1 .

(a) Answer the following questions.

Briefly describe the early technologies that influenced the development of cloud-based businesses.

Virtualization, Distributed computing, mobile computing, grid computing, and utility computing

(b) What is the main benefit of using mobile computing in cloud environments?

The main benefit of using mobile computing in cloud environments is that it enables users to access cloud-based services and resources from anywhere and at any time using their mobile devices.

(c) Briefly describe one popular Infrastructure-as-a-Service (IaaS) provider other than Amazon Web Services (AWS).

Top 10 Infrastructure as a Service (IaaS) Providers

Amazon EC2 Google Compute Engine DigitalOceanAzure Virtual Machines Microhost Vultr Linode IBM Cloud Pak for Data vCloud SUSE Linux Enterprise Server

(d) Briefly describe the architecture of cloud on the basis of virtual switches load balancing.

The architecture of cloud-based virtual switches load balancing involves multiple servers connected to a virtual switch that distributes network traffic across them. The virtual switch monitors the traffic flow and routes it to the appropriate server based on various load balancing algorithms.

(e) Briefly describe the EC2 feature in AWS.

EC2 (Elastic Compute Cloud) is a core service offered by AWS (Amazon Web Services) that provides resizable compute capacity in the cloud. EC2 allows users to launch virtual machines (known as instances) and configure them as needed, including selecting the operating system, storage, and networking options.

(t) What are the main benefits of using load balancing in cloud environments?

Improved Performance, Scalability, High Availability, Cost Savings, Security

(g) Give an example of a Software-as-a-Service (SaaS) application that you use regularly.

Salesforce. Google Workspace apps. Microsoft 365. HubSpot. Trello. Netflix. Zoom. Zendesk.

(h) Briefly describe one popular hypervisor used in virtualization .

Microsoft Hyper V. VMware Free ESXi. ... Lguest. ... Oracle VirtualBox. ...Xvisor. ... VMware Workstation Player.

(i) Briefly describe the cloud issues and challenges faced in e-Governance.
Data Security Interoperability Vendor Lock-In Regulatory Compliance Accessibility

(j) What is VM Provisioning? Briefly describe its process.

VM provisioning is the process of creating and configuring virtual machines (VMs) in a cloud or virtualized environment. The process typically involves the following steps: Specifying VM requirements, Allocating resources, Creating the VM, Configuring the VM, Deploying the VM

SECTION-B

2. (a) Discuss the key differences among private, public, hybrid, and community cloud models. Provide examples of situations where each would be appropriate.

Difference between different types of clouds:

FEATURES/CLOUD	PUBLIC	PRIVATE	HYBRID	COMMUNITY
Host	Service provider	Enterprise	Enterprise	Community (Third party)
Suitable for	Large Enterprise	Large Enterprise	Small and mid-size	Financial, heath and legal companies
Access	Internet	Intranet, VPN	Intranet, VPN	Intranet, VPN
Security	Low	Most secured	Moderate	Secured
Cost	Cheapest	High Cost	Cost effective	Cost effective
Owner	Service provider	Enterprise	Enterprise	Community
Reliability	Moderate	Very High	Medium to High	Very High
Users	Organizations, public like individuals	Business organizations	Business organizations	Community members
Scalability	Very High	Limited	Very High	Limited

(b) In recent years, many organizations have migrated their IT infrastructure to the cloud. Analyze the factors that have led to this trend, and discuss the benefits and challenges associated with this shift.

Organizations are moving to the cloud due to benefits such as scalability, cost savings, flexibility, and security. However, challenges include data privacy, technical expertise, integration issues, and vendor lock-in. Careful consideration of these factors is necessary for a successful cloud migration strategy.

3. (a) Examine the fundamental concepts of distributed systems and grid computing. Which one do you think is the most suitable for cloud computing, and why?

Distributed systems refer to a network of independent computers that work together to provide a single coordinated service to users. These systems are designed to handle large-scale computations by breaking them down into smaller tasks and distributing them across multiple computers.

Grid computing, on the other hand, is a type of distributed computing that focuses on coordinating the sharing of resources across multiple administrative domains. This involves connecting multiple computers or clusters of computers to form a grid, which can be used for large-scale data processing or other complex computing tasks.

(b) Describe the advantages and disadvantages of using cluster and mobile computing for cloud-based systems. What are the key challenges that must be overcome to ensure their effectiveness?

