

ACADEMIC CURRICULA

POSTGRADUATE DEGREE PROGRAMMES

SCHOOL OF COMPUTING

Master of Technology

(M.Tech - Two Years)

in

CLOUD COMPUTING

CURRICULUM

(Empowered by Virtusa)

Academic Year - 2019



SRM INSTITUTE OF SCIENCE & TECHNOLOGY

(Deemed to be University u/s 3 of UGC Act, 1956)

Kattankulathur, Kancheepuram 603203, Tamil Nadu, India



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1. M. Tech in CLOUD COMPUTING

1. (a) Mission of the Department

Mission Stmt - 1	To establish knowledge to excel in their career.
Mission Stmt - 2	To establish research and development in Cloud Computing technology to serve the needs of society
Mission Stmt - 3	To demonstrate strong communication skills and possess the ability to design systems individually as well as part of a multidisciplinary teams.
Mission Stmt - 4	To instill societal , safety, cultural, environmental, and ethical responsibilities in all professional activities
Mission Stmt - 5	To produce successful in Cloud computing postgraduates with personal and professional responsibilities and commitment to lifelong learning

1. (b) Program Educational Objectives (PEO)

PEO - 1	Students will have the ability to adapt, contribute and innovate new technologies and systems in the key domains of Cloud computing
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PEO - 2	Students will be able to perform in technical/managerial roles ranging from design, development, problem solving to production support in software industries and R&D sectors in Cloud platform.
PEO - 3	Students will be able to successfully pursue higher education in reputed institutions.

1. (c) Mission of the Department to Program Educational Objectives (PEO) Mapping

	Mission Stmt. - 1	Mission Stmt. - 2	Mission Stmt. - 3	Mission Stmt. - 4	Mission Stmt. - 5
PEO - 1	H	H	H	H	H
PEO - 2	H	H	H	H	H
PEO - 3	H	H	H	L	H

H – High Correlation, M – Medium Correlation, L – Low Correlation

1. (d) Mapping Program Educational Objectives (PEO) to Program Learning Outcomes (PLO)

	Program Learning Outcomes (PLO)						
	Graduate Attributes (GA)						
	Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Communication	Life Long Learning
PEO - 1	H	H	H	H	H	H	H
PEO - 2	H	H	H	H	H	H	H
PEO - 3	H	H	H	H	H	L	H

1. (a) Program Structure (M. Tech in CLOUD COMPUTING)

1. Core Courses						
Course Code	Course Title	Hours/Week			C	
		L	T	P		
CC2021	Web Application Development	3	0	2	4	
CC2022	Cloud Architectures	3	0	2	4	
CC2023	Cloud Storage Infrastructure	3	0	2	4	
CC2024	Data Center Networking	3	0	2	4	
CC2025	Cloud Security	3	0	2	4	
CC2026	Managing Virtual Environments	3	0	2	4	
Total Learning Credits						24

2. Program Elective courses (Any one course each in 2 nd and 3 rd Semester)						
Course Code	Course Title	Hours/Week			C	
		L	T	P		
CC2131	Design & Development of Cloud Applications	2	0	2	3	
CC2132	Application Development Frameworks	2	0	2	3	
CC2133	Scripting for System Administrators	2	0	2	3	
CC2134	Data Warehousing and Mining	3	0	0	3	
CC2135	Converged Networks	3	0	0	3	
CC2136	Network Security	3	0	0	3	
CC2137	Enterprise Storage Systems	3	0	0	3	
CC2138	Object Oriented Software Engineering	2	0	2	3	
CC2139	Data Center Virtualization	3	0	0	3	
CC2140	Cloud Application Development	2	0	2	3	
CC2141	Cloud Strategy Planning & Management	3	0	0	3	
CC2142	Data Science & Big Data Analytics	2	0	2	3	
Total Learning Credits						6

3. Industry Supportive Elective courses (Any one course each in 1 st & 2 nd semester and two courses in 3 rd Semester)						
Course Code	Course Title	Hours/Week			C	
		L	T	P		
CC2143	Industry Elective Course 1	3	0	0	3	
CC2144	Industry Elective Course 2	3	0	0	3	
CC2145	Industry Elective Course 3	3	0	0	3	
CC2146	Industry Elective Course 4	3	0	0	3	
Total Learning Credits						12

5. Supportive courses						
Course Code	Course Title	Hours/Week			C	
		L	T	P		
CC2012	Data Analysis using Multivariate Techniques and Forecasting Methods	3	0	0	3	
Total Learning Credits						3

6. Seminar						
Course Code	Course Title	Hours/Week			C	
		L	T	P		
CC2057	Seminar (Pass/Fail Course)	0	0	2	1	
Total Learning Credits						1

4. Industry Supportive certification courses						
Course Code	Course Title	Hours/Week			C	
		L	T	P		
CC2147	One Cloud specialized certification course in I semester (Pass/Fail Course)	0	0	2	1	
CC2148	One Cloud specialized certification course in II semester (Pass/Fail Course)	0	0	2	1	
CC2149	One Cloud specialized certification course in III semester (Pass/Fail Course)	0	0	2	1	
Total Learning Credits						3

7. Career Advancement Courses						8. Project Work					
Course Code	Course Title	Hours/Week			C	Course Code	Course Title	Hours/Week			C
		L	T	P				L	T	P	
CAC2001	Career Advancement Course for Engineers - I	1	0	1	1	CC2059	Project Phase-I	0	0	12	6
CAC2002	Career Advancement Course for Engineers - II	1	0	1	1	CC2060	Project Phase-II	0	0	32	16
CAC2003	Career Advancement Course for Engineers - III	1	0	1	1	Total Learning Credits					22
Total Learning Credits					3						

1. (a) Program Articulation (M. Tech in CLOUD COMPUTING)

Course Code	PROFESSIONAL CORE Course Name	Program Learning Outcomes (PLO)						
		Graduate Attributes						
		Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Communication	Life Long Learning
CC2021	Web Application Development	H	H	H	H	H	M	H
CC2022	Cloud Architectures	H	H	H	H	H	M	H
CC2023	Cloud Storage Infrastructure	H	H	H	H	H	L	H
CC2024	Data Center Networking	H	H	H	H	H	L	H
CC2025	Cloud Security	H	H	H	H	H	M	H
CC2026	Managing Virtual Environments	H	H	H	H	H	M	H
CC2057	Seminar (Pass/Fail Course)	H	H	H	H	H	H	H
CC2059	Project Phase-I	H	H	H	H	H	L	H
CC2060	Project Phase-II	H	H	H	H	H	H	H

Course Code	SPECIALIZATION ELECTIVES Course Name	Program Learning Outcomes (PLO)						
		Graduate Attributes						
		Engineering Knowledge	Problem Analysis	Design & Development	Analysis, Design, Research	Modern Tool Usage	Communication	Life Long Learning
CC2131	Design & Development of Cloud Applications	H	H	H		H		M
CC2132	Application Development Frameworks		H	H		H		
CC2133	Scripting for System Administrators	H	H	H		H		M
CC2134	Data Warehousing and Mining	H	M		H			M
CC2135	Converged Networks		H		H	H		
CC2136	Network Security	H			H			H
CC2137	Enterprise Storage Systems	H			M	H		
CC2138	Object Oriented Software Engineering	H	L		H	H		H
CC2139	Data Center Virtualization	H	M	H				
CC2140	Cloud Application Development	H			H			
CC2141	Cloud Strategy Planning & Management		M		H			
CC2142	Data Science & Big Data Analytics		M		H			H

H – High Correlation, M – Medium Correlation, L – Low Correlation

1. (a) Implementation Plan (M. Tech in CLOUD COMPUTING)

Semester – I					
Code	Course Title	Hours/Week			C
		L	T	P	
CC2021	Web Application Development	3	0	2	4
CC2022	Cloud Architectures	3	0	2	4
CC2023	Cloud Storage Infrastructure	3	0	2	4
	Industry Supportive Elective course – 1	3	0	0	3
	Industry Supportive certification course - 1	0	0	2	1
CC2012	Data Analysis using Multivariate Techniques and Forecasting Methods	3	0	0	3
CAC2002	Career Advancement Course for Engineers – I	1	0	1	1
Total Learning Credits					20

Semester - III					
Code	Course Title	Hours/Week			C
		L	T	P	
	Program Elective – 2	3	0	0	3
	Industry Supportive Elective course – 3	3	0	0	3
	Industry Supportive Elective course – 4	3	0	0	3
	Industry Supportive certification course - 3	0	0	2	1
CAC2003	Career Advancement Course for Engineers - III	1	0	1	1
CC2059	Project Phase-I	0	0	12	6
CC2057	Seminar (Pass/Fail Course)	0	0	1	1
Total Learning Credits					18

Semester – II					
Code	Course Title	Hours/Week			C
		L	T	P	
CC2024	Data Center Networking	3	0	2	4
CC2025	Cloud Security	3	0	2	4
CC2026	Managing Virtual Environments	3	0	2	4
	Program Elective – 1	3	0	0	3
	Industry Supportive Elective course – 2	3	0	0	3
	Industry Supportive certification course - 2	0	0	2	1
CAC2001	Career Advancement Course for Engineers - II	1	0	1	1
Total Learning Credits					20

Semester - IV					
Code	Course Title	Hours/Week			C
		L	T	P	
CC2060	Project Phase-II	0	0	32	16
Total Learning Credits					16

Total Credits: 74

		WEB APPLICATION DEVELOPMENT			
CC2021	Total Contact Hours - 75	3	0	2	4
	Prerequisite				
	Knowledge in JAVA programming is preferred				
PURPOSE					
Internet is part and parcel of everybody's life today. Programming in web is every essential for any IT professional .The subject provides knowledge to learn and Implement the various web programming technologies of current trend today.					
INSTRUCTIONAL OBJECTIVES					
1.	Understand the current technologies in Internet world				
2.	Implement client side programming using java script ,CSS				
3.	Learn and implement advanced and current technologies like AJAX, JQuery				
4.	Understand the socket programming in Java, Node.JS, Angular JS				
5.	Learn and implement java server side programming				
6.	Learn and implement web services				
7.	Learn various web development frame works				

UNIT I - INTRODUCTION TO INTERNETWEBTECHNOLOGIES

(6 Hours)

Internet in Industry and Research, HTML5, CSS3, JavaScript, Canvas and jQuery-Evolution of Internet and WWW, Web Basics, HTML tags –new tags in HTML 5 –XML technologies-DTD-Schema-parsers-XHTML-CSS-javascript-datatypes-control structures-functions –objects - mobile web.

