing Protocols and Power-Aware Routing Protocols	5	
FIRST INTERNAL EXAMINATION			
2	Multicast Routing in Ad hoc Wireless Networks: Introduction- Issues in Designing a Multicast Routing Protocol- Operation of Multicast Routing Protocols- An Architecture Reference Model for Multicast Routing Protocols- Classifications of Multicast Routing Protocols- Tree-Based Multicast Routing Protocols and Mesh-Based Multicast Routing Protocols.	8	30%
3	Transport Layer and Security Protocols for Ad hoc Networks: Introduction- Issues in Designing a Transport Layer Protocol; Design Goals of a Transport Layer Protocol; Classification of Transport Layer Solutions; TCP over Transport Layer Solutions; Other Transport Layer Protocols for Ad hoc Networks	9	
SECOND INTERNAL EXAMINATION			
3	Security in Ad hoc Wireless Networks- Issues and Challenges in Security Provisioning- Network Security Attacks- Key Management and Secure Touting Ad hoc Wireless Networks.	7	40%
4	Quality of Service and Energy Management in Ad hoc Wireless Networks Introduction- Issues and Challenges in Providing QoS in Ad hoc Wireless Networks- Classification of QoS Solutions- MAC Layer Solutions- Network Layer Solutions; Energy Management in Ad hoc Wireless Networks: Introduction- Need for Energy Management in Ad hoc Wireless Networks- Classification of Energy Management Schemes- Battery Management Schemes- Transmission Management Schemes- System Power Management Schemes.	13	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6041	Cloud Computing Concepts	3-0-0-3	2015
Prerequisites : Distributed Computing			
Course Objectives :			
<ul style="list-style-type: none"> <li>To impart fundamental concepts in the area of cloud computing</li> <li>To impart knowledge in applications of cloud computing</li> </ul>			
Syllabus :			
Fundamental Cloud Computing, Fundamental Cloud Security, Cloud Infrastructure Mechanisms, Specialized Cloud Mechanisms, Cloud Architectures, Cloud Delivery Models			
Course Outcome :			
On successful completion of this course			
<ul style="list-style-type: none"> <li>Understanding the systems, protocols and mechanisms to support cloud computing</li> <li>Develop applications for cloud computing</li> <li>Understanding the hardware necessary for cloud computing</li> <li>Design and implement a novel cloud computing application</li> </ul>			
Text Books :			
1. Thomas Erl, Zaigham Mahmood, and Ricardo Puttini, Cloud Computing : Concepts, Technology & Architecture, Prentice Hall, 2013. ISBN-13: 978-0-13-338752-0			
References :			
1. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010. 2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", TMH, 2009. 3. Kumar Saurabh, "Cloud Computing – insights into New-Era Infrastructure", Wiley India, 2011. 4. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud" O'Reilly 5. James E. Smith, Ravi Nair, "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005. 6. Katarina Stanoevska-Slabeva, Thomas Wozniak, Santi Ristol, "Grid and Cloud Computing – A Business Perspective on Technology and Applications", Springer. 7. Ronald L. Krutz, Russell Dean Vines, "Cloud Security – A comprehensive Guide to Secure Cloud Computing", Wiley – India, 2010. 8. Rajkumar Buyya, Christian Vecchiola, S.Thamarai Selvi, 'Mastering Cloud Computing', TMGH, 2013. 9. Gautam Shroff, Enterprise Cloud Computing, Cambridge University Press, 2011 10. Michael Miller, Cloud Computing, Que Publishing, 2008 11. Nick Antonopoulos, Cloud computing, Springer Publications, 2010			
COURSE PLAN			
COURSE NO:	COURSE TITLE: Cloud Computing Concepts	(L-T-P : 3-0-0)	CREDITS:3
06NE6041			
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Fundamental Cloud Computing : Business Drivers - Technology Innovations - Basic Concepts and Terminology - Roles and Boundaries - Cloud Characteristics - Cloud Delivery Models - Cloud Deployment Models. Cloud-Enabling Technology - Broadband Networks and Internet Architecture - Data Center Technology - Virtualization Technology - Web Technology - Multitenant Technology - Service Technology.	13	30%

2	Fundamental Cloud Security : Basic Terms and Concepts - Threat Agents - Cloud Security Threats - Additional Considerations	5	
FIRST INTERNAL EXAMINATION			
2	Cloud Infrastructure Mechanisms : Logical Network Perimeter - Virtual Server - Cloud Storage Device - Cloud Usage Monitor - Resource Replication -	8	30%
3	Specialized Cloud Mechanisms : Automated Scaling Listener - Load Balancer - SLA Monitor- Pay-Per-Use Monitor - Audit Monitor -Failover System – Hypervisor - Resource Cluster - Multi-Device Broker - State Management Database	9	
SECOND INTERNAL EXAMINATION			
3	Cloud Architectures : Workload Distribution Architecture - Resource Pooling Architecture - Dynamic Scalability Architecture - Elastic Resource Capacity Architecture - Service Load Balancing Architecture - Cloud Bursting Architecture - Elastic Disk Provisioning Architecture - Redundant Storage Architecture - Hypervisor Clustering Architecture - Load Balanced Virtual Server Instances Architecture - Non-Disruptive Service Relocation Architecture - Zero Downtime Architecture - Cloud Balancing Architecture - Resource Reservation Architecture - Dynamic Failure Detection and Recovery Architecture - Bare-Metal Provisioning Architecture - Rapid Provisioning Architecture - Storage Workload Management Architecture	7	40%
4	Cloud Delivery Models The Cloud Provider Perspective : Building IaaS Environments - Equipping PaaS Environments - Optimizing SaaS Environments. Cloud Delivery Models The Cloud Consumer Perspective : Working with IaaS Environments - Working with PaaS Environments - Working with SaaS Services. Cost Metrics and Pricing Models : Business Cost Metrics - Client Database - Cloud Usage Cost Metrics - Network Usage - Server Usage - Cloud Storage Device Usage - Cloud Service Usage	13	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6061	Research methodology	1-1-0-2	2015
Prerequisites : Nil			
Course Objectives : <ul style="list-style-type: none"><li>Understand some basic concepts of research and its methodologies</li><li>Identify appropriate research topics</li></ul>			
Syllabus : Research process, Data collection –Data Analysis, Basic Statistical measures, Ethics of Research, Statistical test of hypothesis, Guidelines for writing a PhD thesis			
Course Outcome : On successful completion of this course, the student should <ul style="list-style-type: none"><li>Select and define appropriate research problem and parameters</li><li>Prepare a project proposal(to undertake a project)</li><li>Organize and conduct research (advanced project) in a more appropriate manner</li><li>Write a research report and thesis</li><li>Write a research proposal (grants)</li></ul>			
Text Books : <ul style="list-style-type: none"><li>Research Methodology By R Panneerselvam - Prentice Hall International 2004 - Eleventh printing, 2013.</li><li>Research Methodology By CR Kothari - New Age International publishers Second Revised Edition, Reprint 2013.</li></ul>			
References : <ul style="list-style-type: none"><li>A beginners guide to uncertainty of measurement by Stephanie Bell, NPL Publishing</li><li>Research Methodology By Francis C. Dane, Brooks/Cole Publishing Company, California.</li></ul>			
COURSE PLAN			
COURSE NO: 06NE6061	COURSE TITLE: Research methodology	(L-T-P : 1-1-0)	CREDITS:2
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction - Meaning of Research- Objectives- Motivation-Types of Research. Research process- Problem definition- Objectives of Research- Research design- Data collection –Data Analysis –Interpretation of Results- Validation of Results. Formulation of a Research problem.	13	30%
2	Basic Statistical measures - Measures of central tendency – Arithmetic Mean- Median- Mode- Geometric Mean- Harmonic Mean	5	
FIRST INTERNAL EXAMINATION			
2	Measures of variation – Range- Mean Deviation- Quartile Deviation- Coefficient of Variation and Standard Deviation- Measures of skewness.	8	30%
3	Ethics of Research- Scientific Misconduct- Forms of Scientific Misconduct. Measurement of errors	9	
SECOND INTERNAL EXAMINATION			
3	Measurement uncertainty. Statistical test of hypothesis- T-test- Z Test- F-test- Chi-square test.	7	40%

4	Guidelines for writing a PhD thesis - Guidelines for writing the abstract- introduction- methodology- results and discussion- conclusion sections of a manuscript. Impact factor-Validity- Merits- limitations. Other measurements of impact. h-index- advantages- criticism of h-index- modification of h-index- Intellectual property rights (IPR)- forms of IPR- patents- copyrights-Trademarks-Industrial design-geographical indication.	13	
END SEMESTER EXAM			



Course No.	Course Title	L-T-P-Credits	Year
06NE6151	Web and Rich Internet Applications	3-0-0-3	2015
Prerequisites : Fundamentals of Web Application			
Course Objectives : <ul style="list-style-type: none"><li>Understand the various steps in designing a creative and dynamic website.</li></ul>			
Syllabus : Introduction: From Browsers to Rich Clients – browser drawbacks, A solution – rich clients, Rich clients today.			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Clear understanding of hierarchy of objects in HTML and XML.</li><li>Finally they can create good, effective and customized websites.</li><li>Know regarding internet related technologies. Systematic way of developing a website.</li><li>Design dynamic and interactive web pages by embedding Java Script code in HTML.</li><li>Know the advantages and use of Web services.</li></ul>			
Text Book : <ul style="list-style-type: none"><li>HTML 5 Up and Running, Mark Pilgrim, O'REILLY  GOOGLE Press, 2010.</li><li>Professional AJAX, Nicholas C Zakas et al, 2nd Edition, Wrox publications,2007.</li></ul>			
References : <ul style="list-style-type: none"><li>Professional Web 2.0 Programming, Eric Van Der VList et al, Wrox Publications, 2007</li><li>SOA: Concepts, Technology and Design, Thomas Erl, Pearson, 2005</li></ul>			
COURSE PLAN			
COURSE NO: 06NE6151	COURSE TITLE: Web and Rich Internet Applications	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction: From Browsers to Rich Clients – browser drawbacks- A solution – rich clients- Rich clients today. Web 1.0: HTML- URLs and HTTP- The WEB Model and REST – resources- representations- state- transfer – using HTTP methods. XML- XPATH and XSLT – XML Support in browsers- XPath support in browsers- XSLT support in Browsers.	9	30%
2	HTML 5: Detecting HTML 5 features – Canvas- video- local storage- web workers- offline applications- geolocation- placeholders- input types. What does it all mean – doctype- root- headers- articles- dates and times- navigation and footers.	5	
FIRST INTERNAL EXAMINATION			
2	Let's call it a drawing surface – Simple shapes- canvas- Paths- texts- gradients and images. The past- present and future of local storage for web applications- A Form of madness – place holders- autofocus fields- email- web addresses- numbers as spinboxes and sliders- date and color pickers- search boxes.	4	30%
3	AJAX-I: Basic communication techniques – XHR- AJAX with images- Dynamic script loading- Cache control.	5	
SECOND INTERNAL EXAMINATION			

3	AJAX patterns: Communication control patterns – predictive fetch- page preloading- submission throttling- periodic refresh- multi-stage download. Fallback patterns. AJAX libraries – JQuery.	4	40%
4	AJAX-II: Syndication with RSS and Atom – RSS- Atom- XParser- Creating a news ticker- Web search with RSS. JSON – Array-object- mixing literals- syntax- encoding/decoding- JSON versus XML- server-side JSON tools. COMET: HTTP streaming – request delays- file modification example- using Iframes- browser-specific approaches- server-sent DOM events- connection management and server-side support. Mashups and Web services: The rise of mashups- geocoding- Google maps API. Introduction to Service Oriented Architecture- Combining protocols to build Web services – clarifying web services- REST Services- WS-* Web services using SOAP and WSDL- REST vs WS-* services.	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6251	Internetworking Technologies	3-0-0-3	2015
Prerequisites : Network Fundamentals			
Course Objectives : <ul style="list-style-type: none"><li>Ability to understand socket programming.</li><li>Learn about routing sockets</li></ul>			
Syllabus: Introduction to Socket Programming – Overview of TCP/IP Protocols, Introduction to SCTP, Routing sockets, Broadcasting, Multicasting, Advanced UDP sockets			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Implementation of End-to-End protocols</li></ul>			
Text Book : <ul style="list-style-type: none"><li>D.E. Comer, “Internetworking with TCP/IP Vol- III”, (BSD Sockets Version), Second Edition, Pearson Education, 2003.</li><li>W. Richard Stevens, “Unix Network Programming Vol-I”, Second Edition, Pearson Education, 1998.</li></ul>			
References : <ul style="list-style-type: none"><li>Michael Donahoo, Kenneth Calvert, “TCP/IP Sockets in C, A practical guide for programmers”, Second Edition, Elsevier, 2009</li><li>Forouzan, “ TCP/IP Protocol Suite” Second Edition, Tata MC Graw Hill, 2003.</li></ul>			
COURSE PLAN			
COURSE NO: 06NE6251	COURSE TITLE: Internetworking Technologies	(L-T-P : 3-1-0)	CREDITS:4
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction to Socket Programming – Overview of TCP/IP Protocols –Introduction to Sockets – Iterative TCP programming – Iterative UDP programming – Concurrent programming – fork and exec - I/O multiplexing – I/O Models – select function – shutdown function – TCP echo Server (with multiplexing) – poll function – TCP echoClient (with Multiplexing) Multiplexing TCP and UDP sockets- Threaded servers – thread creation and termination – TCP echo server using threads – Mutexes – condition variables	9	30%
2	Introduction to SCTP- Interface Modules – SCTP functions- sctp_bindx- sctp_connectx- sctp_getpaddr- sctp_freepaddr- sctp_getladdr- sctp_freeladdr- sctp_sendmsg-sctp_recvm- sctp_opt_info- sctp_peeloff- shutdown – Notifications - Socket options – getsockopt and setsockopt functions- Socket states – generic socket options – IP socket options – ICMP socket options – TCP socket options -.SCTP socket options – fcntl functions.	5	
FIRST INTERNAL EXAMINATION			

