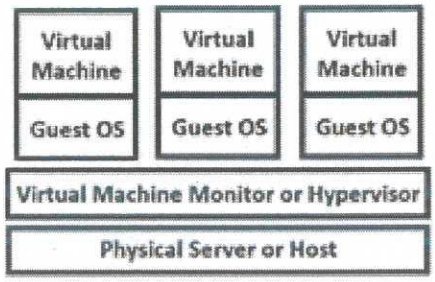
SCHEME OF VALUATION
(Scoring Indicators)

Revision: 2021

Course Name: Virtualization Technology and Cloud Computing

Course Code: 5133A **QID:2109230293**

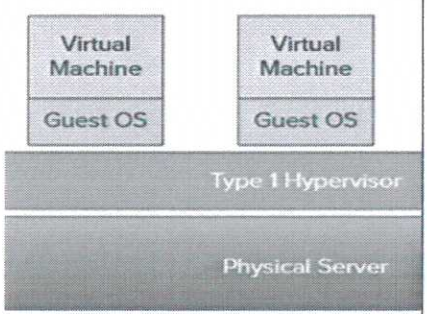
Question No	Scoring Indicator	Split up Score	Total
I	**PART A**		**9**
1	Virtual Machine Monitor	1	1
2	VMware, Virtual box, Hyper-V, Xen, etc	.5x2	1
3	Hypervisor, Virtual Switch, Software-Defined Networking (SDN) Controller, Overlay Networks, Tunnelling Protocols, VNIC	.5x2	1
4	Resource Overhead, Compatibility Issues, Performance Impact, Limited Access to Hardware, Network Dependencies, Licensing and Legal Constraints, Management Complexity,	.5*2	1
5	On-demand self-service, Resource pooling, Scalability and rapid elasticity, Measured service, Resiliency and availability, Security, Broad network access.	.5*2	1
6	Front End, Back End	.5*2	1
7	Infrastructure as a Service (IaaS)	1	1
8	Software-as-a-Service (SaaS) Platform-as-a-Service (PaaS) , Infrastructure-as-a-Service (IaaS)	.5*2	1
9	Scalability, Flexibility, Resource Optimization, Self-Service:	.5*2	1
II	**PART B**		**24**
1	**Virtualization** is a technology that allows multiple operating systems (OS) or applications to run on a single physical machine, sharing its resources in a way that each appears to be running on its dedicated hardware. It abstracts the hardware layer and creates a virtualized environment, where software, known as a hypervisor or Virtual Machine Monitor (VMM), manages the distribution of resources to the virtual instances. 	1 Fig. 2	3

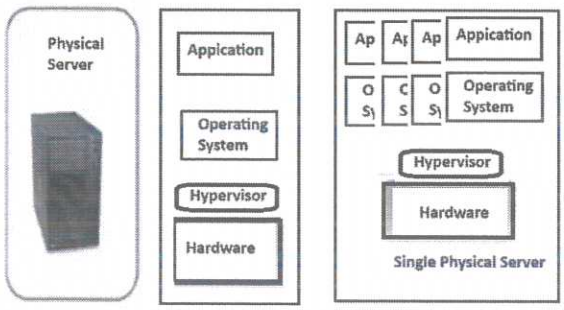
2	**Application virtualization** is a technology that allows applications to be encapsulated and run in isolated environments, separate from the underlying operating system and other applications. Tools used for Application Virtualization **Microsoft App-V (Microsoft Application Virtualization):** Microsoft App-V is a widely used application virtualization solution. It allows applications to be packaged, isolated from the underlying system, and delivered to end-user devices. **VMware:** VMware is a tool that packages applications into portable executable files that can run on various Windows systems without the need for installation. VMware supports both virtualized and non-virtualized environments and can help reduce application conflicts **Citrix Virtual Apps and Desktops (formerly XenApp and Xen Desktop):** Citrix offers a suite of virtualization solutions, including Virtual Apps, which delivers applications to remote devices, and Virtual Desktops, which delivers entire desktop environments.	1*3	3
3	VM (Virtual Machine) Migration Services refer to the process of moving virtual machines from one physical host or hypervisor environment to another It ensures minimal downtime and disruption to the applications and services running on those virtual machines. **VM migration can be performed for various reasons** Hardware maintenance, Load balancing, Data center consolidation, Upgrading infrastructure, Disaster recovery. There are different methods and technologies for VM migration, each with its own benefits and use cases: Cold Migration, Live Migration, Warm Migration, Storage Migration, Cloud Migration:	1.5 1.5	
4	Virtual LAN (VLAN) is a technology used in network virtualization to partition a physical network into multiple logical segments, allowing you to create isolated networks within a single physical infrastructure. VLANs are primarily used to, enhance network security, improve network management, optimize bandwidth usage **VLANs offer several features and benefits, including:** **Improved network security:** VLANs can be used to separate network traffic and limit access to specific network resources.	1.5 1.5	3

