2. Syllabus Detailing and Learning objectives

Module	Chapter	Detailed Content	Syllabus Detailing	Learning Objectives
1	**CH 1** Introduction to Cloud Computing (Hours -1)	Introduction – Component of CC – Comparing CC with Virtualization, Grids, Utility Computing, client- server model, P-to-P Computing - Key Drivers for Cloud Computing - Cloud computing Service delivery model, Cloud Types – Private, Public and Hybrid.	**Purpose**: To make students understand Cloud computing and Virtualization concepts, Components of Cloud, different computing models. Discuss the cloud computing services, delivery models and cloud types. To study their applications, features, service providers , vendors and associated industry standards. **Scope –** **1. Academic Aspects-** Understanding Cloud Computing, its types, delivery models. Virtualization and its levels **2. Technology Aspect-** Understand cloud services from Google, Amazon, Microsoft, their types, Virtualization Levels and its support **3. Application Aspect-** Application of CC in IT industries, application of cloud types, delivery models based applications. Application of Virtualization at various levels. **Students Evaluation** – 1. Theory Questions to be asked on Cloud Computing and virtualization based concepts, their architecture, delivery models, types and levels 2. Lab experiments for installation of hypervisor, configuration of guest and host operating systems, configuration of the admin portals of MS Azure, Amazon AWS 3. Corresponding viva questions can be asked for Cloud configuration, admin console functionality	1. To develop the understanding of fundamentals and technological aspects of Cloud Computing, Virtualization along with various terminologies and the keywords used in Cloud Computing and virtualization**(R)** 2.To understand and explain the various Architectures of Cloud Computing and Virtualization with proper diagrams with labelling and Applications along with the understanding and comprehension of various components **(U)** 3. To Differentiate Between Cloud Computing and Virtualization, cite their types, delivery models and levels among with hardware and network requirements. list and tabulate their features and applications in industries**(A)** 4. To understand different various Avenues for Cloud Computing and Virtualization for their Applications along with the different levels of implementation**(AN)** 5. Evaluate Virtualization Techniques, Grid, Utility and P2P Computing and Their Feasibility, Standards for Cloud computing and the vendors providing services or
	CH 2 Virtualization (Hours -2)	Introduction & benefit of Virtualization –Implementation Levels of Virtualization -Virtualization at OS level – Middleware support for Virtualization	**Purpose** – This chapter gives detailed insight of virtualization, implementation of virtualization, different types of virtualization, its hardware requirements. Different solutions for virtualization and evolution of hypervisors. Hypervisor types and their requirement in cloud computing. Hardware support requirements for virtualization and its types.	

