10. EMERGING TECHNOLOGIES
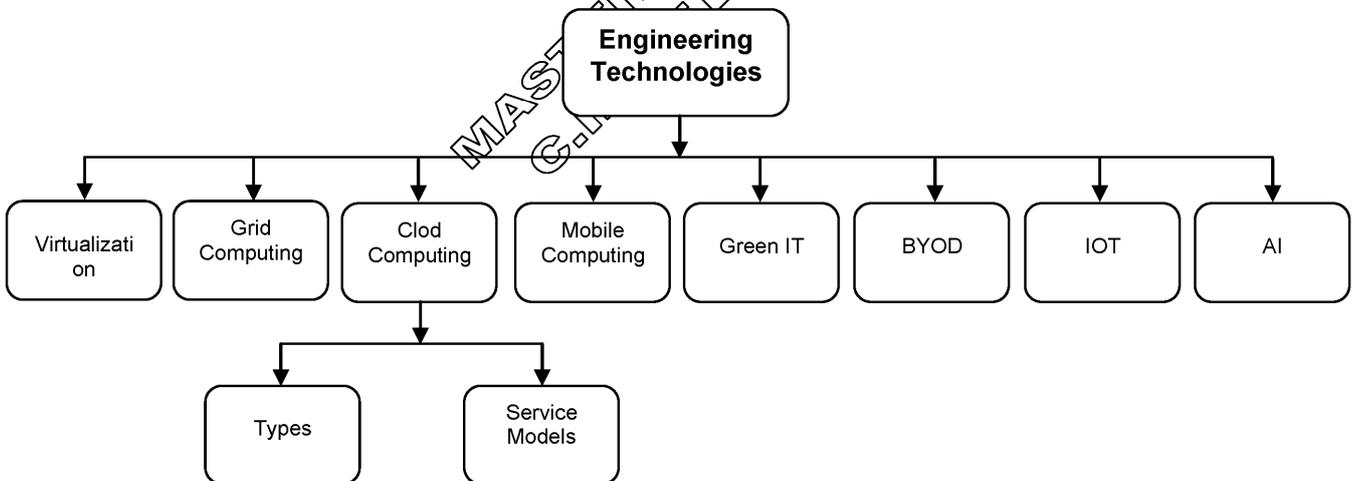
QUESTION WISE ANALYSIS OF PREVIOUS EXAMINATIONS

No.	M-14	N-14	M-15	N-15	M-16	N-16	M-17	N-17	M-18	N-18	M-19	N-19	N-20
THEORY QUESTIONS FOR CLASSROOM DISCUSSION													
6.	-	-	-	-	-	-	-	-	-	-	-	-	4
26.	-	-	-	-	-	-	-	-	2	-	-	-	-
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CHAPTER OVERVIEW

SECTION	TOPIC	STARTING PAGE NO.
1.	THEORY FOR CLASSROOM DISCUSSION	10.1
2.	QUESTIONS FOR ACADEMIC INTEREST FOR STUDENTS SELF STUDY	10.20

SECTION 1: THEORY FOR CLASSROOM DISCUSSION

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                        Engineering
                        Technologies
   ┌──────┬──────┬──────┬──────┬──────┬──────┬──────┬──────┐
Virtualizati  Grid    Clod   Mobile  Green IT  BYOD   IOT    AI
   on      Computing Computing Computing
              ┌────────┴────────┐
            Types          Service
                           Models
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PART 1: VIRTUALIZATION

Q.No.1. What is Virtualization? What are different Application Areas of Virtualization?
(A)RTP M19. N18-4M MTP M19-4M

Virtualization means to create a <u>virtual version or logical version of a physical device</u> or resource, such as a server, storage device, network or even an operating system where the framework divides the resource into one or more execution environments.

The core concept of virtualization lies in <u>partitioning </u>which divides a physical server in to multiple logical servers. For example - Partitioning of a hard drive is considered virtualization because one drive is partitioned in a way to create two separate hard drives.

APPLICATION AREAS OF VIRTUALIZATION

1) **Server Consolidation:** Virtual machines are used to <u>combine   many physical servers into fewer servers, which   hosts virtual machines(= softwares)</u>. Each physical server is shown as a virtual machine. This is also known as "Physical-to-Virtual" or 'P2V' transformation.