Advantages of cluster computing for cloud-based systems:

Improved performance and scalability through parallel processing

Cost-effective, as cluster systems can be built using off-the-shelf hardware

High availability and fault tolerance, as the system can continue to operate even if individual nodes fail

Disadvantages of cluster computing for cloud-based systems:

Complex to set up and maintain, requiring specialized technical expertise

Limited flexibility in terms of resource allocation and usage, as resources are shared among nodes

Risk of bottlenecking and decreased performance if not designed and configured correctly

Advantages of mobile computing for cloud-based systems:

Greater mobility and accessibility, enabling users to access cloud services from anywhere

Cost-effective, as mobile devices can be used as endpoints to access cloud services

Greater efficiency and productivity, as users can access cloud services on-the-go

Disadvantages of mobile computing for cloud-based systems:

Security risks, as mobile devices are more vulnerable to theft, loss, and hacking

Limited processing power and storage capacity, which can limit the functionality and performance of cloud-based applications

Inconsistent network connectivity, which can result in poor user experience and decreased productivity

Key challenges to ensure the effectiveness of both cluster and mobile computing for cloud-based systems include:

Security: Ensuring the security of data and applications is critical for both cluster and mobile computing.

Integration: Ensuring that the cluster or mobile system is integrated with the cloud infrastructure effectively to enable seamless resource allocation and usage.

Maintenance: Both cluster and mobile systems require regular maintenance and updates to ensure optimal performance.

User experience: Ensuring a positive user experience is important for both cluster and mobile systems, as poor user experience can result in decreased productivity and user adoption.

SECTION-C

4. (a) Contrast the concept of virtual machine migration, and discuss how it can be used to improve the availability and reliability of cloud-based systems.

Virtual machine migration is the process of moving a running virtual machine from one physical server to another without disrupting its operation. This improves the availability and reliability of cloud-based systems by enabling maintenance or upgrades on individual servers, balancing server load, and minimizing the impact of hardware failures. Overall, virtual machine migration is an important tool for ensuring that cloud-based services remain responsive and reliable.

(b) Compare and contrast different types of hypervisors with examples and their role in cloud computing. [4]

There are two main types of hypervisors:

Type 1 hypervisors: These hypervisors run directly on the host's hardware, also known as bare-metal hypervisors. They provide better performance and security than type 2 hypervisors. Examples of type 1 hypervisors include VMware ESXi, Microsoft Hyper-V, and Citrix XenServer.

Type 2 hypervisors: These hypervisors run on top of an operating system and are sometimes called hosted hypervisors. They provide less performance and security than type 1 hypervisors. Examples of type 2 hypervisors include Oracle VirtualBox, VMware Workstation, and Parallels Desktop.

5. (a) What is virtualization? Describe para and full virtualization architectures. Compare and contrast between both. How does virtualization enable cloud- based systems to be more flexible and scalable?

Virtualization is the process of creating a virtual version of a resource such as a server, operating system, storage device, or network. This allows multiple virtual instances to run on a single physical resource, improving resource utilization and providing greater flexibility and scalability.

There are two main types of virtualization architectures: para-virtualization and full virtualization.

Para-virtualization allows multiple virtual instances to run on a single physical resource by sharing the host's kernel with the virtual machines. This requires that the operating system running on the virtual machine be modified to run in a para-virtualized environment, which can limit the choice of operating systems that can be used. Examples of para-virtualization hypervisors include Xen and KVM.

Full virtualization, on the other hand, uses a hypervisor to provide virtual hardware to the virtual machines, allowing them to run unmodified operating systems. This provides greater flexibility in the choice of operating systems, but can result in lower performance due to the overhead of the hypervisor. Examples of full virtualization hypervisors include VMware ESXi, Microsoft Hyper-V, and Oracle VirtualBox.

(b) Compare and contrast the features and capabilities of AWS, Google Cloud P1atform (GCP), and Microsoft Azure, including their strengths and weaknesses in different application scenarios.

Features	Amazon	Microsoft Azure	Google Cloud
Age	11 years old	5 years old	6 years old
Pricing	Per second pricing with a 60-second minimum	Per-minute basis	Per-minute basis
Compute	EC2 (Elastic Compute Cloud) provides all the computing administration. The program oversees virtual machines, which can either be designed by the owner or have pre-configured settings for convenience	With Microsoft Azure, you can create virtual machines and scale sets for virtual machines.	As part of GCP (Google Cloud Platform), GCE (Google Compute Engine) does a similar function.
Storage	AWS provides apportioned, transient (brief) stockpiling. As soon as an instance begins, it is demolished at the end of the case.	Azure uses ID drives (transient capacity), and Page Blobs VM-based volumes are stored in Block Storage (Microsoft's choice). Object Storage uses Square Blobs and Files.	Comparatively, Google's Cloud Platform offers both brief stockpiling and constant circles. For Object stockpiling, GCP has Google Cloud Storage.