2	Routing sockets – Datalink socket address structure – Reading and writing – sysctl operations – get_ifi_info function – Interface name and index functions- Key Management sockets – Reading and writing – Dumping Security Association Database – Creating static Security Association – Dynamically maintaining SA's	4	30%
3	Broadcasting – Broadcast addresses – Unicast versus Broadcast – (Client) Application development for broadcasting – Race conditions – Multicasting – Multicast addresses- Multicasting versus Broadcasting on a LAN – Multicasting on a WAN – Source specific Multicast – Multicast socket options – mcast_join- (Client) Application development for multicasting – Receiving IP multicast infrastructure session announcements – Sending and receiving.	5	
SECOND INTERNAL EXAMINATION			
3	Advanced UDP sockets – Receiving flags- Destination IP address and Interface index – Datagram truncation – Using UDP instead of TCP – Adding reliability to UDP – Binding interface addresses – Concurrent UDP servers – Advanced SCTP sockets	4	40%
4	Partial delivery – Notifications – Unordered data – Binding a subset of addresses – Determining peer and local address information – Finding an association Id given an IP address – Heartbeating and Address failure – Peeling off an association – Controlling timing – Using SCTP instead of TCP – Out of band data – Signal driven I/O.	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6351	Multicore Architecture & Programming	3-0-0-3	2015
Prerequisites : Students are expected to know the C language, and know basics on computer architecture.			
Course Objectives : <ul style="list-style-type: none"> <li>• how to organize the computations of the threads in so that they work together and perform the required computations efficiently, making good use of the available hardware resources.</li> <li>• To expose the students to the problems related to multiprocessing</li> <li>• To understand the different types of multi core architectures</li> </ul>			
Syllabus : Multi-core Architecture, Fundamental Concepts of Parallel Programming, Threading and Parallel Programming, OpenMP, Performance oriented Programming, GPU programming			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"> <li>• Point out the salient features of different multi-core architectures and how they exploit parallelism.</li> <li>• Knowledge on architecture of GPUs, warehouse-scale computers and embedded processors.</li> </ul>			
Text Book : <ol style="list-style-type: none"> <li>1. Shameem Akhter and Jason Roberts, Multicore Programming , Increased Performance through Software Multi-threading, Intel Press , 2006.</li> <li>2. Jason Sanders, Jason Sanders, CUDA by Example: An Introduction to General-Purpose GPU Programming, Pearson, 2010</li> </ol>			
References : <ol style="list-style-type: none"> <li>1. John L. Hennessey and David A. Patterson, " Computer architecture – A quantitative approach", Morgan Kaufmann/Elsevier Publishers, 5th. edition, 2011.</li> <li>2. Peter S. Pacheco, "An introduction to parallel programming", Morgan Kaufmann, 2011.</li> <li>3. Michael J Quinn, "Parallel programming in C with MPI and OpenMP", Tata McGraw Hill, 2003.</li> <li>4. Shameem Akhter and Jason Roberts, "Multi-core Programming", Intel Press, 2006.</li> <li>5. David E. Culler, Jaswinder Pal Singh, "Parallel computing architecture : A hardware/ software approach", Morgan Kaufmann/Elsevier Publishers, 2004.</li> <li>6. Wesley Petersen and Peter Arbenz, "Introduction to Parallel Computing", Oxford University Press, 2004.</li> </ol>			
COURSE PLAN			
COURSE NO:	COURSE TITLE: Multicore Architecture & Programming	(L-T-P : 3-0-0)	CREDITS:3
06NE6351			
Module	Contents	Content Hours	Sem.Exam Marks: %
1	Introduction to Multi-core Architecture: Motivation for Concurrency in software- Parallel Computing Platforms- Parallel Computing in Microprocessors- Differentiating Multi-core Architectures from Hyper- Threading Technology- Multi-threading on Single-Core versus Multi-Core Platforms Understanding Performance- System Overview of Threading: Defining Threads- System View of Threads- Threading above the Operating System- Threads inside the OS- Threads inside the Hardware - Case studies – Intel Multi-core architecture – SUN CMP architecture – IBM cell processor – NVIDIA GPU – AMD APU.	9	30%

2	Fundamental Concepts of Parallel Programming: Designing for Threads- Task Decomposition- Data Decomposition- Data Flow Decomposition- Implications of Different Decompositions- Challenges- Parallel Programming Patterns- A Motivating Problem: Error Diffusion- Analysis of the Error Diffusion Algorithm- An Alternate Approach: Parallel Error Diffusion- Other Alternatives.	5	
FIRST INTERNAL EXAMINATION			
2	Threading and Parallel Programming Constructs: Synchronization- Critical Sections- Deadlock- Synchronization Primitives- Semaphores- Locks- Condition Variables- Messages- Flow Control- based Concepts- Fence- Barrier- Implementation-dependent Threading Features. Threading APIs	4	30%
3	OpenMP: A Portable Solution for Threading: Challenges in Threading a Loop- Loop-carried Dependence- Data-race Conditions- Managing Shared and Private Data- Loop Scheduling and Portioning- Effective Use of Reductions- Minimizing Threading Overhead- Work-sharing Sections	5	
SECOND INTERNAL EXAMINATION			
3	Performance oriented Programming- Using Barrier and No wait- Interleaving Single-thread and Multi-thread Execution- Data Copy-in and Copy-out- Protecting Updates of Shared Variables- Intel Task queuing Extension to OpenMP- OpenMP Library Functions- OpenMP Environment Variables- Compilation- Debugging- performance.	4	40%
4	GPU programming : The CUDA standard. Kernels and host-device communication. Shared and constant memory-synchronicity and performance. GPU coding restrictions. Overview of Open CL- Open Acc	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6451	Linux Shell Scripting	3-0-0-3	2015
Prerequisites : Operating Systems Concepts			
Course Objectives : <ul style="list-style-type: none"><li>Perform system administration tasks to manage files, software, storage, users, processes and services.</li><li>Write shell scripts for common shell environment.</li></ul>			
Syllabus : Linux Basics, Managing Users, Boot Loaders, Core System Services, File System, Shell Scripting Basics, Script Control			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Ability to perform system administration tasks</li><li>Ability develop and execute Shell Scripts as per the system level requirements</li></ul>			
Text Book : <ul style="list-style-type: none"><li>Richard Blum, Linux Command Line and Shell Scripting Bible, Wiley Publishing, Inc</li><li>WALE SOYINKA, Linux Administration:A Beginner’s Guide, Fifth Edition, McGraw-Hill</li></ul>			
References : <ul style="list-style-type: none"><li>Linux System Administration Solve Real-life Linux Problems Quickly by Tom Adelstein, Bill Lubanovic. O'Reilly Media, March 2007</li><li>Essential System Administration : Tools and Techniques for Linux and Unix Administration ( 3rd Edition), Ellen Frisch</li></ul>			
COURSE PLAN			
COURSE NO: 06NE6451	COURSE TITLE: Linux Shell Scripting	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Linux Basics: Managing Users- The /etc/passwd File- The /etc/shadow File- The /etc/group File- Pluggable Authentication Modules (PAM)- Commands - useradd- groupadd- usermod- groupmod-userdel-groupdel.Files- File Types- File Ownership- and File Permissions- File Management and Manipulation Commands- Process management commands	9	30%
2	Boot Loaders: GRUB and LILO- Bootstrapping- Init Process- rc Scripts. File System : i-Nodes - Superblocks- ext3 and ReiserFS- Overview of Partitions-Creating Partitions and Logical Volumes	5	
FIRST INTERNAL EXAMINATION			
2	Core System Services : The /etc/inittab File- The /etc/xinetd.conf File-Enabling/Disabling a Service-Invoking rsyslogd- Log Message Classifications-Format of /etc/rsyslog.conf-The crontab File-Editing the crontab File	4	30%
3	Shell Scripting Basics : Creating a Script File- Using Variables- Redirecting Input and Output- Pipes-Performing Math-Exiting the Script.Using Structured Commands : The if-then-else Statement- Advanced if-then Features- The case Command-The for Command- The C-Style for Command- The while Command- The until Command- Looping on File Data- Controlling the Loop	5	
SECOND INTERNAL EXAMINATION			

3	Handling User Input : Command Line Parameters- Special Parameter Variables- Working With Options- Understanding Input and Output- Redirecting Output in Scripts- Redirecting Input in Scripts- Using Temporary Files- Logging Messages	4	40%
4	Script Control : Handling Signals- Running Scripts in Background Mode- Running Scripts without a Console- Job Control-nice command- Scheduling a job using the at command- Using the batch command- Starting your scripts at boot. Text Manipulation: The sed editor- The gawk program	9	
END SEMESTER EXAM			



Course No.	Course Title	L-T-P-Credits	Year
06NE6071	Seminar I	0-0-2-2	2015
<p>Each student shall present a seminar on any topic of interest related to the core / elective courses offered in the first semester of the M. Tech. Programme. He / she shall select the topic based on the References: from reputed International Journals, preferably IEEE journals. They should get the paper approved by the Programme Co-ordinator / Faculty member in charge of the seminar and shall present it in the class. Every student shall participate in the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report submitted.</p> <p>Encourage students to convert these seminar topics into a good survey paper or Technical paper.</p>			

Course No.	Course Title	L-T-P-Credits	Year
06NE6081	Network Systems Lab	0-0-3-1	2015
Prerequisites : Computer Networks			
Course Objectives : <ul style="list-style-type: none"> <li>This course teaches an understanding of networks and systems design through hands-on construction and experimentation with real-world implementations.</li> </ul>			
Syllabus : <ol style="list-style-type: none"> <li>Familiarization of Wireshark</li> <li>Detailed Study of protocols in TCP/IP model using Wireshark</li> <li>Detailed Study of Subnetting and Supernetting</li> <li>Familiarization of following Linux/Unix network commands             <ol style="list-style-type: none"> <li>Ping</li> <li>tracert</li> <li>arp</li> <li>route</li> <li>netstat</li> <li>About /etc folder</li> <li>IP Setting /Subnet Masking</li> <li>Setting up Hostname/Setting local name resolution</li> </ol> </li> <li>Deploy Web, Postgre SQL, Email, DNS, DHCP, SSH FTP,SAMBA and Proxy Servers. Deploy it using virtual machines.</li> <li>Implement LDAP authentication server. Deploy it using virtual machines.</li> <li>Build your own ISP. It should include a DNS, DHCP, Leased Line, PPP, Webserver, Internet Backbone with appropriate routing protocols. Experiment may be implemented using real systems/Simulators</li> <li>Develop your own LAN with WAN for offshore connectivity. It should employ a firewall/proxy to redirect all external traffic. Use CIDR for forming departments. Experiment may be implemented using real systems/Simulators</li> <li>Network administration and defence             <ol style="list-style-type: none"> <li>Measuring Internet topology with BGP Updates</li> <li>Characterizing traffic aggregates with Netflow</li> <li>Analyzing packet-level traffic with tcpdump</li> </ol> </li> <li>Build your own firewall using IPTables.</li> <li>Configure a Distributed Computing Cluster using MPI. Deploy it using virtual machines.</li> <li>Configure a Distributed File System using Hadoop. Deploy it using virtual machines.</li> <li>Familiarization on Open Stack Cloud Computing Tool</li> <li>Familiarization of Open Shift Cloud Computing Tool</li> <li>Familiarization of Google App Engine</li> <li>Socket Programming Experiments on             <ol style="list-style-type: none"> <li>TCP Echo Server, TCP Echo Client</li> <li>UDP Echo server, UDP Echo Client</li> <li>File Server</li> <li>Broadcast, Multicast</li> <li>Simple Network Time Protocol</li> <li>TCP Iterative Server</li> <li>TCP Concurrent Server</li> </ol> </li> </ol>			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"> <li>Will Acquire hands on experience on deploying different network and server services.</li> </ul>			

