

Birla Institute of Technology & Science, Pilani
Work Integrated Learning Programmes Division

Digital Learning Handout

Part A: Content Design

Course Title	Cloud Computing
Course No(s)	CSI ZG527/ SE ZG527
Credit Units	5
Credit Model	-2-2, (total 5 units or credits) ie 1 unit for class room hours, 2 unit for lab hours, 2 units for student preparation. Typically 1 unit translates to 32 hours
Instructors	Dr.P. Chinnasamy
Version No:	V1
Date:	16/01/2025

Course Description: Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

Course Objectives

No	Course Objective
C01	Students will learn the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges
C02	Students will learn the basic ideas and principles in data centre design and management
C03	Students will learn about cloud components and technologies and relevant distributed file systems
C04	Students will learn a variety of programming models and develop working experience

Text Book(s):

T1	Dinkar Sitaram and Geetha Manjunath. Moving to the Cloud. Syngress (Elsevier) Pub, 2011
T2	Marinescu, Cloud computing theory and practice, Morgan Kaufmann Publisher

Reference Book(s) & other resources:

R1	Rajkumar Buyya, James Broburg & Anderzej M.G, Cloud Computing – Principles and Paradigms. John Wiley Pub, 2011
R2	Cloud Computing bible by Barrie Sosinsky, Wiley Publishers, 2010
R3	Virtualization A Beginner's guide, Danielle Ruest, Nelson Ruest, TMH, 2009



R4	Cloud Computing bible by Barrie Sosinsky, Wiley Publishers, 2010
R5	Cloud security, a comprehensive guide to secure cloud computing, by Ronald L.Krutz et al, Wiley Publishers, 2010

Learning Outcomes: Students will be able to

No	Learning Outcomes
LO1	Explain the core concepts of the cloud computing paradigm: how and why this paradigm shift came about, the characteristics, advantages and challenges brought about by the various models and services in cloud computing
LO2	Apply the fundamental concepts in data-centres to understand the tradeoffs in power, efficiency and cost
LO3	Discuss system virtualization and outline its role in enabling the cloud computing system model.
LO4	Illustrate the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3 and HDFS
LO5	Analyze various cloud programming models and apply them to solve problems on the cloud

Modular Content Structure

1. Introduction to Cloud Computing

- 1.1. Cloud Computing, services, deployment models
- 1.2. Introduction to Cloud Computing
- 1.3. Origins and Motivation
- 1.4. Types of Clouds and Services
- 1.5. Cloud Infrastructure and Deployment

2. Virtualization Techniques and Types

- 2.1.1. Introduction to Virtualization
- 2.2. Use & demerits of Virtualization
- 2.3. Types of Virtualization
- 2.4. Examples
- 2.5. x86 Hardware Virtualization
- 2.6. Manage the resources for the SaaS, PaaS and IaaS models
- 2.7. Containers – Docker
- 2.8. Namespace, Cgroup
- 2.9. System Containers and Application Containers
- 2.10. Dockers - Elements, Images, Files, Containers
- 2.11. Virtual Machine vs Container
- 2.12. Cloud orchestration technologies – Brief overview of Kubernetes

3. Infrastructure as a Service

- 3.1. Introduction to IaaS
- 3.2. IaaS examples
- 3.3. Reference Model of AWS
- 3.4. Amazon cloud services - Compute, Database, Storage
 - 3.4.1. Region Vs Availability zones
 - 3.4.2. IAM (A &A)
 - 3.4.3. Compute: Instance, Cluster, VPC





