

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2023 (COGC-2023)

Semester -VI

Course Title: Cloud Computing

(Course Code: 4360709)

Diploma programme in which this course is offered	Semester in which offered
Computer Engineering	6 th semester

1. RATIONALE

This course aims students to understand the hardware, software concepts and architecture of cloud computing. Students realize the importance of Cloud Virtualization, Abstractions and Enabling Technologies.

2. COMPETENCY

Demonstrate comprehensive understanding, practical proficiency, and effective communication in cloud computing concepts, architectures, deployment models, virtualization, and security measures, while collaborating to propose and implement real-world cloud solutions.

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge, and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

The student will develop underpinning knowledge of competency for implementing various applications using cloud computing to attain the following course outcomes.

- a) To describe the principles and paradigm of Cloud Computing
- b) To compare the Deployment models with reference to Cloud Computing
- c) To simulate the Service Model with reference to Cloud Computing
- d) To evaluate various virtualization technologies and methods
- e) To implement comprehensive security measures, ensuring the security and privacy of data

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	CA	ESE	CA	ESE	
3	-	2	4	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

Legends: **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit, **CA** - Continuous Assessment; **ESE** -End Semester Examination.

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the subcomponents of the COs. These PrOs need to be attained to achieve the COs.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	To study cloud architecture and cloud computing model.	1	2
2	Study and implementation of Infrastructure as a Service <ul style="list-style-type: none"> OpenStack Computing Components Install OpenStack on Ubuntu 18.04 with DevStack 	2	2
3	Study and implementation of Storage as a Service	2	2
4	Case Study: "Choosing the Right Cloud Deployment Model" <ul style="list-style-type: none"> Examine case studies of organizations adopting different cloud deployment models (public, private, hybrid, community). Analyze the advantages and disadvantages of each model. Discuss key drivers influencing the choice of a specific cloud deployment model. 	2	2
5	Case Study: "Comparative Analysis of Cloud Service Providers" <ul style="list-style-type: none"> Evaluate case studies of major cloud service providers (e.g., AWS, Azure, Google Cloud). Analyze their service models (SaaS, PaaS, IaaS) and advantages/disadvantages. Discuss the impact of cloud computing on users using real-world examples. 	3	2
6	Working and installation of Google App Engine	3	2
7	Working and installation of Microsoft Azure.	3	2
8	Design an Assignment to retrieve, verify, and store user credentials using Firebase Authentication, the Google App Engine standard environment, and Google Cloud Data store	3	2

9	Develop a hello world program web application and deploy it on the Google app engine.	3	2
10	Case Study: "Implementing Virtualization in Enterprise IT" <ul style="list-style-type: none"> Explore a case where an organization successfully implemented virtualization. Discuss the types of virtualization used (desktop, network, storage, data). Analyze the advantages and disadvantages experienced by the organization. 	4	2
11	Installation and Configuration of virtualization using KVM.	4	2
12	Case Study: "Data Security and Privacy in a Cloud-Based Healthcare System" <ul style="list-style-type: none"> Investigate a case where a healthcare organization adopted cloud computing. Discuss infrastructure security at the network, host, and application levels. Analyze data security, storage, and privacy issues in the context of sensitive healthcare data. 	5	2
13	"Migration to the Cloud: A Banking Sector Perspective" <ul style="list-style-type: none"> Explore how a traditional bank migrated its infrastructure to a public cloud. Analyze the security considerations and challenges faced during the migration. 	5	2
14	"Global Company's Hybrid Cloud Strategy" <ul style="list-style-type: none"> Examine a multinational corporation's use of a hybrid cloud model. Analyze how the organization balances data storage, compliance, and efficiency. 	5	2
	Total		28

Note

- i. More **Case Studies** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Describe basic concepts of Cloud Computing and its applications.	15

2	Describe cloud computing architecture and various cloud deployment models.	25
3	Describe various cloud service models and identify major cloud service providers.	20
4	Understand the introduction and working of virtualization, its types, advantages, and disadvantages.	25
5	Identify and address security and privacy issues in cloud computing.	15
Total		100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Computer system with operating system: Windows 7 or higher VerIntel Core i7 processor 16GB RAM 512GB SSD	All
2	VMware -vSphere Version 7.0 Microsoft Hyper-V Integration with Windows Server OpenStack - Infrastructure as a Service (IaaS)	

7. AFFECTIVE DOMAIN OUTCOMES

The following **sample** Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this competency.