UNIT II - ADVANCED DYNAMIC WEB CLIENT SIDE PROGRAMMING

(9 HOURS)

AJAX-xmlHttpRequest object-AJAX applications-AJAX frame work -java script libraries -jQuery-basics –animation-overview on Yahoo UI, Google web toolkit libraries-Applets-overview on javaFXapplets.

UNIT III –NODE.JS, ANGULAR JS

(12Hours)

Node.JS- Introduction- Node core, Node Modules, Filesystem, Debugger, automation and deployment-Angular JS- Introduction-Expressions, modules, Data Binding, Scopes, Directives & Events, Controllers, Filters, services, HTTP, Tables, Select, Fetching data from MYSQL, validation, API, Animations- Case study: Connect any Angular FrontendwithNodejs Backend.

UNIT IV - DYNAMIC WEB SERVERSIDEPROGRAMMING

(9Hours)

Web servers and java web containers-servlets -lifecycle-content handling-cookies- session tracking-filters-Java server pages-expressions-and declarations-directives- JSP and java beans-include and forward directives-custom tag libraries-JSTL-new features in servlet3.1 and JSP2.5

UNIT V - ADVANCED SERVERSIDEPROGRAMMING

(9Hours)

Web services-SOAP protocol-UDDI-WSDL-creating publishing and describing web services-JDBC database connectivity-drivers-connections-rowset interface-prepared statements-three tier applications; Web application frameworks-MVC (model view controller) frame work-struts- JSF(Java server faces)-Java EE design pattern an overview.

PRACTICAL - (30 Hours)

REFERENCES

1. Paul J. Deitel, Harvey Deitel, Abbey Deitel, “*Internet and World Wide Web How to Program*”, Edition 5, ISBN 0132151006, 9780132151009,2011.
2. Chris Bates, “*Web Programming – Building Intranet applications*”, Wiley Publications, 3rdEdition,2009.
3. Node.js, MongoDB and Angular Web Development, Second Edition, 2018, Pearson Education.
4. Jeffrey C. Jackson, “*Web Technologies A computer Science Perspective*”, Pearson,2011.
5. Eilliotte, Rusty Harold, “*Java Network Programming*”, 3/e, O'Reilly Media, Inc, 2004.
6. “*Java server programming java JavaEE5 Black Book*”, Kogent Solutions Inc, Dreamtech Press,2012.
7. AJAX, “*black book*”, new edition, Kogent Solutions Inc, Dreamtech Press,2008.

Web Resources:

1. https://www.tutorialspoint.com/angularjs/angularjs_tutorial.pdf
2. https://www.tutorialspoint.com/nodejs/nodejs_tutorial.pdf

		CLOUD ARCHITECTURES			
CC2022		L	T	P	C
	Total Contact Hours - 75	3	0	2	4
	Prerequisite				
	Nil				
PURPOSE					
This module gives students the skills and knowledge to understand how Cloud Computing Architecture enables transformation, business development and agility in an organization.					
INSTRUCTIONAL OBJECTIVES					
1.	Analyze the components of cloud computing showing how business agility in an organization can be created.				
2.	Evaluate the deployment of web services from cloud architecture				
3.	Critique the consistency of services deployed from a cloud architecture				
4.	Compare and contrast the economic benefits delivered by various cloud models based on application requirements, economic constraints and business requirements.				
5.	Critically analyze case studies to derive the best practice model to apply when developing and deploying cloud based applications				

UNIT I - CLOUD COMPUTING FUNDAMENTALS

(8 Hours)Cloud

Computing definition, Types of the cloud:private, public and hybrid cloud. Cloud services types; IaaS, PaaS, SaaS. Benefits and challenges of cloud computing, public vs private clouds, role of virtualization in enabling the cloud; Business Agility: Benefits and challenges to Cloud architecture. Application availability, performance, security and disaster recovery; next generation Cloud Applications.

UNIT II - CLOUD APPLICATIONS

(8

Hours)Technologies and the processes required when deploying web services; Deploying a web service from inside and outside a cloud architecture, advantages and disadvantages, Cloud cost optimization techniques for enterprise apps; any two case studies of cloud applications

UNIT III - MANAGEMENT OF CLOUD SERVICES

(10 Hours)

Reliability, availability and security of services deployed from the cloud. Performance and scalability of services, tools and technologies used to manage cloud services deployment; Cloud Economics : Cloud Computing infrastructures available for implementing cloud based services. Economics of choosing a Cloud platform for an organization, based on application requirements, economic constraints and business needs (e.g Amazon, Microsoft and Google, Salesforce.com, Ubuntu and Redhat)

UNIT IV - APPLICATION DEVELOPMENT

(10 Hours)

Service creation environments to develop cloud based applications. Development environments for service development; Amazon, Azure, Google App.

UNIT V - CLOUD IT MODEL

(9 Hours)

Analysis of Case Studies when deciding to adopt cloud computing architecture.How to decide if the cloud is right for your requirements. Cloud based service, applications and development platform deployment so as to improve the total cost of ownership (TCO)

PRACTICAL - (30 Hours)

REFERENCES

1. Gautam Shroff, "Enterprise Cloud Computing Technology ArchitectureApplications",Cambridge University Press; 1 edition,[ISBN: 978-0521137355],2010.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A PracticalApproach" McGraw-Hill Osborne Media; 1 edition [ISBN: 0071626948], 2009.
3. Dimitris N. Chorafas, "Cloud Computing Strategies" CRC Press; 1 edition [ISBN: 1439834539], 2010.
4. Bill Wilder, "Cloud Architecture Patterns", O'Reilly Media, Inc., 2012 (ISBN: 9781449357979)
5. <https://searchcloudcomputing.techtargget.com/essentialguide/Developing-cloud-applications-in-the-new-IT-era>
6. <https://searchcloudcomputing.techtargget.com/tip/Optimize-cloud-computing-costs-for-current-applications>
7. <https://www.e-zest.com/case-studies-cloud>

CC2023	CLOUD STORAGE INFRASTRUCTURES			L	T	P	C
	Total Contact Hours - 75			3	0	2	4
	Pre-requisites						
	Nil						
PURPOSE							
This course provides a comprehensive view of storage and networking infrastructures for highly virtualized cloud ready deployments. The course discusses the concepts and features related to Virtualized datacenter and cloud, Information storage security and design, storage network design and cloud optimized storage.							
INSTRUCTIONAL OBJECTIVES							
1	Critically appraise the opportunities and challenges of information management in complex business environments						
2	Evaluate information storage management design in a cloud environment and how it relates to the business objectives of an organization						
3	Analyze the role technology plays in the design of a storage solution in a cloud architecture						
4	Investigate how a global storage solution can be optimized so that it can be delivered successfully from the cloud						
5	Analyze how best to provide reliable access to information both locally and remotely using storage technologies						

UNIT I - VIRTUALIZED DATACENTERARCHITECTURE

(9Hours)

Cloud infrastructures; public, private, hybrid. Service provider interfaces; Saas, Paas, Iaas. VDC environments; concept, planning and design, business continuity and disaster recovery principles. Managing VDC and cloud environments and infrastructures.

UNIT II - INFORMATION STORAGE SECURITY&DESIGN

(9Hours)

Storage strategy and governance; security and regulations. Designing secure solutions; the considerations and implementations involved. Securing storage in virtualized and cloud environments. Monitoring and management; security auditing and SIEM.

UNIT III - STORAGENETWORKDESIGN

(12Hours)

Architecture of storage, analysis and planning. Storage network design considerations; NAS and FC SANs, hybrid storage networking technologies (iSCSI, FCIP, FCoE), design for storage virtualization in cloud computing, host system design considerations.

UNIT IV – ADVANCED BACKEND STORAGE CONNECTIVITY

(6Hours)

Introduction MongoDB – Mongoose-Schema,models,Built-in validation,connection, Blocking and Non-Blocking code. Database connection-Types, Strings, Options, Events, Schema, models. Interaction-Data, Instance, Reading, Querying, Updating, adding CURD controller.

UNIT V - INFORMATIONAVAILABILITYDESIGN

(9Hours)

Designing backup/recovery solutions to guarantee data availability in a virtualized environment. Design a replication solution, local remote and advanced. Investigate Replication in NAS and SAN environments. Data archiving solutions; analyzing compliance and archiving design considerations.

PRACTICAL - (30 Hours)

REFERENCES

1. Greg Schulz, “Cloud and Virtual Data Storage Networking”, Auerbach Publications [ISBN: 978-1439851739],2011.
2. Marty Poniatoski, “Foundations of Green IT” Prentice Hall; 1 edition [ISBN: 978-0-13-704375-0],2010.
3. EMC, “Information Storage and Management” Wiley; 2 edition [ISBN: 978- 0470294215], 2012.
4. MithunSatheesh, Bruno Joseph D'mello, Jason Krol, “Web Development with MongoDB and NodeJS”,Packt Publications [ISBN: 978-1-78528-752-7], 2015.
5. VolkerHerminghaus,Simon Holmes “Mongoose for Application Development”,Packt Publications [ISBN: 978-1-78216-819-5],2013.
6. AlbrechtScriba, “StorageManagementinDataCenters” Springer; editionN[ISBN: 978-3540850229]. 2009.
7. KlausSchmidt, “HighAvailabilityandDisasterRecovery” Springer;edition[ISBN: 978-3540244608],2006.