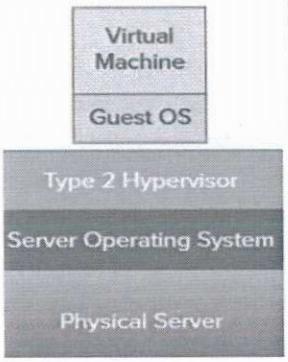
	Better network performance: By segregating network traffic into smaller logical networks, VLANs can reduce the amount of broadcast traffic and improve network performance. **Simplified network management:** VLANs allow network administrators to group devices together logically, rather than physically, which can simplify network management tasks such as configuration, troubleshooting, and maintenance.		
5	**Remote Desktop Services (RDS)** Desktop virtualization is a technology that separates the desktop environment and associated application software from the physical client device used to access it. This separation allows users to access their desktops from various devices while centralizing management and security. Two common forms of desktop virtualization are Remote Desktop Services (RDS) and Virtual Desktop Infrastructure (VDI). Remote Desktop Services (RDS) RDS, formerly known as Terminal Services, is a Microsoft technology that enables users to access Windows-based applications and desktops remotely. **Features** Session-Based Virtualization: Multiple users share a single server operating system. **RemoteApp:** Allows users to run a specific application remotely, rather than the entire desktop. **Load Balancing:** Distributes user sessions across multiple servers for better performance and resource utilization. **Remote Desktop Gateway:** Enables secure remote access to RDS sessions over the internet.	1.5 1.5	3
6	**Cloud infrastructure** refers to a virtual infrastructure that is delivered or accessed via a network or the internet Cloud infrastructure is typically composed of several key components that work together to deliver computing services over the internet. These components collectively provide the foundation for the deployment, management, and scaling of cloud-based applications. **Accessibility.** It is the major responsibility of every central origin that data is accessible to users. **Functioning.** Optimal functioning should be offered by the data center **Safety.** Data must be protected from illegal and malevolent users. **Manageability :** Corporation try to reduce IT expenses on the data center and increase the consumption of prevailing resources	1 .5*4	3

	Compute Resources. Compute resources refer to the processing power, virtual machines, and computing instances that run applications and services in the cloud. **Storage Resources.** Storage resources encompass the data storage solutions available in the cloud. **Network Resources.** Network resources in cloud infrastructure include the components that enable communication between different elements of the cloud environment. **Management and Monitoring Tools.** Management and monitoring tools are essential for controlling and overseeing cloud infrastructure components.		
7	**Platform as a Service (PaaS)** is a cloud computing service model that provides a platform allowing customers to develop, run, and manage applications without dealing with the complexity of building and maintaining the underlying infrastructure. PaaS typically includes development tools, runtime environments, databases, and other resources that facilitate application development and deployment. **Microsoft Azure App Service:** Azure App Service is a fully managed platform for building, deploying, and scaling web apps. It supports multiple programming languages and frameworks, including .NET, Java, Node.js, Python, and more. **Key Features**: Provides features such as automatic scaling, continuous integration, and integration with Azure services. **Google App Engine:** Google App Engine is a fully managed serverless platform for building and deploying applications at scale. It supports multiple programming languages, including Python, Java, Go, and Node.js. **Key Features:** Automatically scales applications based on demand, supports multiple runtime environments, and offers built-in services like databases and storage.	1 1 1	3
8	**Community cloud** is a cloud infrastructure that allows systems and services to be accessible by a group of several organizations to share the information. It is owned, managed, and operated by one or more organizations in the community, a third party, or a combination of them.  **Key features of a community cloud include** Shared Infrastructure, Common Concerns, Collaboration, Cost Sharing, Isolation	1.5 Fig 1.5	3

