Course Outline for CSE4267: Cloud Computing

Prerequisite: CSE3207
Duration: 12 Weeks
Credits: 3

Course Description:

This course provides a comprehensive understanding of cloud computing concepts, including resource sharing, service models, cloud architecture, and deployment models. It explores enabling technologies like virtualization and containerization while addressing critical issues such as scalability, performance, privacy, and security. A hands-on project will ensure the practical application of the knowledge gained.

Learning Outcomes:

Upon successful completion of this course, students will be able to:

1. Define and explain the key concepts and benefits of cloud computing.
2. Identify and differentiate among the main cloud service models (IaaS, PaaS, SaaS).
3. Compare cloud deployment models and select appropriate solutions for various use cases.
4. Understand the role of data centers, virtualization, and containers in cloud computing.
5. Design and analyze cloud-based architectures for dynamic resource provisioning.
6. Address cloud-related issues like scalability, performance, and security.
7. Develop and deploy a cloud-based project using industry-relevant platforms.

Weekly Breakdown:

Week	Topics	Details	Activities/Assignments
1	**Introduction to Cloud Computing**	History, Definitions, Resource Sharing, Benefits, Challenges, Risks	In-class discussion: Cloud computing evolution
2	**Cloud Service Models**	IaaS, PaaS, SaaS – Concepts, Examples, Use Cases (AWS EC2, Azure App Services, GCP BigQuery)	Assignment 1: Compare major cloud service providers
3	**Cloud Deployment Models**	Public, Private, Hybrid Clouds, Multi-cloud, Community Clouds	Case Study: Public vs. Hybrid Cloud

4	**Cloud Platforms Overview**	Introduction to AWS, Azure, Google Cloud, OpenStack, Oracle Cloud	Practice: Create a free-tier cloud account and deploy a basic instance
5	**Enabling Infrastructure I**	Data Centers, Virtualization (VMware, Hyper-V), Containers (Docker)	Practice: Docker basics—container creation and deployment
6	**Enabling Infrastructure II**	Kubernetes for orchestration, Serverless Computing (AWS Lambda, Azure Functions)	Quiz 1
7	**Cloud Operating Systems & Cloud Servers**	CloudStack, OpenStack, Cloud Operating System Architecture	Assignment 2: Research and present on OpenStack
8	**Static & Dynamic Resource Provisioning**	Elastic Load Balancing, Auto-scaling, Cloud Elasticity	Practice: Implement auto-scaling on a cloud platform
9	**Capacity Planning & Cloud Brokers**	Resource Allocation, Cost Optimization, Cloud Broker Role	In-class activity: Capacity planning simulation
10	**Federated Clouds**	Collaboration among multiple clouds, Benefits, Use Cases	Project Milestone: Submit project proposal
11	**Scalability & Performance**	Vertical vs. Horizontal Scaling, Performance Metrics, Latency	Quiz 2
12	**Cloud Security & Privacy**	Authentication, Authorization, Encryption, Compliance (GDPR, HIPAA)	Assignment 3: Analyze a cloud security breach case

Project:

Title: Deploying a Cloud-Based Web Application with Scalability and Security

- **Objective:** Create a cloud-based solution showcasing elasticity, scalability, and basic security measures.
- **Scope:**
    - Deploy a web application (e.g., blog, e-commerce site) using a cloud service provider (AWS/Azure/GCP).
    - Implement dynamic scaling and load balancing.
    - Secure the application using IAM, SSL, and firewall configurations.
- **Phases:**
    - **Proposal Submission (Week 6):** Define objectives, architecture, and tools.
    - **Progress Check (Week 9):** Demonstrate initial deployment.
    - **Final Submission (Week 12):** Submit the project report, deliver the presentation, and demonstrate deployment.
- **Deliverables:**
    - Project Report (5–10 pages): Architecture, implementation details, results.
    - Live Demo: The application is running in the cloud.
    - Presentation: 10–15 minutes showcasing key aspects and learnings.

Grading Policy:

Component	**Marks %**
Final Exam	70%
Quizzes	20%
Assignments	
Project	
Class Participation	10%

Recommended Textbooks & Resources:

1. **Cloud Computing: Concepts, Technology & Architecture** by Thomas Erl
2. **Mastering Cloud Computing** by Rajkumar Buyya
3. **Architecting the Cloud** by Michael J. Kavis
4. **AWS Cloud Practitioner Essentials** (Free Online Course)
5. **Google Cloud Fundamentals** (Free Online Course on Coursera)

CSE4267: Cloud Computing – Detailed Class-wise Breakdown

Week 1: Introduction to Cloud Computing

- **Class 1:** *Introduction to Cloud Computing*
  Overview of cloud computing, its benefits, challenges, and associated risks.
- **Class 2:** *Resource Sharing in the Cloud*
  Key characteristics of cloud computing include on-demand self-service, pay-as-you-go, and multi-tenancy.
- **Class 3:** *Challenges and Risks*
  In-depth discussion on issues such as vendor lock-in, downtime, and data privacy concerns.