		– Virtualization structure/tools and mechanisms: Hypervisor and XEN Architecture, Binary Translation with full Virtualization, Para Virtualization with Compiler Support -Hardware support for Virtualization in intel x86 processor – CPU Virtualization – Memory Virtualization and I/O Virtualization – Virtualization in Multicore processors	**Scope –** **1. Academic Aspects-** Learning the insights of virtualization, types and levels of virtualization, tools and mechanisms. Hypervisors and their applications with the hardware supportrequirements **2. Technology Aspect-**XEN, VMware, oracle virtual box windows Hyper-V, their installation and configuration to implement various levels of virtualization and study of different types of hypervisors **3. Application Aspect-** Application of virtualization in the cloud computing. Role of hypervisor in cloud computing. **Students Evaluation** 1. Questions on virtualization and its levels can be asked, the hardware requirements for virtualization is required to be explained by students 2. Hypervisors, their types and the implementation for the cloud formation is to be evaluated. 3. Installation and Configuration of Type 0 and 1 hypervisor should be done by students in labs.	products for each of the types, understanding the installation, configuration and management of these products**(E)** 6. Examine the Hardware support for virtualization in intelx86Processors, Understanding the procedure for installation of hypervisors, operation of online as well as in house console of cloud deployments. construct setup for testing for CPI, IO and Memory Virtualization **(C)**
Module 2	**Chapter 3** Cloud computing Services (Hours -2)	XaaS, IaaS, PaaS- Leveraging PaaS for Productivity- Languages for PaaS- DBaaS (Database as a services) – SaaS (Software as a service)	**Purpose-** This chapter is focused on the Cloud Service Delivery Model for productivity. The concept of anything as a service (XaaS) is to be discussed in detail. **Scope –** **1. Academic Aspects-** SaaS, PaaS and IaaS model discussion and later on its extension to DBaaS and ultimately XaaS. How to use this for productivity at enterprise level. **2. Technology Aspect-** Google App Engine, Microsoft Azure, Amazon Web Services. Logging into these SaaS providers and understanding their delivery model. MongoDB as DBaaS and its configuration. **3. Application Aspect-** Students should understand how the cloud service model has changed the implementation scenario at various levels. **Students Evaluation –** 1. Comparison of cloud delivery models 2. Listing the vendors and the service types 3. Listing of XaaS and examples 4. Deploying SaaS application on Google App engine or Azure cloud 5. Configuration of MongoDB as a Lab experiment should be added 6. Mini-project using the technologies discussed is possible	1. List type of cloud services and Cite Application of Cloud strategies for SaaS, PaaS, IaaS, DBaaS and XaaS . Discuss functional implementation of each of the above mentioned cloud delivery model.**(R)** 2. Comprehend the concept of XAAS , Illustrate SAAS, PAAS, IAAS, tabulate the feature points along with vendors and applications. **(U)** 3. Illustrate open source cloud implementation, enlist industry standards associated and governing bodies. Discuss the architecture of Openstack and Eucalyptus. Explain the functionality of each block. List the incremental changes in the latest version of Openstack (Mitaka). **(A)**

	Chapter 4 Open Source Cloud Implementation and Administration (Hours -6)	Eucalyptus and Open Stack Architecture Features – Components – Various mode of operations – Installation and configuration process of both open source – Cloud Administration and Management Task – Creating User Interface (Web Interface) of Private cloud.	**Purpose-** Open source cloud technologies are discussed in this chapter. Openstack and Eucalyptus cloud deployment frameworks are the leading technologies in cloud deployment. **Scope -** **1. Academic Aspects-** Student will study Openstack and eucalyptus architecture, modes of operations, installation, configuration **2. Technology Aspect-** Installation of Ubuntu, CentOS Deployment of Openstack and Eucalyptus cloud **3. Application Aspect-** Administration and management. Using Openstack and Eucalyptus for private cloud deployment **Students Evaluation –** 1. Deployment of private cloud on Ubuntu or CentOS using Openstack June/Kilo or Mitaka Version 3. Deploying Eucalyptus on CentOS 4. Explaining architecture of Openstack and listing the changes in version Mitaka as compared to previous versions 5. Deployment and Configuration of Openstack and Eucalyptus, understanding their management console. 6. Comparison of Openstack and eucalyptus, functionality discussion of each block of their architecture.	4. Distinguish between Openstack and Eucalyptus Architecture, tabulate their blocks and functionality of each block, along with the various modes of operation, deployOpenstack and eucalyptus in a lab environment to test the functionality. Understand the administration and management controls of each of them.**(AN)** 5.Evaluate Open Source Cloud Implementation for their feasibility in Enterprise Application, understand the use of web interface, comment on the industry standards related with the cloud applications.**(E)** 6. Construct private cloud using Openstack, configure DBaaS and test its functionality. List the examples of XaaS. **(C)**
Module 3	**Chapter 5** - Cloud Deployment Techniques (Hours -2)	Factors for Successful Cloud Deployment – Network Requirements – Potential Problem areas in a cloud Networkand their Mitigation – Cloud Network Topologies – Automation and Self-service feature in a cloud –	**Purpose –** The cloud deployment and its dependency is studied in this chapters. Cloud deployment pre-requisites, dependencies and potential problems are discussed in detail here. Cloud types, its comparison, selecting specific model for enterprise solutions are the major factors. Student will be also made aware of the automation and self-service feature in cloud computing.	1. Tabulate various factors for cloud deployment, the network, system and infrastructure dependency. Explain how these factors can be deciding successful cloud deployment. List the hardware, software and network requirement for cloud deployment.**(R)**

