INTERNATIONAL UNIVERSITY OF EAST AFRICA

'Learning to Succeed'

FACULTY OF SCIENCE AND TECHNOLOGY

END OF SEMESTER EXAMINATIONS - AUGUST 2025

PROGRAMME: MIT
YEAR/SEM: YEAR 1/SEMESTER 2
COURSE CODE: MIT723
NAME: VIRTUALIZATION AND CLOUD COMPUTING

DATE:
TIME:

INSTRUCTIONS TO CANDIDATES:

SECTION A

ATTEMPT ANY ONE QUESTIONS (40 MARKS)

Question 1:

QUESTION ONE: MERITS OF CLOUD COMPUTING (40 MARKS)

i. Define the term *Cloud Computing* and mention any two essential characteristics **(02 Marks)**

ii. A logistics company experiences unpredictable data processing demands due to varying shipment volumes. Explain how cloud computing allows elastic scaling to support such varying demands and ensures system reliability. **(06 Marks)**

iii. A new education technology startup plans to launch a data-driven learning platform but has limited funds for IT infrastructure. Describe how cloud computing lowers capital expenditure and explain the economic advantages of cloud-based resource allocation.

(06 Marks)

iv. An international consulting firm requires real-time document collaboration and project tracking across its global offices. Discuss how cloud computing fosters efficient remote collaboration and boosts team productivity across locations.

(06 Marks)

v. A healthcare organization is struggling with outdated software systems that require constant manual updates. Analyze how adopting cloud computing can streamline system updates and improve overall IT management and security.

(06 Marks)

vi. A software development team wants to experiment with new microservices and deploy code frequently. Explain how cloud platforms support rapid prototyping, continuous integration, and faster deployment cycles. **(06 Marks)**

vii. A government agency wants to ensure high data security while transitioning to cloud infrastructure. Highlight the key security measures implemented by cloud service providers and how these compare to traditional on-premise security models.

(04 Marks)

viii. A gaming company seeks to deliver smooth, real-time multiplayer experiences to users worldwide. Evaluate how cloud computing supports global service delivery and reduces latency for end-users.
(04 Marks)

Question 2:

QUESTION TWO: DEMERITS OF CLOUD COMPUTING (40 MARKS)

i. An online banking platform hosted in the cloud suffers from an unexpected service disruption due to a regional cloud outage. What high-availability and disaster recovery strategies can the company adopt to minimize downtime in future incidents? **(06 Marks)**

ii. A SaaS-based company heavily integrates its services with a single cloud provider's proprietary APIs and tools. Later, they face challenges when attempting to migrate to another provider. What approaches can businesses use to avoid or reduce the risks of vendor lock-in?

(06 Marks)

iii. A digital content company stores vast media files on the cloud and faces rising storage and retrieval costs each month. What cost management techniques and tools can be applied to optimize cloud usage and reduce operational expenses?
(06 Marks)

iv. A video conferencing platform experiences delays and packet loss for users located far from the cloud provider's main data centers. What network and infrastructure strategies can be implemented to enhance global performance and minimize latency? **(06 Marks)**

v. A company relies on cloud storage for all its documents and discovers that accidentally deleted files cannot be recovered beyond a short retention window. How can businesses build a robust data backup and recovery plan using cloud technologies? **(06 Marks)**

vi. A fully remote company uses cloud-based productivity tools, but during a national internet service disruption, all work operations come to a halt. What

offline or hybrid solutions can help maintain business continuity during internet outages? **(06 Marks)**

vii. An employee with elevated access privileges to a cloud-hosted CRM system downloads and shares confidential customer data after resigning. What cloud-based identity, access management, and monitoring solutions can help prevent insider threats? **(06 Marks)**

SECTION B

Attempt Any Four Questions from this section - Each question carries 15 marks

Question 1:

QUESTION THREE: COMPUTE VIRTUALIZATION (15 MARKS)

i. One of your critical virtual machines is experiencing hardware degradation that may lead to an imminent failure. What virtualization techniques and failover strategies can be implemented to ensure continuity of service and minimize downtime?

(03 Marks)

ii. A mid-sized enterprise is considering shifting its IT operations to a virtualized environment and must choose between hardware-assisted virtualization and a container-based approach. What key differences and trade-offs should be evaluated before making this decision?

(03 Marks)

iii. In a Type-1 hypervisor setting, outline the step-by-step process involved in provisioning a new virtual machine, ensuring that resource allocation is optimized and system performance remains stable.

(03 Marks)

iv. Virtualized environments can introduce unique security challenges, especially in scenarios involving multi-tenancy and shared resources. Identify these key security vulnerabilities and explain the mitigation strategies that can be employed to secure the infrastructure.

(06 Marks)

Question 2:

QUESTION FOUR: CPU VIRTUALIZATION (15 MARKS)

i. You are tasked with deploying multiple compute-intensive virtual machines on a host with limited CPU resources. How would you configure CPU affinity and time slicing to ensure fair resource distribution and stable performance?

