COURSE CODE: CS3226 **COURSE NAME: CLOUD COMPUTING**

Course Prerequisites: Operating Systems, Computer Networks, Database Management System

Course Objectives:

1. To become familiar with cloud computing and its ecosystem
2. To acquire basics of virtualization and its importance
3. To evaluate in-depth analysis of Cloud Computing capabilities and its services.
4. To configure and implement storage services.
5. To analyze different cloud-based services to meet a set of given requirements.
6. To design security aspects for cloud computing

Credits: 4..... **Teaching Scheme Theory: 2 Hours/Week**

Tutorial: 1 Hours/Week

Lab: 2 Hours/Week

Course Relevance: Cloud computing to enable transformation, business development and agility in an organization.

SECTION-I

Topics and Contents:

Unit-I Introduction to Cloud Computing
[CO1 → PO1, PO2, PO5 – CO Strength - 2,1,1]

Recent trends in computing, Cluster computing, Distributed computing ,Evolution of cloud computing, Cloud versus traditional architecture, Cloud Computing Architecture, Google Cloud architecture, Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS), Public cloud, Private cloud, Hybrid cloud, Community cloud **[4 Hrs]**

Unit-II Virtualization
[CO2→ PO1, PO2, PO3, PO4, PO5- CO Strength -2,2,1,1,1]

Introduction to virtualization, Different approaches to virtualization, Hypervisors, Machine Image, Virtual Machine (VM), Compute options in the cloud, Exploring IaaS with Compute Engine, Configuring elastic apps with auto scaling, Basics of virtualization and implementation challenges. System virtualization technologies-architectures and internals. KVM, Xen, VMware.

Memory virtualization-virtualization techniques, ballooning, deduplication and sharing. Network

and storage virtualization, Virtual machine migration and replication techniques pre-copy and post-copy techniques, applicability to system availability. **[6 Hrs]**

Unit-III Cloud Services
[CO3→] [PO1, PO2, PO3, PO4, PO5, PO7, PO8, PSO4 – Strength - 3,2,2,2,2,3,3,2]

Service Oriented Architecture (SOA), Web services, Web 2.0, Web OS. Introduction to IaaS, PaaS, SaaS. Cloud Platform and Management, Exploring PaaS with App Engine, Event driven programs with Cloud Functions, Containerizing and orchestrating apps with Google Kubernetes Engine Software as a Service (SaaS) Docker flow, orchestration with Docker, dynamic linking and legacy linking of containers. The GCP Console, understanding projects, Billing in GCP, Install and configure Cloud SDK, Use Cloud Shell, GCP APIs. **[4 Hrs]**

SECTION-II

Topics and Contents:

Unit-IV Cloud Storage
[CO4→PO1, PO2, PO3, PO4, PO5, PO6, PO9- Strength 3,2,2,2,3,3,3]

Storage options in the cloud, Structured and unstructured storage in the cloud, unstructured storage using Cloud Storage, SQL managed services, Exploring Cloud SQL, Cloud Spanner as a managed service, NoSQL managed service options, Cloud Datastore, a NoSQL document store, Cloud Bigtable as a NoSQL option. OpenStack: NOVA, Neutron, Keystone Cinder, Swift and Glances, VMware Suit, Apache Cloud Stack **[4 Hrs]**

Unit-V Service Management
[CO5 → PO1,PO2,PO3,PO4,PO5,PO9,PO11,PSO2-Strength 3,3,1.3,3,1,2,3]

Service Level Agreements (SLAs), Billing and accounting, Billing in GCP Cloud Security: Introduction to security in the cloud, the shared security model, Encryption options, Authentication and authorization with Cloud IAM, Identify Best Practices for Authorization using Cloud IAM., Introduction to configuration and management tools Ansible, Architecture of DevOps. **[4 Hrs]**

Unit-VI Cloud Network and Security
[CO6→ PO1, PO2, PO3, PO4, PO5, PO10, PO12 - Strength 2,2,1,3,1,3]

Introduction to networking in the cloud, defining a Virtual Private Cloud, Public and private IP address basics, Google's network architecture, Routes and firewall rules in the cloud, Multiple VPC networks, building hybrid clouds using VPNs, interconnecting, and direct peering, Different options for load balancing. Introduction to security in the cloud, the shared security model, Encryption options, Authentication and authorization with Cloud IAM, Identify Best Practices for Authorization using Cloud IAM. **[6 Hrs]**

Tutorials:

List of Tutorials (Any Thirteen)

List of Tutorials:

Unit-I Introduction to Cloud Computing [CO1] [CO2]

1) Install VirtualBox/VMware Workstation with different Linux or Windows Operating Systems.