		cloudperformance.	**Scope –** **1. Academic Aspects-** Student will study the cloud deployment prerequisites, the factors controlling successful deployment and the challenge areas. Use this knowledge for successful cloud deployment in lab environment. **2. Technology Aspect-** Hardware, Software and Network requirement of cloud deployment. OpenstackMitaka on Ubuntu 14 **3. Application Aspect-** List the challenges faced and the mitigation strategy. Explain the concept of automation in cloud computing and how it is executed.	2. Match Key security issues in cloud commuting with cloud types, its deployment in Private, Public and Hybrid mode. Also comment on the threat level of each of the security issues. **(R)** 3. Estimate Security Risks in Cloud Computing, List and tabulate in influencing factors, compare it for SaaS, PaaS and IaaS deployment along with its industry standard followed by cloud vendors for cloud security solutions. **(A)** 4. Examine techniques to counteract security issues at Virtualization, network and Service level. Discuss how the existing vendors are implementation countermeasures based on this**. (A)** 5. categorize the security risks and their mitigation methods, examine the performance of cloud firewall.**(AN)** 6. Asses the need for data security in cloud computing. Discuss the concept of host security and security for cloud deployment models. Comprehend the encryption protocols are used for data security in cloud computing and the products offering security at various levels.**(E)**
			Student Evaluation - 1. List the factors for successful cloud deployment 2. List the hardware and network requirement for cloud deployments 3. Cite the challenges faced and explain the mitigation techniques 4. Students can be asked to implement this skill for cloud deployment 5. students should explain the cloud automation concept and give a demo in Openstack implementation	
	Chapter 6 - Security (Hours -4)	Security for Virtualization Platform – Host security for SaaS,PaaS and IaaS – Data Security – Data Security Concerns – Data Confidentiality and	**Purpose –** Data security is a key issue in cloud computing, students will learn about the concept of host security and its implementation in cloud delivery models. Encryption standards and their use for data security. Data security concepts, storage solution for data availability and further improving security by cloud firewall to be studied.	

		Encryption – Data Availability –Data Integrity – Cloud Storage Gateways – Cloud Firewall	**Scope –** **1. Academic Aspects-** Cloud Security concerns, host security for cloud delivery models, encryption techniques for cloud. Data security, availability and confidentiality. **2. Technology Aspect-** Amazon Cloud Storage Gateway, Cloud Firewall technical details and specification, Encryption standards used in cloud **3. Application Aspect-** Cloud Storage Gateway, Cloud Firewall, Encryption protocols and their use for cloud security. **Student Evaluation -** 1. This chapter is mainly theoretical, question on the cloud security fundamentals, data security, cloud host security is possible. 2. Students can be asked to use and configure the Amazon Cloud Storage Gateway. 3. Explanation of the encryption techniques used at various avenues.	
Module 4	**Chapter 7** Architecture for Cloud Application **(Hours -4)**	Cloud Application requirements- Architecture for traditional Vs Cloud Applications- Multi-ties Application Architecture- SOA for Cloud applications –	**Purpose –** Cloud application requirements are comprehended in this chapter. Comparison with existing architecture, multi-tier architecture, SOA, Resource oriented SOA for cloud application, Cloud Application parallelization and in memory operations are other important topics to be studied.	1 Describe cloud computing architecture, list the components and summarize their functionality, compare the traditional and cloud application architecture, comment on the advantages of cloud