9	Cloud backup refers to the process of storing data, applications, or entire systems in a remote server or data center using the internet. Instead of relying on traditional local storage devices like external hard drives or tapes, cloud backup leverages the infrastructure of cloud service providers. Here's a breakdown of the key elements and **benefits of cloud backup.** Remote Storage, Automatic and Scheduled Backups Scalability, Accessibility, Data Encryption, Redundancy and Reliability, Cost-Efficiency, Versioning and Point-in-Time Recovery, Disaster Recovery, Compliance and Security Standards	1 2	3
10	Cloud storage refers to the practice of storing and managing digital data on remote servers accessed through the internet. Instead of relying on local storage devices like hard drives or physical servers, users can store and retrieve their data from anywhere with an internet connection. This technology has become increasingly popular due to its convenience, scalability, and cost-effectiveness. key aspects of cloud storage: Accessibility, Scalability, Cost Efficiency, Collaboration Examples of cloud storage services include Google Drive, Dropbox, Microsoft OneDrive, and Amazon S3.	1 2	3
III	**PART C**		**42**
1	Virtualization is a technology that allows multiple operating systems (OS) or applications to run on a single physical machine, sharing its resources in a way that each appears to be running on its dedicated hardware. It abstracts the hardware layer and creates a virtualized environment, where software, known as a hypervisor or Virtual Machine Monitor (VMM), manages the distribution of resources to the virtual instances. **Resource Utilization:** Virtualization enables better utilization of hardware resources. By running multiple virtual machines on a single physical server, organizations can maximize the use of CPU, memory, and storage, reducing the need for additional physical hardware. **Cost Savings:** Virtualization can lead to significant cost savings. It allows for server consolidation, reducing the number of physical servers needed. This, in turn, lowers costs associated with hardware purchases, maintenance, and energy consumption. **Scalability:** Virtualization provides a scalable solution for IT environments. New virtual machines can be quickly created and deployed, and existing VMs can be easily migrated between	7*1	7

	physical servers. This flexibility is crucial for adapting to changing workloads and business demands. **Isolation and Security:** Virtualization provides isolation between virtual machines, enhancing security. If one VM is compromised or experiences an issue, it does not impact other VMs on the same host. This isolation is crucial for maintaining the integrity of different applications and operating systems. **Flexibility and Agility:** Virtualization allows for the creation of virtual environments that can mimic various hardware configurations. This flexibility is valuable for software development, testing, and running diverse workloads on the same infrastructure. **Disaster Recovery:** Virtualization simplifies disaster recovery efforts. VM snapshots can be taken to capture the state of a virtual machine at a specific point in time, allowing for quick recovery in the event of hardware failures, data corruption, or other disasters. **Energy Efficiency:** Server consolidation through virtualization leads to improved energy efficiency. By reducing the number of physical servers, organizations can lower their overall energy consumption, contributing to sustainability goals and reducing environmental impact. **Legacy System Support:** Virtualization enables the running of legacy applications on modern hardware. This is especially important for businesses that rely on older software that may not be compatible with newer hardware platforms.		
2	A hypervisor, also known as a virtual machine monitor (VMM), is a software or firmware component that enables the virtualization of computer hardware, allowing multiple virtual machines (VMs) to run on a single physical machine. The hypervisor is a layer of software that resides below the virtual machines and above the hardware. The hypervisor manages the interactions between each virtual machine and the hardware that the guests all share There are two main types of hypervisors: Type 1 and Type 2 **<u>Type 1 virtualization</u>** is a software that runs directly on the physical hardware of a computer or server. It also known as a bare-metal hypervisor. It is called "bare-metal" because it operates directly on the underlying hardware without the need for an underlying host operating system. Because there is no intervening layer between the hypervisor and the physical hardware. 	2 Fig. 2 3	