CC2012	DATA ANALYSIS USING MULTIVARIATE TECHNIQUES AND FORECASTING METHODS	L	T	P	C
	TOTAL CONTACT HOURS - 45	3	0	0	3
	Prerequisite				
	Nil				
PURPOSE					
The purpose of this course is to introduce the students into the field of Multivariate Techniques and Forecasting Methods for analyzing large volumes of data and to take decisions based on inference drawn.					
INSTRUCTIONAL OBJECTIVES					
1.	Data characteristics and form of Distribution of the Data Structures				
2.	Understanding the usage of multivariate techniques and forecasting methods for the problem under the consideration				
3.	For drawing valid inferences and to plan for future investigations				

UNIT I - MULTIVARIATE ANALYSIS

(5 Hours)

Meaning of Multivariate Analysis, Measurements Scales: Metric measurement scales and Non-metric measurement scales, Classification of multivariate techniques (Dependence Techniques and Inter-dependence Techniques), Applications of Multivariate Techniques in different disciplines.

UNIT II - FACTOR ANALYSIS

(10 Hours)

Meanings, Objectives and Assumptions, Designing a factor analysis, Deriving factors and assessing overall factors, Interpreting the factors and validation of factor analysis.

UNIT III - CLUSTER ANALYSIS

(10 Hours)

Objectives and Assumptions, Research design in cluster analysis, Deriving clusters and assessing overall fit (Hierarchical methods, Non Hierarchical Methods and Combinations), Interpretation of clusters and validation of profiling of the clusters.

UNIT IV - FORECASTING TECHNIQUES

(10 Hours)

Basics of forecasting: Basic steps in forecasting task. The forecasting scenario: Averaging methods, Exponential smoothing methods, Holt's linear method, Holt-Winters trend and Seasonality method.

UNIT V - TIME SERIES ANALYSIS

(10 Hours)

Box-Jenkins Methodology for ARIMA models: Examining correlation and stationarity of time series data, ARIMA models for time series data (An Auto-regressive model of order one and a Moving Average Model of order one).

REFERENCES

1. Joseph F.Hair, William C.Black, Barry J.Babin, RolphE.Anderson and Ronald L.Tatham (2006). "*Multivariate Data Analysis, 6th Edition*", Pearson Education, Inc., (Chapters 1, 3 and 8), 2009.
2. Spyros Makridakis, Steven C.Wheelwright and Rob J. Hyndman. "*Forecasting methods and Applications, Third Edition*", John Wiley & Sons Inc., New York (Chapters 1, 4 and 7), 2005.

CC2024	DATA CENTER NETWORKING	L	T	P	C
	Total Contact Hours - 75	3	0	2	4
	Pre-requisites				
	Nil				
PURPOSE					
This course provides an insight to the students on design guidance, configuration examples and best practices with respect to data center networking. This course also deals with building robust, scalable network infrastructure for data centers. current data center architectures, new technologies adopted to create modern data center architecture, and merits and demerits of the same. This course examines these new technologies and demonstrates how consolidation can be realized using a unified network approach					
INSTRUCTIONAL OBJECTIVES					
1.	Understand the reasons for the network architecture for cloud-native data centers.				
2.	Discuss the new trend in networking, the rise of network disaggregation and open networking.				
3.	Understand the behavior of link state and BGP routing protocols in the data center, and decide on which is the right one for your network.				

4.	Understand what virtual networks are, their use and technologies that are used to build data – center and automating network operations.
5.	Understand the topics related to inter connecting data centers.

UNIT I – MOTIVATION FOR A NEW NETWORK ARCHITECTURE

(6 Hours)

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

UNIT II – NETWORK TOPOLOGY & NETWORK DISAGGREGATION

(10 Hours)

Clos Topology- A Deeper Dive Into The Clos Topology, Scaling The Clos Topology, Implications of the Clos Topology, Some Best Practices For a Clos Network, Host Attach Models, Network Disaggregation- What and Why is Network Disaggregation Important, What Made Network Disaggregation Possible Now, Difference in Network Operations With Disaggregation, Open Network Installer Environment (ONIE), The Players in Network Disaggregation: Hardware, Common Myths About Network Disaggregation.

UNIT III – NETWORK OPERATING SYSTEM

(8 Hours)

Requirements of a Network Device, The Rise of SDN and Openflow, NOS Design Models, Comparing the NOS Models With Cloud-Native NOS Requirements, Routing Protocol Choices-Routing Overview, Routing Protocols Overview, Distance Vector Protocols Versus Link State Protocols, Routing Protocols in Clos Networks, Requirements of a Routing Protocol in the Data Center, Choosing the Routing Protocol For Your Network.

UNIT IV – NETWORK VIRTUALIZATION & AUTOMATION

(12Hours)

Network Virtualization-Uses of Network Virtualization in the Data Center, Network Virtualization Models, Network Tunnels, Network Virtualization Solutions For the Data Center, Practical Limits on the Number of Virtual Networks, Packet Forwarding Control Protocol For Network Virtualization, Illustrating VXLAN Bridging and Routing- Network Automation-Introduction, Network operators, Tools For Network Automation.

UNIT V – INTERCONNECTING DATA CENTERS

(9Hours)

Data Center Layer 2 Interconnect-Overview of High availability clusters, Data Center Interconnect: Legacy deployment models, problems associated with extended layer2 Networks. Data Center Interconnect: Architecture Alternatives- Ensuring a loop free global topology, Data Center Interconnect design alternatives, Case Studies: Large government organization, Large outsourcer for server migration and clustering.

PRACTICAL - (30 Hours)

REFERENCES

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

CC2025	CLOUD SECURITY				
	Total Contact Hours - 75	3	0	2	4
	Pre-requisite				
	NIL				
PURPOSE					
The course on cloud security introduces the basic concepts of security systems and cryptographic protocols, which are widely used in the design of cloud security. The issues related multi tenancy operation, virtualized infrastructure security and methods to improve virtualization security are also dealt with in this course.					
INSTRUCTIONAL OBJECTIVES					
1.	Compare modern security concepts as they are applied to cloud computing				
2.	Assess the security of virtual systems				

3.	Evaluate the security issues related to multi-tenancy
4.	Appraise compliance issues that arise from cloud computing

UNIT I - SECURITY CONCEPTS

(10 Hours)

Confidentiality, privacy, integrity, authentication, non-repudiation, availability, accesscontrol, defence in depth, least privilege, how these concepts apply in the cloud, whatthese concepts mean and their importance in PaaS, IaaS and SaaS. e.g. Userauthentication in the cloud; Cryptographic Systems- Symmetric cryptography, streamciphers, block ciphers, modes of operation, public-key cryptography, hashing, digitalsignatures, public-key infrastructures, key management, X.509 certificates, OpenSSL.

UNIT II - MULTI-TENANCY ISSUES

(9 Hours)

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 systemsecurity, storage considerations, backup and recovery; Virtualization SystemVulnerabilities- Management console vulnerabilities, management servervulnerabilities, administrative VM vulnerabilities, guest VM vulnerabilities, hypervisorvulnerabilities, hypervisor escape vulnerabilities, configuration issues, malware(botnets etc).

UNIT III - VIRTUALIZATION SYSTEM-SPECIFIC ATTACKS

(7 Hours)

Guest hopping, 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,hyperjacking.

UNIT IV - TECHNOLOGIES FOR VIRTUALIZATION-BASED SECURITY ENHANCEMENT

(9 Hours)

IBM security virtual server protection, virtualization-based sandboxing; StorageSecurity- HIDPS, log management, Data Loss Prevention.Location of the Perimeter.

UNIT V - LEGAL AND COMPLIANCE ISSUES

(10 Hours)

Responsibility, ownership of data, right to penetration test, local law where data isheld, examination of modern Security Standards (eg PCIDSS), how standards dealwith cloud services and virtualization, compliance for the cloud provider vs.compliance for the customer.

PRACTICAL - (30 Hours)

REFERENCES

1. Tim Mather, Subra Kumaraswamy, ShahedLatif, "Cloud Security and Privacy: AnEnterprise Perspective on Risks and Compliance" O'Reilly Media; 1 edition[ISBN: 0596802765], 2009.
2. Ronald L. Krutz, Russell Dean Vines, "Cloud Security" [ISBN: 0470589876],2010.
3. 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.
5. Cloud Security Alliance, "Security Guidance for Critical Areas of Focus in CloudComputing" 2009.
6. Vmware "VMware Security Hardening Guide" White Paper, June 2011 .
7. Cloud Security Alliance 2010, "Top Threats to Cloud Computing" Microsoft 2013.
8. Timothy Grance; Wayne Jansen;NIST "Guidelines on Security and Privacy inPublic Cloud Computing", 2011.
9. Evelyn Brown NIST "Guide to Security for Full Virtualization Technologies",2011.
10. Peter Mell, Timothy Grance, NIST "The NIST Definition of Cloud Computing ", 2011.
11. William Hau, Rudolph Araujo et al "How Virtualization Affects PCI DSS",www.foundstone.com.
12. Chenxi Wang "Compliance with Clouds: Caveat Emptor",www.forrester.com/2010.

CC2026	MANAGING VIRTUAL ENVIRONMENTS				L	T	P	C
	Total Contact Hours - 75	3	0	2	4			
	Pre-requisite							
	Nil							
PURPOSE								
This course deals with management of complex virtual environments, analysis of key performance factors of virtualized systems, principal issues in troubleshooting virtual environments, evaluation of small scale virtual environment developed in the lab. This course will equip students with the in-depth knowledge and techniques used toefficiently optimize and effectively trouble-shoot virtual infrastructures								
INSTRUCTIONAL OBJECTIVES								
1.	Discuss and evaluate the management of complex virtual environments.							
2.	Critically analyze key performance factors in virtualized systems.							
3.	Identify and formulate judgements for management requirements relating to the configuration and performance of virtual environments.							
4.	Identify and analyze the principal issues in troubleshooting virtual environments.							

UNIT I - PERFORMANCE MANAGEMENT IN A VIRTUAL ENVIRONMENT (9 Hours)

Management techniques, methodology and key performance metrics used to identify CPU, memory, network, virtual machine and application performance bottlenecks in a virtualized environment. Configuration and change management goals and guidelines.