## References :

1. WALE SOYINKA, Linux Administration:A Beginner's Guide, Fifth Edition, McGraw-Hill
2. Tom Adelstein, Bill Lubanovic , Linux System Administration, O'Reilly

# SEMESTER – II

Course No.	Course Title	L-T-P-Credits	Year
06NE6012	Design of Computer Networks	4-0-0-4	2015
Prerequisites : Computer Networks			
Course Objectives : <ul style="list-style-type: none"> <li>To obtain knowledge on major protocols used in computer networks for the design of LAN, WAN and WLAN systems</li> <li>To analyse and resolve all issues in implementing the selected protocols at LAN, WAN and WLAN designs</li> <li>To apply the detailed knowledge and understanding of secure network architectures for the design and implementation of firewalls</li> </ul>			
Syllabus : Overview of Analysis, Architecture and Design Process, Requirement Analysis Process, Developing the requirements specification Individual and Composite Flows, Architecture and design, Design Concepts, Network Management Architecture, Design Concepts.			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"> <li>analyse the use of models for performance measures and performance prediction of advanced data networks;</li> <li>demonstrate practical ability to design and setup LANs, WANs, and wireless LANs using standard protocols and typical hardware;</li> <li>make recommendations for network performance improvements;</li> <li>demonstrate practical skills in setting up TCP/IP connections and routing configurations for different environments;</li> </ul>			
Text Book : <ol style="list-style-type: none"> <li>Network Analysis, Architecture, and Design By James D. McCabe, Morgan Kaufmann, Third Edition, 2007.ISBN-13: 978-0123704801</li> </ol>			
References : <ol style="list-style-type: none"> <li>Computer Networks: A Systems Approach by Larry L. Peterson, Bruce S. Davie - 2007, Elsevier Inc.</li> <li>Top-down Network Design: [a Systems Analysis Approach to Enterprise Network Design] By Priscilla Oppenheimer, Cisco Press , 3rd Edition, ISBN-13: 978-1-58720- 283-4 ISBN-10: 1-58720-283-2</li> <li>Integrated Management of Networked Systems: Concepts, Architectures, and Their Operational Application (The Morgan Kaufmann Series in Networking), Heinz-Gerd Hegering, Sebastian Abeck, and Bernhard Neumair, 1999.</li> <li>"Network Design and Management" – by Steven T.Karris, Orchard publications, Second edition, Copyright 2009, ISBN 978-1-934404-15-7</li> <li>"Network Design, Management and Technical Perspective", Teresa C. Mann-Rubinson and Kornel Terplan, CRC Press, 1999</li> <li>"Ethernet Networks-Design, Implementation, Operation and Management by Gilbert Held,John Wiley and sons, Fourth Edition</li> <li>James Kurose and Keith Ross, "Computer Networking: A Top-Down Approach Featuring theInternet", 1999</li> </ol>			
COURSE PLAN			
COURSE NO: 06NE6012	COURSE TITLE: Design of Computer Networks	(L-T-P : 4-0-0)	CREDITS:4
Module	Contents	Content Hours	Sem.Exam Marks:%

1	Overview of Analysis, Architecture and Design Process-System Methodology, Service methodology- Service Description - Service characteristics - Performance Characteristics -Network supportability - Requirement analysis – User Requirements – Application Requirements – Device Requirements – Network Requirements – Other Requirements - Requirement specification and map.	9	30%
2	Requirement Analysis Process – Gathering and Listing Requirements- Developing service metrics – Characterizing behavior – Developing RMA requirements – Developing delay Requirements - Developing capacity Requirements - Developing supplemental performance Requirements – Requirements mapping	5	
FIRST INTERNAL EXAMINATION			
2	Developing the requirements specification Individual and Composite Flows – Critical Flows - Identifying and developing flows – Data sources and sinks – Flow models- Flow prioritization – Flow specification algorithms – Example Applications of Flow Analysis	4	30%
3	Architecture and design – Component Architectures – Reference Architecture – Architecture Models – System and Network Architecture – Addressing and Routing Architecture – Addressing and Routing Fundamentals – Addressing Mechanisms – Addressing Strategies – Routing Strategies	5	
SECOND INTERNAL EXAMINATION			
3	Network Management Architecture – Network Management Mechanisms Performance Architecture – Performance Mechanisms – Security and Privacy Architecture – Planning security and privacy Mechanisms	4	40%
4	Design Concepts – Design Process - Network Layout – Design Traceability – Design Metrics – Logical Network Design – Topology Design – Bridging- Switching and Routing Protocols- Physical Network Design – Selecting Technologies and Devices for Campus and Enterprise Networks – Optimizing Network Design	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6022	Foundations in Big Data Processing	3-0-0-3	2015
Prerequisites : NIL			
Course Objectives : <ul style="list-style-type: none"><li>The course provides an introduction to Data Science.</li></ul>			
Syllabus : Introduction to KDD process, Association Rule Mining , Classification vs. Prediction, Support Vector Machines , Cluster Analysis,Hadoop			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Understand basic concepts in data mining</li><li>Learn how to map data mining concepts to big data streams</li><li>Fundamental knowledge in Big data tool</li></ul>			
Text Book : 1. Jiawei Han and Micheline Kamber, “Data Mining Concepts and Techniques” Second Edition, Elsevier, Reprinted 2008.			
References : 1. K.P. Soman, Shyam Diwakar and V. Ajay, “Insight into Data mining Theory and Practice”, Easter Economy Edition, Prentice Hall of India, 2006. 2. G. K. Gupta, “Introduction to Data Mining with Case Studies”, Easter Economy Edition, Prentice Hall of India, 2006. 3. BERSON, ALEX & SMITH, STEPHEN J, Data Warehousing, Data Mining, and OLAP, TMH Pub. Co. Ltd, New Delhi, 2012 4. Pang-Ning Tan, Michael Steinbach and Vipin Kumar, “Introduction to Data Mining”, Pearson Education, 2007 5. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012. 6. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.			
COURSE PLAN			
COURSE NO: 06NE6022	COURSE TITLE: Foundations in Big Data Processing	(L-T-P : 3-0-0)	CREDITS:4
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction to KDD process – Knowledge Discovery from Databases - Need for Data Preprocessing – Data Cleaning – Data Integration and Transformation – Data Reduction – Data Discretization and Concept Hierarchy Generation.Association Rule Mining - Mining Frequent Itemsets with and without Candidate Generation - Mining Various Kinds of Association Rules - Constraint- Based Association Mining.	9	30%
2	Classification vs. Prediction – Data preparation for Classification and Prediction – Classification by Decision Tree Induction – Bayesian Classification – Rule Based Classification	5	
FIRST INTERNAL EXAMINATION			

2	Support Vector Machines – Associative Classification – Lazy Learners – Other Classification Methods – Prediction – Accuracy and Error Measures – Evaluating the Accuracy of a Classifier or Predictor. Cluster Analysis: - Types of Data in Cluster Analysis- A Categorization of Major Clustering Methods – Partitioning Methods – Hierarchical methods – Density-Based Methods – Grid-Based Methods – Model-Based Clustering Methods	4	30%
3	Clustering High- Dimensional Data – Constraint- Based Cluster Analysis – Outlier Analysis. Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes.	5	
SECOND INTERNAL EXAMINATION			
3	Design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow- Data Ingest with Flume and Sqoop. Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures- MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN	9	40%
4	job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats Introduction to Hbase- Introduction to Cassandra- Introduction to Pig- Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries.	4	
END SEMESTER EXAM			



Course No.	Course Title	L-T-P-Credits	Year
06NE6032	Enterprise Devices & Networks	3-0-0-3	2015
Prerequisites : Cloud computing			
Course Objectives :			
<ul style="list-style-type: none"><li>To attain basic ideas and principles in data center design and management.</li></ul>			
Syllabus :			
Introduction to Cloud Networking, Switch Fabric Technology , Cloud Data Center Networking Topologies , Data Center Evolution, Cloud Data Center Networking Topologies, Server Virtualization and Networking, Storage Networks , Software-Defined Networking			
Course Outcome :			
On successful completion of this course			
<ul style="list-style-type: none"><li>Apply the fundamental concepts in datacenters to understand the tradeoffs in power, efficiency and cost.</li><li>Discuss system virtualization and outline its role in enabling the cloud computing system model.</li></ul>			
Text Book :			
1. Gary Lee, “Cloud Networking - Understanding Cloud-based Data Center Networks”, Elsevier, 2014			
References :			
1.			
COURSE PLAN			
COURSE NO: 06NE6032	COURSE TITLE: Enterprise Devices & Networks	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction to Cloud Networking: Networking Basics- The network stack- Packets and frames- Network equipment- Interconnect- Cloud Data Center- Cloud Networking- Characteristics of Cloud Networking- Ethernet usage- Virtualization- Convergence- Scalability- Software. Data Center Evolution: Mainframes to the Cloud: The Data Center Evolution- Computer Networks- Ethernet- Enterprise versus Cloud Data Centers- Movement to the Cloud.	9	30%
2	Switch Fabric Technology: Switch Fabric Architecture Overview- Switch Fabric Topologies- Congestion Management- Flow Control- Traffic Management- Switch Chip Architecture Examples	5	
FIRST INTERNAL EXAMINATION			
2	Cloud Data Center Networking Topologies: Traditional Multitiered Enterprise Networks- Data Center Network Switch Types, Flat Data Center Networks, Rack Scale Architectures, Network Function Virtualization.	4	30%
3	Data Center Networking Standards: Ethernet Data Rate Standards, Virtual Local Area Networks- Data Center Bridging- Improving Network Bandwidth- Remote Direct Memory Access.	5	
SECOND INTERNAL EXAMINATION			
3	Server Virtualization and Networking: VM Overview- Virtual Switching- PCI Express- Edge Virtual Bridging- VM Migration. Network Virtualization: Multi-tenant Environments- Traditional Network Tunneling Protocols- VXLAN- NVGRE- Tunnel	4	40%

	Locations- Load Balancing		
4	Storage Networks: Storage Background- Advanced Storage Technologies- Storage Communication Protocols- Network Convergence- Software-Defined Storage- Storage in Cloud Data Centers. Software-Defined Networking: Data Center Software Background- OpenStack- OpenFlow- Network Function Virtualization- SDN Deployment.	9	
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year
06NE6142	Modern Concurrent Programming Paradigm	3-0-0-3	2015
Prerequisites : NIL			
Course Objectives : <ul style="list-style-type: none"><li>The course is designed for people who want to gain expertise in their understanding of concurrent programming paradigm.</li></ul>			
Syllabus : Design Patterns and MapReduce, Summarization Patterns, Filtering Patterns, Data Organization Patterns Join Patterns, Metapatterns, Input and Output Patterns, Erlang , Fundamentals on Erlang Programming, Concurrent Programming			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Understand about the commonly used Design Patterns in MapReduce</li><li>Learn the scenarios where to apply those Patterns in real world problems</li><li>Write mature code using MapReduce</li><li>Learn the best practices for using MapReduce</li><li>Fundamental knowledge on Erlang and its use in concurrent programming</li></ul>			
Text Book : <ul style="list-style-type: none"><li>Donald Miner &amp; Adam Shook , “ MapReduce Design Patterns ” ,Published by O’Reilly Media, Inc., 1005 Gravenstein Highway North, Sebastopol, CA 95472.</li><li>Joe Armstrong, Programming Erlang Software for a Concurrent World, Second Edition, The Pragmatic Bookshelf</li></ul>			
References : <ol style="list-style-type: none"><li>Jeffy Patton, “User Story Mapping Discover the Whole Story, Build the Right Product ”, O’Reilly Media, September 2014</li><li>Sandeep Karanth, “Mastering Hadoop”,Packt Publishing Ltd, 29-Dec-2014.</li><li>Thilina Gunarathne, “Hadoop MapReduce v2 Cookbook - Second Edition”, Packt Publishing Ltd, 25-Feb-2015</li><li>Francesco Cesarini and Simon Thompson, Erlang Programming, O’Reilly Media</li></ol>			
COURSE PLAN			
COURSE NO: 06NE6142	COURSE TITLE: Modern Concurrent Programming Paradigm	L-T-P : 3-0-0	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Design Patterns and MapReduce - Summarization Patterns:Numerical Summarizations - Pattern Description - Numerical Summarization - Filtering Patterns:Filtering-Pattern Description-Filtering Examples-Bloom Filtering-Pattern Description-Bloom Filtering	9	30%
2	Data Organization Patterns: Structured to Hierarchical - Partitioning -Binning-Pattern-Total Order Sorting- Shuffling Join Patterns:Reduce Side Join -Replicated Join -Composite Join-Cartesian Product	4	
FIRST INTERNAL EXAMINATION			
2	Metapatterns - Job Chaining - Chain Folding - Job Merging Input and Output Patterns.:Customizing Input and Output in Hadoop-Generating Data- External Source Output- External Source Input- Partition Pruning	5	30%