	Key characteristics of a Type 1 hypervisor **Direct Hardware Access:** Type 1 hypervisors interact directly with the physical hardware of the host system **Efficiency**. By eliminating the need for an additional operating system layer, Type 1 hypervisors are generally more efficient in terms of system resource usage. **Performance:** VMs managed by a Type 1 hypervisor typically exhibit higher performance levels compared to those running on Type 2 hypervisors. **Security:** The direct interaction with hardware makes Type 1 hypervisors potentially more secure than Type 2 hypervisors. **Server Virtualization:** Type 1 hypervisors are commonly used in server virtualization scenarios, where multiple virtual servers run on a single physical host		
3	**Server Virtualization:** This form of virtualization enables the partitioning of a physical server into multiple virtual machines (VMs). Each VM operates as an independent server with its own operating system, applications, and resources.  **Benefits of Server Virtualization:** Resource Consolidation, Cost Savings, Isolation and Security, Flexibility and Scalability: **Storage virtualization** combines physical storage devices into a single virtual storage unit. It simplifies management, improves data availability, and facilitates efficient storage allocation and utilization. There are two types **Block Virtualization** Block-level storage virtualization operates at the lowest level of storage access, dealing with individual storage blocks rather than files. **File Virtualization** This type of virtualization is commonly used in distributed file systems and cloud storage environments. Benefits of Storage Virtualization: Simplified Management, Improved Utilization Enhanced Flexibility, Non-disruptive Migration Reduced Downtime, Cost Efficiency	3 Fig(2) 2	

4	A hypervisor, also known as a virtual machine monitor (VMM), is a software or firmware component that enables the virtualization of computer hardware, allowing multiple virtual machines (VMs) to run on a single physical machine. The hypervisor is a layer of software that resides below the virtual machines and above the hardware. The hypervisor manages the interactions between each virtual machine and the hardware that the guests all share **Type 2 Hypervisors** A type 2 hypervisor is a software-based virtualization technology that runs on top of an existing operating system. The first x86 offerings were Type 2 because that was the quickest path to market. The actual operating system already handled all of the hardware resources and the hypervisor would leverage that capability. One benefit of this model is that it can support a large range of hardware because that is inherited from the operating system it uses. Type 2 hypervisors are easy to install and deploy because much of the hardware configuration work, such as networking and storage, has already been covered by the operating system. **Characteristics:** Hosted on a Host OS: Type 2 hypervisors are installed as software applications on a host operating system (OS), such as Windows, macOS, or Linux. **User-Friendly:** They are generally easier to set up and use compared to Type 1 hypervisors. Users can install and manage virtual machines through a graphical user interface (GUI). **Resource Sharing:** Since they run on top of a host OS, Type 2 hypervisors share resources such as memory, CPU, and storage with the host system. Ideal for Development and Testing: Type 2 hypervisors are often used for software development, testing, and other non-production environments where performance is not critical. **Compatibility:** They can be installed on a wide range of hardware, making them more versatile for use on desktops or laptops.	 2 Fig(2) 3	7
5	**Virtual Machine Clones** refer to exact or near-exact duplicates of existing virtual machines (VMs). Allowing you to replicate a VM's entire state, including its operating system, installed software, data, and configurations. You cannot convert back the cloned virtual machine. A clone of a virtual machine can be created when the virtual machine is powered on. Two types of VM clone.	3	