- a) Appreciation for Collaboration
- b) Ethical Awareness
- c) Communication Skills
- d) Leadership Qualities

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- i. 'Valuing Level' in 1st year
- ii. 'Organization Level' in 2nd year.
- iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher-level UOs of *Revised Bloom's taxonomy* in order development of the COs and competency is not missed out by the

students and teachers. If required, more such higher-level UOs could be included by the course teacher to focus on the attainment of COs and competency.

Unit	Unit Outcomes (UOs)	Topics and Sub-topics
Unit – I Introduction to Cloud Computing	1.1 Describe basic concept of Cloud Computing and its applications 1.2 Advantages and Disadvantages of Cloud Computing	1.1.1 cloud computing <ul style="list-style-type: none"> ● About cloud ● About computing ● Definition of cloud computing ● Central Ideas Behind Cloud Computing 1.1.2 Characteristics of Cloud Computing 1.1.3 Challenges of Cloud Computing 1.1.4 Novel Applications of cloud computing 1.1.5 Security risk of cloud computing 1.2.1 Advantages and Disadvantages of Cloud Computing
Unit – II Cloud Computing Architecture & Deployment Model	2.1 Describe cloud computing architecture 2.2 Describe various cloud deployment model 2.3 Compare and contrast different cloud deployment models, including public, private, hybrid, and community clouds.	2.1.1 Introduction Cloud Computing Architecture 2.1.2 Components of Cloud Computing Architecture <ul style="list-style-type: none"> ● Client Infrastructure ● Cloud access device ● Application ● Services ● Runtime cloud ● storage ● Infrastructure ● Security 2.2.1 Types of Cloud Deployment Model <ul style="list-style-type: none"> ● Public cloud: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages ● Private cloud: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages ● Hybrid cloud: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages ● Community cloud: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages 2.3.1 Key drivers to adopting the cloud

		<p>2.3.2 The impact of Cloud computing on Users</p> <p>2.3.3 A Comparative Analysis of Cloud Deployment Models</p>
<p>Unit – III Cloud Service Model & service providers</p>	<p>3.1 Describe various cloud service model</p> <p>3.2 Simulate the delivery of a cloud service using a specific service model</p> <p>3.3 Identify and discuss the impact of cloud computing on users and industries</p>	<p>3.1.1 Cloud Service Model</p> <ul style="list-style-type: none"> ● SaaS: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages ● PaaS: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages ● IaaS: <ul style="list-style-type: none"> ● Brief Introduction ● Advantages and Disadvantages <p>3.2.1 Difference between SaaS, PaaS, IaaS</p> <p>3.3.1 Service provider:</p> <ul style="list-style-type: none"> ● Amazon web service ● Microsoft Azure ● Google cloud platform ● IBM cloud service ● VMWare cloud ● Oracle cloud ● Red hat
<p>Unit– IV Virtualization</p>	<p>4.1 Demonstrate the working of virtualization technologies, including desktop, network, storage, data, hardware, and software virtualization</p> <p>4.2 Choose and justify the use of specific hypervisors (e.g., Type 1, Type 2) in various scenarios</p>	<p>4.1.1 Introduction of Virtualization</p> <p>4.1.2 Working of Virtualization</p> <p>4.1.3 Types of Virtualization</p> <ul style="list-style-type: none"> ● Desktop virtualization, ● Network Virtualization, ● Storage Virtualization, ● Data virtualization ● Hardware Virtualization ● Software Virtualization <p>4.1.4 Advantages and Disadvantage of Virtualization</p> <p>4.1.5 Characteristic and Applications of Virtualization</p> <p>4.2.1 Technologies of virtualization : Hypervisors</p> <ul style="list-style-type: none"> ● Type 1 Hypervisor ● Type 2 Hypervisor ● Choosing the right hypervisor

		(Xen, VMM)
Unit– V Security and Privacy Issues in Cloud Computing	5.1 Conduct a security risk assessment for a cloud infrastructure, identifying vulnerabilities and proposing mitigation strategies. 5.2 Perform a privacy impact assessment for a cloud-based application, considering data life cycle and key privacy concerns.	5.1.1 Infrastructure Security <ul style="list-style-type: none"> ● The Network level ● The Host level ● The Application Level 5.2.1 Data Security and storage 5.2.2 Privacy issue 5.2.3 Data Life Cycle 5.2.4 Key Privacy concern in the cloud 5.2.5 Protecting Privacy

Note: The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Cloud Computing	06	4	4	4	12
II	Cloud Computing Architecture & Deployment Model	10	4	5	7	16
III	Cloud Service Model & service providers	08	4	5	4	13
IV	Virtualization	10	5	6	6	17
V	Security and Privacy Issues in Cloud Computing	08	5	4	3	12
Total		42	22	24	24	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from the above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and

prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a) Create cloud computing concept map
- b) Arrange a debate on security risks
- c) Deployment model comparison
- d) Service model simulation
- e) Privacy policy analysis