3	Erlang Programming : Introducing Concurrency - The Shell - Processes- Modules- and Compilation - Basic Concepts - Starting and Stopping the Erlang Shell - Simple Integer Arithmetic – Variables - Floating-Point Numbers – Atoms – Tuples – Lists – Strings	6	
SECOND INTERNAL EXAMINATION			
3	Modules and Functions - Simple List Processing - List Comprehensions – BIFs – Guards - case and if Expressions - Building Lists in Natural Order – Accumulators - Records and Maps	3	40%
4	Concurrent Programming – Processes - Receive with a Timeout - Selective Receive - Registered Processes - Tail Recursion - Distributed Programming - Models for Distribution - Building the Name Server - Libraries and BIFS for Distributed Programming - Socket-Based Distribution	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6242	Distributed Algorithms	3-0-0-3	2015
Prerequisites : Basic familiarity with algorithms, including theory.			
Course Objectives :			
<ul style="list-style-type: none"><li>The course is intended to give students a thorough introduction to the topic of distributed algorithms with emphasis on principles and theory.</li></ul>			
Syllabus :			
Introduction to model of synchronous distributed computing system, Introduction to model of asynchronous distributed computing system, Resource Allocation.			
Course Outcome :			
On successful completion of this course			
<ul style="list-style-type: none"><li>The student will have developed a working understanding of the distributed problem domain and its main tools and techniques and be able to use these techniques in their own research.</li></ul>			
Text Book :			
1. Nancy A. Lynch, Morgan," Distributed Algorithms", Kaufmann Publishers, Inc			
References :			
1. Wolfgang Reisig, W. Reisig, "Elements Of Distributed Algorithms: Modeling And Analysis With Petri Nets", Springer-verlag			
2. Tel Gerard , "Introduction To Distributed Algorithms", 2nd Edition, Cambridge University Press			
3. Sukumar Ghosh, "Distributed Systems: An Algorithmic Approach (Hardcover)", Chapman & Hall/crc			
4. Valmir C. Barbosa,"An Introduction To Distributed Algorithms", Mit Press			
5. Randy Chow, Theodore Johnson, "Distributed Operating Systems and Algorithm Analysis, , Pearson Education			
6. Santoro N., Nicola Santoro, "Design And Analysis Of Distributed Algorithms", Wiley-interscience			
7. Fionnuala O'donnell, Vdm Verlag Dr. Muller, "A Simulated Framework For The Teaching Of Distributed Algorithms", Aktiengesellschaft & Co. Kg			
8. Ajay D. Kshemkalyani, Mukesh Singhal, "Distributed Computing - Principles, Algorithms, And Systems", Cambridge University Press			
COURSE PLAN			
COURSE NO: 06NE6242	COURSE TITLE: Distributed Algorithms	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction to model of synchronous distributed computing system- Leader election in a General Network - Simple Flooding Algorithm- Basic Breadth-First Search Algorithm.- Bellman-Ford algorithm.	9	30%
2	Algorithms in Synchronous Networks- Minimum Spanning Tree- Leader Election in a Synchronous Ring - LCR algorithm- HS algorithm- Time Slice Algorithm- Variable Speeds Algorithm- Lower Bound for Comparison-Based Algorithms	5	
FIRST INTERNAL EXAMINATION			
2	Maximal Independent Set- LubyMIS algorithm. Distributed Consensus with Link Failures and Process Failures – Basics	4	30%
3	Introduction to model of asynchronous distributed computing system- Send/Receive systems- Broadcast systems- Multicast systems- Basic algorithms- Peterson Leader-Election Algorithm- Local Synchronizer- Safe Synchronizer.	5	

SECOND INTERNAL EXAMINATION			
3	Asynchronous System Model. Shared Memory Systems- Environment Model- Shared Variable Types- Mutual Exclusion - Asynchronous Shared Memory Model- Dijkstra's Mutual Exclusion Algorithm.	4	40%
4	Resource Allocation - Nonexistence of Symmetric Dining Philosophers Algorithms- Right-Left Dining Philosophers Algorithm- mutual exclusion and consensus- relationship between shared memory and network models- asynchronous networks with failures	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6342	High Performance Networks	3-0-0-3	2015
Prerequisites : Computer Networks			
Course Objectives :			
<ul style="list-style-type: none"> <li>To introduce the new developments in modern networking systems, multimedia communications and high speed networks.</li> </ul>			
Syllabus :			
Network Performance analysis, Gigabit Ethernet, ADSL and DSL Technologies, Introduction to MPLS and QOS, Network Components of MPLS, Storage and networking concepts, SAN topologies			
Course Outcome :			
On successful completion of this course			
<ul style="list-style-type: none"> <li>Describe and interpret the basics of high speed networking technologies.</li> <li>Apply the concept learnt in this course to optimize and troubleshoot high-speed network.</li> <li>Demonstrate the knowledge of network planning and optimization</li> </ul>			
Text Book :			
<ol style="list-style-type: none"> <li>Alex Goldman, "Storage Area Networks Fundamentals", Cisco Press 2002</li> <li>Storage Area Network Essentials: a Complete Guide to understanding and implementing SANs- Richard Barker and Paul Massiglia, John Wiley India</li> </ol>			
References :			
<ol style="list-style-type: none"> <li>Storage Networks Explained – Uif Troppens, Raiver Erkens and Wolfgang Muller, John Wiley &amp; Sons, 2003.</li> <li>William Stallings: ISDN And BISDN</li> <li>William Stallings: High Speed Networks</li> <li>M Shwartz: Telecommunication Network Protocol Modeling And Analysis: Addison Wesley</li> <li>Gallangar: Data Networks: Prentice Hall</li> <li>Fred Halsall: Data Communication Computer Networks, And Open Systems: Addison Wesley.</li> <li>Kershanbaum : Telecommunication Network Design Algorithms: MGH</li> <li>Jochetl Schiller: Mobile Communication: Addison Wesley.</li> <li>Tanenbaum: Computer Networks: PHI</li> <li>Johnson: Fast Ethernet</li> <li>Tom Clark, "Designing Storage Area Networks", Addison-Wesley Professional, 1st edition, 1999</li> <li>Storage Networks: The Complete Reference – Robert Sparding, Tata Mcgraw Hills, 2003.</li> </ol>			
COURSE PLAN			
COURSE NO: 06NE6342	COURSE TITLE: High Performance Networks	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Network Performance analysis : Objectives and requirements for Quality of Service (QoS) in high performance networks. Architecture of high performance networks (HPN)- design issues- protocols for HPN- VHF backbone networks- virtual interface architectures- virtual interface for networking- High-speed switching and routing - internet and PSTN IP switching techniques- SRP protocols- SRP authentication- and key exchange- comparison of TCP/IP- FTP- TELNET- queuing systems- network modeling as a graph	9	30%

2	Gigabit Ethernet : Architecture- standards- interface-applications- network design Frame relay: Frame relay protocols and services- frame relay congestion Control ATM: Architecture- protocol- switching- traffic and congestion control- flow control ATM service categories- ATM in LAN environment- classical IP over ATM	5	
FIRST INTERNAL EXAMINATION			
2	ADSL and DSL Technologies : Background and technological capabilities- Standards and associations- Architecture. Fiber Optics Communication: GPON (Gigabit capable Passive Optical Network)- SONET/SDH and comparison with other available standards.	4	30%
3	Introduction to MPLS and QOS- Network Components of MPLS-working RSVP protocol- MPLS network Components- MPLS basic working- Applications- IETF approach- RSVP protocol- Integrated & differential Services Framework.	5	
SECOND INTERNAL EXAMINATION			
3	Storage and networking concepts – SCSI bus architecture – Networking in front of the server – Networking behind the server – Network -attached Storage – Fibre channel internals – Layers – Data encoding – Framing protocol – class of service – flow control – Name and addressing conventions.	4	40%
4	SAN topologies – Point-to Point – Arbitrated Loop – Loop Addressing-Loop Initialization-Port Login-Loop port state machine – Design considerations for Arbitrated Loop –Fabrics – Fabric login – Simple Name Server – State Change Notification – Private Loop Support – Fabric Zoning – Building Extended SANs. Fibre Channel Products – Gigabit Interface Converters (GBICs) – host Bus Adapters – Fibre channel RAID – Fibre channel JBODs – Arbitrated Loop Hubs – hub Architecture – Unmanaged Hubs – Managed Hubs – Switching Hubs – Fabric Switches – Fibre Channel-to-SCSI Bridges – SAN software Products – Problem isolation in SANs – Isolation Techniques – Fibre channel Analyzers.	9	
END SEMESTER EXAM			



Course No.	Course Title	L-T-P-Credits	Year
06NE6442	Internet Routing Design	3-0-0-3	2015
Prerequisites : Computer Networks			
Course Objectives : <ul style="list-style-type: none"><li>To study the design, operation, and challenges of the Internet as a global network.</li></ul>			
Syllabus : Routing protocols: framework and principles, Internet routing and Router architectures, Analysis of network algorithms, Quality of service routing, Routing and Traffic engineering			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Able to describe the architecture of the Internet.</li><li>Able to describe the functions performed by routers.</li><li>Able to describe IP switching and the operation of MPLS</li></ul>			
Text Book : 1. Network Routing: Algorithms, Protocols, and Architectures Deepankar Medhi and Karthikeyan Ramasamy (Morgan Kaufmann Series in Networking)			
References : 1. Network Algorithmics: An Interdisciplinary Approach to Designing Fast Networked Devices George Varghese (Morgan Kaufmann Series in Networking) 2. TCP/IP Protocol Suite, (B.A. Forouzum) Tata McGraw Hill Edition, Third Edition 3. TCP/IP Volume 1,2,3 (N. Richard Steveus Addison Wesley) 4. Computer Networks (A.S. Taueubaum) Pearson Edition, 4th Edition			
COURSE PLAN			
COURSE NO: 06NE6442	COURSE TITLE: Internet Routing Design	(L-T-P : 3--0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	ROUTING PROTOCOLS: FRAMEWORK AND PRINCIPLES : Routing Protocol- Routing Algorithm- and Routing Table- Routing Information Representation and Protocol Messages- Distance Vector Routing Protocol- Link State Routing Protocol- Path Vector Routing- Protocol- Link Cost.	9	30%
2	INTERNET ROUTING AND ROUTER ARCHITECTURES : Architectural View of the Internet- Allocation of IP Prefixes and AS Number- Policy- Based Routing- Point of Presence- Traffic Engineering Implications- Internet Routing Instability. Router Architectures: Functions- Types- Elements of a Router- Packet Flow- Packet Processing: Fast Path versus Slow Path- Router Architectures	5	
FIRST INTERNAL EXAMINATION			
2	ANALYSIS OF NETWORK ALGORITHMS : Network Bottleneck- Network Algorithmics- Strawman solutions- Thinking Algorithmically- Refining the Algorithm- Cleaning up- Characteristics of Network Algorithms.	4	30%