(03 Marks)

ii. An organization plans to consolidate its physical servers into a smaller number of virtualized hosts. To avoid CPU performance issues, what best practices should be followed to minimize virtualization overhead and optimize resource usage? **(03**

Marks)

iii. Real-time applications such as VoIP or industrial control systems are being migrated to a virtualized platform. What challenges do such workloads pose for CPU virtualization, and how can hypervisors be tuned to support their time-sensitive requirements? **(03 Marks)**

iv. In a scenario where multiple virtual machines are competing for CPU time and causing noticeable slowdowns, outline the steps you would take to analyze and optimize CPU performance to reduce contention and improve overall throughput. **(06 Marks)**

Question 3:

QUESTION FIVE: MEMORY VIRTUALIZATION (15 MARKS)

i. A system administrator notices that a virtual machine is underperforming due to limited available memory. What memory tuning strategies, including adjusting reservation, limit, and shares settings, can be applied to improve performance? **(03 Marks)**

ii. In a data center running multiple virtual machines, administrators use memory overcommitment to increase efficiency. How do techniques like transparent page sharing (TPS) and ballooning enable overcommitment, and what risks should be considered? **(03 Marks)**

iii. Explain the concept of second-level address translation (SLAT) in modern processors. How does SLAT enhance memory virtualization performance in cloud environments? **(03 Marks)**

iv. Compare and contrast ballooning, swapping, and memory compression as methods of managing memory in virtualized systems. For each method, identify scenarios where it is most effective, and discuss the potential performance implications. **(06 Marks)**

Question 4:

QUESTION SIX: I/O VIRTUALIZATION (15 MARKS)

i. A virtual machine running a data-intensive application suffers from poor network throughput. How can technologies like VirtIO or paravirtualized network drivers enhance I/O performance in such virtualized environments, and what are the key configuration requirements? **(03 Marks)**

ii. During a performance audit, it is observed that a virtualized database server is experiencing slow disk I/O despite adequate physical resources. What storage-related configuration issues or I/O bottlenecks might be responsible, and how can they be resolved?

(03 Marks)

iii. Direct device assignment methods such as PCI passthrough offer near-native performance but raise concerns around isolation and multi-tenancy. What are the primary security implications of using direct I/O techniques, and how can administrators safeguard against them?
(03 Marks)

iv. Discuss the role of I/O virtualization in enabling high-performance and scalable cloud services. Using examples, explain how modern cloud providers leverage SR-IOV, NVMe over Fabrics, or paravirtualized I/O to improve network and storage efficiency.

(06 Marks)

Question 5:

QUESTION SEVEN: MAINSTREAM COMPUTE VIRTUALIZATION (15 MARKS)

i. A company wants to virtualize its aging physical servers to consolidate resources and reduce hardware maintenance. Outline the essential phases involved in a successful compute virtualization migration project, and highlight common pitfalls during the transition.
(03 Marks)

ii. A virtualized data center is experiencing poor application performance due to overutilized compute resources. What proactive and reactive techniques can be used to optimize CPU and memory distribution among virtual machines? **(03 Marks)**

iii. Compare containers and virtual machines with respect to boot time, operating system overhead, and security isolation. Identify specific use cases where one approach would be preferred over the other, especially in

cloud-native development.
(03 Marks)

iv. Discuss how live migration contributes to the flexibility and high availability of virtualized infrastructures. What are the technical and operational considerations to ensure data consistency, minimal downtime, and network stability during live migration? **(06 Marks)**

Question 6:

QUESTION EIGHT: NETWORK VIRTUALIZATION (15 MARKS)

i. Describe the key components of a Software-Defined Networking (SDN) architecture and explain how SDN separates the control plane from the data plane. How does this separation benefit network programmability and automation? Provide a use case. **(03 Marks)**

ii. Compare traditional networking with virtualized networking in terms of provisioning speed, hardware dependency, and network visibility. What are the key benefits and limitations of using virtual switches in a virtualized environment?
(03 Marks)

iii. Hypervisors enable the creation of virtual switches for VM communication. Explain how a Type 1 hypervisor's direct access to hardware differs from a Type 2 hypervisor's reliance on a host OS, and discuss the implications for network throughput and security.
(03 Marks)

iv. An organization wants to segment its internal network to isolate the Marketing, Engineering, and Support departments on the same physical infrastructure.

a. Describe how VLANs can be used to logically separate the network traffic between departments.
(02 Marks)

b. List and explain the Cisco IOS commands used to create VLANs and assign them to switch ports.
(02 Marks)

c. If users from different VLANs need to communicate with each other, what configuration or device would you use to enable inter-VLAN routing? **(02 Marks)**

Question 7:

QUESTION NINE: CLOUD DEPLOYMENT MODELS (15 MARKS)

i. A healthcare company is evaluating different cloud deployment models for hosting its sensitive patient data and running analytics services. What key factors such as security, control, cost, and scalability should influence their choice between public, private, and hybrid cloud solutions? **(05 Marks)**

ii. A financial institution must adopt cloud computing but must also comply with strict data localization and industry-specific regulations. Which cloud deployment model best aligns with these needs, and what features make it a secure and compliant choice? **(05 Marks)**

iii. Define the main characteristics of Public, Private, and Hybrid Cloud models. Then, explain why a Hybrid Cloud approach might be ideal for businesses looking to balance cost efficiency with control over sensitive workloads. **(05 Marks)**

iv. A company uses a private cloud for its internal systems but wants to leverage the public cloud for seasonal spikes in workload. Explain how this scenario benefits from a hybrid cloud model and what technical or operational challenges may arise.
(05 Marks)

v. What are the advantages and disadvantages of choosing a community cloud model for organizations that share common compliance, security, or operational concerns? Provide examples of industries where this model might be most suitable. **(05 Marks)**