		Resource oriented SOA – Method –oriented SOA and Event Driven SOA – Parallelization within Cloud Applications – Leveraging In-memory Operations for Cloud Application.	**Scope –** **1. Academic Aspects-** To study cloud application requirements, comparison with existing architecture. SOA and Resource oriented SOA. Method and Event driven SOA. Cloud application parallelization. **2. Technology Aspect-** Designing multi-tier application and deploying on Azure cloud or Amazon AWS. Writing applications using SOA and resource driven SOA concepts. **3. Application Aspect-** SOA and Resource Oriented SOA. Cloud Application Architecture and its comparison with traditional architecture. Multi-tier cloud application and its examples. Cloud Application penalization and in-memory operation concept in cloud computing.	application architecture **(R)** 2. Comprehend basic consideration for designing cloud computing environment **(U)** 3. Cite avenues for Multi-tier application in industry, give their architecture. Comment on the migration of existing application to multi-tier cloud applications. **(A)** 4. Summarize the features of cloud computing services given by Google App Engine, AWS, MS Azure. Code secure applications for the cloud in single and multi- tire mode. **(AN)** 5. Synthesize Application using SaaS Framework given by google, Microsoft and Amazon AWS, include No SQL database in the application. Cite need and functionality of Chubby DLM in cloud computing. **(C)** 6. Examine the feasibility of SOA in cloud computing, comment on how the SOA has emerged as cloud based applications and describe the variations in SOA **(E)**
			Student Evaluation - 1. Listing the requirements for cloud app deployments 2. Comparison of cloud and traditional application architecture 3. Comprehension of SOA, Resource oriented SOA and Event driven SOA, its application in cloud application design. 4. Multi-tier application design and deployment on Google App Engine/ Azure/ Amazon AWS.	
	Chapter 8 Cloud Programming **(Hours -4)**	Programming Support for Google Apps engine: GFS, Big Tables, Googles NO SQL System, Chubby, Google Distributed Lock Service, Programming Support for Amazon EC2: Amazon S3, EBS and Simple DB etc.	**Purpose –** This chapter is covering the application development aspect of cloud computing. This covers Google file system, Big table, NO SQL unstructured database. Lock Systems and managers. Writing applications on PaaS provided by Google, Microsoft and Amazon.	
			Scope – **1. Academic Aspects-** Programming support for Google App Engine, Distributed Lock Managers, Programming requirement of Google App Engine, Azure and Amazon AWS. **2. Technology Aspect-** Google App Engine Configuration, Python Programming for GAE.	

			Application deployment steps for GAE. Writing Application using NetBeans/ Eclipse for AWS. Using Visual Studio .Net 2015 Community edition for development of Cloud Application on Azure. Configuration of Google No SQL database (Bigtable), Amazon SimpleDB, MongoDB etc. **3. Application Aspect-** Application of SOA and resource driven SOA to cloud computing application architecture. Google File system and its role in cloud computing. Functionality of chubby DLM. Programming applications for AWS, GAE and Azure cloud. **Student Evaluation –** 1. Theory questions on GFS, Big Table, SOA and resource driven SOA, Event driven SOA , Chubby are possible 2. Application should be written in Eclipse using Python for deployment on GAE, Azure or AWS. 3. Configuration of Google NoSQL database, MongoDB should be asked	
Module 5	**Chapter 9** Adoption and Use of Cloud **(Hours -4)**	Adoption of Public cloud by SMBs- Public Cloud Adoption phase for SMBs- Vendor liability and Management Adoption process of Public clouds by Enterprises – Managed Private clouds Migrating Application to the cloud – Impact of Shared Resources and Multi-Tenancy on cloud Applications – Phases during Migration an Application to An IaaS Cloud	**Purpose –** The cloud adoption model is discussed here. Phases involved in cloud adoption by SMBs, vendor liability management and adoption by enterprise to be discussed. Cloud management, cloud migration and impact of shared resources, militancy on cloud adoption is to be studied here. **Scope –** **1. Academic Aspects-** Cloud adoption phases, cloud application migration, requirement and deployment strategy. **2. Technology Aspect-** To understand the Phases during Migration an Application to an IaaS Cloud **3. Application Aspect-** Adoption process of cloud by Enterprise. Steps in cloud application migration. Concept of cloud multitenancy. **Student Evaluation –** 1. Theory and viva questions on Cloud Adoptions by SMBs and Enterprises 2. Cloud Adoption phases. Cloud migration **3.** Phases during Migration an Application to an IaaS Cloud 4. Multitenancy and its implications on cloud adoption.	1. Cite Risk involved in cloud computing, enlist the root cause factors for the risk and how the risk is lined with cloud reference framework**(R)** 2. Tabulate Factors driving SMBs to Adopt Cloud, include the factors considered by SMBs for Cloud Adoption and the steps taken for deployment**(R)** 3. Summarize the Techniques for securing Multitenant Environment, the possible topologies involved in the solution**(U)** 4 Investigate Adoption of Cloud by SMBs, examine the security concerns and the tools and techniques used.**(AN)** 5. Analyze Cloud Adoption Model ,