3	IP Address Lookup Algorithms : Impact- Address Aggregation- Longest Prefix Matching- Naïve Algorithms- Binary - Multibit and Compressing Multibit Tries- Search by Length Algorithms- Search by Value Approaches- Hardware Algorithms- Comparing Different Approaches IP Packet Filtering and Classification : Classification- Classification Algorithms- Naïve Solutions- Two-Dimensional Solutions- Approaches for d Dimensions-	5	
SECOND INTERNAL EXAMINATION			
3	QUALITY OF SERVICE ROUTING : QoS Attributes- Adapting Routing: A Basic Framework. Update Frequency- Information Inaccuracy- and Impact on Routing- Dynamic Call Routing in the PSTN- Heterogeneous Service- Single-Link Case- A General Framework for Source-Based QoS Routing with Path Caching - Routing Protocols for QoS Routing.	4	40%
4	ROUTING AND TRAFFIC ENGINEERING : Traffic Engineering of IP/MPLS Networks- VPN Traffic Engineering- Problem Illustration: Layer 3 VPN- LSP Path Determination: Constrained Shortest Path Approach- LSP Path Determination: Network Flow Modeling Approach- Layer 2 VPN Traffic Engineering- Observations and General Modeling Framework- Routing/Traffic Engineering for Voice Over MPLS.	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6152	Cyber Physical Systems	3-0-0-3	2015
Prerequisites : Nil			
Course Objectives : <ul style="list-style-type: none"><li>To understand the fundamental and practical issues in designing and analysing cyber-physical systems.</li></ul>			
Syllabus : Cyber-Physical Systems Concepts, Modeling Issues in Cyber-Physical Systems, Sensor based Cyber Physical Systems, Civilian cyber-physical system applications, Ubiquitous computing: basics and vision.			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Understand the basic principles of Cyber Physical Systems</li></ul>			
Text Book : 1. Cyber-Physical Systems: Integrated Computing and Engineering Design, Fei Hu CRC Press, 26-Sep-2013			
References : 1. Ubiquitous Computing: Smart Devices, Environments and Interactions By Stefan Poslad,John Wiley & Sons Ltd			
COURSE PLAN			
COURSE NO: 06NE6152	COURSE TITLE: Cyber Physical Systems	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Cyber-Physical Systems Concepts - Cyber-Physical Systems: Design Challenges- Mobile Cyber-Physical Systems DESIGN PRINCIPLES: Cyber-Physical System Controls- Apprenticeship Learning for Cyber-Physical System- Intelligence Application of HDP- HMM in Recognition of Dynamic Hand Gestures.	9	30%
2	Modeling Issues in Cyber-Physical Systems Cyber-Physical System Modeling on Cognitive Unmanned Aerial Vehicle Cyber-Physical System Security—Smart Grid Example	5	
FIRST INTERNAL EXAMINATION			
2	SENSOR-BASED CYBER-PHYSICAL SYSTEMS: Wireless Sensor and Actuator Networks for Cyber-Physical System Applications-Community Sensing- Wireless Embedded/Implanted Microsystems: Architecture and Security-The Application of Machine Learning in Monitoring Physical Activity with Shoe Sensors	4	30%
3	CIVILIAN CYBER-PHYSICAL SYSTEM APPLICATIONS Energy Efficient Building- Cyber-Physical System for Smart Grid Applications -Cyber-Physical System for Transportation Applications-Video Communications in Unmanned Aerial Vehicle-Based -Cyber- Physical Systems.	5	
SECOND INTERNAL EXAMINATION			
3	UBIQUITOUS COMPUTING: BASICS AND VISION Ubiquitous Communication -Data Networks-Wireless Data Networks - Universal and Transparent Audio- Video and Alphanumeric Data Network Acces-Ubiquitous Networks -Further Network Design	4	40%

	Issues -Service Oriented Networks		
4	Management of Smart Devices -Managing Smart Devices in Virtual Environments -Managing Smart Devices in Human User Centred Environments -Ubiquitous System: Challenges and Outlook -Overview of Challenges -Smart Devices -Smart Human Device Interaction -Human Intelligence Versus Machine Intelligence -Social Issues: Promise Versus Peril Case study: Smart city networks	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6252	Network Security	3-0-0-3	2015
Prerequisites : Basic knowledge of computer networking & Protocols			
Course Objectives : <ul style="list-style-type: none"><li>Understand security concepts, Ethics in Network Security.</li><li>Comprehend and apply relevant protocol like SSL, SSH etc.</li></ul>			
Syllabus : Security Problem in TCP/IP Protocol Suite, Security at Network Layer, Security at Transport Layer, Security at Application Layer, Firewalls and IDS.			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Should be able to identify network security threats and determine efforts to counter them</li><li>Understand the security in different layers of protocol stack.</li></ul>			
Text Book : 1. Stallings, W., "Cryptography and Network Security: Theory and Practice", Second Edition, John Wiley.			
References : 1. "Charles P. Pfleeger "Security in computing", Pearson Education 2. Stalling W., "Network Security Essentials", Pearson 3. Garfinkel S., Spafford G., "Practical Unix and Internet Security", O'Reilly 4. Blacharski D., "Network Security in a Mixed Environment" Practical Packet Analysis: Using Wireshark to Solve Real-Word Network problems by Chris Sanders			
COURSE PLAN			
COURSE NO: 06NE6252	COURSE TITLE: Network Security	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Security Problem in TCP/IP Protocol Suite: Identification of Security issues in Ethernet- ARP- IP- TCP- Application and Routing protocols. Security Models: Military and civil security- vulnerability and threat models- End-end security ( COMSEC)- I n k encryption (TRANSEC)- compartments. Privacy. Authentication. Denial of service. Nonrepudiation. Issues in multi-level secure systems. Internet security models: IPv4/IPv6 encapsulation header	9	30%
2	Security at Network Layer: Routing algorithm vulnerabilities: route and sequence number spoofing- instability and resonance effects. Information hiding: DMZ networks- route aggregation and segregation ICMP redirect hazard: denial of service. ARP hazard: phantom sources- ARP explosions and slow links. Defending against Chernobyl packets and meltdown.	5	
FIRST INTERNAL EXAMINATION			

2	Fragmentation vulnerabilities and remedies: (ICMP Echo overrun) IPSec: IP Security Overview- IP Security Architecture- Security Associations- Security Association Database- Security Policy Database- Tunnel and Transport mode- AH and ESP- IP and IPv6- Encapsulating Security Payload- Internet Key Exchange	4	30%
3	Security at Transport Layer: SSL and TLS Secure network infrastructure services: DNS, NTP, SNMP, SSL Architecture, SSL/TLS Basic Protocol, SSL Message Formats, Session Resumption, Computing the keys, Client Authentication, PKI as deployed by SSL, Version Numbers, Negotiating Cipher Suites, Negotiating Compression Methods, Exportability, Encoding,	5	
SECOND INTERNAL EXAMINATION			
3	Mobile systems: Address Export and re-use. Session key management: Blindkey cryptosystems (NTP). Security at Application Layer: PGP- S/MIMIE E-mail security- PGP- PEM- S/MIME- Secure binding of multimedia streams- Secure RTP. Secure RSVP.	4	40%
4	Firewalls and IDS - Firewalls: Network partitioning- firewall platforms- partitioning models and methods- Secure SNMP- Secure routing interoperability: virtual networks (DARTnet/CAIRN). Transparent and opaque network services. Source masking and hidden channels. IDS- Honeypots-Honey nets	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6352	Advances in Storage Area Networks	3-0-0-3	2015
Prerequisites : Computer Networks, Operating Systems			
Course Objectives :			
<ul style="list-style-type: none"><li>To Understand Storage Area Networks characteristics and components.</li><li>To Define storage management software and its application to storage</li></ul>			
Syllabus :			
Server Centric IT Architecture and its Limitations, I/O Techniques, Network Attached Storage , Storage Virtualization, SAN Architecture, Management of Storage Network.			
Course Outcome :			
On successful completion of this course			
<ul style="list-style-type: none"><li>Understand Storage Area Networks characteristics and components.</li><li>Familiar with storage virtualization.</li></ul>			
Text Book :			
1. Ulf Troppens, Rainer Erkens and Wolfgang Muller: Storage Networks Explained, Wiley India,2013.			
References :			
1. Robert Spalding: "Storage Networks The Complete Reference", Tata McGraw-Hill, 2011.			
2. Marc Farley: Storage Networking Fundamentals – An Introduction to Storage Devices, Subsystems, Applications, Management, and File Systems, Cisco Press, 2005.			
3. Richard Barker and Paul Massiglia: "Storage Area Network Essentials A CompleteGuide to understanding and Implementing SANs", Wiley India, 2006.			
COURSE PLAN			
COURSE NO: 06NE6352	COURSE TITLE: Advances in Storage Area Networks	(L-T-P : 3-1-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction: Server Centric IT Architecture and its Limitations; Storage – Centric IT Architecture and its advantages. Case study: Replacing a server with Storage Networks The Data Storage and Data Access problem; The Battle for size and access. Intelligent Disk Subsystems: Architecture of Intelligent Disk Subsystems; Hard disks and Internal I/O Channels; JBOD-Storage virtualization using RAID and different RAID levels; Caching: Acceleration of Hard Disk Access; Intelligent disk subsystems- Availability of disk subsystems.	9	30%
2	I/O Techniques: The Physical I/O path from the CPU to the Storage System; SCSI; Fibre Channel Protocol Stack; Fibre Channel SAN; IP Storage.	5	
FIRST INTERNAL EXAMINATION			
2	Network Attached Storage: The NAS Architecture- The NAS hardware Architecture- The NAS Software Architecture- Network connectivity- NAS as a storage system. File System and NAS: Local File Systems; Network file Systems and file servers; Shared Disk file systems; Comparison of fibre Channel and NAS.	4	30%

3	Storage Virtualization: Definition of Storage virtualization ; Implementation Considerations; Storage virtualization on Block or file level; Storage virtualization on various levels of the storage Network; Symmetric and Asymmetric storage virtualization in the Network.	5	
SECOND INTERNAL EXAMINATION			
3	SAN Architecture and Hardware devices: Overview- Creating a Network for storage; SAN Hardware devices; The fibre channel switch; Host Bus Adaptors; Putting the storage in SAN; Fabric operation from a Hardware perspective. Software Components of SAN: The switch's Operating system; Device Drivers; Supporting the switch's components; Configuration options for SANs.	4	40%
4	Management of Storage Network: System Management- Requirement of management System- Support by Management System- Management Interface- Standardized Mechanisms- Property Mechanisms- In-band Management- Use of SNMP- CIM and WBEM- Storage Management Initiative Specification (SMI-S)- CMIP and DMI	9	
END SEMESTER EXAM			



Course No.	Course Name	L-T-P-Credits	Year
06NE6452	Next Generation Internetworking Protocol	3-0-0-3	2015
Prerequisites : Computer Networks			
Course Objectives : <ul style="list-style-type: none"><li>To understand IPv6</li></ul>			
Syllabus : Introduction to IPv6, IPv6 Addressing, IPv6 Address Types, ICMPv6 and Neighbor Discovery Protocol, IPv6 Configuration, Introduction to Routing IPv6			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Know and design network with IPv6</li><li>Background Justification and Perspective for IPv6</li></ul>			
Text Book : 11. Rick Graziani , IPv6 Fundamentals: A Straightforward Approach to Understanding IPv6, Cisco Press			
References : 1. Silvia Hagen, IPv6 Essentials, ISBN-13: 978-1449319212, 3 <sup>rd</sup> EditionO'Reilly 2. Edward Horley , Practical IPv6 for Windows Administrators, Apress, ISBN-13: 978-1430263708, First Edition			
COURSE PLAN			
COURSE NO: 06NE6452	COURSE TITLE: Next Generation Internetworking Protocol	(L-T-P :3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction to IPv6 : History of IPv6- Benefits of IPv6- IPv4 Address Depletion- IPv4 Header- IPv6 Header- Comparing IPv4 and IPv6	9	30%
2	IPv6 Addressing- Representation of IPv6 Addresses- Prefix Notation- Global Unicast Address- Subnetting	3	
FIRST INTERNAL EXAMINATION			
2	IPv6 Address Types : IPv6 Address Space- Unicast Address-Global Unicast Address-Manual Global Unicast Configuration-Dynamic Configuration-Link-local Unicast-Dynamic Link-local Address: EUI-64 109-Randomly Generated Interface IDs-Static Link-local Address-Link-local Addresses and Duplicate Address Detection-Link-local Addresses and Default Gateways- Isolated Link-local Address-Loopback Address-Unspecified Address- Unique Local Address-IPv4 Embedded Address-IPv4-Compatible IPv6 Addresses-IPv4-Mapped IPv6 Addresses-Multicast	6	30%
3	ICMPv6 and Neighbor Discovery Protocol: General Message Format- ICMP Error Messages- Path MTU Discovery ICMP Informational Messages-Neighbor Discovery Protocol	4	
SECOND INTERNAL EXAMINATION			
3	IPv6 Configuration- Configuring Global Unicast Addresses-Configuring Link-local Addresses- Enabling IPv6 Packet Forwarding and ND Router Advertisements- Tuning Neighbor Discovery Parameters	5	40%