Question 8:

QUESTION TEN: CLOUD SERVICE MODELS (15 MARKS)

i. A small software development team wants to build and deploy applications quickly without managing the underlying infrastructure. Which cloud service model should they adopt, and what advantages does it provide in terms of development speed and resource management? **(05 Marks)**

ii. An organization needs to run legacy enterprise applications in the cloud

with complete control over operating systems, middleware, and storage. Which cloud service model would meet these requirements, and how does it compare to other models in terms of flexibility and responsibility?

(05 Marks)

iii. A business is looking for an out-of-the-box CRM system that can be accessed via the internet with minimal setup and no internal IT support. Which cloud service model is most appropriate, and what are the benefits and limitations of using it?
(05 Marks)

iv. Compare IaaS, PaaS, and SaaS in terms of user control, responsibility, and use cases. Provide an example of a suitable application or business scenario for each model. **(05 Marks)**

v. A university plans to offer students access to productivity tools like document editing, cloud storage, and email without installing any software on campus computers. Which cloud service model fits this need best, and what are the key features that support this use case? **(05 Marks)**

Question 9:

QUESTION ELEVEN: CLOUD COMPUTING ARCHITECTURE (15 MARKS)

i. A fintech company is designing its cloud platform with microservices for payment processing, fraud detection, and customer management. Explain how loose coupling among these services contributes to system flexibility, fault isolation, and easier maintenance. **(05 Marks)**

ii. A startup uses serverless functions triggered by HTTP requests, which in turn interact with different cloud storage and messaging services. How does the loose coupling of these components help the application handle sudden spikes in traffic and reduce downtime? **(05 Marks)**

iii. In a smart city project, various sensors and devices communicate asynchronously with cloud services that analyze data and send alerts. Discuss how loose coupling between edge devices, cloud analytics, and notification services improves scalability and fault tolerance.

(05 Marks)

iv. Describe how adopting a loosely coupled architecture in a cloud-based online learning platform can enable independent updates of user authentication, course content delivery, and analytics services without disrupting the overall system.

(05 Marks)

Question 10:

QUESTION TWELVE: CLOUD INFRASTRUCTURE (15 MARKS)

i. A banking institution implements a disaster recovery strategy using geographically distributed cloud data centers and automated backup solutions. Explain how storage devices and cloud orchestration tools contribute to ensuring data durability and quick recovery in case of failures.

(05 Marks)

ii. A global enterprise requires a secure and resilient cloud storage system to enable seamless file sharing among international teams. Discuss how storage hardware, cloud management platforms, and network design work together to guarantee availability, data security, and fast access. **(05 Marks)**

iii. A healthcare provider adopts a hybrid cloud setup where sensitive medical data is kept on-premises while leveraging cloud-based platforms for big data analytics. Describe how servers, storage technologies, and virtualization support data segregation, security, and efficient processing in this environment.

(05 Marks)

iv. An e-commerce company relies on cloud storage services for product images and customer data, with strict requirements for data consistency and fault tolerance. What roles do replication, snapshots, and cloud management software play in maintaining data integrity and availability? **(05 Marks)**

Question 11:

QUESTION FOURTEEN: RISKS RELATED TO CLOUD (15 MARKS)

i. An online retailer experiences a data breach where attackers exploited weak authentication to access customer profiles stored in the cloud. What technical and organizational security controls should be implemented to prevent unauthorized access and protect sensitive data? **(05 Marks)**

ii. A cloud-hosted financial trading platform faces downtime due to the cloud provider's infrastructure failure, disrupting user transactions. What strategies can the company adopt to improve fault tolerance and minimize service disruption during cloud outages?

(05 Marks)

iii. A pharmaceutical company moves its research data to a public cloud but later discovers that data residency requirements conflict with the provider's storage locations. How can organizations ensure regulatory compliance and retain control over their data in cloud deployments? **(05 Marks)**

iv. What role do Service Level Agreements (SLAs) and cloud governance policies play in managing risks related to security, availability, and compliance for businesses using cloud services? **(05 Marks)**

Question 12:

QUESTION FOURTEEN: (15 MARKS)

i. Differentiate between the terms *security threats* and *vulnerabilities* in the context of private cloud data centers. Why is it important to understand this distinction for effective cloud security management?

(04 Marks)

ii. Identify and describe at least three common vulnerabilities found in private cloud data centers. For each vulnerability, explain how attackers might exploit it to compromise security.

(03 Marks)

iii. Security threats to private cloud environments can be categorized into interception, interruption, modification, and fabrication. Define each type of threat and provide a real-world example illustrating how it could impact a private cloud data center. **(08 Marks)**