6. (a) Analyze the importance of load balancing and horizontal & vertical scaling in resource management. What are the key challenges associated with these techniques, and how can these be overcome?

Load balancing and horizontal and vertical scaling are essential techniques for managing resources in cloud-based systems.

Load balancing involves distributing incoming network traffic across multiple servers to ensure that no single server is overwhelmed with traffic. This helps to improve the performance, availability, and scalability of cloud-based applications and services.

Horizontal scaling involves adding more servers to a cloud-based system to increase its capacity and performance. This approach can help to handle increased traffic and workload demands but can also increase costs and introduce complexity in managing and maintaining a larger number of servers.

Vertical scaling involves increasing the capacity and performance of individual servers by adding more resources, such as CPU, memory, and storage. This approach can be more cost-effective and simpler to manage but can also be limited by the physical constraints of the hardware.

The key challenges associated with load balancing and scaling include managing the increasing complexity of the system, ensuring data consistency and availability, and maintaining security and compliance. These challenges can be overcome through the use of automation and orchestration tools, effective monitoring and management, and the implementation of appropriate security measures.

(b) Analyze the scheduling issues in cloud computing, and explain the different types of job and task scheduling. How can schedu ling be used to improve resource utilization in the cloud?

Scheduling is an important aspect of cloud computing, as it plays a critical role in improving resource utilization and performance. There are various scheduling issues in cloud computing, such as task allocation, load balancing, and resource allocation. These issues can be addressed through the use of efficient scheduling algorithms and techniques.

Job scheduling involves the allocation of resources to execute a particular task or job. It involves selecting an appropriate resource that meets the task's requirements and optimizing the allocation process to maximize the utilization of available resources. Task scheduling is a finer-grained process that involves scheduling individual tasks within a job or workflow.

There are various types of job and task scheduling, such as batch scheduling, interactive scheduling, and real-time scheduling. Batch scheduling is used for executing large sets of tasks that require minimal user interaction. Interactive scheduling is used for tasks that require user interaction and can be executed in an interactive manner. Real-time scheduling is used for tasks that have strict time constraints and require immediate execution.

SECTION-D

7. (a) Investigate the challenges and opportunities associated with cloud co1nputing in the context of mobile devices and wireless sensor nentworks.

Cloud computing has become an important technology in recent years, and its adoption has been increasing rapidly. With the increasing use of mobile devices and wireless sensor networks (WSNs), cloud computing has become an attractive solution for handling the large amounts of data generated by these devices.

However, there are several challenges associated with cloud computing in the context of mobile devices and WSNs. One of the main challenges is the limited resources of mobile devices and WSNs, which can affect the performance and reliability of cloud-based services. The use of cloud computing also raises security and privacy concerns, as sensitive data is often stored and processed outside of the user's device.

(b) Summarize the challenges and issues associated with cloud security and privacy, and describe the n1easures that can be taken to mitigate these risks.

Cloud security and privacy are major concerns for organizations and individuals who use cloud services. One of the main challenges is the lack of control over data and applications that are hosted in the cloud. This can make it difficult to ensure the confidentiality, integrity, and availability of data.

Other challenges include the risk of data breaches, data loss, and unauthorized access to data. The shared infrastructure and multi-tenant environment of cloud computing can also create vulnerabilities that can be exploited by attackers.

8. (a) Analyze the benefits and challenges associated in cloud computing applications in different domains.

Cloud computing offers benefits such as cost savings, scalability, flexibility, reliability, and speed. However, it also presents challenges such as security and privacy concerns, compliance, performance issues, vendor lock-in, and data sovereignty. It is important for organizations to carefully consider these factors when deciding to adopt cloud computing solutions.

Illustrate the concept of wireless sensor networks. Analyze How they can be integrated with cloud computing and discuss the benefits.

Wireless sensor networks (WSNs) are networks of spatially distributed autonomous devices that use sensors to monitor physical or environmental conditions. These devices can be used in a wide range of applications, such as environmental monitoring, traffic control, and industrial automation.

Integration of WSNs with cloud computing can enable more efficient and scalable data processing and analysis. The cloud can provide the necessary storage and processing power for the large amounts of data generated by WSNs, as well as advanced analytics and machine learning capabilities to derive insights and predictions from the data.