4	Introduction to Routing IPv6- IPv6 Routing Table- Configuring IPv6 Static Routes- RIPng for IPv6- EIGRP for IPv6-OSPFv3 DHCPv6 Services- Basics of Dual-Stack and Tunneling- Basics of Network Address Translation IPv6 to IPv4 (NAT64)	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE6062	Mini Project	0-0-4-2	2015
<p>Each student shall identify a Mini project from networks and related areas . The Mini project work has to be carried out within the department itself. There is a project guide allotted to each student by the head of the division / course coordinator. The project work shall be reviewed and evaluated periodically by the project guide. At the end of the semester, each student shall submit a project report . The project must be evaluated by a team comprising of 3 internal examiners including the project guide,coordinator &amp; a senior faculty member.</p> <p>Encourage students to convert Mini Project work into a good Technical paper.</p>			

Course No.	Course Title	L-T-P-Credits	Year
06NE6072	Network Simulation Lab	0-0-3-1	2015
Prerequisites : Computer Networks, Wireless Sensor Networks, Cloud Computing, Fundamentals of Big Data Processing			
Course Objectives : <ul style="list-style-type: none"> <li>• To learn and simulate computer networks using in NS2/ns3/OMNeT++</li> <li>• To learn and simulate cloud computing environment using cloudsim</li> <li>• To learn and implement map reduce programs</li> <li>• Visualising network data using Gephi</li> </ul>			
Syllabus : <ol style="list-style-type: none"> <li>1. Familiarizing a network simulator tool - OMNeT++/ns3/ns2(least preference) (Select one for experiments)</li> <li>2. Simulate a wired network consisting of TCP and UDP Traffic and then calculate their respective throughput.</li> <li>3. Compare the behavior of different variants of TCP (Tahoe, Reno, Vegas....) in wired network. Comparison can be done on the congestion window behavior by plotting graph.</li> <li>4. Simulation of wireless Ad hoc networks</li> <li>5. Simulate a wireless network consisting of TCP and UDP Traffic and then calculate their respective throughput.</li> <li>6. Familiarization of CloudSim with suitable examples.</li> <li>7. Modeling and simulation Cloud computing environments, including Data Centers, Hosts and Cloudlets and perform VM provisioning using CloudSim. (Atleast 3 Experiments)</li> <li>8. Implementtion of Map Reduce concepts (Atleast 3 Experiments)</li> <li>9. Familiarization of Graph Visualizing Tool – Gephi.</li> <li>10. Graph Visualization experiments (Atleast 3 Experiments)</li> </ol>			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"> <li>• Simulation experience in NS2/ns3/OMNeT++</li> <li>• Simulation experience in Cloud Sim</li> <li>• Basic concepts on Gephi</li> <li>• Implement Map-Reduce concept.</li> </ul>			
References : <ol style="list-style-type: none"> <li>1. OMNeT++ Tutorials : <a href="https://omnetpp.org/documentation">https://omnetpp.org/documentation</a></li> <li>2. Ns3 Tutorials : <a href="https://www.nsnam.org/docs/tutorial/html/">https://www.nsnam.org/docs/tutorial/html/</a></li> <li>3. Issariyakul, Teerawat, Hossain, Ekram, Introduction to Network Simulator NS2, Springer</li> <li>4. CloudSim Official Tutorials - <a href="http://www.cloudbus.org/cloudsim/examples.html">http://www.cloudbus.org/cloudsim/examples.html</a></li> <li>5. Gephi Tutorial - <a href="http://gephi.github.io/users/">http://gephi.github.io/users/</a></li> <li>6. Hadoop Map Reduce Official Tutorial - <a href="http://hadoop.apache.org/docs/r1.2.1/mapred_tutorial.html">http://hadoop.apache.org/docs/r1.2.1/mapred_tutorial.html</a></li> </ol>			

# SEMESTER – III

Course No.	Course Title	L-T-P-Credits	Year
06NE7111	Big Data Analytics	3-0-0-3	2015
Prerequisites : Distributed Systems			
Course Objectives :			
<ul style="list-style-type: none"> <li>To understand about basic concepts of big data analytics.</li> </ul>			
Syllabus :			
Introduction to BigData Platform, Regression Modeling, Bayesian Modeling, Fuzzy Logic, Search by simulated Annealing, Introduction to Streams Concepts.			
Course Outcome :			
On successful completion of this course, the student should			
<ul style="list-style-type: none"> <li>Understand and apply the Big Data Flow to actual projects .</li> <li>Successfully apply appropriate techniques (such as ML) and tools to solve actual Big</li> <li>Data problems (derive value from vast data sets) . Have an in-depth understanding of the Big Data ecosystem, specifically the Apache projects</li> <li>Understand about different data analysis techniques.</li> </ul>			
Text Book :			
1. Michael Berthold, David J. Hand, "Intelligent Data Analysis", Springer, 2007.			
References :			
<ol style="list-style-type: none"> <li>Anand Rajaraman and Jeffrey David Ullman, "Mining of Massive Datasets", Cambridge University Press, 2012.</li> <li>Bill Franks, "Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with Advanced Analytics", John Wiley &amp; sons, 2012.</li> <li>Glenn J. Myatt, "Making Sense of Data", John Wiley &amp; Sons, 2007</li> <li>Pete Warden, "Big Data Glossary", O'Reilly, 2011.</li> <li>Jiawei Han, Micheline Kamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.</li> <li>Da Ruan, Guoqing Chen, Etienne E.Kerre, Geert Wets, Intelligent Data Mining, Springer,2007</li> <li>Paul Zikopoulos ,Dirk deRoos , Krishnan Parasuraman , Thomas Deutsch , James Giles, David Corrigan , Harness the Power of Big Data The IBM Big Data Platform, Tata McGraw Hill Publications, 2012</li> <li>Michael Minelli (Author), Michele Chambers (Author), Ambiga Dhiraj (Author) , Big Data, Big Analytics: Emerging Business Intelligence and Analytic Trends for Today's Businesses,Wiley Publications,2013</li> <li>Zikopoulos, Paul, Chris Eaton, Understanding Big Data: Analytics for Enterprise Class Hadoop and Streaming Data, Tata McGraw Hill Publications, 2011</li> </ol>			
COURSE PLAN			
COURSE NO:	COURSE TITLE: Big Data Analytics	(L-T-P : 3-0-0)	CREDITS:3
06NE7111			
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction To Big Data : Introduction to Big Data Platform – Traits of Big data -Challenges of Conventional Systems - Web Data – Evolution Of Analytic Scalability - Analytic Processes and Tools - Analysis vs Reporting - Modern Data Analytic Tools - Statistical Concepts: Sampling Distributions - ReSampling - Statistical Inference - Prediction Error	9	30%
2	Data Analysis : Regression Modeling - Multivariate Analysis - Bayesian Modeling - Inference and Bayesian Networks - Support Vector and Kernel Methods - Analysis of Time Series: Linear	5	

	Systems Analysis - Nonlinear Dynamics - Rule Induction -		
FIRST INTERNAL EXAMINATION			
2	Neural Networks: Learning And Generalization - Competitive Learning - Principal Component Analysis and Neural Networks - Fuzzy Logic: Extracting Fuzzy Models from Data - Fuzzy Decision Trees - Stochastic Search Methods.	4	30%
3	Search by simulated Annealing – Stochastic- Adaptive search by Evaluation – Evaluation Strategies – Genetic Algorithm – Genetic Programming – Visualization – Classification of Visual Data Analysis Techniques.	5	
SECOND INTERNAL EXAMINATION			
3	Data Types – Visualization Techniques – Interaction techniques – Specific Visual data analysis Techniques. Introduction To Streams Concepts – Stream Data Model and Architecture - Stream Computing - Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Estimating Moments.	4	40%
4	Counting Oneness in a Window – Decaying Window - Real time Analytics Platform(RTAP) Applications - Case Studies - Real Time Sentiment Analysis, Stock Market Predictions. Frequent Item sets and Clustering: Mining Frequent Itemsets - Market Based Model – Apriori Algorithm – Handling Large Data Sets in Main Memory – Limited Pass Algorithm – Counting Frequent Itemsets in a Stream – Clustering Techniques – Hierarchical – K-Means – Clustering High Dimensional Data – CLIQUE And PROCLUS – Frequent Pattern based Clustering Methods – Clustering in Non-Euclidean Space – Clustering for Streams and Parallelism.	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE7211	Concurrent Algorithms and Data Structures	3-0-0-3	2015
Prerequisites :			
Familiarity with standard programming techniques, familiarity with concurrent programming			
Course Objectives :			
<ul style="list-style-type: none"><li>For familiarization with concurrent data types and implementation.</li><li>To understand the importance of mutual exclusion.</li></ul>			
Syllabus :			
Mutual exclusion; correctness conditions for concurrent data types, foundations of shared memory, the relative power of synchronization methods; universality of consensus. Implementing locks, monitors and barriers; implementing concurrent data types such as linked lists, queues, counting and sorting networks, hash tables, skip lists and priority queues.			
Course Outcome :			
On successful completion of this course			
<ul style="list-style-type: none"><li>Understand the importance of mutual exclusion, and different ways to implement it.</li><li>Understand correctness criteria for concurrent data types.</li><li>Understand the relative power of different concurrency primitives.</li></ul>			
Text Book :			
1. “The Art of Multiprocessor Programming “ by Maurice Herlihy and Nir Shavit, revised first edition, Morgan Kaufman, 2012.			
References :			
1. Data Structures Using C and C++ by Y. Langsam, M. Augenstein & A. Tenenbaum			
2. Mark Moir and Nir Shavit (2007). "Concurrent Data Structures". In Dinesh Metha and Sartaj Sahni. 'Handbook of Data Structures and Applications' (1st ed.). Chapman and Hall/CRC Press. pp. 47–14–47–30.			
3. Concurrent Algorithms and Data Structures for Many-Core Processors Daniel Cederma ISBN 978-91-7385-503-7			
COURSE PLAN			
COURSE NO: 06NE7211	COURSE TITLE: Concurrent Algorithms and Data Structures	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction: Shared Objects and Synchronization-The Producer–Consumer Problem-The Readers–Writers Problem-The Harsh Realities of Parallelization-Parallel Programming. Mutual Exclusion: Time- Critical Sections- 2-Thread Solutions-The Filter Lock- Fairness- Lamport’s Bakery Algorithm- Bounded Timestamps- Lower Bounds on the Number of Locations.	9	30%
2	Concurrent Objects: Concurrency and Correctness- Sequential Objects- Quiescent Consistency- Sequential Consistency- Linearizability- Formal Definitions- Progress Conditions- The Java Memory Model.	5	
FIRST INTERNAL EXAMINATION			
2	Foundations of Shared Memory: The Space of Registers- Register Constructions- Atomic Snapshots- The Relative Power of Primitive Synchronization Operations- Universality of Consensus	3	30%
3	Spin Locks and Contention: Test-And-Set Locks- queue locks- A Composite Lock- Hierarchical Locks- Monitors and Blocking Synchronization- Monitor Locks and Conditions- Readers–	5	



