- **What is Cloud Computing?**

Ans: Cloud computing is the delivery of on-demand computing resources, including servers, storage, databases, and software, over the internet. It enables users to access and use computing services without having to manage the underlying infrastructure.

- **Why Cloud Computing?**

Ans: Cloud computing offers numerous benefits over traditional on-premises computing, including scalability, flexibility, cost-effectiveness, and ease of use. It enables users to access and use computing resources from anywhere at any time, and it allows businesses to easily scale up or down their IT resources as needed.

- **Advantages and Disadvantages of Cloud Computing ?**

Ans: Advantages of cloud computing include scalability, flexibility, cost-effectiveness, and ease of use. Disadvantages include potential security and privacy risks, reliance on internet connectivity, and lack of control over the underlying infrastructure.

- **Essential Characteristics of Cloud Computing?**
  Ans: The National Institute of Standards and Technology (NIST) has defined five essential characteristics of cloud computing: on-demand self-service, broad network access, resource pooling, rapid elasticity, and measured service. These characteristics define the fundamental aspects of cloud computing that distinguish it from other computing models.

- **Three Service Models (PaaS, SaaS, IaaS)?**
  Ans: There are three primary service models in cloud computing: Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

IaaS provides users with access to virtualized computing resources, such as servers, storage, and networking.

PaaS provides a platform for users to develop, run, and manage applications without the need for infrastructure management.

SaaS provides access to software applications that are hosted and managed by a third-party provider.

- **Four Deployment Models:**
  - Private Cloud: Cloud infrastructure that is operated solely for an organization, either internally or externally.
  - Public Cloud: Cloud infrastructure that is operated by a third-party provider and made available to the general public.
  - Hybrid Cloud: A mix of public and private cloud deployment models that allow the sharing of data and applications between them.
  - Community Cloud: Cloud infrastructure that is shared by several organizations that have similar interests or requirements.
- **Overview of Public Cloud Service Providers:**

Public cloud service providers are companies that offer cloud computing services to businesses and individuals. Some of the major public cloud service providers include Amazon Web Services (AWS), Microsoft Azure, Google Cloud Platform (GCP), and IBM Cloud.

- **Exploring Deployment of Web Apps on Azure C**loud:
  This refers to the process of deploying web applications on the Azure Cloud platform, which is a public cloud service provided by Microsoft. It involves creating a virtual machine, configuring it, deploying the web application, and ensuring that it is running smoothly.

- **Define SLAs and SLOs and illustrate their importance in Cloud Computing:**
  Service Level Agreements (SLAs) and Service Level Objectives (SLOs) are contractual agreements between cloud service providers and their customers that define the quality of service the provider agrees to deliver. SLAs specify the level of service and uptime guarantees, while SLOs define the level of service that must be maintained. They are important in cloud computing because they provide customers with a way to measure the performance and reliability of cloud services, and they help providers to ensure that they are meeting their customers' expectations.

- **Virtualization technology:**

Virtualization is a technology that enables multiple operating systems or applications to run on a single physical server or hardware by creating virtual machines.

- **Cloud Computing and Virtualization:**

Cloud computing heavily relies on virtualization technology to provide services such as Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS).

- **Different CPU, memory, and I/O virtualization techniques:**

Different virtualization techniques are used to provide CPU, memory, and I/O resources to the virtual machines, such as full virtualization, para-virtualization, and OS-level virtualization.

- **Virtual Machine Monitor (VMM)/Hypervisors:**

Virtual Machine Monitor (VMM) or hypervisors are the software that enables virtualization by creating and managing virtual machines.

- **Virtualization Models (Type-I and Type-II hypervisors):**

There are two types of hypervisors - Type-I hypervisors or bare-metal hypervisors run directly on the host's hardware, whereas Type-II hypervisors run on the host's operating system.

- **Full Virtualization vs Para Virtualization:**

Full virtualization is a type of virtualization where the guest operating system runs unmodified on top of a virtual machine. In para virtualization, the guest operating system is modified to run on top of the virtual machine. This can improve performance but requires modifications to the guest operating system.

- **Device Virtualization (Pass-through, Hypervisor-Direct, and Split Device Driver):**

Device virtualization refers to the process of creating virtual devices that can be used by virtual machines. Pass-through device virtualization involves directly connecting a physical device to a virtual machine, while hypervisor-direct device virtualization involves the hypervisor acting as an

intermediary between the virtual machine and the physical device. Split device driver virtualization involves splitting the device driver into two parts, one running in the virtual machine and the other running on the physical machine.