- 3.4.4. Storage: File, Block and Object
- 3.4.5. Data: RDS, NoSQL data services,
- 3.4.6. Data storage, processing and analytics
- 3.4.7. Data warehousing - examples HDFS, EMR
- 4. Platform as a Service and SaaS**
 - 4.1. Introduction to PaaS
 - 4.2. PaaS examples
 - 4.3. AWS/Azure – Managed Services
 - 4.4. Introduction to SaaS
 - 4.5. Pros and Cons of SaaS model and applications
- 5. Managing Virtual Resources on the Cloud: Provisioning and Migration**
 - 5.1. Virtual Machine Provisioning and Manageability
 - 5.2. VM Provisioning Process
 - 5.3. Virtual Machine Migration Services
 - 5.4. Migrations Techniques
 - 5.5. VM Provisioning and Migration in action
- 6. Capacity management and Scheduling in cloud computing**
 - 6.1. Capacity management and Scheduling
 - 6.2. Distributed management of virtual machines
 - 6.3. Reservation-based provisioning of virtualized resource
 - 6.4. Provisioning to meet SLA commitments
 - 6.5. Stages of VM life cycle within OpenNebula
 - 6.6. Network model for OpenNebula
- 7. Issues and Challenges : Availability, Multi-Tenancy, Security and SLA**
 - 7.1. Multi-Tenancy, 4 levels of multi tenancy
 - 7.2. Multi-tenant models for cloud
 - 7.3. Introduction to cloud security
 - 7.4. Cloud security Issues
 - 7.5. Threat Model
 - 7.6. Top 5 cloud security threats
 - 7.7. who is responsible for managing security
 - 7.8. Service License Agreements: Lifecycle and Management
 - 7.9. Traditional approaches to SLO management
 - 7.10. SLA Management in Cloud
 - 7.11. Automated Policy based management
 - 7.12. Managing Clouds: Services and Infrastructure
- 8. Application Development and Deployment**
 - 8.1. Development: Services, BaaS, FaaS, Dev Environments (formation and runs), IDEs, Integrations with other services (APIs and Gateways)
 - 8.2. CT/CI/CD: Continuous build and testing, deployment with cloud based service
 - 8.3. Deployment, scaling and availability: Custom, Managed, Containers





Part B: Learning Plan

Contact Hour	List of Topic Title (from content structure in Part A)	Topic # (from content structure in Part A)	Text/Ref Book/external resource
1	1.1. Cloud Computing, services, deployment models 1.2. Introduction to Cloud Computing 1.3. Origins and Motivation	Already Part of list in Column 2(List of Topic Title)	T1: Ch1 T2: Ch1
2	1.4. Types of Clouds and Services 1.5. Cloud Infrastructure and Deployment		T1: Ch1 T2: Ch1
3	2. Virtualization Techniques and Types 2.1. Introduction to Virtualization 2.2. Use & demerits of Virtualization		T1: Ch9 T2: Ch5
4	2.3. Types of Virtualization 2.4. Examples		T1: Ch9 T2: Ch5
5	2.5. x86 Hardware Virtualization		T1: Ch9 T2: Ch5
6	2.6. Manage the resources for the SaaS, PaaS and IaaS models		T1: Ch9
7-8	2.7. Containers – Docker 2.8. Namespace, Cgroup 2.9. System Containers and Application Containers		https://linuxcontainers.org/lxc/introduction/ https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux_atomic_host/7/html/overview_of_containers_in_red_hat_systems/introduction_to_linux_containers
9-10	2.10. Dockers - Elements, Images, Files, Containers 2.11. Virtual Machine vs Container 2.12. Cloud orchestration technologies – Brief overview of Kubernetes		https://docs.docker.com/get-started/ more focus on 1: Orientation 2: Containers 3. Services



11-12	<p>Infrastructure as a Service (3L)</p> <p>3.1. Introduction to IaaS</p> <p>3.2. IaaS examples</p> <p>3.3. Reference Model of AWS</p>		T1: Ch2 T2: Ch3
13-14	<p>3.4. Amazon cloud services - Compute, Database, Storage</p> <p>3.4.1. Region Vs Availability zones</p> <p>3.4.2. IAM (A &A)</p> <p>3.4.3. Compute: Instance, Cluster, VPC</p>		
15-16	<p>3.4.4. Storage: File, Block and Object</p> <p>3.4.5. Data: RDS, NoSQL data services,</p> <p>3.4.6. Data storage, processing and analytics</p> <p>3.4.7. Data warehousing - examples HDFS, EMR</p>		
17-18	<p>4. Platform as a Service and SaaS (2L)</p> <p>4.1. Introduction to PaaS</p> <p>4.2. PaaS examples</p> <p>4.3. AWS/Azure – Managed Services</p>		T1: Ch3
19-20	<p>4.4. Introduction to SaaS</p> <p>4.5. Pros and Cons of SaaS model and applications</p>		T1: Ch4
21-22	<p>5. Managing Virtual Resources on the Cloud: Provisioning and Migration (1L)</p> <p>5.1. Virtual Machine Provisioning and Manageability</p> <p>5.2. VM Provisioning Process</p> <p>5.3. Virtual Machine Migration Services</p> <p>5.4. Migrations Techniques</p> <p>5.5. VM Provisioning and Migration in action</p>		R1: Ch5 T2: Ch6
23-24	<p>6. Capacity management and Scheduling in cloud computing (2L)</p> <p>6.1. Capacity management and Scheduling</p> <p>6.2. Distributed management of virtual machines</p> <p>6.3. Reservation-based provisioning of virtualized resource</p>		R1: Ch6 T2: Ch6