	Chapter 10 Risks of Cloud Computing and Related Costs **(Hours -2)**	Risk Assessment and Management – Risk of Vendor Lock- in – Risk of Loss of control over IT services- Risk of Poor Provisioning – Risk of Multi-tenant environment – Risk failure of cloud provider – SLA risk –security, malware and Internet Attacks – Risk with Application Licensing.	**Purpose –** This chapter is focused on the risk assessment of cloud computing. The different risks involved are Vendor lock-in, loss of control, poor provisioning, multitenancy, cloud failure, SLA, security and application licensing. The mitigation techniques for the risk involved should be comprehended. **Scope –** **1. Academic Aspects-** Risks involved in cloud computing as discussed above. Mitigation techniques and options to overcome the risk involved. **2. Technology Aspect-** Concept of SLA, cloud migration phases, mitigation techniques for risk in cloud computing, solutions considered by industry people should be discussed in class. **3. Application Aspect-** Application licensing, Multitenancy and its effect on Application Execution spaces **Student Evaluation –** 1. Theory and viva questions on the risks involved in cloud computing and the mitigation techniques. 2. Examples of multitenancy, its impact on selecting specific cloud delivery model. 3. Public, private cloud deployment and the role of multitenancy factor in it.	data security, availability and integrity along with its implementation in cloud storage gateways.**(AN)** **6.** Evaluate the need of SLA, the Application licensing and its impact on cloud adoption by SMBs and Enterprises. Cite the risks involved in this and how vendors are providing solutions to overcome this.**(E)**
Module 6	**Chapter 11** AAA Administration for Clouds **(Hours -2)**	AAA model – SSO for Clouds – Authentication management and Authorization management in clouds – Accounting for Resource utilization.	**Purpose –** The cloud administration is discussed here, SSO, Authentication and authorization management for cloud resource utilization is the matter for the consideration. **Scope –** **1. Academic Aspects-** Cloud Authentication and Authorization architecture **2. Technology Aspect-** Industry standards for SSO and AAA model. Tools used for SSO. SSO architecture. **3. Application Aspect-** AAA, SSO and its implementation. Using these concepts for cloud resource utilization.	1. Define Authentication Authorization and Accounting **(R)** 2. Summarize the Concept of SSO, explain SSO architecture and the flow for SSO **(U)** 3. Examine the use of Accounting for Resource Utilization. Cite need and application of resource utilization. (**A)** 4. Asses Mobile Cloud Architecture, list the dependencies for mobile cloud deployment. Explain the advantage of deploying cloud on

			Student Evaluation – 1. Theory and viva questions for AAA and its components 2. Need for SSO 3. Industry standards for SSO, SSO Architecture	mobile network **(E)** 5. Asses the challenges in Mobile Cloud Computing and list its mitigation strategies **(E)**
	Chapter 12 Mobile Cloud Computing **(Hours -1)**	Introduction, Definition, Architecture, Benefits, challengesin mobile and at cloud shield.	**Purpose –** This chapter covers mobile cloud computing, its definition architecture, benefits and the challenges involved. As the mobile devices are major part of consumer end this chapter play a key role in cloud computing.	
			Scope – **1. Academic Aspects-** Introduction, Definition, Architecture, Benefits, challenges in mobile and at cloud shield. **2. Technology Aspect-** High speed internet connectivity over mobile network in 4G and 5G networks and its impact on mobile cloud computing **3. Application Aspect-** Mobile cloud Application Architecture	
			Student Evaluation – 1. Mobile Cloud architecture 2. Technology involved in mobile cloud computing 3. Challenges in mobile and cloud side and their mitigation techniques.	