3. Implement Breadth-First Search (Synchronous Network)

4. Implement Maximal Independent Set (Synchronous Network)

5. Implement Leader Election in an Asynchronous Ring.

6. Implement Asynchronous Banking System (Optional)

7. Implement distributed consensus with link failure (Synchronous Network)

8. Implement distributed consensus with Process failure (Synchronous Network)

DISCIPLINE SPECIFIC ELECTIVE COURSE: Cloud Computing

Credit distribution, Eligibility and Pre-requisites of the Course

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
DSE8e: Cloud Computing	4	3	0	1	Pass in Class XII	

Course Objective:

The objective of an undergraduate cloud computing course is to provide students with a comprehensive understanding of cloud computing technologies, services, and applications.

Course Learning Outcomes:

On successful completion of this course, the student will be able to:

1. Apply the fundamental concepts and principles of cloud computing, including virtualisation, scalability, reliability, and security.

2. design, develop, and deploy cloud-based applications using popular cloud platforms and services.

3. understand cloud computing architectures, including Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

4. Visualise the economic, legal, and ethical implications of cloud computing, including issues related to data privacy, ownership, and security.

5. evaluate and select cloud-based solutions based on their technical, economic, and business requirements.

6. understand of the broader societal and environmental impacts of cloud-based services and applications.

Syllabus:

Unit 1: (6 hours)

Overview of Computing Paradigm: Recent trends in Computing - Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing,

Unit 2: (7 hours)

Introduction to Cloud Computing :History of Cloud Computing, Cloud service providers, Benefits and limitations of Cloud Computing,

Unit 3: (12 hours)

Cloud Computing Architecture: Comparison with traditional computing architecture (client/server), Services provided at various levels, Service Models- Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service(SaaS), How Cloud Computing Works, Deployment Models- Public cloud, Private cloud, Hybrid cloud, Community cloud, Case study of NIST architecture.

Unit 4: (7 hours)

Case Studies :Case study of Service model using Google Cloud Platform (GCP), Amazon Web Services (AWS), Microsoft Azure, Eucalyptus.

Unit 5: (6 hours)

Cloud Computing Management : Service Level Agreements(SLAs), Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of scaling.

Unit 6:

<p style="text-align:right">**(7 hours)**</p>

Cloud Computing Security: Infrastructure Security- Network level security, Host level security, Application level security, Data security and Storage- Data privacy and security Issues, Jurisdictional issues raised by Data location, Authentication in cloud computing.

References:

1. Thomas Erl, Ricardo Puttini and Zaigham Mahmood, Cloud Computing: Concepts, Technology and Architecture, Publisher: PHI, 2013.

2. Rajkumar Buyya, James Broberg, and Andrzej Goscinski, Cloud Computing: Principles and Paradigms, Wiley, 2013.

3. Boris Scholl, Trent Swanson, and Peter Jausovec, Cloud Native: Using Containers, Functions, and Data to Build Next-Generation Applications, Publisher : Shroff/O'Reilly, 2019.

Additional References:

1. *Cloud Computing Bible,* Barrie Sosinsky, *Wiley-India,* 2010
2. *Cloud Computing: Principles and Paradigms,* Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, *Wile,* 2011
3. *Cloud Computing: Principles, Systems and Applications, Editors:* Nikos Antonopoulos, Lee Gillam, *Springer,* 2012
4. *Cloud Security: A Comprehensive Guide to Secure Cloud Computing,* Ronald L. Krutz, Russell Dean Vines, *Wiley-India,* 2010

Suggested Practical List:

1. Introduction to Cloud Platforms

   Objective: Familiarize students with cloud platforms and their interfaces.
   Steps:

   d) Create free-tier accounts on AWS, Azure, and GCP.
   e) Explore dashboards and identify key services (compute, storage, networking).
   f) Understand pricing calculators on each platform.

2. Launch Your First Amazon EC2 Instance

   Objective: Deploy a virtual machine on AWS using Amazon EC2.

Steps:

 e) Launch an EC2 instance from the AWS Management Console.

 f) Use a pre-configured AMI (e.g., Amazon Linux 2).

 g) Configure security groups to allow SSH access.

 h) Connect to the instance using SSH.

3. Set Up a VPC

Objective: Create and configure a Virtual Private Cloud (VPC).

Steps:

 a) Create a custom VPC with a public and private subnet.

 b) Launch an EC2 instance in the public subnet and another in the private subnet.

 c) Configure an Internet Gateway for Internet access in the public subnet.

 d) Use a NAT Gateway to provide internet access for instances in the private subnet.

4. Configure Auto Scaling and Load Balancing

Objective: Set up an auto-scaling group and a load balancer

Steps:

 e) Create an Auto Scaling Group and define a launch template.

 f) Configure scaling policies (e.g., scale up when CPU utilization exceeds 70%).

 g) Deploy an Application Load Balancer (ALB) to distribute traffic.

 h) Test auto-scaling by simulating high traffic.

5. Deploying a Static Website on the Cloud

Objective: Host a static website using cloud storage services.

Steps:

 c) Deploy a static website using any of the following:

  - AWS S3

  - Azure Blob Storage

  - GCP Cloud Storage

 d) Configure permissions and enable public access.

6. Monitor Resources Using AWS CloudWatch

Objective: Use CloudWatch to monitor AWS resources

Steps

 e) Set up CloudWatch metrics for an EC2 instance (e.g., CPU utilization).

f) Create a CloudWatch Alarm to send notifications when a threshold is exceeded.

g) Configure an SNS topic for email notifications.

h) Test the setup by simulating high CPU usage.

7. Install OpenStack

Objective: Set up a local OpenStack environment for practice.

8. Launch Your First Instance

Objective: Create a virtual machine (VM) using OpenStack.

Steps:

e) Create a project and assign roles to users.

f) Upload an image (e.g., Ubuntu cloud image) to the Glance service.

g) Define a flavor to specify VM configurations.

h) Launch an instance using the Horizon dashboard or CLI.

Resources Needed:

- OpenStack Horizon access or CLI setup.
- Sample Ubuntu or CentOS cloud image (from Ubuntu Cloud Images).

9. Set Up Networking

Objective: Configure OpenStack Neutron to provide networking for instances.

Steps:

d) Create a private network and a public network.

e) Attach a router to connect the private network to the public network.

f) Assign floating IPs to instances for external access.

10. Cloud Security

Objective: Understand security practices in the cloud.

Steps:

e) Implement IAM roles and policies for a cloud platform.

f) Create and assign least-privilege roles to users.

g) Configure data encryption for storage (e.g., S3 bucket encryption).

h) Set up a firewall rule and test its functionality.