

**Program Name** : Computer Engineering Program Group  
**Program Code** : CO/CM/IF/CW  
**Semester** : Sixth  
**Course Title** : Cloud Computing  
**Course Code** : 22624

### 1. RATIONALE

Cloud computing has evolved as a very important computing model, which enables information, software, and other shared resources to be provisioned over the network as services in an on-demand manner. There are many aspects of cloud computing viz cloud types, storage in cloud, security in cloud, cloud monitoring and management. Having specific skills in these areas is necessary for diploma pass-outs to create and maintain cloud based services. After learning this course student will be able to implement virtualization, create cloud based storage, Implement security, and manage cloud services.

### 2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- **Maintain cloud based services.**

### 3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:

- Maintain Cloud Based Application.
- Implement virtualization in Cloud Computing.
- Maintain Storage System in Cloud.
- Maintain Cloud Services.
- Implement Security in Cloud Computing.
- Implement cloud on different platforms.

### 4. TEACHING AND EXAMINATION SCHEME

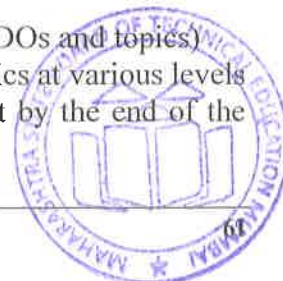
Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
				Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
3	-	2	5	3	70	28	30*	00	100	40	25@	10	25	10	50	20

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

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

### 5. COURSE MAP COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the



course, in all domains of learning in terms of the industry/employer identified competency depicted at the center of this map.