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Massive open online courses (**MOOCs**) may be used to teach various topics/subtopics.
- b) Guide student(s) in undertaking micro-projects.
- c) '**L**' in **section No. 4** means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- d) About **20% of the topics/sub-topics** which are relatively simpler or descriptive in nature is to be given to the students for **self-learning**, but to be assessed using different assessment methods.
- e) With respect to **section No.11**, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be **individually** undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed two**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain a dated work diary consisting of individual contributions in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit a micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

1. Cloud Infrastructure Design for a Small Business:

Develop a detailed cloud infrastructure design for a small business, considering their specific needs, budget constraints, and growth expectations.

2. Multi-Cloud Strategy Implementation:

Design and implement a multi-cloud strategy for an organization, considering the use of multiple cloud service providers to optimize performance, cost, and reliability.

3. Cloud-Based Healthcare System:

Design a secure and scalable cloud-based healthcare system that includes data storage, processing, and sharing while ensuring compliance with healthcare regulations.

4. Cloud-Native Application Development:

Develop a cloud-native application with microservices architecture, containerization, and serverless components. Present the application's features and deployment strategy.

5. Disaster Recovery Plan for a Cloud Environment:

Create a comprehensive disaster recovery plan for a cloud-based infrastructure, considering data backup, redundancy, and failover strategies.

6. Cloud-Based E-Learning Platform:

Develop an e-learning platform hosted on the cloud, incorporating features such as content delivery, user authentication, and analytics for student progress.

7. Cloud Migration Project:

Plan and execute the migration of an on-premise infrastructure to the cloud. Document the challenges, strategies, and outcomes of the migration.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Cloud Computing: Concepts, Technology & Architecture	Thomas Erl , Ricardo Puttini , Zaigham Mahmood	Pearson Service Technology ISBN(9780133387520)
2	Cloud Computing for Dummies	Judith Hurwitz , Robin Bloor, Marcia Kaufman, Fern Halper	Wiley Publications ISBN(8126524871)
3	Cloud Computing Black Book	Kailash Jayaswal, Jagannath Kallakurchi, Donald J. Houde, Dr. Deven Shah	Dreamtech Press ISBN(978-9351193944)
4	Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security and More	Kris Jamsa	Jones & Bartlett Learning ISBN (978-9380853772)
5	Cloud Computing: Master the Concepts, Architecture and Applications with Real-world examples and Case studies	Kamal Kant Hiran, Ruchi Doshi, Temitayo Fagbola, Mehul Mahrishi, Dr Maria-Alexandra Paun, Deepak Modi	BPB Publications ISBN (978-9388511407)

14. SOFTWARE/LEARNING WEBSITES

- a. https://www.tutorialspoint.com/cloud_computing/index.htm
- b. <https://www.geeksforgeeks.org/cloud-computing/>
- c. https://www.w3schools.com/aws/aws_cloudeessentials_cloudcomputing.php
- d. <https://www.w3schools.in/cloud-computing>
- e. <https://www.javatpoint.com/cloud-computing>
- f. https://onlinecourses.nptel.ac.in/noc21_cs14/preview
- g. <https://www.edx.org/learn/cloud-computing/ibm-introduction-to-cloud-computing>
- h. <https://www.coursera.org/specializations/cloud-computing>
- i. <https://aws.amazon.com/education/awseducate/>

15. PO-COMPETENCY-CO MAPPING

Semester II	Cloud Computing (Course Code: 4360709)						
	POs and PSOs						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentatio &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Manage ment	PO 7 Life-long learning
Competency Demonstrate comprehensive understanding, practical proficiency, and effective communication in cloud computing concepts, architectures, deployment models, virtualization, and security measures, while collaborating to propose and implement real-world cloud solutions.							
Course Outcomes							
a) To describe the principles and paradigm of Cloud Computing	2	-	-	-	-	-	1
b) To compare the Deployment models with reference to Cloud Computing	2	1	2	2	2	2	2
c) To simulate the Service Model with reference to Cloud Computing	2	2	1	2	2	2	2
d) To evaluate various virtualization technologies and methods	2	2	2	2	2	2	2
e) To implement comprehensive security measures, ensuring the security and privacy of data	2	2	1	1	2	2	2

Legend: '3' for high, '2' for medium, '1' for low or '-' for the relevant correlation of each competency, CO, with PO/ PSO

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE**GTU Resource Persons**

Sr. No.	Name and Designation	Institute	Contact No.	Email
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