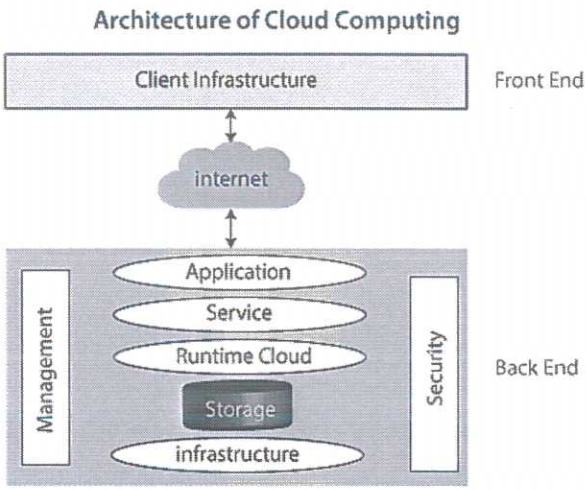
	Full Clone: A full clone is an independent, standalone copy of the original VM. It does not share any storage with the source VM and operates as a completely separate entity. **Linked Clone**: A linked clone is a copy of VM that shares virtual disk with the parent VM in an ongoing manner. This conserve disk space and allows multiple Vm to use the same software installation. Once that copy exists, the guest operating system only needs some customization in the form of unique system information, such as a system name and IP address, before it can be instantiated. **Templates.** We can convert a virtual machine in to a template. A template is a mold, a preconfigured, preloaded virtual machine that is used to stamp out copies of a commonly used server. Template is an image that typically include guest OS, application and specific virtual machine configuration. The difference between a template and a clone is that the clone is running and a template is not. In most environments, a template cannot run, and in order to make changes to it a template must first be converted back to a virtual machine. **Snapshots** is capturing of a VM's state at a particular point in time. A snapshot preserves the state of a VM, its data, and its hardware configuration. Once you snapshot a VM, changes that are made no longer go to the virtual machine. They go instead to a delta disk, sometimes called a child disk. Snapshots can be used to test a patch or an update where the outcome is unsure, and they provide an easy way to undo what was applied. Applying multiple snapshots to a VM is fine for a test environment but can cause large headaches and performance issues in a production system.	2 2	7
6	**Desktop virtualization**, also known as virtual desktop infrastructure (VDI). Desktop virtualization is a technology that allows multiple virtual desktop instances to run on a single physical machine. This approach offers several advantages for both individuals and organizations. 1.Centralized Management. With desktop virtualization, the desktop environments are hosted on centralized servers, making management and updates easier to handle. 2.Enhanced Security. Centralizing desktop environments on servers can enhance security. Data remains in the data center, reducing the risk of data loss through physical theft or hardware failure. 3.Simplified Deployment. Setting up new desktop environments becomes more efficient as administrators can create a master image that can be replicated for multiple users.	1x4	7

	4.Hardware Resource Optimization. Desktop virtualization allows for resource pooling, where multiple virtual desktops share the resources of a single physical server. 5. Remote Access and Mobility. Users can access their virtual desktops from various devices and locations, as long as they have an internet connection. **Limitations of Desktop Virtualization** Complex Implementation, Performance and Latency: Hardware Requirements: , Network Dependency: Licensing Costs, Data Security Concerns: Compatibility Issues, User Experience Variability: Limited Offline Access, Initial Costs:	.5*6	
7	Cloud computing is a technology that enables the delivery of computing services over the internet, allowing users to access and use resources such as servers, storage, databases, networking, software, and analytics. **Cost Efficiency:** Cloud computing eliminates the need for organizations to invest in and maintain expensive on-premises hardware. Users pay for the resources they consume, enabling cost savings and efficient resource allocation. **Cost Efficiency:** Cloud computing eliminates the need for organizations to invest in and maintain expensive on-premises hardware. Users pay for the resources they consume, enabling cost savings and efficient resource allocation. **Scalability:** Cloud services can be scaled up or down based on demand. This flexibility allows organizations to easily adapt to changing workloads and ensures that they only pay for the resources they actually use. **Accessibility:** Users can access cloud services and data from anywhere with an internet connection. This promotes remote work, collaboration, and accessibility, enhancing productivity and flexibility. **Automatic Updates:** Cloud service providers handle the maintenance, updates, and patching of software and infrastructure. This ensures that users always have access to the latest features and security updates without the need for manual intervention. **Reliability and Redundancy:** Cloud providers often have multiple data centers in different geographic locations, offering redundancy and high availability. This helps ensure continuous service availability even in the case of hardware failures or other issues. **Resource Pooling:** Cloud computing allows multiple users to share a pool of computing resources. This multi-tenancy model promotes resource efficiency and optimizes resource utilization. **Limitations of Cloud Computing:**	1 3*1	7