UNIT II – CLOUD NATIVE ARCHITECTURE & APPLICATIONS (10 Hours)

Introduction, Cloud native architecture, Defining cloud native maturity model, cloud operating environment, cloud native architecture-use study: Netflix, Cloud Native application Design-monolithic to micro services, containers and serverless, Development and frameworks, cloud native toolkit, Cloud Native services- case studies: AWS, Azure, Google Cloud platform

UNIT III - SECURE VIRTUAL NETWORKING (8Hours)

Configuration and change management goals and guidelines, tools and technologies in virtualized environments; Virtual network security architecture, network segmentation and traffic isolation to secure a virtual network configuration.

UNIT IV - PROTECTING THE MANAGEMENT ENVIRONMENT (9 Hours)

Server authentication, authorization, and accounting, SSL certificates, server hardening; Protecting the host system: security architecture, controlling access to storage, hardening hosts, Hardening virtual machines; Virtual machine security architecture, security parameters; Protecting the host and virtual machine systems using server authentication, authorization, and accounting techniques.

UNIT V – TROUBLESHOOTING VIRTUAL ENVIRONMENTS (9 Hours)

Interpreting host, network, storage, cluster and virtual machine log files. Network troubleshooting, traffic sniffing, storage access problems, iSCSI authentication and digests. Virtual machine migration, cluster errors with shares, pools, and limits; Command line interfaces and syntax, interpreting host, network, storage, cluster, virtual machine log files and network traces.

PRACTICAL - (30 Hours)**REFERENCES**

1. Massimo Cafaro (Editor), Giovanni Aloisio (Editor), “*Grids, Clouds and Virtualization*” Springer; edition [ISBN: 978-0857290489]2011.
2. Tom Laszewski , Kamal Arora, Erik Farr, PiyumZonooz, “Cloud Native Architectures: Design high-availability and cost-effective applications for the cloud”, 2018, packt publishing
3. Chris Wolf and Erick M. Halter, “*Virtualization*” A press; 1 edition [ISBN: 978- 1590594957]2005.
4. Gaurav Somani, “*Scheduling and Isolation in Virtualization*”, VDM Verlag Dr. Müller [ISBN: 978-3639295139], Muller Publishers, Germany, Sept.2010
5. LatifaBoursas (Editor), Mark Carlson (Editor), Wolfgang Hommel (Editor), Michelle Sibilla (Editor), KesWold (Editor), “*Systems and Virtualization Management: Standards and New Technologies*” [ISBN:978-3540887072], October 14, 2008
6. Edward L. Haletky, “*VMware ESX Server in the enterprise*” [ISBN: 978- 0132302074]. Prentice Hall; 1 edition 29 Dec2007.
7. Edward Haletky, “*VMware ESX and ESXi in the Enterprise - Planning Deployment of Virtualization Servers*” [ISBN: 978-0137058976]., Prentice Hall;2 edition February 18, 2011.

CC2057	SEMINAR	L	T	P	C
			0	0	2
PURPOSE					
Seminar is one of the important components for the engineering graduates to exhibit and expose their knowledge in their field of interest. It also gives a platform for the students to innovate and express their ideas in front of future engineering graduates and professionals					
INSTRUCTIONAL OBJECTIVES					
1.	To make a student study and present a seminar on a topic of current relevance in Information Technology or related fields.				
2.	Enhancing the debating capability of the student while presenting a seminar on a technical topic				
3.	Training a student to face the audience and freely express and present his ideas without any fear and nervousness, thus creating self-confidence and courage which are essentially needed for anEngineer.				

GUIDELINES

1. Each student is expected to give a seminar on a topic of current relevance in IT/Related field with in a semester.
2. Students have to refer published papers from standard journals.
3. The seminar report must not be the reproduction of the original papers but it can be used as reference.

ASSESMENT:

The students are expected to give at least two presentations on their topics of interest which will be assessed by a committee constituted for this purpose. This course is mandatory and a student has to pass the course to become eligible for the award of degree. Marks will be awarded out of 100 and appropriate grades assigned as per the regulations.

Program Electives

CC2131	DESIGN & DEVELOPMENT OF CLOUD APPLICATIONS	L	T	P	C
	Total Contact Hours - 60	2	0	2	3
	Pre-requisite				
	Web Application Development				
PURPOSE					
This module is focused on developing web and mobile applications in the cloud. By the end of this module the student will have a detailed overview of the design and development process involved in creating a cloud based application.					
INSTRUCTIONAL OBJECTIVES					
1	Design and develop elegant and flexible cloud software solutions.				
2	Evaluate the security issues related to the development of cloud applications.				
3	Manage and deploy a cloud based application.				
4	Research and critique a topic related to Software development in the cloud.				
5	Analyze a real world problem and develop a cloud based software solution.				

UNIT I - DESIGNING CLOUD BASED APPLICATIONS (5 Hours)

Role of business analyst, requirements gathering, UML, use of state diagrams, wire frame prototypes, use of design tools such as Balsamiq. Selecting front end technologies and standards, Impact of growth in mobile computing on functional design and technology decisions.

UNIT II - CLOUD APPLICATION DEVELOPMENT (7 Hours)

Technical architecture considerations – concurrency, speed and unpredictable loads. Agile development, team composition (including roles/responsibilities), working with changing requirements and aggressive schedules. Understanding Model View Controller (MVC).

Advanced understanding of “views”, location, and the presentation layer: Advanced Ajax and JQuery. Presenting to different browsers and devices. Localization and internationalization; Understanding client location and device type. Mobile application development – Android, iOS, WP, RIM, Symbian.

UNIT III - STORING OBJECTS IN THE CLOUD (5 Hours)

Session management. Advanced database techniques using MySQL and SQL Server, blob storage, table storage. Working with Third Party APIs: Overview of interconnectivity in cloud ecosystems. Working with Twitter API, Flickr API, Google Maps API. Advanced use of JSON and REST.

UNIT IV - CLOUD APPLICATIONS AND SECURITY ISSUES (6 Hours)

Understanding cloud based security issues and threats (SQL query injections, common hacking efforts), SSL, encrypted query strings, using encryption in the database. Authentication and identity. Use of OAuth. OpenID; Understanding QA and Support: Common support issues with cloud apps: user names and passwords, automated emails and spam, browser variants and configurations. Role of developers in QA cycle. QA techniques and technologies. Use of support forums, trouble ticketing.

UNIT – V Cloud-Native Applications- Design & Configurations (7 hours)

Concept of cloud native applications, traditional vs. cloud native applications, 12 factor design principles, codebase, dependencies, config, backing services

REFERENCES

1. Jim Webber, SavasParastatidis, Ian Robinson, “*REST in Practice*” O’Reilly Media; 1 edition, [ISBN: 978-0596805821] 2010.
2. Eugenio Pace, Dominic Betts, Scott Densmore, Ryan Dunn, Masashi Narumoto, MatiasWoloski, “*Developing Applications for the Cloud on the Microsoft Windows Azure Platform*” Microsoft Press; 1 edition, [ISBN: 9780735656062] 2010.
3. Dan Wellman, “*jQuery UI 1.6*” Packt Publishing [ISBN: 9781847195128] 2009.
4. Peter Lubbers, Brian Albers, Frank Salem, Ric Smith, “*Pro HTML5 Programming*” A press, [ISBN: 9781430227908] 2010.
5. Lee Babin, “*Beginning Ajax with PHP*” A press; 1 edition, [ISBN: 9781590596678] 2006.
6. Richard York, “*Beginning JavaScript and CSS development with jQuery*”, Wiley Pub. Indianapolis, IN [ISBN: 9780470227794] 2009.
7. Edward Benson, “*The art of Rails*”, Wiley Pub. Indianapolis, IN [ISBN: 9780470189481] 2008.
8. Kevin Hoffman, “*Beyond the Twelve-Factor App*”, O’Reilly Media, Inc. 2016, [ISBN: 9781492042631]

CC2132	APPLICATION DEVELOPMENT FRAMEWORKS	L	T	P	C
	Total Contact Hours - 60	2	0	2	3
	Pre-requisite				
	CC2021, CC2023				
PURPOSE					
This module has two distinct sections. In the first section students will learn about building applications using a popular application development framework. After the first section is completed the module will focus on one of the following areas: Enterprise Integration or Rich Web Applications.					
INSTRUCTIONAL OBJECTIVES					
1.	Identify the key aspects of developing applications using a framework.				
2.	Write code to integrate frameworks to access relational databases				
3.	Evaluate framework technologies for remote communication.				
4.	Option 1 - Enterprise Integration: Design and build concurrent applications and schedule tasks using an application framework. Assess the integration of serialization and remoting to call remote applications.				
5.	Option 2 - Rich Web Applications: Integrate an application framework to implement stateful interactions. Compare rapid productivity tools such as Grails and Roo, etc.				

UNIT I –INTRODUCTION ANDSPRING FRAMEWORK

(8Hours)

Twelve factors- Codebase; Dependencies; Config; Backing services; Build, release, run; process, port binding; concurrency; disposability, dev/prod/parity, logs, admin process. Overview of Java frameworks, introduction to Spring. configure an application, the bean life-cycle, simplifying application configuration, annotation-based dependency injection, testing a Spring-based application.

UNIT II- EFFECTIVEMIDDLE-TIERARCHITECTURE

(6Hours)

Adding behavior to an application using aspects, data access with Spring, simplifying JDBC-based data access, driving database transactions in a Spring environment.

UNIT III - IMPLEMENTING ENTERPRISE INFORMATION CONNECTIVITY

(6 Hours)

Object-to-relational mapping (ORM), Hibernate in a Spring environment, effective web application architecture, Spring MVC, RESTful web services with Spring MVC.