25-26	6.4. Provisioning to meet SLA commitments 6.5. Stages of VM life cycle within OpenNebula 6.6. Network model for OpenNebula		R1: Ch6 T2: Ch6
27-28	7. Issues and Challenges : Availability, Multi-Tenancy, Security and SLA (2L) 7.1. Multi-Tenancy, 4 levels of multi tenancy 7.2. Multi-tenant models for cloud 7.3. Introduction to cloud security 7.4. Cloud security Issues 7.5. Threat Model 7.6. Top 5 cloud security threats		T1: Ch6,7 R1: Ch 23 T2: Ch9
29-30	7.7. who is responsible for managing security 7.8. Service License Agreements: Lifecycle and Management 7.9. Traditional approaches to SLO management 7.10. SLA Management in Cloud 7.11. Automated Policy based management 7.12. Managing Clouds: Services and Infrastructure		R1: Ch16 T2:Ch9
31-32	8. Application Development and Deployment (1L) 8.1. Development: Services, BaaS, FaaS, Dev Environments (formation and runs), IDEs, Integrations with other services (APIs and Gateways) 8.2. CT/CI/CD: Continuous build and testing, deployment with cloud based service 8.3. Deployment, scaling and availability: Custom, Managed, Containers		

Experiential Learning Components:

1. Quiz 1
2. Quiz 2
3. Quiz 3

Objective of Experiential Learning Component: Application of concepts explained in lectures

Scope of Experiential Learning Component: Understanding real-life scenarios and appropriately managing disasters / disease outbreaks

Lab Infrastructure: Not Applicable

List of Experiments: Not Applicable

Evaluation Scheme

Legend: EC = Evaluation Component; AN = After Noon Session; FN = Fore Noon Session

No	Name	Type	Duration	Weight	Day, Date, Session, Time
EC-1	Quiz-1		*	5%	Feb 2nd – Feb 9th
	Quiz-2		*	5%	Mar 2nd – Mar 9th
	Assignment - 1		*	20%	Feb 9th – Mar 25th
EC-2	Mid-Semester Test	Closed Book	2 hours	30%	•Regular – Mar 21-23 •Make-up – Apr 4-6
EC-3	Comprehensive Exam	Open Book	2 ½ hours	40%	•Regular – May 23-25 •Make-up – May 30-31, Jun 1

Note - Evaluation components can be tailored depending on the proposed model.

EC1: Quiz 5 % (*2) = 10%

Assignment 1 20 % (*1) = 20%

Syllabus for Mid-Semester Test (Closed Book): Topics in Contact session: 1 to 8 **Syllabus for Comprehensive Exam (Open Book): All topics**

Important Links and Information:

eLearn Portal: <https://elearn.bits-pilani.ac.in>



Students must visit the eLearn portal regularly and stay updated with the latest announcements and deadlines.

Contact Sessions: Students should attend the online lectures as per the schedule provided on the eLearn portal.

Evaluation Guidelines:

1. EC-1 consists of three Quizzes. Students will attempt them through the course pages on the eLearn portal. Announcements will be made on the portal in a timely manner.
2. For Closed Book tests: No books or reference material of any kind will be permitted.
3. For Open Book exams: “open book” means text/ reference books (publisher copy only) and does not include any other learning material. No other learning material will be permitted during the open book examinations. For Detailed Guidelines refer to the attached document.
[EC3 Guidelines](#)
4. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam, which will be made available on the eLearn portal. The Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self-study schedule as given in the course handout, attend the online lectures, and take all the prescribed evaluation components such as Assignments/Quizzes, Mid-Semester Tests and Comprehensive Exams according to the evaluation scheme provided in the handout.

