1.3) Cloud Service Model:
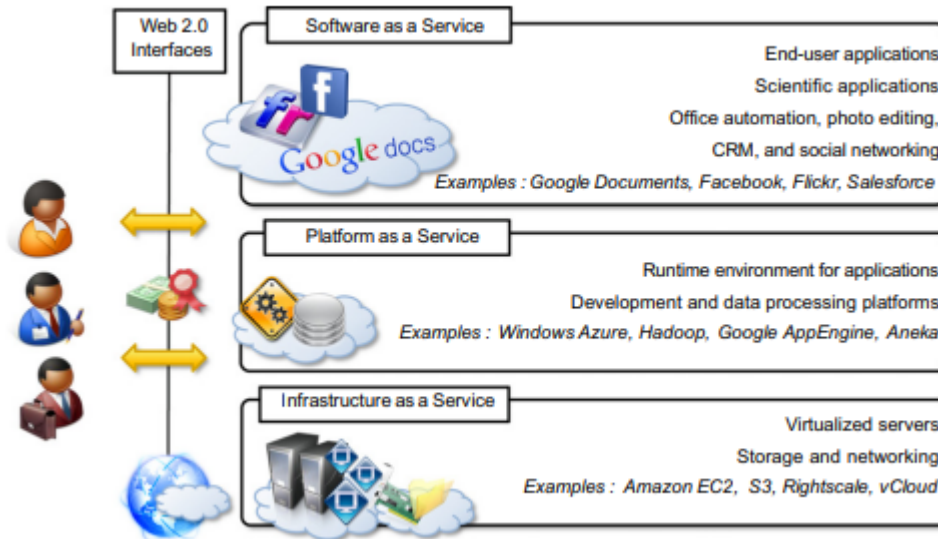
   a) List Cloud Service Models.

Ans.: Cloud Service Models:

1.   Infrastructure-as-a-Service (IaaS)
2.   Platform-as-a-Service (PaaS)
3.   Software-as-a-Service (SaaS)

  b) Describe Cloud Service Models.

Ans.:Cloud Service Models / The Cloud Computing Reference Model:

1.   A fundamental characteristic of cloud computing is the capability to deliver, on demand, a variety of IT services that are quite diverse from each other.
2.   This variety creates different perceptions of what cloud computing is among users. Despite this lack of uniformity, it is possible to classify cloud computing services offerings into three major categories: Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS), and Software-as-a-Service (SaaS).
3.   These categories are related to each other as described in Figure, which provides an organic view of cloud computing:

Figure.: Cloud Service Models / The Cloud Computing Reference Model

4.   We refer to this diagram as the Cloud Computing Reference Model, and we will use it throughout the book to explain the technologies and introduce the relevant research on this phenomenon. The model organizes the wide range of cloud computing services into a layered view that walks the computing stack from bottom to top.
5.   At the base of the stack, Infrastructure-as-a-Service solutions deliver infrastructure on demand in the form of virtual hardware, storage, and networking. Virtual hardware is utilized to provide compute on demand in the form of virtual machine instances. These are created at users' request on the provider's infrastructure, and users are given tools and interfaces to configure the software stack installed in the virtual machine. The pricing model is usually defined in terms of dollars per hour, where the hourly cost is influenced by the characteristics of the virtual hardware. Virtual storage is delivered in the form of raw disk space or object store. The former complements a virtual hardware offering that requires persistent storage. The latter is a more high-level abstraction for storing entities rather than files. Virtual networking identifies the collection of services that manage the networking among virtual instances and their connectivity to the Internet or private networks.
6.   Platform-as-a-Service solutions are the next step in the stack. They deliver scalable and elastic runtime environments on demand and host the execution of applications. These services are backed by a core middleware platform that is responsible for creating the abstract environment where applications are deployed and executed. It is the responsibility of the service provider to provide scalability and to manage

fault tolerance, while users are requested to focus on the logic of the application developed by leveraging the provider's APIs and libraries. This approach increases the level of abstraction at which cloud computing is leveraged but also constrains the user in a more controlled environment.