UNIT IV –INTEGRATION WITHENTERPRISESERVICES

(4Hours)

Securing web applications, emoting framework, simplifying message applications with Spring JMS, adding manageability to an application with Spring JMX

UNIT V -ENTERPRISEINTEGRATION

(6 Hours)

Integration Foundations Essential concurrency, tasks and scheduling, serialization and remoting. Working with Web Services Advanced XML, SOAP web services, RESTful web services, web service security. Messaging and Transactions Messaging, working with JMS, transactional JMS, distributed transaction management. Spring Batch and Integration Spring batch, advanced Spring integration, Service-Oriented Architecture(SOA)

PRACTICAL - (30 Hours)

REFERENCES

1. Rod Johnson,[et al.] “*Professional Java development with the Spring Framework*”, Wiley Pub. Indianapolis, IN [ISBN: 978-0764574832],2005.
2. Mark Fisher, “*Spring Integration in Action*”, 1st Ed., Manning Publications [ISBN: 978-1935182436],2011.
3. Craig Walls, Ryan Breidenbach, “*Spring in Action*” Manning Publications; 2 edition [ISBN: 978-1933988139],2007.
4. Paul Fisher, Solomon Duski, “*Spring Persistence with Hibernate*” A press; 1 edition, [ISBN: 978-430226321]2009.
5. Website: “*SpringSource*”.<http://www.springsource.com/>.
6. Website: “*Sun –Oracle*”. <http://www.oracle.com/us/technologies/java/index.html>.
7. Website: “*IBM*”. <http://www.ibm.com/developerworks/java/>.
8. Website: “*Twelve factors to design and build apps*”.<https://developer.ibm.com/courses-center/the-twelve-factors-dwc024/>

CC2133	SCRIPTING FOR SYSTEM ADMINISTRATORS	L	T	P	C
Total Contact Hours - 60		2	0	2	3
Pre-requisite					
Nil					
PURPOSE					
This module will address the scripting skills that System administrators need to help them with their daily tasks.					
INSTRUCTIONAL OBJECTIVES					
1.	Assess system administration tasks and design scripts to automate these tasks.				
2.	Solve system administration problems using a shell interface.				
3.	Design complex scripts in a scripting language such as Perl, Python or Ruby.				
4.	Develop scripts to a high level in Power shell				

UNIT I - POWERSHELL and cmdlets

(6 Hours)

Shell and Powershell Scripting: Shell syntax, sed, awk, grep, diff, join, etc. Unix and Windows CLI. cmdlets, wmic.

UNIT II – LINUX BASICS

(6 Hours)

Introduction to Linux, File System of the Linux, General usage of Linux kernel & basic commands, Linux users and group, Permissions for file, directory and users, Searching a file & directory, zipping and unzipping concepts, linux Networking

UNIT III - SCRIPTING LANGUAGES

(6 Hours)

PERL Scripting, Python Scripting, TCL scripting

UNIT IV – SCRIPTING and TROUBLESHOOTING

(6 Hours)

Scripting in a high-level Language: Language syntax, Applications of scripting e.g. querying SNMP devices, running external processes, managing user accounts, monitoring file systems & processes, Managing processes, services, events and network connections; Troubleshooting.

UNIT V – USING LDAP AND AD

(6 Hours)

Working with LDAP and AD, analyze log files, administer network names and configuration services, maintain, monitor and map network services, processes, package management, statistics gathering and reporting. Using scripting to automate tedious and repetitive tasks.

PRACTICAL - (30 Hours)

REFERENCES

1. Hal Rottenberg, “*Managing VMware Infrastructure with Windows PowerShell TFM*”, Sapien Press 2009.
2. Justin Seitz, “*Gray Hat Python*”, NO STARCH PRESS [ISBN: 1593271921], 2009.
3. RytisSileika, “*Pro Python System Administration*” A press; 1 edition [ISBN: 978-1-4302-2605-5], 2010.
4. Noah Gift and Jeremy Jones, “*Python for Unix and Linux system administration*”, O'Reilly Farnham 2008.
5. Marty Alchin, “*Pro Python*” A press [ISBN: 978-1-4302-2757-1], 2010.
6. Mark Lutz, “*Learning Python*” O'Reilly Media; 5 edition [ISBN: 978-0596158064], 2013.
7. Mark Summerfield, “*Programming in Python 3: A Complete Introduction to the Python Language*” Addison-Wesley Professional; 2 edition, [ISBN: 978-0-321-68056-3], 2009.
8. David N. Blank-Edelman, “*Automating system administration with Perl*”, O'Reilly Media Sebastopol, CA 2009.
9. Website: “*Command Line Kung Fu*” <http://blog.commandlinekungfu.com/>.
10. Python Tutorial by Guido van Rossum, and Fred L. Drake, Jr., editor, Release 2.6.4
11. Practical Programming in Tcl and Tk by Brent Welch , Updated for Tcl 7.4 and Tk 4.0
12. Teach Yourself Perl 5 in 21 days by David Till.
13. Red Hat Enterprise Linux 4: System Administration Guide Copyright 2005 Red Hat, Inc

CC2134	DATA WAREHOUSING AND MINING	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
	Pre-requisites				
	NIL				
PURPOSE					
This course focuses on the fundamentals of data warehousing and their associated problem areas. Data pre-processing and preparation, outlier detection, data warehouse design, On-line analytical processing are the major areas of coverage of this course. This course also deals with the fundamentals of data mining and algorithms associated with the same.					
INSTRUCTIONAL OBJECTIVES					
1.	Describe the fundamental concepts, benefits and problem areas associated with data warehousing				
2.	Describe the various architectures and main components of a data warehouse.				
3.	Design a data warehouse, and be able to address issues that arise when implementing a data warehouse.				
4.	Compare and contrast OLAP and data mining as techniques for extracting knowledge from a data warehouse.				
5.	Algorithms for Predictive modeling, link analysis and deviation detection and CRISP-DM				

UNIT I - DATA WAREHOUSING

(6 Hours)

OLTP systems versus data warehousing. Data warehousing concepts; benefits and problem areas; Architecture and main components of a data warehouse; Managing metadata.

UNIT II - DATA PREPARATION AND PRE-PROCESSING

(11 Hours)

Need to pre-process data; Data Cleaning; Handling Missing Data; Identifying Misclassifications; Graphical methods for identifying Outliers; Data Transformation; Numerical Methods for Identifying Outliers.

UNIT III - DATA WAREHOUSE DESIGN

(8 Hours)

Corporate Information Factory (CIF) versus Business Dimensional Lifecycle Methodologies. Dimensionality modeling: Star, Snowflake and Starflake schemas.

UNIT IV - ON-LINE ANALYTICAL PROCESSING (OLAP)

(8 Hours)

OLAP applications. OLAP operations: roll-up, drill-down, slice and dice, and pivot. OLAP Tools: Multidimensional OLAP (MOLAP), Relational OLAP (ROLAP), Hybrid OLAP (HOLAP) and Desktop OLAP (DOLAP).

UNIT V - Data Mining

(12 Hours)

Algorithms: Predictive modeling, database segmentation, link analysis and deviation detection. Cross Industry Standard Process for Data Mining (CRISP-DM) specification.

REFERENCES

1. Thomas M. Connolly, Carolyn E. Begg, "Database Systems: A Practical Approach to Design, Implementation and Management", 5th Ed., Addison Wesley [ISBN: 0321523067], 2010.
2. Jiawei Han and Micheline Kamber, Jian Pei, "Data Mining Concepts and Techniques", Third Edition, Elsevier, 2012.
3. Anthony David Giordano, "Data Integration Blueprint and Modeling", IBM Press; 1 edition [ISBN: 0137084935], 2011.
4. Ralph Kimball, Margy Ross, Warren Thornthwaite (Contributor), Joy Mundy (Contributor), Bob Becker (Contributor) "The Kimball Group Reader", Wiley [ISBN: 9780470563106], 2010.
5. Daniel T. Larose "Discovering knowledge in data", Wiley-Interscience Hoboken, N.J. [ISBN: 978-0-471-66657-8], 2005.
6. Richard Roiger, Michael Geatz, "Data mining", Addison Wesley Boston [ISBN: 0201741288], 2002.

CONVERGED NETWORKS		L	T	P	C
CC2135	Total Contact Hours - 45	3	0	0	3
	Prerequisite				
	Knowledge of basic networking concepts, routing protocols and IP addressing mechanisms.				
PURPOSE					
This course focuses on the overview of convergence, benefits, types, technology and Architecture. This course provides knowledge on various convergence protocols and Real-Time applications. This course aims at providing an in depth knowledge to the learners in the field of Multiprotocol label switching and Voice over IP. QoS details of converged network shall be dealt in a detailed manner in this course.					
INSTRUCTIONAL OBJECTIVES					
1.	Implement Real-Time applications enabled by a convergent network and its Protocols.				
2.	Explain how Quality of Service is achieved in a Converged Network				
3.	Design Multiprotocol Label Switching				
4.	Engineer voice over IP and convergence.				

UNIT I – INTRODUCTION

(8 Hours)

Overview of convergence, Benefits of Converged network, Challenges, Types of convergence, OSI layered perspective: Possible convergence at each layer and protocol modifications - Cable and DSL Technology, cable system components and benefits, DOCSIS, HFC Cable Network Architecture

UNIT II – CONVERGENCE PROTOCOLS AND REAL-TIME APPLICATIONS

(10 Hours)

Voice Compression, VOIP Convergence, H.323 protocol, SIP, Media Gateway Control Protocol (MGCP), MEGACO - Review of Traditional Voice Networks; Codec / Vocoder Technologies; VoIP Transport; Real-Time Concerns; RTP/RTCP; H.323 and SIP as signaling protocols; Cloud-based VoIP & Video services

UNIT III - QOS FOR A CONVERGED NETWORK

(10 Hours)

IP QoS review of QoS; 802.1p/q; Queuing mechanisms – WFQ, CBWFQ, Low Latency, Random Early Detection; Integrated Services; Reservation Protocol (RSVP); Differentiated Services (Diffserv); QoS issues in WANs; implementation of Diffserv QoS model

UNIT IV - MULTIPROTOCOL LABEL SWITCHING

(8 Hours)

MPLS Header; MPLS forwarding basics; Quality of service with MPLS TE; MPLS VPN applications; implementation of MPLS and MPLS VPN

Unit V - VOICE OVER INTERNET PROTOCOL AND CONVERGENCE

(9 Hours)

Voice over IP- H.323 Framework for VoIP- Session Initiation Protocol (SIP)- Comparison between H.323 and SIP- Real time protocols- Convergence Technologies- Call routing- VoIP applications- IP Multimedia Subsystems (IMS) Mobile VoIP – Cloud Computing – Applications – Limitation – Regulatory Issues – Security Concerns.