2) **Disaster Recovery:** Virtual machines can be used as <u>"hot standby" for physical production servers(=live server or core server) in times of server breakdown</u>.

3) **Testing and Training:** Virtualization can give root access (=complete access) to a virtual machine. This can be very useful such as in kernel development (=core part of the operating system) and operating systems courses.

4) **Portable Applications:** Portable applications are needed when running an application from a removable drive, without installing it on the system's main disk drive.

5) **Portable Workspaces:** Recent technologies have used virtualization to create portable work spaces (=A portable workspace is one that can be moved across multiple computers without requiring repeated installation, customization and data setup.) on devices like iPods and USB memory sticks.

SIMILAR QUESTION:

1. The digital world runs on virtualization today because it offers many benefits and efficiencies. Comment.

A. Refer the above answer.

2. Virtualization can increase IT agility, flexibility and scalability while creating significant cost savings. Greater workload mobility, increased performance and availability of resources, automated operations .In this context, define virtualization and write its application areas.

A. Refer the above answer.

Q.No.2. Explain Common Types of Virtualization?	(A)

HARDWARE VIRTUALIZATION: (MTP N18 4M)

1) Hardware Virtualization or Platform Virtualization(For example, a computer that is running Microsoft Windows may host a virtual machine that looks like a computer with the Ubuntu Linux operating system; Ubuntu-based software can be run on the virtual machine.) refers to the <u>creation of a virtual machine that acts like a real computer</u> with an operating system.

2) The software that creates a virtual machine on the host hardware is called a <u>hypervisor</u> or Virtual Machine Manager.

3) The <u>hypervisor controls</u> everything by allowing several different operating systems to run on the same machine without the need for a source code.

4) The basic idea of Hardware virtualization is to consolidate many small physical servers into one large physical server so that the processor can be used more effectively.

NETWORK VIRTUALIZATION: (MTP N18 4M)

1) Network virtualization is a method of combining the available resources in a <u>network by splitting up the available bandwidth into channels,</u> each of which can be assigned (or reassigned) to a particular server or device in real time.

2) This allows a large physical network to be provisioned into multiple smaller logical networks and conversely allows multiple physical LANs to be combined into a larger logical network.

STORAGE VIRTUALIZATION:

1) Storage virtualization is the <u>clear pooling of data from multiple storage devices</u>, even different types of storage devices, into a single device that is managed from a central console.

2) Storage virtualization helps the storage administrator perform the tasks of <u>backup, archiving, and recovery</u> more easily and in less time by disguising the actual complexity of a Storage Area Network (SAN).

3) Storage virtualization is sometimes described as "abstracting" the logical storage from the physical storage.

SIMILAR QUESTIONS:

1. Hardware virtualization, sometimes called *platform* or *server virtualization*, is executed on a particular hardware platform by host software. The host software that is actually a control program is called a *hypervisor*. Comment.

A. Refer Hardware virtualization point in the above answer.

2. Network Virtualization can combine multiple physical networks to one virtual, software-based network, or it can divide one physical network into separate, independent virtual networks. Comment.

A. Refer Network virtualization point in the above answer.

3. Storage virtualization runs on multiple storage devices and makes them appear as if they were a single storage pool, greatly increasing efficiency and manageability. Comment.

A. Refer Storage virtualization point in the above answer.

PART 2: GRID COMPUTING

| Q.No.3. What is Grid Computing? Explain different Application Areas of Grid Computing? (A) |

1) Grid Computing is a <u>computer network</u> in which each computer's resources(like processors, storage etc.) are shared with every other computer in the system.

2) <u>It is a distributed architecture of large numbers of computers connected to solve a complex problem.</u>

3) In the grid computing model, servers or personal computers run independent tasks and are <u>loosely linked</u> by the internet or low-speed networks.