7. At the top of the stack, Software-as-a-Service solutions provide applications and services on demand. Most of the common functionalities of desktop applications—such as office automation, document management, photo editing, and customer relationship management (CRM) software—are replicated on the provider's infrastructure and made more scalable and accessible through a browser on demand. These applications are shared across multiple users whose interaction is isolated from the other users. The SaaS layer is also the area of social networking Websites, which leverage cloud-based infrastructures to sustain the load generated by their popularity.

8. Each layer provides a different service to users. IaaS solutions are sought by users who want to leverage cloud computing from building dynamically scalable computing systems requiring a specific software stack. IaaS services are therefore used to develop scalable Websites or for background processing. PaaS solutions provide scalable programming platforms for developing applications and are more appropriate when new systems have to be developed. SaaS solutions target mostly end users who want to benefit from the elastic scalability of the cloud without doing any software development, installation, configuration, and maintenance. This solution is appropriate when there are existing SaaS services that fit users needs (such as email, document management, CRM, etc.) and a minimum level of customization is needed.

c) Explain Iaas, PaaS, SaaS.
Ans.:

1. **Infrastructure-as-a-Service (IAAS)**
- IaaS allows the cloud provider to freely locate the infrastructure over the Internet in a cost-effective manner.
- IaaS allows the customer to access computing resources through administrative access to virtual machines.
- IaaS provides access to fundamental resources such as physical machines, virtual machines, virtual storage, bandwidth, IP addresses, monitoring services, firewalls, etc. to the customers on rent.
- The payment is based upon the amount of time the customer retains a resource.
- Also with administrative access to virtual machines, the customer can run any software, even an operating system.
- IAAS is generally used by network architects.
- Examples: Amazon Web Services (AWS), Rackspace, Cisco Metapod, Microsoft Azure, Google Compute Engine (GCE)

2. **Platform-as-a-Service (PAAS)**
- PAAS gives access to run time environment to deployment and development tools for application.
- PaaS has a feature of point-and-click tools that enables non-developers to create web applications.
- In this customers need not bother about the administration because it is the responsibility of the cloud service provider.
- Customer need not purchase expensive hardware, servers, power, and data storage.
- It is very easy to scale the resources up or down automatically, based on their demand.
- It is the responsibility of the cloud service provider to maintain software versions and patch installations.
- PAAS is generally used by developers.
- Examples: AWS Elastic Beanstalk, Windows Azure, Heroku, Force.com, Google App Engine, Apache Stratos, OpenShift, and Magento Commerce

3. **Software-as-a-Service (SaaS)**
- SaaS model allows to provide software applications as a service to the end-users.
- It refers to software that is deployed on a hosting service and is accessible via the Internet.
- The SaaS application deployment requires a little or no client-side software installation.
- Therefore, there is no requirement for complex software packages on the client-side, little or no risk of configuration at the client-side, and low distribution cost.

- The customer can have a single license for multiple computers running at different locations which reduces the licensing cost.
- Also, there is no requirement for license servers because the software runs in the provider's infrastructure.
- The cloud provider stores data centrally. However, cloud service providers may store data in a decentralized manner for the sake of redundancy and reliability.
- All platform responsibilities such as backups, system maintenance, security, hardware refresh, power management, etc. are performed by the cloud service provider. The customer does not need to bother about them.
- Multi-Tenant solutions allow multiple users to share a single instance of different resources in virtual isolation.
- Customers can customize their application without affecting the core functionality.
- SaaS provides us with an Application Programming Interface (API), which allows the developer to develop a customized application.
- SAAS is generally used by the end-user.
- Examples: Google Workspace, Dropbox, Salesforce, Cisco WebEx, Concur, GoToMeeting, Gmail, Slack, and Microsoft Office 365.