REFERENCES

1. Oliver C. Ibe, (2002) “*Converged Network Architectures, Delivering Voice and Data over IP, ATM, and Frame Relay*”, John Wiley & Sons
2. Scott Firestone, Thiya Ramalingam, Steve Fry, “*Voice and Video Conferencing Fundamentals*”, 1st Ed. Ed., Cisco Press [ISBN: 978-1-58705-268-7], 2007
3. Luc De Ghein, “*MPLS Fundamentals*”, 1st Ed. Ed., Cisco Press [ISBN: 978-1-58705-197-5] 2006.
4. Christina Hattingh, Darryl Sladden, ATM Zakaria Swapan, “*SIP Trunking*”, Cisco Press [ISBN: 978-1-58705-944-4] 2010.
5. Eric Osborne, Ajay Simha, “*Traffic engineering with MPLS*”, Cisco Press [ISBN: 978-1587050312], 2003. 5. Amir Ranjbar, “*CCNP ONT Official Exam Certification Guide*”, Cisco Press [ISBN: 978-1-58720-176-3], 2007.
6. Website: Cisco Systems Inc., “*Voice/Data Integration Technologies*”. 2006.
7. http://www.cisco.com/univercd/cc/td/doc/cisintwk/ito_doc/voicdata.htm

NETWORK SECURITY		L	T	P	C
CC2136	Total Contact Hours - 45	3	0	0	3
	Prerequisite				
PURPOSE					
This course will explore the aspects of IPSec, Virtual Private Networks and SSH tunneling in addition to the cloud security issues. The course covers the details of wireless security including WEP and WPA. Different types of firewalls including packet filters, application level gateway and NAT are also the topics of discussion in this course. This course provides the learners with the details on IDS/IPS, sniffers and, packet capturing tools and mechanisms.					
INSTRUCTIONAL OBJECTIVES					
1. Identify and evaluate threats to network security and data loss.					
2. Install, configure, and evaluate firewalls					
3. Configure and appraise Intrusion Detection and Response Systems.					
4. Install, configure, and evaluate VPN (Virtual Private Network) Technology.					
5. Evaluate the security of a wireless network system.					
6. Create and evaluate packet captures					

UNIT I - INTERNET SECURITY & ENCRYPTION

(10 Hours)

Encryption of static data, IPSec, AH, ESP, IKE, ISAKMP/Oakley, Tunnel mode, Transport mode, Virtual Private Networks (VPNs), SSH Tunneling, IP6 issues, Cloud Security Issues.

UNIT II – FIREWALLS

(10 Hours)

Packet Filters, Stateful, Stateless, Bastion Host, Circuit Level, Application gateway, SOCKS, DMZ, Host-Based Firewall, Egress Filtering, Network Address Translation(NAT), Multi-homing, IPTables/NetFilter, implementing NAT.

UNIT III - SNIFFERS AND PACKET CRAFTING

(10 Hours)

Libpcap, dSniff, Wireshark, tcpdump, Mitigation of Sniffer Attacks, ARP Cache Poisoning, Port Stealing, Switch flooding, DNS and IP Spoofing, Session Hijacking, Sequence Numbers, Ettercap, idle host scanning, Default TTLs, Countermeasures, Packet Crafting using eghping, scapy.

UNIT IV - WIRELESS SECURITY

(6 Hours)

802.11, war driving, net stumbler, kismet, wellenreiter, WEP, WPA, cowpatty.

UNIT V - INTRUSION DETECTION & PREVENTION

(9 Hours)

Focus on NIDS, snort, Types of IDSs, Network IDSs, Anomaly based Detection, Signature based Detection, Evasion Techniques, False Positives, NIDS implementation using eg snort, Data Loss Prevention.

REFERENCES

- 1.Eric Cole, Ronald L. Krutz, James Conley, “Network Security Bible”, Wiley [ISBN: 0764573977], 2005.
- 2.John R. Vacca, “Guide to Wireless Network Security”, Springer [ISBN: 0387954252], 2006.
- 3.Johnny Long, Chris Hurley, SensePost, Mark Wolfgang, Mike Petruzzi, “Penetration Tester's Open Source Toolkit”, Syngress [ISBN: 1597490210] 2005.
- 4.BarrieDempster, James Eaton-Lee, “Configuring IPCop Firewalls: Closing Borders with Open Source”, Packet Publishing [ISBN: 1-904811-36-1], 2006.
- 5.Lucian Gheorghe, “Designing and Implementing Linux Firewalls and QoS using netfilter, iproute2, NAT, and L7-filter”, Packt Publishing [ISBN: 1-904811-65-5] 2006.
- 6.Mark Rhodes-Ousley, Roberta Bragg, Keith Strassberg “Network Security: The Complete Reference”, McGraw-Hill [ISBN: 0072226978], 2003,.

7. Chuck Easttom, "Network Defense and Countermeasures: Principles and Practices" [ISBN: 978-0131711266], 2005.
8. Charlie Kaufman, Radia Perlman, Mike Speciner, "Network Security", Prentice Hall, 2nd edition, 2002, ISBN-10: 0130460192, ISBN-13: 978-0130460196.
9. Charles Pfleeger, "Security in Computing", Prentice Hall, 4th Edition, 2006, ISBN10: 0132390779, ISBN-13: 978-0132390774.
10. Ulysess Black, "Internet Security Protocols: Protecting IP Traffic", Prentice Hall PTR; 1st edition, 2000, ISBN-10: 0130142492, ISBN-13: 978-0130142498.
11. William Stallings, "Cryptography and Network Security", Pearson Education, 6th Edition, 2013, ISBN 10: 0133354695.
12. Juniper Networks, "VPN Decision Guide: IPSec vs. SSL VPN Decision Criteria" 2007.
13. http://www.juniper.net/solutions/literature/white_papers/200232.pdf.

CC2137	ENTERPRISE STORAGE SYSTEMS	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
	Pre-requisites				
	Nil				
PURPOSE					
This course provides a comprehensive introduction to storage technology in an increasingly complex IT environment. It builds a strong understanding of underlying storage technologies and prepares you to learn advanced concepts and technologies. The course also deals with architectures, comprehensive understanding of the various storage infrastructure ,features and benefits of Intelligent Storage Systems; networked storage technologies such as FC-SAN, NAS and IP-SAN; long-term archiving solutions, the increasingly critical area of information security and the emerging field of storage virtualization technologies.					
INSTRUCTIONAL OBJECTIVES					
1.	Evaluate various storage classifications and technologies.				
2.	Analyze storage architectures, processes, components and how they relate to virtualization.				
3.	Justify the implementation of a range of storage solutions to enable business continuity.				
4.	Analyze storage security design, implementation, monitoring and management.				

UNIT I - STORAGE SYSTEMS

(10 Hours)

Data Classification, Storage Evolution and Data Center infrastructure.Host components, Connectivity, Storage, and Protocols. Components of a disk drive, physical disk and factors affecting disk drive performance. RAID level performance and availability considerations.Components and benefits of an intelligent storage system.

UNIT II - STORAGE NETWORKING TECHNOLOGIES

(12 Hours)

Direct-Attached Storage (DAS)architecture, Storage Area Network (SAN) attributes, components, topologies, connectivity options and zoning. FC protocol stack, addressing, flow control, and classes of service. Networked Attached Storage (NAS)components, protocols, IP Storage Area Network (IP SAN) iSCSI, FCIP and FCoE architecture. Content Addressed Storage (CAS) elements, storage, and retrieval processes.

UNIT III - VIRTUALIZATION

(8 Hours)

CPU virtualization, Memory virtualization and Network virtualization, Block-level and file-level storage virtualization technology, virtual provisioning and cloud computing.

UNIT-IV - BUSINESS CONTINUITY

(8 Hours)

Business Continuity measurement, terminologies, and planning. Backup designs, architecture, topologies, and technologies in SAN and NAS environments. Local and Remote replication using host and array-based replication technologies such as Synchronous and Asynchronous methods.

UNIT V - STORAGE SECURITY AND MANAGEMENT

(7 Hours)

Storage security framework and various security domains. Security implementation in SAN,NAS and IP-SAN networking. Monitoring and Storage management activities and challenges

REFERENCES

1. EMC, "Information Storage and Management" Wiley; 2 edition [ISBN: 978- 0470294215], 2012.
2. Richard Barker, Paul Massiglia, "Storage area network essentials", Wiley New York [ISBN: 978-0471034452] 2002.
3. Ulf Troppens, Rainer Erkens, Wolfgang Mueller-Friedt, Rainer Wolafka, Nils Haustein, "Storage Networks Explained" Wiley; 2 edition, [ISBN: 978- 0470741436], 2009.
4. W. Curtis Preston, "Using SANs and NAS", O'Reilly & Associates Sebastopol, Calif. [ISBN: 978-0596001537], 2002.
5. HimanshuDwivedi, "Securing storage", Addison-Wesley Upper Saddle River, NJ [ISBN: 978-0321349958], 2006.

OBJECT ORIENTED SOFTWARE ENGINEERING		L	T	P	C
CC2138	Total Contact Hours - 60	2	0	2	3
	Prerequisite				
	Nil				
PURPOSE					
To learn the advanced software engineering principles and methodologies for effective software development					
INSTRUCTIONAL OBJECTIVES					
1.	To learn about software prototyping, analysis and design				
2.	To learn UML and its usage				
3.	Case studies to apply the principles				

UNIT I - INTRODUCTION

(5 Hours)

Software Engineering Paradigms - Software Development process models - Project & Process -Project management – Process & Project metrics - Object Oriented concepts & Principles.

UNIT II - PLANNING & SCHEDULING

(6 Hours)

Software prototyping - Software project planning – Scope – Resources - Software Estimation -Empirical Estimation Models- Planning-Risk Management - Software Project Scheduling – Object oriented Estimation & Scheduling.