	Despite high availability measures, cloud services may experience downtime. This can impact users' access to data and applications, and organizations should consider the reliability of their chosen cloud providers. **Security and Privacy:** Security concerns, including data breaches and unauthorized access, are considerations when moving data to the cloud. Organizations must carefully manage access controls, encryption, and compliance with data protection regulations. **Limited Customization:** Cloud services are often standardized, and customization options may be limited. This can be a challenge for organizations with specific or unique requirements that may not align with the offerings of a cloud provider. **Dependency on Internet Connectivity:** Cloud services require a stable internet connection. If the internet is slow or unavailable, users may experience disruptions in accessing cloud resources. **Data Transfer Costs:** While storing data in the cloud is often cost-effective, data transfer costs (uploading and downloading data) can add up, particularly for large datasets. **Vendor Lock-In:** Adopting certain cloud services may lead to vendor lock-in, making it challenging to switch to another provider without significant effort and cost. Organizations should carefully consider their options and plan for potential migrations	3*1	
8	**Amazon Web Services (AWS):** AWS is one of the largest and most widely used cloud service providers globally, offering a vast array of infrastructure and platform services. It provides scalable and flexible computing power, storage, databases, machine learning, analytics, and more. Amazon S3 (Simple Storage Service), EC2 (Elastic Compute Cloud), RDS (Relational Database Service), Lambda (serverless computing), and Amazon AI services. **Microsoft Azure**: Microsoft Azure is a comprehensive cloud platform that provides a variety of services, including computing power, storage, databases, AI and machine learning, IoT, and more. It integrates well with Microsoft's other products, making it a popular choice for organizations already using Microsoft technologies. Azure Virtual Machines, Azure Blob Storage, Azure SQL Database, Azure Functions, and Azure Cognitive Services. **Google Cloud Platform (GCP):** Google Cloud Platform is known for its data analytics and machine learning capabilities, as well as a suite of infrastructure services. GCP offers services for computing, storage, databases, machine learning, and big data analytics.	1.5*4	7

	Compute Engine, Cloud Storage, Cloud SQL, BigQuery (data analytics), and TensorFlow (machine learning). **IBM Cloud:** IBM Cloud provides a wide range of cloud services, including IaaS, PaaS, and SaaS. It is recognized for its enterprise-grade solutions and offers services for AI, blockchain, IoT, and more. IBM Cloud often caters to businesses with specific regulatory and compliance requirements. IBM Virtual Servers, IBM Cloud Object Storage, Db2 on Cloud (database service), Watson AI services, and IBM Blockchain.		
9	A cloud data center consists of computer systems and related components, For example, networking. storage, etc. which are kept at one place. The data center is a highly sensitive area with very strict environmental control, and entry is restricted for unauthorized users. Safety measures are also designed in a way that protect any type of physical hazard in the data center. The power supply in the data center is also not easy to install, as it requires a high level of expertise. -In cloud data center, various IT and non-IT equipment are kept at one place; this needs a proper power backup facility in case of a power cut or any other problem. **Architectural Influences:** **High-performance Computing** Due to high-functioning computers and the Internet. fast development has taken place in computing. **Utility and Enterprise Grid Computing** It is a kind of distributed and parallel system which facilitates the selection and sharing of geographically spread resources. **Autonomic Computing** Autonomic computing is a computing model with self-managing capabilities without the need of any external intervention. It works like a human body's nervous system. **Service Consolidation** Sharing and consolidation of services built up as a profitable tie-up to supply such services over a network, as required. is known as service consolidation. **Network Infrastructure:** High-performance, low-latency networking is crucial for interconnecting servers and delivering services. **Web Services** A web service is defined by the World Web Consortium as a software system designed to support interoperable machine-to-machine interactions over a network **2. Technological Influences:** **Universal Connectivity**	1 2 2	7

