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|---------|-----------------|----------|---|---|---|--------|
| 18IT610 | CLOUD COMPUTING | Category | L | T | P | Credit |
| | | PC | 3 | 0 | 0 | 3 |

Preamble

Cloud computing paradigm covers a range of distributed computing, hosting and access solutions, including service-based computing. The objective of the course is to provide comprehensive view of cloud computing concepts, technologies, architecture, security breaches, corrective measures, deploying applications and researching state-of-the-art in Cloud Computing fundamental issues, technologies, applications and deployments

Prerequisite

NIL

Course Outcomes

On the successful completion of the course students will be able to

| CO Number | Course Outcome Statement | Weightage*** in % |
|-----------|--|-------------------|
| CO1 | Explain the key technologies, strengths, limitations and applications of cloud computing | 11 |
| CO2 | Apply suitable virtualization concept for the given scenario | 17 |
| CO3 | Categorize the cloud service types, architecture, contract negotiations needed for cloud service delivery and cloud software development | 25 |
| CO4 | Identify the necessity, appropriate cloud architecture/model for deploying an application in a cloud environment based on the given requirements | 22 |
| CO5 | Develop a cloud application with a user interface and diagnose the suitable data components | 17 |
| CO6 | Outline the emerging technologies in cloud computing platforms | 8 |

*** Weightage depends on Bloom's Level, number of contact hours,

CO Mapping with CDIO Curriculum Framework

| CO # | TCE Proficiency Scale | Learning Domain Level | | | CDIO Curricular Components (X.Y.Z) |
|------|-----------------------|-----------------------|-----------|------------------------|--|
| | | Cognitive | Affective | Psychomotor | |
| CO1 | TPS2 | Understand | Respond | Guided Response | 1.2, 2.3.1, 2.4.6 |
| CO2 | TPS2 | Apply | Value | Mechanism | 1.2, 2.3.1, 2.3.2, 2.3.4 |
| CO3 | TPS4 | Analyze | Organize | Complex Overt Response | 1.2, 2.4.5, 2.4.6, 3.2.1 -3.2.6, 4.3.1, 4.3.2 |
| CO4 | TPS3 | Apply | Value | Mechanism | 1.2, 2.4.5, 2.4.6, 2.5.1, 3.1.1, 3.2.1 – 3.2.6, 4.5.3, 4.5.5 |
| CO5 | TPS3 | Apply | Value | Mechanism | 1.2, 2.4.5, 2.4.6, 2.5.1, 3.1.1, 3.2.1 – 3.2.6, 4.5.3, 4.5.5 |
| CO6 | TPS2 | Understand | Respond | Guided Response | 1.2, 2.3.1, 2.4.6 |

Mapping with Programme Outcomes and Programme Specific Outcomes

| Cos | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO8 | PO 9 | PO 10 | PO 11 | PO 12 | PSO1 | PSO 2 | PSO 3 |
|-----|------|------|------|------|------|------|------|-----|------|-------|-------|-------|------|-------|-------|
| CO1 | M | L | | | | | | | | | | | L | | |
| CO2 | S | M | L | | S | L | | | S | S | | | M | M | L |
| CO3 | S | S | M | L | | | | | S | S | | M | M | | M |
| CO4 | S | M | L | | | L | | | S | S | L | M | M | L | S |
| CO5 | S | M | L | | S | M | L | L | S | S | M | S | M | S | S |
| CO6 | M | L | | | | | | | | | | | L | | |

S- Strong; M-Medium; L-Low

- CO4 and CO5 partially evaluated through assignments/min projects

Assessment Pattern: Cognitive Domain

| Cognitive Levels | Continuous Assessment Tests | | | Assignment | | | Terminal Examination |
|------------------|-----------------------------|----|----|------------|----|-----|----------------------|
| | 1 | 2 | 3 | 1 | 2 | 3 | |
| Remember | 10 | 10 | 10 | | | | 10 |
| Understand | 30 | 30 | 20 | | | | 20 |
| Apply | 40 | 60 | 60 | 50 | 50 | 100 | 60 |
| Analyse | 20 | | 10 | 50 | 50 | | 10 |
| Evaluate | | | | | | | |
| Create | | | | | | | |