- **Network and Storage Virtualization:**

Network and storage virtualization are techniques used to create virtual versions of physical resources. Network virtualization involves creating virtual networks that operate independently of physical network infrastructure, while storage virtualization involves creating virtual storage devices that can be accessed by virtual machines.

- **Software Defined Networks (SDN) and Software Defined Storage (SDS):**

Software-defined networks (SDN) and software-defined storage (SDS) are approaches to network and storage virtualization that use software to abstract and control the underlying hardware. SDN separates the control plane from the data plane, allowing administrators to centrally manage and configure network resources. SDS abstracts and virtualizes physical storage resources, allowing administrators to dynamically allocate and manage storage as needed.

CLO Questions:

Define and explain the fundamental ideas behind Cloud Computing, the evolution of the paradigm, its applicability; and benefits; Also understand how to use Cloud Services, deployment models, SLAs and SLOs?
Ans: Cloud computing is a computing paradigm that involves delivering on-demand computing resources, including servers, storage, applications, and services, over the internet. It allows users to access resources and services quickly, easily, and with minimal effort, eliminating the need for local infrastructure and reducing costs.
The evolution of cloud computing began with the emergence of the internet, which enabled users to access resources remotely. This led to the development of distributed computing, grid computing, cluster computing, utility computing, and software as a service (SaaS), which are all enabling technologies that paved the way for cloud computing.

Cloud computing is applicable to a wide range of industries and use cases, including e-commerce, gaming, big data analysis, and artificial intelligence. Its benefits include increased flexibility, scalability, cost savings, improved security, and reduced environmental impact.

To use cloud services, users can choose from three service models: Platform as a Service (PaaS), Infrastructure as a Service (IaaS), and Software as a Service (SaaS). There are also four deployment models to consider: private, public, hybrid, and community clouds.

Service Level Agreements (SLAs) and Service Level Objectives (SLOs) are important to ensure quality of service in cloud computing. SLAs are legal agreements between the provider and the user that outline the terms and conditions of the service. SLOs define the expected level of service quality, including availability, response time, and reliability.

In order to deploy web apps on a cloud platform, such as Microsoft Azure, users need to understand the deployment process, including setting up virtual machines, configuring databases, and integrating with other services.

Virtualization technology is a key component of cloud computing, which allows multiple virtual machines to run on a single physical machine, maximizing resource utilization and minimizing costs. Virtualization models include Type-I and Type-II hypervisors, and there are different CPU, memory, and I/O virtualization techniques that serve in offering software, computation, and storage services on the cloud. Network and storage virtualization, as well as software-defined networks and software-defined storage, are also important components of cloud computing.

Q2. Understand the importance of Virtualization and containerization technologies in cloud. Describe and implement open source private cloud platform using OpenStack. Also understand the working of different cloud storage services and distributed cloud programming models

Ans: Virtualization and containerization technologies play a crucial role in the cloud computing paradigm, as they enable efficient resource utilization and allocation, scalability, and isolation of applications and services. Virtualization allows multiple virtual machines to run on a single physical machine, while containerization provides a lightweight way to isolate and run applications. OpenStack is an open-source platform that provides a complete private cloud infrastructure, including compute, storage, and networking capabilities. It allows users to create and manage virtual machines, containers, and other resources in a flexible and scalable way. The architecture of OpenStack is modular, with different components working together to provide a complete cloud environment.

Cloud storage services allow users to store and access data in the cloud, providing scalability, reliability, and accessibility. Some popular cloud storage services include Amazon S3, Google Cloud Storage, and Microsoft Azure Storage.

Distributed cloud programming models, such as MapReduce and Hadoop, allow developers to process large amounts of data across a distributed network of machines. These models provide scalability, fault tolerance, and high availability, making them well-suited for big data applications.

To implement an open source private cloud platform using OpenStack, you can follow these general steps:

1. Choose a suitable hardware platform that meets the minimum requirements for OpenStack.
2. Install and configure the operating system (e.g. Ubuntu) and network settings.
3. Install and configure the OpenStack components, including Keystone, Glance, Nova, Neutron, Cinder, and Horizon.
4. Configure the network and storage resources, including virtual networks, routers, and storage backends.
5. Create virtual machines and containers, and deploy applications and services.
6. Monitor and manage the cloud infrastructure using tools such as Nagios, Zabbix, and OpenStack Dashboard.

In summary, understanding virtualization and containerization technologies, private cloud platforms like OpenStack, cloud storage services, and distributed cloud programming models are all important for building and managing cloud-based applications and services.