

**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI**

**WORK INTEGRATED LEARNING PROGRAMMES**

**Digital Learning**

**Part A: Content Design**

<b>Course Title</b>	Cloud Computing
<b>Course No(s)</b>	CC ZG527
<b>Credit Units</b>	5
<b>Credit Model</b>	1-2-2, (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
<b>Course Author</b>	Chandra Shekar RK/Saleem/Dr. Sai Kishore
<b>Version No</b>	V 1.5
<b>Date</b>	27th June 2015/08th Aug 2015/12th Jan 2016/12th Nov 2017/25 <sup>th</sup> September 2022

**Course Objectives**

<b>No</b>	<b>Course Objective</b>
<b>CO1</b>	Students will learn the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; benefits, as well as current and future challenges;
<b>CO2</b>	Students will learn the basic ideas and principles in data centre design and management
<b>CO3</b>	Students will learn about cloud components and technologies and relevant distributed file systems
<b>CO4</b>	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, <i>Cloud computing theory and practice</i> , 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

## 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. 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

### Learning Outcomes:

No	Learning Outcomes
LO1	<b>Explain</b> 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	<b>Apply</b> the fundamental concepts in data-centres to understand the tradeoffs in power, efficiency and cost
LO3	<b>Discuss</b> system virtualization and outline its role in enabling the cloud computing system model.
LO4	<b>Illustrate</b> the fundamental concepts of cloud storage and demonstrate their use in storage systems such as Amazon S3 and HDFS
LO5	<b>Analyze</b> various cloud programming models and apply them to solve problems on the cloud

### Experiential learning components

1. Lab work: See below in **Detailed Plan for Lab work/Design work**.

### Additional documentation

**Part B: Course Handout**

<b>Academic Term</b>	Second Semester 2024-2025
<b>Course Title</b>	Cloud Computing
<b>Course No</b>	<b>CC ZG527</b>
<b>Lead Instructor</b>	<b>SHWETHA VITTAL</b>

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		<a href="https://linuxcontainers.org/lxc/introduction/">https://linuxcontainers.org/lxc/introduction/</a>  <a href="https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux_atomic_host/7/html/overview_of_containers">https://access.redhat.com/documentation/en-us/red_hat_enterprise_linux_atomic_host/7/html/overview_of_containers</a>

			_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		<a href="https://docs.docker.com/get-started/">https://docs.docker.com/get-started/</a> more focus on 1: Orientation 2: Containers 3. Services
11-12	Infrastructure as a Service (3L) 3.1. Introduction to IaaS 3.2. IaaS examples 3.3. Reference Model of AWS		T1: Ch2 T2: Ch3
13-14	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		
15-16	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		
17-18	4. Platform as a Service and SaaS (2L) 4.1. Introduction to PaaS 4.2. PaaS examples 4.3. AWS/Azure – Managed Services		T1: Ch3
19-20	4.4. Introduction to SaaS 4.5. Pros and Cons of SaaS model and applications		T1: Ch4
21-22	5. Managing Virtual Resources on the Cloud: Provisioning and Migration (1L) 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		R1: Ch5 T2: Ch6
23-24	6. Capacity management and Scheduling in cloud computing (2L) 6.1. Capacity management and		R1: Ch6 T2: Ch6

	<p>Scheduling</p> <p>6.2. Distributed management of virtual machines</p> <p>6.3. Reservation-based provisioning of virtualized resource</p>		
25-26	<p>6.4. Provisioning to meet SLA commitments</p> <p>6.5. Stages of VM life cycle within OpenNebula</p> <p>6.6. Network model for OpenNebula</p>		<p>R1: Ch6</p> <p>T2: Ch6</p>
27-28	<p>7. Issues and Challenges : Availability, Multi-Tenancy, Security and SLA (2L)</p> <p>7.1. Multi-Tenancy, 4 levels of multi tenancy</p> <p>7.2. Multi-tenant models for cloud</p> <p>7.3. Introduction to cloud security</p> <p>7.4. Cloud security Issues</p> <p>7.5. Threat Model</p> <p>7.6. Top 5 cloud security threats</p>		<p>T1: Ch6,7</p> <p>R1: Ch 23</p> <p>T2: Ch9</p>
29-30	<p>7.7. who is responsible for managing security</p> <p>7.8. Service License Agreements: Lifecycle and Management</p> <p>7.9. Traditional approaches to SLO management</p> <p>7.10. SLA Management in Cloud</p> <p>7.11. Automated Policy based management</p> <p>7.12. Managing Clouds: Services and Infrastructure</p>		<p>R1: Ch16</p> <p>T2:Ch9</p>
31-32	<p>8. Application Development and Deployment (1L)</p> <p>8.1. Development: Services, BaaS, FaaS, Dev Environments (formation and runs), IDEs, Integrations with other services (APIs and Gateways</p> <p>8.2. CT/CI/CD: Continuous build and testing, deployment with cloud based service</p> <p>8.3. Deployment, scaling and availability: Custom, Managed, Containers</p>		



**Detailed Plan for Lab work/Design work**

Lab No	Lab Objective	Lab Sheet Access URL	Content Reference
1	Understand Virtualization Install Virtual Box and create VM(Linux) for MVC model	TBD	
2	Understand the concept of Docker-Container Implement a Docker web server container with Ubuntu, Nginx, MongoDB/MySQL	TBD	
3	Understand the working of AWS Create AWS-InstanceCreation, AWS-S3-ObjStorage	TBD	
4	Understand the working of Openstack OS-InstanceCreateWithVol, OS-Swift-ObjStorage, OS-LoadBalancer-Manual	TBD	
5	Understand Provisioning in VB and Openstack OS-InstanceCreate-Heat-Provision, OS-LoadBalancer-Heat-Provision, Vagrant-Provision-WebServer	TBD	
6	Understand Migration Implement Proxmox cluster and try migration	TBD	
7	PaaS Exercise : Running Azure app locally and Deploying the local app to Azure		
8	PaaS Exercise : Determine which instance gets serves the request		
9	SaaS: Developing website using Salesforce		
10	Understanding Hadoop Implement Hadoop MapReduce - Market Rating		
11	Understanding Hadoop Components Implement Word Counting with Apache Pig		

**Case studies: Detailed Plan**

Case study No	Case study Objective	Case study Sheet Access URL
1		
2		

**Work integration: Detailed plan**

No	Activity description
1	
2	
3	
4	

#### **Project work: Detailed Plan**

1. Objective of the project:
2. Project scenario description:
3. Tasks to be performed by the students:
4. Expected deliverables:
5. Duration of the project:

#### **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%	February 17-27, 2025
	Quiz-2		*	5%	April 1-10, 2025
	Experience Learning		*	30%	May 1-10, 2025
EC-2	Mid-Semester Test	Closed Book	2 hours	25%	21/03/2025 (AN)
EC-3	Comprehensive Exam	Open Book	2 ½ hours	35%	23/05/2025 (AN)

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