2) Study Google Cloud Architecture.

Unit-II Virtualization [CO2]

3) Find a procedure to launch virtual machine

4) Find a procedure to transfer the files from one virtual machine to another virtual machine.

Unit-III Cloud Services [CO3]

5) Simulate a cloud scenario using CloudSim and run a scheduling algorithm that is not present in CloudSim.

6) Install Google App Engine. Create hello world app and other simple web applications using python/java.

Unit-IV Cloud Storage [CO4]

7) Launch the Web Applications using GAE launcher.

8) Install Hadoop single node cluster and run simple applications like wordcount.

Unit-V Service Management [CO5]

9) Use AWS Pricing Calculator: Create estimate for EC2 Compute cost for VM instance. Use region closest to you. Find On demand cost and compare the pricing for other regions.

Unit-VI Cloud Network and Security [CO6]

9) Launch EC2instane and explore Public/Private/Elastic IP

Practical's:

List of Practical's (Any Six)

Unit-I Introduction to Cloud Computing [CO1] [CO2]

1) To setup AWS accounts and launch instances.

Unit-II Virtualization [CO2]

2) To install an OS using VirtualBox/ VMWare Workstation. Add Storage to create new virtual disk.

3) To Deploy Virtual Machine on hypervisor such as KVM, ESXi. Take Backup and Migrate them.

Unit-III Cloud Services [CO3]

4) To use Infrastructure as a Service to facilitates for creating and deleting compute resources. Create network and attach volumes to run instances.

5) To install docker on window/linux and build docker image from docker hub.

6) Deploy a stateless/stateful application on Kubernetes cluster.

Unit-IV Cloud Storage [CO4]

7) To work on different Cloud Storage Services.

Unit-V Service Management [CO5]

8)To create login into AWS and use S3 Bucket Service for storage.

Unit-VI Cloud Network and Security [CO6]

9) Develop elastic services for dynamic load scenario using AWS APIs. Build load balancer and explore on scalability, fault detection and performance.

Course Projects:

List of Course Project Topics

1. Creating Google Account to store files and programs.
2. Creating Account to Store Images.
3. Creating a Warehouse Application in SalesForce.com
4. Creating an Application in SalesForce.com using Apex programming Language.
5. To study and implement Web services in SOAP for JAVA Applications.

6. Implementation of Para-Virtualization using VMWare ‘s Workstation/ Oracle’s Virtual Box and Guest Operator System.
7. Installation and Configuration of Hadoop.
8. AWS Case Study: Amazon.com.
9. Case Study of Google App Engine.

10. Case Study of Face book.

Seminars:

List of Course Seminar Topics

1. Storage Cost Optimization on Cloud.
2. Cloud Security and Cryptography
3. Infrastructure As A Code (IAC)
4. Cloud Computing in Healthcare
5. Serverless
6. Deployment of Microservices in Kubernetes Engine
7. RPA Using AWS Cloud
8. Cloud Trends In Supporting Ubiquitous Computing
9. Mobile Cloud Computing
10. Modern Data Center Architecture

Group Discussion:

List of Group Discussion Topics

1. Data Storage Security in Cloud
2. Cloud Services for SMB's.
3. Monitoring Services Provided by GCP and AWS.
4. Docker and Kubernetes.
5. SaaS vs FaaS (Function as a service).
6. Hybrid Cloud.
7. GCP Vs AWS Web Service Architecture.