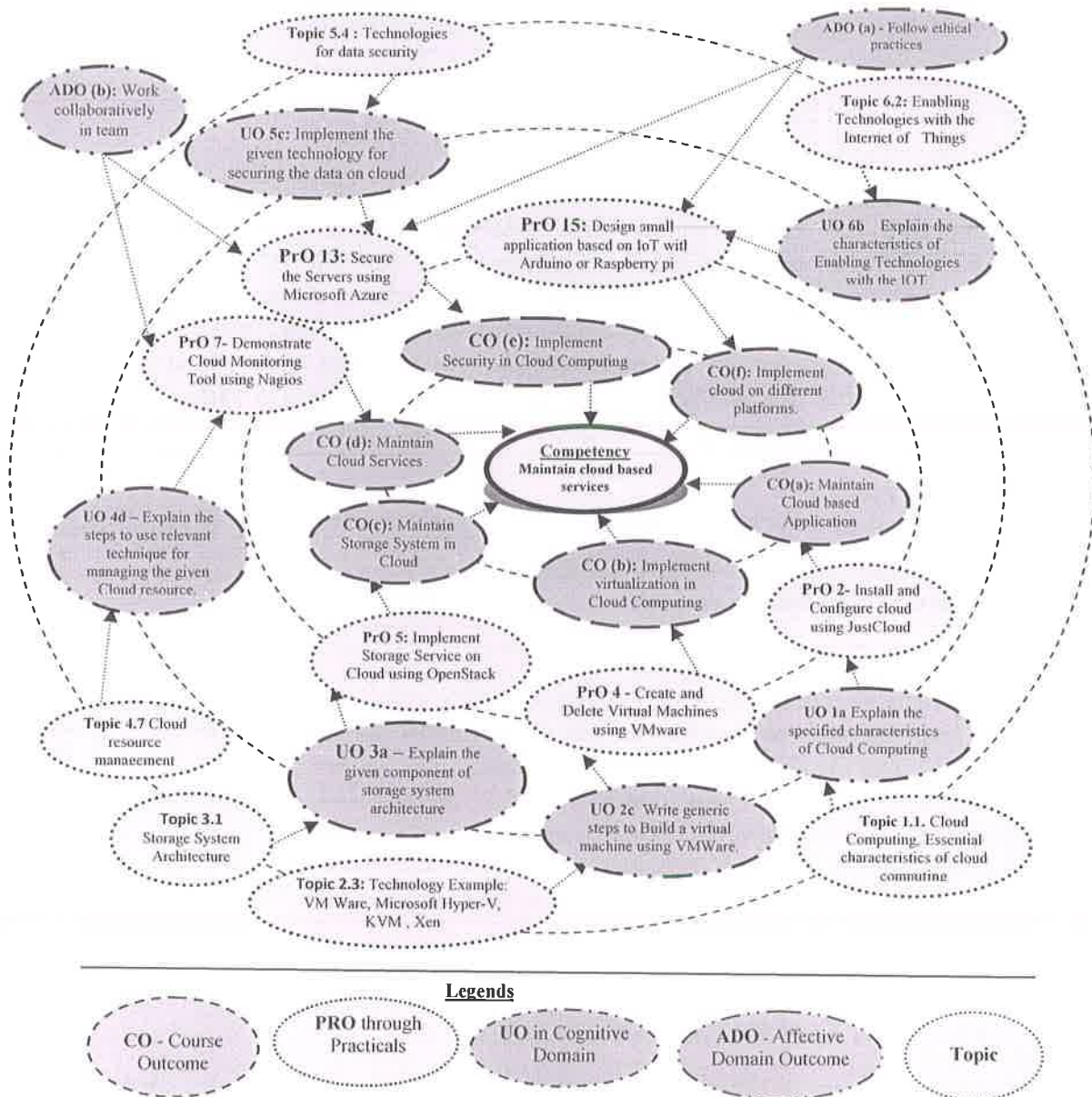


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use Goggle Doc to make spreadsheet and notes	I	02*
2	Install/Configure cloud using JustCloud	I	02*
3	Use Cloud9 to demonstrate use of different language	I	02*
4	Create/Delete Virtual Machines using VMware (Private Cloud)	II	02*
5	Implement Storage Service on Cloud using OpenStack	III	02*
6	Use OpenStack for File Management	III	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
7	Monitor cloud using Nagios Tool	IV	02*
8	Create and Host Simple Web Application on Microsoft Azure/Google cloud/Any cloud platform(Part-I)	IV	02*
9	Create and Host Simple Web Application on Microsoft Azure/Google cloud/Any cloud platform (Part-II)	IV	02*
10	Work in Codenvy to show Provisioning and Scaling of a website (Part-I)	IV	02
11	Work in Codenvy to show Provisioning and Scaling of a website (Part-II)	IV	02
12	Implement Identity Management and Access Management using OpenStack	V	02*
13	Configure Servers using Microsoft Azure to secure it. (Part-I)	V	02
14	Configure Servers using Microsoft Azure to secure it. (Part-II)	V	02
15	Design a small application based on IoT using Arduino or Raspberry pi (Part-I)	VI	02
16	Design a small application based on IoT using Arduino or Raspberry pi (Part-II)	VI	02
<b>Total</b>			<b>32</b>

### Note

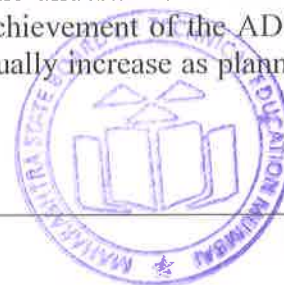
- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. The practicals marked as '\*' are compulsory, so that the student reaches the 'Application Level' of Bloom's Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO are to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Preparation of experimental setup	30
2	Setting and Operation	20
3	Observation and Recording	20
4	Interpretation of result and conclusion	10
5	Answer to sample questions	10
6	Submission of report in time	10
<b>Total</b>		<b>100</b>

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:

- a) Work collaboratively in team
- b) Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:



- 'Valuing Level' in 1<sup>st</sup> year
- 'Organization Level' in 2<sup>nd</sup> year.
- 'Characterization Level' in 3<sup>rd</sup> year.