	Cloud computing needs global access and connectivity to the Internet in order to be successful. It assists associations and customers by providing connectivity anywhere among consumers, government companies, and enterprises via ways like peer-to-peer exchanges, Web 2.0, and web services. **Compute Resources:** Employing powerful processors and GPUs to handle diverse workloads. Leveraging serverless computing for event-driven applications. **Security Measures:** Implementing robust security protocols, encryption, and access controls. Using hardware security modules (HSMs) for key management. Regularly updating and patching software to address vulnerabilities. **Open-source Software** **Open**-source software in cloud computing may draw distinct views. **Virtualization** Conventionally, virtualization of server was observed as a price-saving process. **3. Operational Influences:** **Consolidation** Consolidation refers to the fact that a physical resource or server can be shared by many users and also made accessible by a variety of applications at the same time. **Storage consolidation** is a system of centralizing data storage between multiple servers. It is helpful to facilitate data backup at various levels and minimizes the time required for accessing and storing data. **Server consolidation** can be done in several ways. One of the options is to use blade servers, which consists of modular circuits within a card. Server virtualization makes a single physical server available to others by creating virtual instances of the server **Outsourcing** Cloud computing offers flexible billing alternatives and price savings via outsourcing. The huge investments of cloud suppliers in emergent high-capacity infrastructures eliminate the requirement for consumers to make huge additional or initial open expenditures for internal IT systems. **Automation** The capability to handle resources automatically and make virtual instance available by transferring virtual applications dynamically is a **Cost Management:** Employing cost-effective solutions and optimizing resource usage. Utilizing pay-as-you-go models to align costs with actual usage.	2	

	Human Resource Training: Ensuring staff is well-trained on cloud technologies and security practices. Fostering a culture of continuous learning and adaptation. **Disaster Recovery Planning:** Developing comprehensive disaster recovery plans to minimize downtime. Regularly testing and updating recovery procedures.		
10	Cloud computing technology is used by both small and large organizations to store information in the cloud and access it from anywhere and anytime using an internet connection. Cloud computing architecture is a combination of service-oriented architecture and event-driven architecture. The cloud computing architecture is divided into the following two parts: **Front End, Back End** **Front End** The front end is used by the client. It contains client-side interfaces and applications that are required to access the cloud computing platforms. The front end includes web servers (including Chrome, Firefox, internet explorer, etc.), thin & fat clients, tablets, and mobile devices.  **Back End** The back end is used by the service provider. It manages all the resources that are required to provide cloud computing services. It includes a huge amount of data storage, security mechanism, virtual machines, deploying models, servers, traffic control mechanisms, etc. **Components of Cloud Computing Architecture** 1. **Client Infrastructure.** Client Infrastructure is a Front-end component. It provides GUI (Graphical User Interface) to interact with the cloud. 2. **Application.** The application may be any software or platform that a client wants to access. **3. Service.** A Cloud Services manages that which type of service you access according to the client's requirement. Cloud computing offers the following three type of services: **IaaS, PaaS., SaaS.** **4. Runtime Cloud**	1 3*2	7