UNIT III - ANALYSIS & DESIGN

(10 Hours)

Analysis Modeling - Data Modeling - Functional Modeling& Information Flow-BehavioralModeling-Structured Analysis - Object Oriented Analysis - Domain Analysis-Object oriented Analysis process - Object Relationship Model - Object Behavior Model; Design Concepts & Principles - Design Process - Design Concepts - Modular Design –Design Effective Modularity - Introduction to Software Architecture - Data Design – Transform Mapping – Transaction Mapping – OOD - Design System design process- Object design process -Design Patterns.

UNIT IV - IMPLEMENTATION & TESTING

(5 Hours)

Top-Down, Bottom-Up, object oriented product Implementation & Integration. Software Testing methods-White Box, Basis Path-Control Structure –Black Box-Unit Testing- Integration testing-Validation & System testing. Testing OOA & OOD models-Object oriented testing strategies.

UNIT V - MAINTENANCE

(4 Hours)

Maintenance process-System documentation-program evolution dynamics-Maintenance costs-Maintainability measurement – Case Studies

PRACTICAL - (30 Hours)

REFERENCES

1. Roger S. Pressman, “*Software Engineering A Practitioner’s Approach*”, Fifth Edition, Tata McGraw Hill,2010.
2. Grady Booch, James Rumbaugh, Ivar Jacobson –“*the Unified ModelingLanguage User Guide*” –(Unit III) Addison Wesley, 1999.
3. Ian Sommerville, *Software Engineering*”, 9th Edition, Pearson Education, 2011.
4. Carlo Ghezzi Mehdi Jazayer, Dino Mandrioli, “*Fundamentals of SoftwareEngineering*”, Prentice Hall of India 2002.
5. Fairley, “*Software Engineering Concepts*”, Tata McGraw Hill, 2001.

CC2139	DATA CENTER VIRTUALIZATION			L	T	P	C
	Total Contact Hours - 60			3	0	0	3
	Pre-requisite						
	Managing Virtual Environments						
PURPOSE							
This course focuses on the challenges in setting up a data center. Resource monitoring using hypervisors and access control to virtual machines will be covered in depth in this course. Setting up of a virtual data center and how to manage them with software interfaces will be discussed in detail.							
INSTRUCTIONAL OBJECTIVES							
1	Identify various constraints and challenges in setting up a data center						
2	Demonstrate Enterprise level virtualization and access control in virtual machines						
3	Manage and deploy a cloud based application in AWS using Devops						

UNIT I - DATA CENTER CHALLENGES

(10Hours)

How server, desktop, network Virtualization and cloud computing reduce data center footprint, environmental impact and power requirements by driving server consolidation;

Evolution of Data Centers: The evolution of computing infrastructures and architectures from standalone servers to rack optimized blade servers and unified computing systems (UCS).

UNIT II - ENTERPRISE-LEVEL VIRTUALIZATION

(10 Hours)

Provision, monitoring and management of a virtual datacenter and multiple enterprise-level virtual servers and virtual machines through software management interfaces;

Networking and Storage in Enterprise Virtualized Environments - Connectivity to storage area and IP networks from within virtualized environments using industry standard protocols.

UNIT III –THE CLOUD AND THE DEVOPS with AWS

(12 Hours)

What is Devops – The origin of DevOps - The developers versus operations dilemma - Key characteristics of a DevOps culture - Deploying Your First Web Application - Creating and configuring your account - Creating our first web server - Managing your infrastructure with CloudFormation - Adding a configuration management system

UNIT IV –Devops Deployment and Scaling of Cloud Application

(14 Hours)

Adding Continuous Integration and Continuous Deployment - Preparing our CI environment - Building a continuous deployment pipeline - Scaling a monolithic application - Improving performance and cost saving - Architecting your application to handle massive amounts of traffic

UNIT VRunning ,Monitoring and Hardening security of AWSEnvironment

(14 hours)

Running Containers in AWS - Using the EC2 container service - Creating a CI/CD pipeline to deploy to ECS - Instrumenting our application for monitoring - Monitoring our infrastructure - Creating alarms using CloudWatch and SNS -Hardening the Security of Your AWS Environment - Improving the security of the IAM layer - Strengthening the security at the network level - Protecting against targeted attacks

REFERENCES

1. Mickey Iqbal, “*IT Virtualization Best Practices: A Lean, Green Virtualized Data Center Approach*”, MC Press [ISBN: 978-1583473542] 2010.
2. Nathaniel Felsen, “*Effective DevOps with AWS*”, Packt Publishing, [ISBN:9781786466815], 2017

	CLOUD APPLICATION DEVELOPMENT	L	T	P	C
CC2140	Total Contact Hours - 60	2	0	2	3
	Pre-requisites				
	Nil				
PURPOSE					
This module introduces students to developing web and cloud based applications. By the end of the module the student will be able to build and deploy real-time cloud-based application and Cloud Automation Framework.					
INSTRUCTIONAL OBJECTIVES					
1. Use best practices in the design and development of elegant and flexible cloud software solutions.					
2. Create, implement and deploy a cloud Automation based application.					
3. Analyze a real world problem and develop a cloud Automation Framework includes Terraform/Chef/Ansible.					
4. Contrast software development in the web, cloud and others					

UNIT I - CLOUDBASED APPLICATIONS

(4Hours)

Introduction, Contrast traditional software development and development for the cloud. Public v private cloud apps. Understanding Cloud ecosystems – IaaS, SaaS/PaaS, popular APIs, mobile cloud.

UNIT II - DESIGNING CODE FOR THE CLOUD

(4Hours)

Class and Method design to make best use of the Cloud infrastructure; **Web** Browsers and the Presentation Layer- Understanding Web browsers attributes and differences. Building blocks of the presentation layer: HTML, HTML5, CSS, Silverlight, and Flash

UNIT III - WEB DEVELOPMENT TECHNIQUES AND FRAMEWORKS

(6Hours)

Building Ajax controls, introduction to Javascript using JQuery, working with JSON, XML, REST. Application development Frameworks e.g. Ruby on Rails, .Net, Java API's or JSF; Deployment Environments – Platform As A Service (PAAS), Amazon, vmForce, Google App Engine, Azure, Heroku, AppForce

UNIT IV – CLOUD AUTOMATION USING TERRAFORM

(8 Hours)

Introduction, Infrastructure as code, DevOps, Installing and Configuring Terraform, Configuration Management Tools-Server, Provision, Building application stack, Provisioning, collaboration with S3, Multi-environment architecture, Terraform-Deployment, State, Modules, Loops, Gotchas, Terraform Team, Infrastructure testing.

UNIT V – CLOUD CONFIGURATION MANAGEMENT USING CHEF AND ANSIBLE

(8 Hours)

Chef-Introduction, Chef component, server API, Recipes, Resources, ChefRuns, Chef Language and style, working with Files and Packages, Templates, Writing recipes, Testing Recipes, Form development and deployment, writing custom extensions, Databags, Chef Shell, Kitchen Test, , Creating users and application-SSD, MySQL, Chef on Cloud Infrastructure. Ansible: Ansible Introduction, Ansible versus other tools, Playbooks, YAML, Ansible Commands, Task blocks, Security management, Provisioning resources, Debugging Ansible playbooks

PRACTICAL - (30 Hours)

REFERENCES

1. Chris Hay, Brian Prince, "Azure in Action" Manning Publications [ISBN: 978- 1935182481],2010.
2. Henry Li, "Introducing Windows Azure" Apress; 1 edition [ISBN: 978-1-4302- 2469-3],2009.
3. Eugenio Pace, Dominic Betts, Scott Densmore, Ryan Dunn, Masashi Narumoto, Matias Woloski, "Developing Applications for the Cloud on the Microsoft Windows Azure Platform" Microsoft Press; 1 edition [ISBN: 9780735656062],2010.
4. Eugene Ciurana, "Developing with Google App Engine" Apress; 1 edition [ISBN: 978-1430218319],2009.
5. Dan Sanderson, "Programming Google App Engine" O'Reilly Media; 1 edition [ISBN:978-0596522728],2009.
6. Paul J. Deitel, Harvey M. Deitel, "Ajax, rich Internet applications, and web development for programmers", Prentice Hall Upper Saddle River, NJ [ISBN: 978-0-13-158738-0],2008.
7. The Terraform Book By James Turnbull, Version v1.4.7,2018
8. Terraform: Up and Running: Writing Infrastructure as Code By Yevgeniy Brikman, O'Reilly Media Inc., First Edition, 2017.
9. Learning Chef, By Rishabh Sharma, Mitesh Soni, Packt Publishing Ltd., First Edition, 2015
10. Chef: Powerful Infrastructure Automation, By John Ewart, Matthias Marschall, Earl Waud, Packt Publishing Ltd., First Edition, 2017
11. Learn Ansible: Automate cloud, security, and network infrastructure using Ansible 2.x, By Russ McKendrick, Packt Publishing Ltd, First Edition 2018.
12. Learning Ansible2, By Fabio Alessandro Locati, Packt Publishing Ltd, Second Edition 2016.

13. Ansible: Up and Running: Automating Configuration Management and Deployment, By Lorin Hochstein, O'Reilly Media Inc., First Edition, 2015.