### 7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of practicals, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO S. No.
1	<b>Computer system</b> - Hardware: Min 8GB RAM, 512 GB HDD, Gigabit Ethernet network equipment, Software Requirement: Apache Tomcat, Java, Python, Virtualization Software Academic version of any public cloud service(Google/AWS/Azure)	All

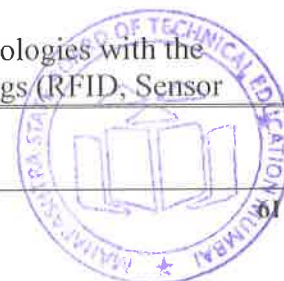
### 8. UNDERPINNING THEORY COMPONENTS

The following topics/subtopics should be taught and assessed to develop UOs in cognitive domain for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Major Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
<b>Unit – I Fundamentals of Cloud Computing</b>	1a. Explain the specified characteristics of Cloud Computing. 1b. Compare the given Cloud Deployment Models on the given criteria. 1c. Explain the given service offered by identified Cloud Service Model. 1d. Explain the given component of cloud computing architecture 1e. Write steps to use Cloud Based Integrated Development Environment to develop the given application.	1.1 Cloud Computing, Essential characteristics of cloud computing 1.2 Cloud Deployment Model: Public cloud, Private cloud, Community cloud, Hybrid cloud 1.3 Cloud Service Models: IaaS, PaaS, SaaS 1.4 Cloud Economics and Benefits 1.5 Architecture of Cloud Computing 1.6 Cloud Computing Infrastructure 1.7 Cloud-Based Integrated Development Environment (IDE) to write, run, and debug code with a browser.
<b>Unit– II Virtualization</b>	2a. Explain the given feature of Virtualization. 2b. Explain the characteristics of the specified Virtualization type 2c. Write generic steps to build a virtual machine using VMWare on the given OS. 2d. Describe the given disadvantage of Virtualization.	2.1 Introduction, Virtualization Reference Model, Characteristics of virtualized environment 2.2 Virtualization Types 2.3 Technology Example: VMWare, Microsoft Hyper-V, KVM, Xen 2.4 Advantages: Virtual Machine (VM), VM Migration, VM Consolidation, VM Management 2.5 Disadvantages of Virtualization



Unit	Major Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
<b>Unit- III Storage in Clouds</b>	3a. Explain the given component of storage system architecture. 3b. Write steps to design storage system for the given cloud set-up. 3c. Compare GFS and HDFS based on the given criteria.	3.1 Storage System Architecture, 3.2 Virtualize Data Centre (VDC) Architecture, VDC Environment, server, storage, networking, desktop and application virtualization techniques and benefits. 3.3 Block and file level storage virtualization, Virtual Provisioning, and automated storage tiering, Virtual storage area network(VSAN) and benefits, 3.4 Cloud file systems: Google File System GFS and Hadoop Distributed File System HDFS,
<b>Unit-IV Cloud monitoring and management</b>	4a. Describe the given component of federated cloud computing. 4b. Compare different types of SLA based on the given criteria. 4c. Describe the given cloud interface standard. 4d. Explain the steps to use relevant technique for managing the given Cloud resource.	4.1 Service Provider and users 4.2 An architecture of federated cloud computing 4.3 Service Level Agreement (SLA) management: Types of SLA, Life cycle of SLA. 4.4 Service catalog, management and functional interfaces of services , 4.5 Cloud portal and its functions 4.6 Cloud Service life cycle phases: Service planning, service creation, service operation and service termination 4.7 Cloud resource management <ul style="list-style-type: none"> <li>• Ab-initio Resource Assignment</li> <li>• Periodic Resource Optimization</li> </ul>
<b>Unit -V Security in Cloud Computing</b>	5a. Explain the given security related risk in Cloud Computing. 5b. Explain the specified feature of Key security terminology for data security. 5c. Write steps to implement the given Technology for Securing the Data on cloud. 5d. Write steps to manage the Identity and Access facility of given Cloud set-up. 5e. Explain the given feature of Security-As-A-Cloud Service.	5.1 Cloud Security Fundamentals 5.2 Cloud Risk, Cloud Risk division <ul style="list-style-type: none"> <li>• Polity and Organizational Risks</li> <li>• Technical Risks</li> <li>• Legal risks</li> </ul> 5.3 Technologies for Data security, Data security risk 5.4 Digital identity and access management, 5.5 Content level security 5.6 Security-As-A-Cloud Service
<b>Unit -VI Trends and future in cloud</b>	6a. Explain the characteristics of the given Enabling Technology with the IoT. 6b. Select relevant cloud platform	6.1 Cloud trends in supporting Ubiquitous Computing 6.2 Enabling Technologies with the Internet of Things (RFID, Sensor