Assessment Pattern: Psychomotor

| Psychomotor Skill | Miniproject /Assignment/Practical Component |
|-------------------------|---|
| Perception | |
| Set | |
| Guided Response | |
| Mechanism | 80 |
| Complex Overt Responses | 20 |
| Adaptation | |
| Origination | |

Sample Questions for Course Outcome Assessment**

** (2 to 3 at the cognitive level of course outcome)

Course Outcome 1(CO1):

- Define Cloud computing and explain essential characteristics of cloud computing.
- What is self service provisioning?
- Discuss the benefits of cloud computing with respect to conventional computing.

Course Outcome 2(CO2):

- Explain some of the common pitfalls that come with virtualization.
- Show the difference between process virtual machines, host VMMs and native VMMs.

3. Contrast the virtual machine as perceived by a traditional operating system processes and a system VM.

Course Outcome 3(CO3):

1. Explain the services provided by the Amazon infrastructure cloud from a user perspective.
2. What is cloud computing? Enlist and explain three service models, and four deployment models of cloud computing.
3. How to deploy a web application in a Google App Engine? Explain

Course Outcome 4 (CO4):

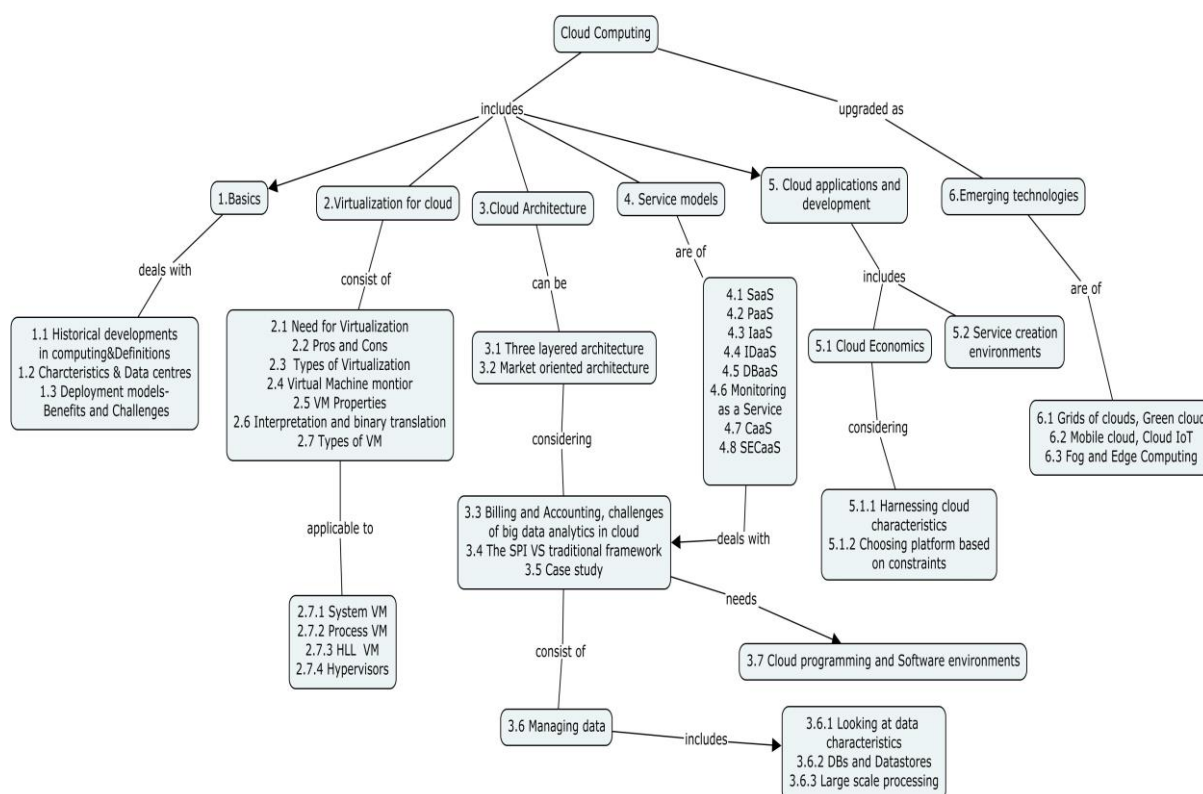
1. Identify when to use cloud application and explain how architecture affects the performance
2. Compare the differences between an internal application and a cloud application.
3. Propose several samples of risk/benefit assessments when selecting applications

