## **ICT 4045: CLOUD COMPUTING [3 0 0 3]**

**Objectives:**

* To learn the fundamental concepts and various delivery, deployment models in cloud computing.
* To understand the demand and need based allocation of resources to the applications running in cloud
* To familiarize with the role of virtualization layer, various types of virtualization techniques.
* To understand various techniques to secure the cloud resources from unauthorized access.

**Abstract:**

Introduction, Cloud infrastructure, Cloud computing delivery models and services, Cloud computing at Amazon, The Google perspective, Microsoft Windows Azure, Application paradigms, Architectural styles of cloud computing, Cloud resource management and scheduling, Cloud resource virtualization, Types of virtualization, Understanding hypervisors, Virtual machine and its components, Resource management, Memory ballooning, Thin virtual provisioning, Storage tiering, Virtual LAN, VLAN trunking, VLAN tagging, Business continuity and cloud management, Virtual machine fault tolerance, Virtual machine replication methods, Cloud security, Virtual machine security, Access control and identity management, Cloud tools: Eucalyptus, OpenNebula/OpenStack, CloudSim.

**Syllabus:**

**Introduction, Cloud Infrastructure:**

Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Major challenges, Cloud computing at Amazon, The Google perspective, Microsoft Windows Azure, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. **[4 Hours]**

**Application Paradigms:**

Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model. **[4 Hours]**

**Cloud Resource Management and Scheduling:**

Policies and mechanisms for resource management, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling subject to deadlines, Scheduling MapReduce applications subject to deadlines, Resource management and dynamic scaling. **[5 Hours]**

**Cloud Resource Virtualization:**

Virtualization, Layering and virtualization, Virtualization Overview, Virtualized Data Center (VDC) – Compute, Types of Virtualization, Understanding Hypervisors, Virtual Machine and its Components, Resource Management, Share, Limit and Reservation, Optimizing Memory Resource, Memory Ballooning, Virtual Machine Affinity, Physical to Virtual Conversion: Hot and Cold Conversion Process, Virtualized Data Center (VDC) – Storage, Storage Virtualization at different Layers, Virtual Machine Storage Options and Considerations, Virtual Provisioning, Storage Tiering, Virtualized Data Center (VDC) – Networking, Components of VDC network infrastructure, Virtual Network Components, Virtual LAN, VLAN Trunking, VLAN Tagging, Network Traffic Management, Virtualized Data Center (VDC) - Desktop and Application, Performance comparison of virtual machines, The dark side of virtualization, Case Study: Xen, a VMM based par virtualization. **[9 Hours]**

**Business Continuity and cloud management:**

Overview, virtual machine fault tolerance, NIC teaming, backup optimization, Virtual machine replication methods, Service failure, Virtual infrastructure management software, Cloud service management. **[5 Hours]**

**Cloud Security:**

Information Security, Basic Terminology, Cloud security risks, Security concerns and Threats, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by shared images, Security risks posed by a management OS, A trusted virtual machine monitor,Access Control and Identity Management in Cloud, Governance, Risk and Compliance, Virtualization Security Management, Trusted Cloud Computing **[6 Hours]**

**Cloud Tools:**

Overview of cloud software: Eucalyptus, Open Nebula/Open stack, CloudSim Framework: Modelling and simulating the cloud environment **[3 Hours]**

**Outcome:**

**Upon completion of the course, the students will be able to:**

* Evaluate the understanding of fundamental concepts in cloud computing
* Analyse and compare various resource management techniques in cloud computing
* Apply the various compute, storage and network virtualization techniques in cloud computing
* Identify and analyse various security threats and mitigations in cloud computing

References:

1. Dan C Marinescu, *Cloud Computing Theory and Practice*, Elsevier 2013
2. Rajkumar Buyya, Christian Vecchiola, S. Thamarai Selvi, *Mastering Cloud Computing*, McGraw Hill 2017
3. Anthony T. Velte, Toby J. Velte, Robert Elsenpeter, *Cloud Computing: A Practical Approach*, McGraw Hill 2017