8. Cloud based security issues and threats.

9. Authentication and identity.

10. Future of Cloud-Based Smart Devices.

List of Home Assignments:

List of Design Based Home Assignments

1. Serverless Web App to order taxi rides using AWS lambda.

2. Deploying App on Kubernetes.

3. Serverless web Application (GCP Cloud Functions).

4. Demonstration of EBS, Snapshot, Volumes.

5. Single Node Cluster Implementation (Hadoop).

List of Case Study Based Home Assignments

1. PayU Migration to AWS.

2. Cloud object storage.

3. Deployment and Configuration options in AWS.

4. Deployment and Configuration options in Microsoft Azure.

5. Deployment and Configuration options in GCP.

List of Blog Based Home Assignment

1. Comparing design of various cloud computing platforms.

2. AWS EKS and Google Cloud Functions.

3. App Engine.

4. Cloud Endpoints.

5. Cloud Pub/Sub.

List of Survey Based Home Assignments

1. Disaster Recovery in Cloud Computing.

2. Cloud Economics.

3. Data archiving solutions.

4. Salesforce.

5. Dropbox.

Suggest an assessment Scheme:

MSE, ESE, GD, Seminar, HA

Text Books: ***(As per IEEE format)***

1. Judith Hurwitz, R.Bloor, M.Kanfman, F.Halper, "Cloud Computing for Dummies", Wiley,India.
2. Ronald Krutz and Russell Dean Vines, "Cloud Security", Wiley-India
3. Gautam Shroff. "Enterprise Cloud Computing", Cambridge

Reference Books: ***(As per IEEE format)***

1. *Barrie Sosinsky, "Cloud Computing Bible", Wiley India*
2. Antohy T Velte, et.al, "Cloud Computing : A Practical Approach", McGraw Hill.
3. Michael Miller, "Cloud Computing", Que Publishing.
4. Tim Malhar, S.Kumaraswammy, S.Latif, "Cloud Security & Privacy", SPD,O'REILLY
5. Scott Granneman, "Google Apps", Pearson

MOOCs Links and additional reading material:

https://nptel.ac.in/courses/106/105/106105167/

https://swayam.gov.in/nd1_noc20_cs55/preview

https://www.coursera.org/specializations/cloud-computing

https://azure.microsoft.com/en-in/overview/what-is-cloud-computing/

https://aws.amazon.com/what-is-cloud-computing/

https://www.ibm.com/in-en/cloud/learn/cloud-computing

Course Outcomes:

Course Outcomes:

On the completion of course, student will able to

1. Describe the main concepts, key technologies, strengths, and limitations of cloud computing and the possible applications for state-of-the-art cloud computing
2. Explain the architecture and infrastructure of cloud computing, including SaaS, PaaS, IaaS, public cloud, private cloud, hybrid cloud, etc.
3. Identify problems, and explain, analyze, and evaluate various cloud computing solutions.
4. Choose the appropriate technologies, algorithms, and approaches for the related issues.
5. Display new ideas and innovations in cloud computing.
6. Collaboratively research and write a paper on the state of the art (and open problems) in cloud computing.

CO-PO Map:

CO	Program Outcomes (PO)												PSO			
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CS3226.1	2	1			1											
CS3226.2	2	2	1	1	1											
CS3226.3	3	2	2	2	2		3	3								2
CS3226.4	3	2	2	2	3	3			3							
CS3226.5	3	3	1	3	3				1		2			3		

CS3226.6	2	2	1	3	1					3		3				
Average	2.50	2.00	1.40	2.20	1.83	3.00	3.00	3.00	2.00	3.00	2.00	3.00		3.00		2.00

CO attainment levels:

Attainment Levels:1,2,3,5,4,3

Future Course Mapping:

After completing this course different certifications courses in cloud be taken such as AWS, Azure, Google cloud certifications. One can go for higher studies in specialization of cloud computing and allied subjects

Job Mapping:

Cloud Architect, Cloud Engineer, Cloud Administrator, Solutions Architect - Cloud Computing - AWS / Kubernetes, Cloud Computing Technical Consultant, Associate Cloud Computing Engineer, Cloud Computing Trainer