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| --- | --- | --- | --- | --- | --- |
| **ME2** | **Cloud Computing Architecture and Deployment Models** | L | T | P | C |
| **Version 1.0** |  | 3 | 0 | 0 | 3 |
| **Pre-requisites/Exposure** | Cloud Computing Fundamentals | | | | |
| **Co-requisites** | -- | | | | |

**Course Objectives**

1. To understand the characteristics, benefits, and limitations of cloud service models (IaaS, PaaS, SaaS) and evaluate their suitability for different organizational needs.
2. To examine the deployment models (public, private, hybrid) of cloud computing and analyze their advantages, limitations, and considerations for effective cloud infrastructure implementation.
3. To explore cloud computing reference architectures NIST, IBM & AWS and gain a comprehensive understanding of their objectives, components, and control mechanisms for designing robust cloud solutions.
4. To analyze and evaluate fundamental and advanced cloud architectures, including workload distribution, scalability, resource pooling, and redundancy, to design optimized cloud environments.

**Course Outcomes**

On completion of this course, the students will be able to

**CO1:** Analyze and compare the key characteristics, benefits, and limitations of IaaS, PaaS, and SaaS cloud service models to effectively assess their suitability for different organizational needs.

**CO2:** Analyze and assess the cloud deployment models (Public, Private, Hybrid) demonstrating a deep understanding of their advantages, limitations, and challenges to make informed decisions regarding the selection and management.

**CO3:** Analyze and evaluate NIST, IBM's and AWS cloud computing reference architectures to make informed decisions about their adoption and implementation in diverse usage scenarios.

**CO4:** Ability to apply fundamental as well as advanced cloud computing architectures in various business scenarios.

**Catalog Description**

This course explores the intricacies of cloud computing architecture, encompassing service models (IaaS, PaaS, SaaS), deployment models (public, private, hybrid), and reference architectures (NIST, IBM). Students will analyze and evaluate cloud service and deployment models, examine different cloud reference architectures, and explore fundamental and advanced cloud architectures, including workload distribution, resource pooling, scalability, and redundancy. Additionally, students will gain insights into Amazon Web Services (AWS) and its role within a cloud computing reference architecture.

**Course Content**

**Cloud Computing Architecture and Deployment models**

**Unit 1. Service Models (IaaS, PaaS and SaaS) (10 hrs)**

*Infrastructure as a Service (IaaS):* Characteristics of IaaS, Comparing ISPs and IaaS, IaaS case studies, IaaS enabling technology, the trusted cloud, IaaS as the best/not best option, PaaS: Platform as a Service.

*Platform as a Service:* PaaS characteristics, Integrated lifecycle platforms, Anchored lifecycle platforms, Enabling technologies as a platform, Case studies: Integrated lifecycle platform, PaaS as the best/ not best option.

*Software as a Service (SaaS):* SaaS origin, Evolution of SaaS: Salesforce.com’s approach, Characteristics of Software as a Service (SaaS), SaaS economics and the ecosystem, Types of SaaS platforms, SaaS: Providers, Collaboration as a service, Enabling and management tools as a service, Monitoring and management tools as a service, SaaS as the best/not best option.

**Unit 2. Deployment Models (Pubic, Private, Hybrid) (10 hrs)**

*Private Cloud Deployment:* Private Cloud, Illustration of Private Cloud, Advantages of Private Cloud, Limitations of Private Cloud, Service Management, Journey into Private Cloud, Planning and Strategy, Standardization, Virtualization, Automation, Cloud, Case study – VMware vCloud, Case Study – IBM SmartCloud Entry, Private cloud.

*Public Cloud Deployment:*: Public Cloud, Illustration of Public Cloud, Why Public Cloud, Advantages of Public Cloud, Limitations of Public Cloud: Low degree of security and control, Lack of control on infrastructure, Configuration, Network latency and accessibility concerns, Highest long term cost; Public v/s Private: Journey into Public Cloud, Revisit the idea of adopting public cloud: Cloud vendor selection, migrating to Cloud, Cloud vendor selection, SLA – Service Level Agreements, Credits/Compensation terms, Credit process, Disaster recovery plan, Exclusions, Security and Privacy, Periodic upgrade and maintenance, Data location and Jurisdiction, Pricing and Measurability, Interoperability and Lock-in, Exit process/Termination policies, Proven track record; Public cloud vendors and Case studies: AWS, Microsoft Azure, Google GCP

*Hybrid Cloud deployment:* Hybrid Cloud, Why Hybrid Cloud, Illustration of Hybrid Cloud, Advantages of Hybrid Cloud, Challenges of Hybrid Cloud, Develop and manage hybrid workloads, Developing applications for hybrid cloud, Develop applications using PaaS, Managing hybrid workloads, Journey into Hybrid Cloud

*OpenStack*: Introduction, OpenStack Architecture, IBM SoftLayer, *IBM Bluemix* -Benefits of IBM Bluemix, -More Bluemix features, -Bluemix architecture.