	Runtime Cloud provides **the** execution and runtime environment to the virtual machines. **5. Storage.** Storage is one of the most important components of cloud computing. It provides a huge amount of storage capacity in the cloud to store and manage data. 6. **Infrastructure.** It provides services on the host level, application level, and network level. Cloud infrastructure includes hardware and software components such as servers, storage, network devices, virtualization software, and other storage resources that are needed to support the cloud computing model. **7. Management.** Management is used to manage components such as application, service, runtime cloud, storage, infrastructure, and other security issues in the backend and establish coordination between them. **8 Security.** Security is an in-built back-end component of cloud computing. It implements a security mechanism in the back end. **9. Internet.** The Internet is medium through which front end and back end can interact and communicate with each other.		
11	The cloud deployment model works as your virtual computing environment, with a choice of deployment model depending on how much data you want to store and who has access to the infrastructure. Different Types of Cloud Computing Deployment Models **Private Cloud:** A private cloud is a computing environment that is set up for the exclusive use of a single organization. In a private cloud, the computing resources—such as servers, storage, and networking infrastructure—are dedicated to and operated solely by that organization. Unlike public clouds, which are shared by multiple organizations, private clouds offer a higher level of control, customization, and security. **Example Providers:** • **VMware Cloud Foundation:** Enables the creation of a private cloud infrastructure using VMware's virtualization technologies. • **Microsoft Azure Stack:** Allows organizations to run Azure services on-premises for a private cloud environment. • **OpenStack:** An open-source cloud platform that organizations can use to build private clouds. **Public Cloud**: A public cloud is a type of cloud computing deployment model where computing resources, such as virtual machines, storage, and applications, are provided as services over the internet by third-party service providers. These resources are made available to the general public or a large industry group and are hosted in data centers that may be geographically distributed. **Example Providers:**	1 4*1.5	7

	Amazon Web Services (AWS): Offers a wide range of services, including computing power, storage, and databases. **Microsoft Azure:** Provides cloud services for computing, analytics, storage, and networking. **Community Cloud:** A community cloud is a type of cloud computing deployment model where infrastructure is shared by several organizations that have common computing concerns, such as regulatory compliance and industry-specific requirements. Unlike the public cloud, where services are made available to the general public, and the private cloud, which is dedicated to a single organization, a community cloud is shared by a specific community of users with shared goals and interests. patient data securely while complying with healthcare regulations. **Hybrid Cloud:** It combines elements of both public and private clouds, allowing data and applications to be shared between them. **Example Providers:** **AWS Outposts:** Extends AWS infrastructure to on-premises locations for a consistent hybrid experience. **Azure Hybrid Cloud:** Microsoft's solution for integrating on-premises data centers with Azure services. **Google Anthos:** Enables the management of applications across on-premises, Google Cloud, and other clouds.		
12	**On-demand computing** in cloud computing refers to the ability to quickly and easily access computing resources and services whenever they are needed, without requiring manual intervention or long-term commitments. It allows users to provision and utilize computing resources on a pay-as-you-go basis, aligning costs with actual usage. With on-demand computing, users can request and obtain resources from the cloud provider in a self-service manner, usually through web-based interfaces or APIs. The cloud provider dynamically allocates and provisions the requested resources, such as virtual machines, storage, and networking, based on the user's specifications. Key aspects of on-demand computing include: 1. **Resource Provisioning:** Users can request computing resources on-demand, without needing to own or maintain the underlying physical infrastructure. The cloud provider automatically allocates and provisions the requested resources based on availability and the user's requirements. 2. **Instant Availability**: On-demand computing enables quick access to computing resources. Users can obtain the resources within minutes or even seconds, allowing them to rapidly scale up or down based on their needs. This agility is especially beneficial during peak periods or sudden spikes in demand. 3. **Flexibility and Scalability**: On-demand computing allows users to easily scale their resources up or down as required. They can increase resource capacity during periods of high demand and	2 5x1	7

	decrease it when demand subsides. This scalability ensures optimal resource utilization and cost-efficiency. 4. **Pay-as-you-go Model**: With on-demand computing, users pay only for the resources they consume. Costs are typically based on usage metrics such as the number of virtual machine hours, storage capacity, network bandwidth, or data transfer. This pay-as-you-go model eliminates the need for upfront investments and provides cost transparency and control. 5. **Self-Service Provisioning:** On-demand computing emphasizes self-service, empowering users to provision resources autonomously. Users can select the desired resource configurations, specify the quantity, and initiate the provisioning process themselves. This self-service capability reduces administrative overhead and enables faster deployment of applications and services. 6. **Dynamic Allocation**: On-demand computing relies on the cloud provider's ability to dynamically allocate and de-allocate resources based on user demand. This dynamic allocation ensures efficient resource utilization across multiple users and allows the provider to optimize their infrastructure for maximum efficiency.		