Web References:

1. <https://www.terraform.io/docs/index.html>
2. <https://www.terraform.io/downloads.html>
3. <https://cloudacademy.com/blog/configuration-management-introducing-chef/>
4. <https://www.chef.io/chef/>
5. <https://docs.chef.io/>
6. <https://www.chef.io/chef/get-chef/>
7. <https://www.ansible.com/>
8. <https://www.ansible.com/products/tower>
9. https://docs.ansible.com/ansible/latest/modules/list_of_cloud_modules.html
10. <https://www.ansible.com/integrations/cloud/amazon-web-services>

CC2141	CLLOUD STRATEGY PLANNING & MANAGEMENT	L	T	P	C
	Total Contact Hours - 45	3	0	0	3
	Pre-requisites				
	Nil				
PURPOSE					
This course deals with the concepts and technological advances fueling the rapid adoption of cloud computing today. This course provides the students with the skills and knowledge required to plan and manage a Cloud Computing strategy within an organization. This course will enable students to evaluate the strategic value of Cloud Computing using IT Governance and Compliance.					
INSTRUCTIONAL OBJECTIVES					
1.	Strategically assess how cloud computing enables IT Transformation and business value in an organization.				
2.	Analyze the role that cloud computing can play in the business process.				
3.	Critically appraise how the incorporation of cloud computing in an IT strategy can deliver on strategic business objectives.				
4.	Evaluate how cloud computing and Service Oriented Architecture (SOA) can deliver business agility.				
5.	Implement IT governance to manage business realization from cloud IT services.				

UNIT I - ACHIEVING BUSINESS VALUE FROM IT TRANSFORMATION (9 Hours)

Moving to a cloud architecture and strategy to achieve business value. BPM, IS, Porter's Value chain model and BPR as a means of delivering business value; **Developing Business Strategy:** Investigate business strategy models to gain competitive advantage for organizations, SWOT/PEST, Economies of scale, Porter's 3 Strategies and 5 Competitive Forces, D'Aveni's hypercompetition models.

UNIT II - STRATEGIC IT LEADERSHIP IN THE ORGANIZATION (9Hours)

Emphasize the roles of the strategic IS/IT leaders such as Chief Information Officer (CIO) and the Chief Technology Officer (CTO) in planning and managing IT Strategic development in the organization.

UNIT III - PLANNING A CLOUD COMPUTING BASED IT STRATEGY (9Hours)

Develop an IT strategy to deliver on strategic business objectives in the business strategy. IT Project planning in the areas of ITaaS, SaaS, PaaS and IaaS are essential in delivering a successful strategic IT Plan.

UNIT IV - SOA AND BUSINESS AGILITY (9Hours)

Shared services delivered by a Service Oriented Architecture (SOA) in a Private or Public Cloud. Services, Databases and Applications on demand. The effect on Enterprise Architecture and its traditional frameworks such as Zachman and The Open Group Architecture Framework (TOGAF).

UNIT V - BENEFIT REALIZATION AND IT GOVERNANCE (9Hours)

Managing resources (people, process, technology), to realize benefit from Private/Public Cloud IT services (IaaS, PaaS, SaaS), Gartner's 5 pillars of benefit realization. IT governance as a service in measuring the delivery of IT Strategy from Cloud IT Services using Sarbanes Oxley (CobIT) and other commonly-used approaches.

REFERENCES

1. Arnold J Cummins, “Easiest Ever Guide to Strategic ITPlanning”<http://strategicitplanningguide.com/>.
2. Andy Mulholland, Jon Pyke, Peter Finger, “Enterprise Cloud Computing - A Strategy Guide for Business and Technology Leaders”, Meghan Kiffer [ISBN: 0929652290],2010.
3. David S. Linthicum, “Cloud Computing and SOA Convergence in Your Enterprise”, Addison Wesley [ISBN: 0136009220],2009.
4. Charles Babcock, “Management Strategies for the Cloud Revolution”, 1st Ed., Tata McGraw/Hill [ISBN:0071740759],2010.
5. Mark I. Williams, “A Quick Start Guide to Cloud Computing: Moving Your Business into the Cloud” Kogan Page [ISBN:0749461306],2010.
6. Website: “Whitepapers and news for the CIO”www.cio.com.
7. Website: “Gartner Research Website”www.gartner.com.

CC2142	DATA SCIENCE AND BIG DATA ANALYTICS	L	T	P	C
	Total Contact Hours - 60	2	0	2	3
	Pre-requisites				
	Knowledge of statistical techniques				
PURPOSE					
This course provides practical foundation level training that enables immediate and effective participation in big data and other analytics projects. It includes an introduction to big data and the Data Analytics Lifecycle to address business challenges that leverage big data. The course provides grounding in basic and advanced analytic methods and an introduction to big data analytics technology and tools, including MapReduce, Hadoop, MongoDB with Mongoose, Cloud Analytics, Birt, Knimeetc					
INSTRUCTIONAL OBJECTIVES					
1.	Deploy the Data Analytics Lifecycle to address big data analytics projects				
2.	Apply appropriate analytic techniques and tools to analyze big data, create statistical models, and identify insights that can lead to actionable results				
3.	Select appropriate data visualizations to clearly communicate analytic insights to business sponsors and analytic audiences				
4.	Use tools such as: R and RStudio, MapReduce/Hadoop, in-database analytics, Window and MADlib functions				
5.	Explain how advanced analytics can be leveraged to create competitive advantage and how the data scientist role and skills differ from those of a traditional business intelligence analyst. Use Mongoose with MongoDB to interact with data on the backend. Learn Cloud Analytics with BI using tools like Birt,Knime.				

UNIT I - INTRODUCTION TO BIG DATA ANALYTICS: (5 Hours)
Big Data overview, State of the practice in analytics role of data scientists, Big Data Analytics in industry verticals

UNIT II - END-TO-END DATA ANALYTICS LIFE CYCLE (4 Hours)
Key roles for successful analytic project, main phases of life cycle, Developing core deliverables for stakeholders

UNIT III - BASIC ANALYTIC METHODS: (8 Hours)
Introduction to “R”, analyzing and exploring data with “R”, statistics for model building and evaluation

UNIT IV - ADVANCED ANALYTICS AND STATISTICAL MODELING FOR BIG DATA (7 Hours)
Naïve Bayseian Classifier, K-means Clustering, Association Rules, Decision Trees, Linear and Logistic Regression, Time Series Analysis, Text Analytics;

UNIT V - MAPREDUCE/HADOOP (6 Hours)
Technology and Tools – MapReduce/Hadoop , In- database Analytics, MADlib and advanced SQL Tools, Mongoose with MongoDB with BI; tools like Birt,Knime etc.,

PRACTICAL - (30 Hours)

REFERENCES

1. Noreen Burlingame , “*The little book on Big Data*”, New Street publishers, 2012.
2. Norman Matloff, “*The Art of R Programming: A Tour of Statistical Software Design*”, No Starch Press; 1 edition , 2011.
3. http://www.johndcook.com/R_language_for_programmers.html.
4. Kristina Chorodow, “*MongoDB : The Definitive Guide*”, Second Edition, O’Reilly Media Inc., 2013
5. Simon Holmes, ”*Mongoose for Application Development*”, PACKT Publishing, 2013
6. Judith Hurwitz, Alan Nugent, Dr. Fern Halper and Marcia Kaufman, “*Big Data for DUMMIES*”, John Wiley & Sons Inc., 2013
7. <http://bigdatauniversity.com/>.
8. <http://home.ubalt.edu/ntsbarsh/stat-data/topics.htm#rintroduction>.

		L	T	P	C
CC2059	Project Phase-I	0	0	12	6
CC2060	Project Phase-II	0	0	32	16
PURPOSE					
To undertake research in an area related to the program of study					
INSTRUCTIONAL OBJECTIVES					
1.	The student shall be capable of identifying a problem related to the program of study and carry out wholesome research on it leading to findings which will facilitate development of a new/improved product, process for the benefit of the society.				

M.Tech projects should be socially relevant and research oriented ones. Each student is expected to do an individual project. The project work is carried out in two phases – Phase I in III semester and Phase II in IV semester. Phase II of the project work shall be in continuation of Phase I only. At the completion of a project the student will submit a project report, which will be evaluated (end semester assessment) by duly appointed examiner(s). This evaluation will be based on the project report and a viva voce examination on the project. The method of assessment for both Phase I and Phase II is shown in the following table:

Assessment	Tool	Weightage
In- semester	I review 10%	10%
	II review 15%	15%
	III review 35%	35%
End semester	Final viva voce examination	40%

Student will be allowed to appear in the final viva voce examination only if he / she has submitted his / her project work in the form of paper for presentation / publication in a conference / journal and produced the proof of acknowledgement of receipt of paper from the organizers / publish

Industry Supportive Elective and Certification courses

Course Code	Course Title	Certification Name	Course Details
CC2143	Industry Elective Course 1	AWS Certified Solutions Architect – Associate	https://linuxacademy.com/amazon-web-services/training/course/name/aws-certified-solutions-architect-associate-level
CC2144	Industry Elective Course 2	AWS Certified Solutions Architect - Professional	https://linuxacademy.com/amazon-web-services/training/course/name/aws-certified-solutions-architect-professional-2018
CC2145	Industry Elective Course 3	Red Hat Certified Specialist in Containerized Application Development	https://linuxacademy.com/containers/courses
		Certified Kubernetes Administrator (CKA) Program	https://linuxacademy.com/linux/training/course/name/cloud-native-certified-kubernetes-administrator-cka
CC2146	Industry Elective Course 4	Machine Learning Certification by Stanford University	https://www.coursera.org/learn/machine-learning
CC2147	One Cloud specialized certification course in I semester (Pass/Fail Course)	Certified Jenkins Engineer	https://linuxacademy.com/devops/training/course/name/certified-jenkins-engineer-2018 Jenkins- https://www.cloudbees.com/jenkins/jenkins-certification
		Learn DevOps: Infrastructure Automation with Terraform	https://www.udemy.com/learn-devops-infrastructure-automation-with-terraform/ https://linuxacademy.com/devops/training/course/name/managing-applications-and-infrastructure-with-terraform https://www.hashicorp.com/training
CC2148	One Cloud specialized certification course in II semester (Pass/Fail Course)	Red Hat Certificate of expertise in Ansible Automation	https://www.redhat.com/en/services/training/ex407-red-hat-certified-specialist-in-ansible-automation-exam?extIdCarryOver=true&sc_cid=701f2000001OH7YAAW
CC2149	One Cloud specialized certification course in III semester (Pass/Fail Course)	Salesforce Certified Platform Developer I	https://trailhead.salesforce.com/en/credentials/platformdeveloper Udemy

Note: Students will be asked to register for certification courses and earn a certificate to be awarded the required credits.