**Unit 3. Cloud Computing Reference Architectures (NIST & IBM) (8 hrs)**

*NIST Cloud Computing Reference Architecture (CCRA):* Objectives of NIST, The conceptual reference model, Example: Usage scenarios, Cloud consumer, Cloud provider, Cloud auditor, Cloud broker, Cloud carrier, Scope of control between provider and consumer, CCRA: Architectural components, Service orchestration, Cloud service management, Business support, Provisioning and configuration Portability and interoperability, Security, Privacy, Cloud taxonomy.

*IBM’s CCRA:* IBM CCRA roles, Cloud service consumer, Cloud service provider, Cloud services, Infrastructure, Common Cloud Management Platform (CCMP), CCMP supports any level of virtualization, Business Support Services (BSS), Operational Support Services (OSS), Security, resilience, performance and consumption, Cloud service creator: Service development tools, IBM CCRA versions or CCRA evolution, Adoption patterns, Adoption pattern in CCRA 3.0, Examples of cloud services.

**Unit 4. Fundamental Cloud Architectures (7 hrs)**

*Fundamental Cloud Architectures*: Workload distribution architecture, Resource pooling architecture, Dynamic scalability architecture, Elastic resource capacity architecture, Service load balancing architecture, Cloud bursting architecture, Elastic disk provisioning architecture, Redundant storage architecture.

**Unit 5. Advanced Cloud architecture and AWS CCRA (10 hrs)**

*Advanced Cloud Architectures*: Overview of the advanced cloud architecture, Hypervisor clustering architecture, Load balanced virtual server instances architecture, Non-disruptive service relocation architecture, Zero downtime architecture, Cloud balancing architecture, Resource reservation architecture, Dynamic failure detection and recovery, Bare-metal provisioning architecture, Rapid provisioning architecture, Components that can comprise the system, Automated administration pattern, Storage workload management architecture, Live VM migration.

*AWS CCRA:* What is amazon web services, Features of AWS, Web application hosting, Content and media serving, Large scale computing and huge data sets, Disaster recovery for local applications, Ecommerce website: Web frontend, Ecommerce website: Checkout service, Marketing and recommendations, Fault tolerance and high availability, File synchronization service

**Text Books**

1. Cloud Computing Architecture (IBM ICE Publication)
2. Cloud Computing Deployment Model (IBM ICE Publication)
3. Cloud Computing For Dummies Judith Hurwitz, Robin Bloor, Marcia Kaufman, Fern Halper, For Dummies, Edition 1, Nov 2009.
4. Cloud Computing: Concepts, Technology & Architecture, Thomas Erl,Pearson Education India, Jan 2014
5. OpenStack Essentials, Dan Radez, PackIT publication, publications , 2nd Edition, Jan 2016

**Reference Books**

1. Cloud Computing: Principles and Paradigms, Editors: Rajkumar Buyya, James Broberg, Andrzej M. Goscinski, Wiley, Jan 2013
2. Enterprise Cloud Computing Technology Architecture Applications, GautamShroff, Cambridge, Oct 2010.
3. About Openstack: A Comprehensive Tutorial To Revolutionize Cloud Computing Solutions  [Kalyn Sehrt](https://www.amazon.com/s/ref=dp_byline_sr_book_1?ie=UTF8&field-author=Kalyn+Sehrt&text=Kalyn+Sehrt&sort=relevancerank&search-alias=books)–  Independently published, March 27, 2023

**Case Studies:**

1. <https://aws.amazon.com/blogs/architecture/> (AWS blogs)
2. <https://techcommunity.microsoft.com/t5/azure-architecture-blog/bg-p/AzureArchitectureBlog> (Microsoft Azure blogs)
3. <https://www.googlecloudcommunity.com/gc/Architecture-Framework-Community/bg-p/cloud-architecture-framework-blog> (Google Cloud blogs)

**Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination**

**Examination Scheme:**

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| --- | --- | --- | --- | --- |
| **Components** | **Internal** | **Mid Term** | **ESE** | **Total** |
| **Weightage (%)** | **50%** | **20%** | **30%** | **100%** |

**Relationship between the Course Outcomes (COs), Program Outcomes (POs) and Program Specific Outcomes (PSOs)**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Course Outcomes | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| CO1 | 1 | 1 |  | 1 | 2 |  |  |  |  |  |  |  | 1 | 1 | 3 |
| CO2 | 1 | 1 |  | 1 | 2 |  |  |  |  |  |  |  | 1 | 1 | 3 |
| CO3 | 1 | 1 |  | 1 | 2 |  |  |  |  |  |  |  | 1 | 1 | 3 |
| CO4 | 1 | 1 |  | 1 | 2 |  |  |  |  |  |  |  | 1 | 1 | 3 |
| Average | 1 | 1 |  | 1 | 2 |  |  |  |  |  |  |  | 1 | 1 | 3 |

1=weak 2= moderate 3=strong