	Writers Locks Linked Lists: the Role of Locking: concurrent reasoning; coarse-grained synchronization; ne-grained synchronization; optimistic synchronization; lazy synchronization; non-blocking synchronization.		
SECOND INTERNAL EXAMINATION			
3	Concurrent Queues and the ABA Problem: bounded partial queue; unbounded total queue; unbounded lock-free queue; memory reclamation and the ABA problem. Concurrent Stacks and Elimination: a lock-free stack; elimination back-off stack.	4	40%
4	Concurrent Hashing and Natural Parallelism: closed-address hash sets (coarse-grained- striped- sharded- refinable); lock-free hash set (recursive split-ordering); open-addressed hash set (sharded; cuckoo hashing). Skiplists and Balanced Search: lock-based concurrent skiplist; lock-free concurrent skiplist. Priority Queues: array-based priority queue; tree-based priority queue; unbounded heap-based priority queue; skiplist-based unbounded priority queue. Barriers: sense-reversing barrier; combining tree barrier; static tree barrier; termination detecting barriers.	10	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE7311	Social Network Analysis	3-0-0-3	2015
Prerequisites : Internet And Web Technology			
Course Objectives : <ul style="list-style-type: none"> <li>To understand the concepts of Social networks and Web Social Networks</li> <li>To appreciate the modeling and visualizing techniques associated with Social Networks</li> <li>To understand the different techniques used to mine communities from Web Social Networks</li> <li>To appreciate concepts of evolution and prediction in Social Networks</li> <li>To understand the application of text mining techniques for Content and Opinion mining</li> </ul>			
Syllabus : Social Networks, Visualizing Online Social Networks, Modelling and aggregating social network data, Aggregating and reasoning with social network data, Framework, Algorithms and Systems for Expert Location in Social Networks, Text Mining in Social Networks			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"> <li>Build a social network data set from existing social networking sites</li> <li>Identify the different components of a web social network that can be used for analyzing and mining</li> <li>Identify the different data structures and graph algorithms that can be used for web social network mining</li> <li>Implement a community detection algorithm</li> <li>Process Social Network data using MapReduce paradigm</li> <li>Design an application that uses various aspects of Social Network Mining to improve its functionality and to harvest information available on the web to build recommender systems</li> <li>Analyze social media data using appropriate data/web mining techniques</li> </ul>			
Text Book : 1. Charu C. Aggarwal, Social Network Data Analytics, Springer; 2011			
References : <ol style="list-style-type: none"> <li>Peter Mika, Social Networks and the Semantic Web, Springer, 1st edition 2007.</li> <li>Borko Furht, Handbook of Social Network Technologies and Applications, Springer, 1st edition, 2010.</li> <li>Guandong Xu , Yanchun Zhang and Lin Li, Web Mining and Social Networking – Techniques and applications, Springer, 1st edition, 2011.</li> <li>Giles, Mark Smith, John Yen, Advances in Social Network Mining and Analysis, Springer, 2010.</li> <li>Ajith Abraham, Aboul Ella Hassanien, Václav Snášel, Computational Social Network Analysis: Trends, Tools and Research Advances, Springer, 2009.</li> <li>Toby Segaran, Programming Collective Intelligence, O'Reilly, 2012</li> </ol>			
COURSE PLAN			
COURSE NO: 06NE7311	COURSE TITLE: Semantic Web and Social Networks	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction to Web - Limitations of current Web – Development of Semantic Web – Emergence of the Social Web – Statistical Properties of Social Networks -Network analysis - Development of Social Network Analysis - Key concepts and measures in network analysis - Discussion networks - Blogs and online communities - Web-based networks.	9	30%
2	Visualizing Online Social Networks - A Taxonomy of	5	

	Visualizations - Graph Representation - Centrality- Clustering - Node-Edge Diagrams - Visualizing Social Networks with Matrix-Based Representations- Node-Link Diagrams - Hybrid Representations -		
FIRST INTERNAL EXAMINATION			
2	Modelling and aggregating social network data – Random Walks and their Applications –Use of Hadoop and Map Reduce - Ontological representation of social individuals and relationships.	4	30%
3	Aggregating and reasoning with social network data- Advanced Representations - Extracting evolution of Web Community from a Series of Web Archive - Detecting Communities in Social Networks - Evaluating Communities – Core Methods for Community Detection & Mining - Applications of Community Mining Algorithms - Node Classification in Social Networks.	5	
SECOND INTERNAL EXAMINATION			
3	Evolution in Social Networks – Framework - Tracing Smoothly Evolving Communities - Models and Algorithms for Social Influence Analysis - Influence Related Statistics - Social Similarity and Influence - Influence Maximization in Viral Marketing	4	40%
4	Algorithms and Systems for Expert Location in Social Networks - Expert Location without Graph Constraints - with Score Propagation – Expert Team Formation - Link Prediction in Social Networks - Feature based Link Prediction - Bayesian Probabilistic Models - Probabilistic Relational Models - Text Mining in Social Networks -Opinion extraction – Sentiment classification and clustering - Temporal sentiment analysis - Irony detection in opinion mining - Wish analysis - Product review mining – Review Classification – Tracking sentiments towards topics over time.	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE7411	Intrusion Detection Systems	3-0-0-3	2015
Prerequisites : Network Security			
Course Objectives : <ul style="list-style-type: none"><li>Understand the concepts of Intrusion Detection System.</li><li>Understanding on Snort Technology.</li></ul>			
Syllabus : IDS,SNORT, Intrusion Prevention Systems, Working with Snort Rules, Using Snort with MySQL.			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Learn to configure ID systems (e.g. SNORT) and analyze their output.</li></ul>			
Text Book : 1. Rafeeq Rehman, Intrusion Detection with SNORT, Apache, MySQL, PHP and ACID, Prentice Hall PTR, 2003.			
References : 1. Richard Bejtlich , The Practice of Network Security Monitoring, No Starch Press, 978-1-59327-509-9 2. Ryan Trost , Practical Intrusion Analysis: Prevention and Detection for the Twenty-First Century ,Addison-Wesley; ISBN 0-321-59180-1. 3. Michael Rash , Linux Firewalls: Attack detection and Response with iptables, psad, and fwsnort No Starch Press; ISBN 1-59327-141-7.			
COURSE PLAN			
COURSE NO: 06NE7411	COURSE TITLE: Intrusion Detection Systems	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction- Some Definitions- Where IDS Should be Placed in Network Topology- Honey Pots- Security Zones and Levels of Trust- IDS Policy- Components of an intrusion detection system - Packet Decoders- Preprocessors- The Detection Engine- Logging and Alerting System- Output Modules- Dealing with Switches- TCP Stream Follow Up- How to Protect IDS Itself- Internal and external threats to data- attacks- need and types of IDS.	9	30%
2	Intrusion Prevention Systems- Network IDSs- Protocol based IDSs- Application protocol- host based- hybrid based IDSs- architectures- Snort - Snort Installation Scenarios- Test Installation- Single Sensor Production IDS- Single Sensor with Network Management System Integration- Single Sensor with Database and Web Interface.	5	
FIRST INTERNAL EXAMINATION			
2	Multiple Snort Sensors with Centralized Database- Installing Snort- Running Snort on a Non-Default Interface- Automatic Startup and Shutdown- Running Snort on Multiple Network Interfaces- Location of Snort Files- Snort Modes- Snort Alert Modes- Running Snort in Stealth Mode Working with Snort Rules - TCP/IP Network Layers- CIDR- Structure of a Rule- Rule Headers- Rule Options- The Snort Configuration File- Order of Rules Based upon Action.	4	30%

3	AutomaticallyUpdating Snort Rules- Default Snort Rules and Classes- Sample Default Rules- Writing Good Rules. Plugins- Preprocessors and Output Modules - Preprocessors - HTTP Decode- Port Scanning- The frag2 Module- The stream4 Module- The spade Module- ARP Spoofing- Output Modules - The alert_syslog Output Module.	5	
SECOND INTERNAL EXAMINATION			
3	The alert_full Output Module- The alert_fast Output Module- The alert_smb Module- The log_tcpdump Output Module- The XML Output Module- Logging to Databases- CSV Output Module- Unified Logging Output Module- SNMP Traps Output Module- Log Null Output Module- Using BPF Filters. Using Snort with MySQL - Making Snort Work with MySQL- Snort Compilations with MySQL Support- Install MySQL.	4	40%
4	Creating Snort Database in MySQL- Creating MySQL User and Granting Permissions to User and Setting Password- Creating Tables in the Snort Database- Modify snort.conf Configuration File- Starting Snort with Database Support- Logging to Database- Secure Logging to Remote Databases Securely- Using Stunnel, Snort Database Maintenance.	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE7121	Software Defined Networking	3-0-0-3	2015
Prerequisites: Enterprise Devices & Networking			
Course Objectives : <ul style="list-style-type: none"><li>Introduces an emerging paradigm in computer networking that allows a logically centralized software program to control the behaviour of an entire network.</li></ul>			
Syllabus : Basic Packet-Switching Terminology, Software Defined Networking, Open Flow, SDN in the Data Center			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>Learn Software controlled virtual network devices</li><li>Knowledge on Mininet and Open Flow</li></ul>			
Text Book : 1. Paul Göransson, Chuck Black, Software Defined Networks A Comprehensive Approach, Elsevier,2014			
References : 1. Paul Goransson,Chuck Black, Software Defined Networks: A Comprehensive Approach, 1st Edition, MK 2. Thomas D. Nadeau, SDN: Software Defined Networks, 1st Edition, Oreilly			
COURSE PLAN			
COURSE NO: 06NE7121	COURSE TITLE: Software Defined Networking	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Basic Packet-Switching Terminology- The Modern Data Center-Traditional Switch Architecture- Autonomous and Dynamic Forwarding Tables- Evolution of Switches and Control Planes-Cost- SDN Implications for Research and Innovation- Data Center Innovation- Data Center Needs	9	30%
2	The Evolution of Networking Technology- Forerunners of SDN - Software Defined Networking	5	
FIRST INTERNAL EXAMINATION			
2	OpenFlow- Sustaining SDN Interoperability- Network Virtualization- Fundamental Characteristics of SDN- SDN Operation- SDN Devices- SDN Controller- SDN Applications- Alternate SDN Methods	4	30%
3	OpenFlow Overview- OpenFlow 1.0 and OpenFlow Basics- OpenFlow 1.1 Additions- OpenFlow 1.2 Additions- OpenFlow 1.3 Additions- OpenFlow Limitations- Potential Drawbacks of Open SDN- SDN via APIs- DN via Hypervisor-Based Overlays- SDN via Opening Up the Device- Network Functions Virtualization- Alternatives Overlap and Ranking	5	
SECOND INTERNAL EXAMINATION			
3	SDN in the Data Center- Data Center Demands- Tunneling Technologies for the Data Center- Path Technologies in the Data Center- Ethernet Fabrics in the Data Center- SDN Use Cases in the Data Center	4	40%
4	Open SDN versus Overlays in the Data Center- Real-World Data Center- SDN in Other Environments- Wide Area Networks-	9	

	Service Provider and Carrier Networks- Campus Networks- Hospitality Networks- Mobile Networks- Optical Networks		
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE7221	Network Forensics	3-0-0-3	2015
Prerequisites : Basics of System Administration			
Course Objectives :			
<ul style="list-style-type: none"> <li>Provide an overview of network security devices and infrastructures, including proxy servers and firewalls.</li> <li>Describe network security risk and the range of threats.</li> <li>Describe the key network protocols, such as IP, TCP, ARP, ICMP, DNS.</li> </ul>			
Syllabus :			
Introduction to Network Forensics, Evidence Acquisition, Traffic Analysis, Statistical Flow Analysis, Intrusion Detection and Analysis , Network Tunneling, Covert Tunneling, Malware Forensics.			
Course Outcome :			
On successful completion of this course			
<ul style="list-style-type: none"> <li>Learn how to discuss and describe these common network security and forensic principles and concepts.</li> <li>Knowledge about key concepts in information security and network forensics.</li> </ul>			
Text Book :			
1. Sherri Davidoff, Jonathan Ham, Network Forensics: Tracking Hackers through Cyberspace, Pearson Education, 2012.			
References :			
<ol style="list-style-type: none"> <li>Katzendbisser, Petitcolas, Information Hiding Techniques for Steganography and Digital Watermarking, Artech House. 42</li> <li>Peter Wayner, Disappearing Cryptography: Information Hiding, Steganography and Watermarking 2/e, Elsevier</li> <li>John Vecca, Computer Forensics: Crime scene Investigation, Firewall Media</li> <li>Christopher L.T. Brown, Computer Evidence: Collection and Preservation, Firewall Media</li> </ol>			
COURSE PLAN			
COURSE NO:	COURSE TITLE: Network Forensics	(L-T-P : 3-0-0)	CREDITS:3
06NE7221			
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Introduction to Network Forensics : Concepts in Digital Evidence- Challenges relating to Network Evidence- Network Forensics Investigative Methodology- Technical Fundamentals- Sources of Network-Based Evidence- On the Wire- In the Air- Switches - Routers- DHCP Servers- Name Servers- Authentication Servers- Network Intrusion Detection /Prevention Systems- Firewalls- Web Proxies- Application Servers- Central Log Servers- Evidence Acquisition: Physical Interception-Cables- Radio Frequency- Hubs- Switches- Traffic Acquisition Software- libpcap and WinPcap	9	30%
2	The Berkeley Packet Filter (BPF) Language- tcpdump - Wireshark- tshark- dumpcap- Active Acquisition- Common Interfaces- Inspection Without Access- Strategy. Traffic Analysis : Protocol Analysis- Protocol Analysis Tools- Protocol Analysis Techniques- Packet Analysis- Packet Analysis Tools- Packet Analysis Techniques- Flow Analysis- Flow Analysis Tools- Flow Analysis Techniques- Higher-Layer Traffic Analysis- Common Higher-Layer Protocols- Higher-Layer Analysis Tools- Higher-	5	