Week 2: Cloud Service Models

- **Class 4:** *Cloud Service Models*
  Introduction to the three primary cloud service models: IaaS, PaaS, and SaaS.
- **Class 5:** *Examples of Service Models*
  Case studies on popular cloud services, including AWS EC2 (IaaS), Azure App Services (PaaS), and GCP BigQuery (SaaS).
- **Class 6:** *Comparison of Service Models*
  Discussion on different use cases for IaaS, PaaS, and SaaS, and when each model is most appropriate.

Week 3: Cloud Deployment Models

- **Class 7:** *Cloud Deployment Models*
  Overview of different cloud deployment models: public, private, hybrid, and community clouds.
- **Class 8:** *Multi-cloud and Hybrid Cloud*
  Exploring the benefits and challenges of using multi-cloud environments and hybrid cloud architectures.
- **Class 9:** *Use Cases of Deployment Models*
  Real-world examples illustrate how different organizations utilize various cloud deployment models for specific needs.

Week 4: Cloud Platforms Overview

- **Class 10:** *Cloud Platforms Overview*
  Introduction to major cloud platforms: AWS, Microsoft Azure, and Google Cloud, with a focus on their unique features.
- **Class 11:** *Cloud Platform Services*
  Key cloud services offered by these platforms, include computing, storage, and networking resources.
- **Class 12:** *Getting Started with Cloud Platforms*
  Lab session where students will create a cloud account and deploy a basic instance on a cloud platform (AWS, Azure, or GCP).

Week 5: Enabling Infrastructure I

- **Class 13:** *Data Centers*
  A detailed look at the design and architecture of data centers, power efficiency, and different tier levels of data centers.
- **Class 14:** *Virtualization*
  Introduction to virtualization technologies such as VMware and Hyper-V, exploring their benefits in cloud computing.
- **Class 15:** *Containers*
  Overview of containers, with a focus on Docker—understanding how containers enable cloud portability and scalability.

Week 6: Enabling Infrastructure II

- **Class 16:** *Kubernetes: Container Orchestration*
  Introduction to Kubernetes and its role in managing containerized applications across multiple cloud environments.
- **Class 17:** *Serverless Computing*
  Exploring serverless computing with platforms such as AWS Lambda and Azure Functions, and their use cases.
- **Class 18:** *Lab: Docker & Kubernetes Basics*
  A hands-on session where students will create containers using Docker and deploy them using Kubernetes for orchestration.

Week 7: Cloud Operating Systems & Servers

- **Class 19:** *Cloud Operating Systems*
  Overview of cloud operating systems such as CloudStack and OpenStack, and how they manage cloud resources.
- **Class 20:** *Cloud Servers*
  Introduction to different types of cloud servers and their configurations for optimal performance.
- **Class 21:** *Assignment Discussion*
  Discussion on a research assignment: Students will prepare and present on OpenStack and its capabilities in cloud management.

Week 8: Resource Provisioning & Auto-scaling

- **Class 22:** *Static vs. Dynamic Resource Provisioning*
  Discussing how cloud resources are allocated statically and dynamically, and the associated benefits.
- **Class 23:** *Elastic Load Balancing & Auto-scaling*
  Exploring the concepts of elastic load balancing and auto-scaling in cloud environments, with real-world examples.
- **Class 24:** *Lab: Implementing Auto-scaling*
  Practical lab where students will implement auto-scaling and load balancing for a cloud-based application.

Week 9: Capacity Planning & Federated Clouds

- **Class 25:** *Capacity Planning*
  Understanding the process of capacity planning in the cloud, including resource allocation, cost optimization, and scaling strategies.
- **Class 26:** *Cloud Brokers*
  Examining the role of cloud brokers in managing multi-cloud environments and facilitating cloud service procurement.
- **Class 27:** *Federated Clouds*
  Exploring federated clouds, including how different cloud providers can collaborate to meet complex organizational needs.

Week 10: Scalability & Performance Metrics

- **Class 28:** *Scalability in Cloud Computing*
  Exploring the concepts of horizontal and vertical scaling in cloud environments, and when each type of scaling is appropriate.
- **Class 29:** *Performance Metrics*
  Introduction to key performance metrics in cloud environments such as latency, throughput, and uptime.
- **Class 30:** *Quiz 2*
  A quiz covering topics from Weeks 5 to 9, focusing on enabling infrastructure, resource provisioning, and performance.

Week 11: Cloud Security

- **Class 31:** *Cloud Security Concepts*
  Overview of cloud security principles, including authentication, authorization, and encryption mechanisms.
- **Class 32:** *Privacy and Compliance*
  Understanding privacy concerns in the cloud, with a focus on regulations such as GDPR and HIPAA.
- **Class 33:** *Cloud Security Risks*
  Examining real-world case studies of cloud security breaches, and discussing the risks associated with cloud computing.

Week 12: Future Trends & Project Presentations

- **Class 34:** *Ethics & Future Trends in Cloud Computing*
  Discussion on ethical issues related to cloud computing, and emerging trends such as edge computing and IoT in the cloud.
- **Class 35:** *Project Presentations*
  Students will present their final projects, demonstrating their ability to design and deploy cloud-based solutions.
- **Class 36:** *Course Review and Final Exam Preparation*
  A final review of the course material and a Q&A session to prepare for the final exam.