Unit	Major Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
computing	for the identified application with justification. 6c. Describe the features of the given type of cloud-based smart device. 6d. Compare features of the given cloud platforms on the specified criteria.	Networks and ZigBee Technologies, GPS) 6.3 Innovative Applications with the Internet of Things (Ex: Smart Buildings and Smart Power Grid) 6.4 Future of Cloud-Based smart Devices, Home Based Cloud Computing, Energy Aware Cloud Computing. 6.5 Cloud Platforms: Amazon EC2 and S3, Microsoft Azure , Cloudstack, Intercloud, Google App Engine, Open Source cloud Eucalyptus, Open stack, Open Nebulla, etc.,

*Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' of Bloom's 'Cognitive Domain Taxonomy'.*

## 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	Fundamentals of Cloud Computing	04	02	02	02	06
II	Virtualization	08	02	02	04	08
III	Storage in Clouds	10	04	04	08	16
IV	Cloud monitoring and management	10	04	04	08	16
V	Security in Cloud Computing	08	02	04	04	10
VI	Trends and future in cloud computing	08	02	04	08	14
<b>Total</b>		<b>48</b>	<b>16</b>	<b>20</b>	<b>34</b>	<b>70</b>

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

*Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and assess students with respect to attainment of LOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from 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:

- Prepare journal of practical.
- Undertake micro-projects.

## 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/sub topics.
- b) '**L**' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c) About **15-20% of the topics/sub-topics** which is relatively simpler or descriptive in nature is to be given to the students for **self-directed learning** and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for **co-curricular activities**.
- e) Use different Audio Visual media for Concept understanding.
- f) Guide student(s) in undertaking micro-projects.
- g) Demonstrate students thoroughly before they start doing the practice.
- h) Ensure use of latest version of tools.
- i) Encourage students to refer various web sites to have detail understanding of JSP and related concepts.
- j) Encourage students to refer different web-applications to have deeper understanding of web-applications.
- k) Observe continuously the performance of students in laboratory.

## 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 three**.

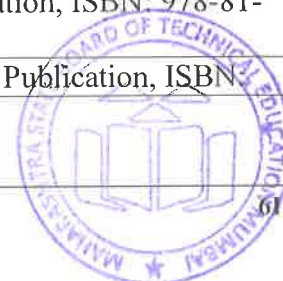
The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution 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 micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects is given here. Similar micro-projects could be added by the concerned faculty:

- a) Prepare the report on case study of Amazon Cloud Services.
- b) Prepare the report on case study of Google App Engine.
- c) Create infrastructure as service using OpenStack.
- d) Develop Personal Cloud using ownCloud and Raspberry Pi

## 13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Cloud Computing, Principals and Paradigms	Buyya Rajkumar, J.Broberg, A. Goscinski	A John Wilwy & Sons, Inc., Pubication, ISBN: 978-0-470-88799-8
2	Cloud Computing	Sharma Rishabh	Wiley Publication, ISBN: 978-81-265-5306-8
3	Mastering Cloud	Buyya Rajkumar.	McGraw Hill Publication, ISBN



S. No.	Title of Book	Author	Publication
	Computing	Vecchiola Christian, Selvi S Thamarai	978-1-25-902995-0
4	Cloud Computing	Singh Shailendra	Oxford University Press, ISBN: 9780199477388

**14. SOFTWARE/LEARNING WEBSITES**

- a) <http://nptel.ac.in/courses/106105167/1>
- b) <https://www.techopedia.com/definition/2/cloud-computing>
- c) <https://onlinelibrary.wiley.com/doi/book/10.1002/9780470940105>
- d) <http://www.chinacloud.cn/upload/2011-07/11073107539898.pdf>