Course Outcome 5 (CO5):

1. Deploy cloud application with user interface that to be used on a smart phone
2. Adapt suitable data component for E-Governance applications
3. Design an interface for rural development system using suitable cloud platform

Course Outcome 6(CO6):

1. Compare the difference between fog and edge computing
2. Outline the benefits of cloud in IoT applications
3. Explain the key characteristics of mobile cloud computing
4. Infer the role of using green cloud in IT services

Concept Map**Syllabus**

Basics of Cloud: Historical developments in computing- Definition of Cloud Computing, Essential Characteristics- Data centres-Cloud deployment models-benefits and challenges

Virtualization for cloud

Need for Virtualization, Pros and cons of Virtualization, Types of Virtualization, Virtual Machine monitor, Virtual machine properties, Interpretation and binary translation, Types of VM: System VM, Process VM, , HLL VM, Hypervisors : Xen, KVM , VMWare, Virtual Box, Hyper-V.

Cloud architecture

Three layer cloud architecture-market oriented cloud architecture ,SLA-billing and Accounting, challenges of big data analytics in cloud-The SPI Framework vs. the Traditional IT Model-Case study : Openstack, Nimbus, Microsoft Azure-Managing Data: Looking at Data, Scalability & Cloud Services-Database & Data Stores in Cloud-Large Scale Data Processing- cloud programming and software environments- Hadoop, GFS, Spark, map reduce, Big Table, Hbase, Libvirt ,openVswitch-.

Service Models

SaaS – Multi-tenant, OpenSaaS, SOA. PaaS – IT Evolution, Benefits, Disadvantages. IaaS – Improving performance, System and storage redundancy, Cloud based NAS devices, Advantages, Server types. IDaaS – Single Sign-on, OpenID. Database as a Service, Monitoring as a Service, Communication as services- Security as a Service (SECaaS)- ISO/IEC Standards

Cloud applications and development

Cloud Economics-Harnessing cloud characteristics in application design- Cloud Economics of choosing a Cloud platform for an organization, based on application requirements, economic constraints and business needs-Service creation environments to develop cloud based application-Case study: Meghdoot, Amazon, Azure, Google App, Docker, IBM, Sales force.

Emerging technologies

Grid of Clouds, Green Cloud- Mobile cloud Computing, Cloud in IoT applications, Fog and Edge computing

Learning Resources

- John Rittinghouse& James Ransome, “Cloud Computing, Implementation, Management and Strategy”, CRC Press, 2010.
- Cloud Computing Principles and Paradigms, RajkumarBuyya,JamesBroberg, AndrzejGoscinski, Wiley Publishers,2011
- Cloud Security and Privacy: An Enterprise Perspective on Risks and Compliance, Tim Mather, SubraKumaraswamy, ShahedLatif,O'Reill,2010.
- RajkumarBuyya, Christian Vecchiola, S.ThamaraiSelvi, “Mastering cloud computing”, Morgan Kaufman, 2013.
- Dr. Kris Jamsa, “Cloud Computing: SaaS, PaaS, IaaS, Virtualization, Business Models, Mobile, Security and More”, Jones and Bartlett learning, First edition, 2013.
- ArshdeepBahga, Vijay Madiseti, “Cloud Computing: A Hands-On Approach”, CreateSpace Independent Publishing Platform, 1st edition, 2013.
- Massimo Cafaro (Editor), Giovanni Aloisio (Editor), “Grids, Clouds and Virtualization” Springer; edition, 2011.
- GautamShroff, “Enterprise Cloud Computing Technology Architecture Applications”, Cambridge University Press; 1 edition, 2010.
- Barrie Sosinsky, “ Cloud Computing Bible” John Wiley & Sons, 2010
- Cloud Security Alliance, “Security Guidance for Critical Areas of Focus in Cloud Computing” 2011