	Layer Analysis Technique		
FIRST INTERNAL EXAMINATION			
2	Statistical Flow Analysis- Process Overview- Sensors- Sensor Types- Sensor Software- Sensor Placement- Flow Record Export Protocols- NetFlow- IPFIX- sFlow- Collection and Aggregation- Wireless Traffic Capture and Analysis- Spectrum Analysis- Wireless Passive Evidence Acquisition- Common Attacks – Sniffing- Rogue Wireless Access Points- Evil Twin- WEP Cracking- Locating Wireless Devices.	4	30%
3	Network Devices- Intrusion Detection and Analysis : Typical NIDS/NIPS Functionality- Sniffing - Higher-Layer Protocol Awareness- Alerting on Suspicious Bits Modes of Detection- Signature-Based Analysis- Protocol Awareness- Behavioral Analysis- Types of NIDS/NIPSs - NIDS/NIPS Evidence Acquisition - Comprehensive Packet Logging - Event Log Aggregation- Correlation- and Analysis	5	
SECOND INTERNAL EXAMINATION			
3	Sources of Logs - Operating System Logs - Application Logs Physical Device Logs- Network Equipment Logs- Network Log Architecture- Three Types of Logging Architectures- Remote Logging: Common Pitfalls and Strategies. Switches - Content-Addressable Memory Table- ARP- Switch Evidence- Routers- Types of Routers- Router Evidence- Firewalls -Types of Firewalls - Firewall Evidence. Advanced Topics : Network Tunneling- Tunneling for Functionality- Inter-Switch Link (ISL)- Generic Routing Encapsulation (GRE).	4	40%
4	Tunneling for Confidentiality- Internet Protocol Security (IPsec)- Transport Layer Security (TLS) and Secure Socket Layer (SSL)- Covert Tunneling- Covert Tunneling Strategies - TCP Sequence Numbers - DNS Tunnels - ICMP Tunnels. Malware Forensics- Trends in Malware Evolution- Network Behavior of Malware- Propagation- Command-and-Control Communications- Payload Behavior.	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE7321	Cloud Security	3-0-0-3	2015
Prerequisites : Cloud Computing			
Course Objectives : <ul style="list-style-type: none"><li>• Compare modern security concepts as they are applied to cloud computing</li><li>• Appraise compliance issues that arise from cloud computing</li></ul>			
Syllabus : Security concepts, Multi-tenancy issues, Virtualization system-specific attacks, Legal and compliance issues			
Course Outcome : On successful completion of this course <ul style="list-style-type: none"><li>• Understand the basic concepts in cloud security.</li><li>• Learn the methods to improve virtualization security</li></ul>			
Text Book : 1. Tim Mather, SubraKumaraswamy, ShahedLatif, Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance O'Reilly Media; 1 edition [ISBN: 0596802765], 2009.			
References : 1. Ronald L. Krutz, Russell Dean Vines, Cloud Security" [ISBN: 0470589876], 2010. 2. John Rittinghouse, James Ransome, Cloud Computing" CRC Press; 1 edition [ISBN: 1439806802], 2009. 4. J.R. ("Vic") Winkler, Securing the Cloud" Syngress [ISBN: 1597495921] 2011. 3. Cloud Security Alliance, Security Guidance for Critical Areas of Focus in Cloud Computing 2009. 4. VMware VMware Security Hardening Guide White Paper, June 2011 . 5. Cloud Security Alliance 2010, Top Threats to Cloud Computing Microsoft 2013.			
COURSE PLAN			
COURSE NO: 06NE7321	COURSE TITLE: Cloud Security	(L-T-P : 3-0-0)	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Confidentiality- privacy- integrity- authentication- non-repudiation- availability- access control- defence in depth- least privilege- how these concepts apply in the cloud- what these concepts mean and their importance in PaaS- IaaS and SaaS. e.g. User authentication in the cloud; Cryptographic Systems- Symmetric cryptography- stream ciphers- block ciphers- modes of operation- public-key cryptography- hashing- digital signatures- public-key infrastructures- key management- X.509 certificates- OpenSSL.	9	30%
2	MULTI-TENANCY ISSUES: Isolation of users/VMs from each other. How the cloud provider can provide this; Virtualization System Security Issues- e.g. ESX and ESXi Security- ESX file system security- storage considerations- backup and recovery;	5	
FIRST INTERNAL EXAMINATION			
2	Virtualization System Vulnerabilities- Management console vulnerabilities- management server vulnerabilities- administrative VM vulnerabilities- guest VM vulnerabilities- hypervisor vulnerabilities- hypervisor escape vulnerabilities- configuration issues- malware (botnets etc).	4	30%
3	VIRTUALIZATION SYSTEM-SPECIFIC ATTACKS: Guest hopping-	5	

	attacks on the VM (delete the VM- attack on the control of the VM- code or file injection into the virtualized file structure)- VM migration attack- hyper jacking.		
SECOND INTERNAL EXAMINATION			
3	IBM security virtual server protection- virtualization-based sandboxing; Storage Security- HIDPS- log management- Data Loss Prevention. Location of the Perimeter.	4	40%
4	LEGAL AND COMPLIANCE ISSUES: Responsibility- ownership of data- right to penetration test- local law where data is held- examination of modern Security Standards (eg PCIDSS)- how standards deal with cloud services and virtualization- compliance for the cloud provider vs. compliance for the customer.	9	
END SEMESTER EXAM			

Course No.	Course Name	L-T-P-Credits	Year
06NE7421	Green Computing	3-0-0-3	2015
Prerequisites : NIL			
Course Objectives :			
<ul style="list-style-type: none"> <li>Course present the energy management policies at the operating system level that consider performance vs. energy saving tradeoffs.</li> </ul>			
Syllabus :			
Low-Power,Massively Parallel,Energy-Efficient Supercomputers:Introduction-Voltage Scaling in Hardware Technologies			
Course Outcome :			
On successful completion of this course, the student should			
<ul style="list-style-type: none"> <li>Understand the concepts of technologies that conform to low-power computation</li> <li>Understand green (power-efficient) technologies for components of one single computer, such as CPU, memory and disk, and appreciate cutting edge designs for these components including memristors</li> <li>Have a basic understanding of a variety of technologies applied in building a green system (especially green datacentres), including networks, Virtual Machine (VM) management and storage systems</li> <li>Be able to use a range of tools to help monitor and design green systems</li> </ul>			
Text Book :			
1. Wu-chun Feng – “The Green Computing Book: Tackling Energy Efficiency at Large Scale”, CRC Press			
References :			
<ol style="list-style-type: none"> <li>John W.Rittinghouse and James F.Ransome, “Cloud Computing: Implementation, Management, and Security”, CRC Press, 2010.</li> <li>Toby Velte, Anthony Velte, Robert Elsenpeter, “Cloud Computing, A Practical Approach”,TMH, 2009.</li> <li>Kumar Saurabh, “Cloud Computing – insights into New-Era Infrastructure”, Wiley India,2011.</li> <li>George Reese, “Cloud Application Architectures: Building Applications and Infrastructure in the Cloud” O'Reilly</li> <li>James E. Smith, Ravi Nair, “Virtual Machines: Versatile Platforms for Systems and Processes”, Elsevier/Morgan Kaufmann, 2005.</li> <li>Katarina Stanoevska-Slabeva, Thomas Wozniak, Santi Ristol, “Grid and Cloud Computing – A Business Perspective on Technology and Applications”, Springer.</li> <li>Ronald L. Krutz, Russell Dean Vines, “Cloud Security – A comprehensive Guide to Secure Cloud Computing”, Wiley – India, 2010. In Networks”</li> </ol>			
COURSE PLAN			
COURSE NO: 6NE7421	COURSE TITLE: Green Computing	L-T-P : 3-0-0	CREDITS:3
Module	Contents	Content Hours	Sem.Exam Marks:%
1	Low-Power,Massively Parallel,Energy-Efficient Supercomputers:Introduction-Voltage Scaling in Hardware Technologies : Low-Voltage Scaling of Active Devices-On-Chip Digital Noise-Power Delivery- Off-Chip Connections-Cooling-Blue Gene Hardware : Voltage Scaling- Low-Power Floating-Point Units-Power Delivery -Off-Chip Connections-Cooling-System Software:Overview-System Monitoring-Job History-Operational Phases-Applications	9	30%

2	Compiler-Driven Energy Efficiency:Introduction-Energy-Aware I/O Optimizations-Modifying Application Code-Modifying Disk Layout of Data-Energy-Aware NoC Optimization-History -Based Dynamic Link Voltage Scaling-Static Analysis-Based Link Voltage Scaling	4	
FIRST INTERNAL EXAMINATION			
2	An Adaptive Run-Time System for Improving Energy Efficiency:Introduction-An Adaptive Run-Time System-Evaluation Methodology and setup-Experimental Results-Conclusion-Energy	5	30%
3	Efficient Multithreading through Run-Time Adaptation:Introduction-Run-Time Systems for Power-Performance Adaptation:An Overview-Scalability Prediction: Static Scalability Prediction Models-Dynamic Scalability Prediction Models-Evaluation-Multidimensional Power-Performance Adaptation: Sca Analysis of parallel applications-Run-Time support for Energy-Efficient Multithreading – Intergrating DCT with DVFS Exploring Trade-Offs between Energy Savings and Reliability in Storage Systems:Introduction-Reliability versus Energy-Efficient of storage system	6	
SECOND INTERNAL EXAMINATION			
3	Current state of the Art:Reliability Improvement Techniques-Redundant Array of Inexpensive Disks-Latent sector errors - Interleaved parity check-Disk Scrubbing-Intradisk Redundancy-Idle Read after Write-Fine-Tuning Intradisk Redundancy and Accelerated Scrubbing-Staggered Scrubbing -Energy Management Technique-High-Energy Consumption of Disk Arrays-Energy Conservation via Disk Block Migration	3	40%
4	Energy-Efficient Virtualized Systems:Introduction-Virtualization and Power management-Benefits of virtualized data center deployments-Virtualization Architectural overview-Power management requirements for virtualized systems-Platform enhancement for energy-aware VM management-Coordinated VM power Management with VirtualPower- VirtualPower architectural Overview-Experimental Results-Paravirtualized Management Interfaces for platform power budgeting-Power Management mechanisms for distributed Virtualized platforms-Experimental Results	9	
END SEMESTER EXAM			

Course No.	Course Title	L-T-P-Credits	Year
06NE7031	Seminar II	0-0-2-2	2015
<p>Each student shall present a seminar on any topic of interest related Computer Networks/ Related fields. He / she shall select the topic based which can be extended for their Course Project on the References: from reputed International Journals, preferably IEEE journals. They should get the paper approved by the Programme Co-ordinator / Faculty member in charge of the seminar and shall present it in the class. Every student shall participate in the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report submitted.</p> <p>Encourage students to convert these seminar topics into a good survey paper or Technical paper.</p>			

Course No.	Course Title	L-T-P-Credits	Year
06NE7041	Project(Phase 1)	0-0-8-6	2015
<p>In Project(Phase 1), the students are expected to select an emerging research area in Network Engineering or related fields, After conducting a detailed literature survey, they should compare and analyze research work done and review recent developments in the area and prepare an initial design of the work to be carried out as Project(Phase 2). It is expected that the students should refer National and International Journals and proceedings of National and International conferences while selecting a topic for their thesis. He/She should select a recent topic from a reputed International Journal, preferably IEEE/ACM. Emphasis should be given for introduction to the topic, literature survey, and scope of the proposed work along with some preliminary work carried out on the thesis topic.</p> <p>Students should submit a copy of Project(Phase 1) thesis report covering the content discussed above and highlighting the features of work to be carried out in Phase-II of the thesis. Students should follow standard practice of thesis writing. Presenting the work, carried out by the students in a National/International Conference is encouraged.</p> <p>The project work has to be carried out within the department itself. There is a project guide allotted to each student by the head of the division / course coordinator. The project work shall be reviewed and evaluated periodically by the project guide. Under special cases, student can carry out a project in a reputed Industry / R&amp;D institutions with the permission of course coordinator / HOD.</p> <p>The candidate should present the current status of the thesis work and the assessment will be made on the basis of the work and the presentation, by a panel of internal examiners in which one will be the internal guide. The examiners should give their suggestions in writing to the students so that it should be incorporated in the Project(Phase 2)of the thesis.</p>			

# SEMESTER – IV



Course No.	Course Title	L-T-P-Credits	Year
06NE7012	Project(Phase 2)	0-0-21-12	2015
In the fourth semester, the student has to continue the Project () work and after the successful completion of the work, he / she have to submit a detailed thesis report. The work carried out should lead to a publication in a National / International Conference. They should submit the paper before the evaluation of the thesis and specific weightage will be given to accepted papers in reputed conferences.			