- Cloud Security Alliance, “Top Threats to Cloud Computing”, 2013.
- <http://nptel.ac.in/courses/106105167/>

Course Contents and Lecture Schedule

| Module No. | Topic | No. of Hours | Course Outcome |
|------------|--|--------------|----------------|
| 1. | Basics of Cloud | | |
| 1.1 | Historical developments in Computing, Definition of Cloud Computing | 1 | CO1 |
| 1.2 | Essential Characteristics, Data centres | 1 | |
| 1.3 | Deployment models -Benefits, Challenges | 2 | |
| 2. | Virtualization for cloud | | CO2 |
| 2.1 | Need for Virtualization | 1 | |
| 2.2 | Pros and cons of Virtualization | | |
| 2.3 | Types of Virtualization | 1 | |
| 2.4 | Virtual Machine monitor | | |
| 2.5 | Virtual machine properties | 2 | |
| 2.6 | Interpretation and binary translation | | |
| 2.7 | Types of VM | | |
| 2.7.1 | System VM | 1 | |
| 2.7.2 | Process VM | | |
| 2.7.3 | HLL VM | | |
| 2.7.4 | Hypervisors :Xen, KVM , VMWare, Virtual Box, Hyper-V. | 1 | |
| 3. | Cloud architecture | | |
| 3.1 | Three layer cloud architecture | 2 | CO4 |
| 3.2 | Market oriented cloud architecture, SLA | | |
| 3.3 | Billing and Accounting, Challenges of big data analytics in cloud | 1 | |
| 3.4 | The SPI Framework vs. the Traditional IT Model | 2 | |
| 3.5 | Case study : Eucalyptus, Nimbus, Microsoft Azure | | |
| 3.6 | Managing Data | | |
| 3.6.1 | Looking at Data, Scalability & Cloud Services | 1 | |
| 3.6.2 | Database & Data Stores in Cloud | 1 | |
| 3.6.3 | Large Scale Data Processing | 1 | |
| 3.7 | Cloud programming and software environments | | |
| 4. | Service models | | CO3 |
| 4.1 | SaaS – Multitenant, OpenSaaS, SOA | 1 | |
| 4.2 | PaaS – IT Evolution, Benefits, Disadvantages | 2 | |
| 4.3 | IaaS – Improving performance, System and storage redundancy, Cloud based NAS devices, Advantages, Server types | 2 | |
| 4.4 | IDaaS – Single Sign-on, OpenID. | 1 | |
| 4.5 | Database as a Service | 1 | |
| 4.6 | Monitoring as a Service | 1 | |
| 4.7 | Communication as services | 1 | |
| 4.8 | SECaaS-ISO/IEC Standards | | |
| 5. | Cloud applications and development | | CO5 |
| 5.1 | Cloud Economics | 2 | |
| 5.1.1 | Harnessing cloud characteristics in application design | | |
| 5.1.2 | Cloud Economics of choosing a Cloud platform for an organization, based on application requirements, economic constraints and business needs | 2 | |
| 5.2 | Service creation environments to develop cloud based applications—Meghdoot, Amazon, Azure, Google App, | 2 | |

| | | | |
|-----|--------------------------------------|----|-----|
| | Docker, IBM, Sales force | | |
| 6. | Emerging technologies | | CO6 |
| 6.1 | Grid of Clouds, Green Cloud | 1 | |
| 6.2 | Mobile cloud Computing, Cloud in IoT | 1 | |
| 6.3 | Fog and Edge computing | 1 | |
| | Total Lectures | 36 | |

Course Designers:

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