4) In the ideal grid computing system, every resource is shared, turning a computer network into a powerful <u>supercomputer</u>.
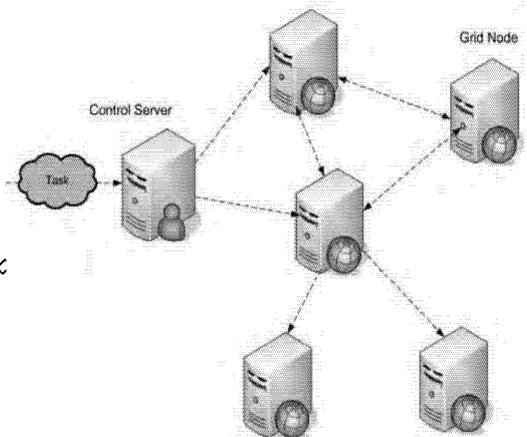
APPLICATION AREAS OF GRID COMPUTING:

1) Civil engineers collaborate to design, execute, & analyze <u>shake table experiments.</u>

2) An insurance company mines data from partner hospitals for <u>fraud detection</u>.

3) An <u>application service provider offloads</u> excess load to a compute cycle provider.

4) An enterprise configures internal & external resources to support <u>e-Business workload</u>.

5) <u>Large-scale science and engineering</u> computing resources which are geographically and organizationally dispersed could use Grid.

SIMILAR QUESTION:

1. Vitualization offers new ways of resource optimization and cheaper processing capabilities. Comment.

A. Refer the above answer.

B. Grid computing systems work on the principle of pooled resources. It's a special kind of distributed computing. In this context define what is Grid computing and write its application areas.

A. Refer the above answer.

| Q.No.4. Explain different Benefits of Grid Computing? (B) |

1) **MAKING USE OF UNDERUTILIZED RESOURCES:** Grid computing provides a <u>basis for exploiting the underutilized resources</u> and increases the efficiency of resource usage.

2) **RESOURCE BALANCING:** This feature of grid computing handles occasional peak loads of activity to idle machines in the grid;

3) **PARALLEL CPU CAPACITY:** A CPU-intensive grid application can be thought of as many smaller sub-jobs, each executing on a different machine in the grid.

4) **VIRTUAL RESOURCES AND VIRTUAL ORGANIZATIONS FOR COLLABORATION:** The users of the grid can be organized dynamically into a number of virtual organizations, each with different policy requirements. These virtual organizations can share their resources, <u>collectively as a larger grid.</u>

5) **Access to additional resources:** In addition to CPU and storage resources, a grid can provide access to other resources such as <u>bandwidth to perform a complex task.</u>

6) **Reliability:** The machines also <u>use duplicate processors</u> in such a way that when they fail, one can be replaced without turning the other off. Power supplies and cooling systems are also duplicated.

7) **Management:** The goal to virtualize the resources on the grid and more uniformly handle heterogeneous systems create new opportunities to better manage a larger, more distributed IT infrastructure.

SIMILAR QUESTIONS:

1. Grid computing is an obvious data processing choice for large companies and academic institutes. It is efficient, affordable, and fast while delivering high levels of accuracy and data integrity. In this context elucidate how can organizations benefit from grid computing?

A. Refer above answer.

Q.No.5. What type of resources used by all users of the grid? Explain?   **(C)**

RESOURCES MAY BE USED BY ALL USERS OF THE GRID ARE:

1) **Computation:** The most common resource is Computing Cycles provided by the processors of the machines on the grid.

2) **Storage:** A grid providing an <u>integrated view of data storage is sometimes called a Data Grid</u>. Each machine on the grid contributes some storage for grid use, even if temporary.

3) **Communications:** Redundant communication paths are sometimes needed to <u>better handle potential network failures and excessive data traffic.</u>

4) **Software and Licenses:** Some software licensing arrangements permit the <u>software to be installed on all of the machines of a grid</u> but may limit the number of installations that can be simultaneously used at any given instant.

5) **Special equipment, capacities, architectures, and policies:** Platforms on the grid will often have different architectures, operating systems, devices, capacities, and equipment. Each of these items represents a different kind of resource that the grid can use as criteria for assigning jobs to machines.

Similar question:

1. Grid computing technologies enable controlled resource sharing in distributed communities and the coordinated use of those shared resources as community members tackle common goals. In this context what are the different resources that can be shared using grid architecture?

A. Refer above answer.

Q.No.6. What are the constraints to be taken to develop secured grid?   **(C) (N20-4M) (MTP N18-6M)**

Following constraints are taken from the characteristics of grid environment and application.

1) **SECURED SINGLE SIGN-ON:** A user should authenticate once and they should be able to acquire resources, use them, and release them and to communicate internally <u>without any further authentication.</u>

2) **PROTECTION OF CREDENTIALS:** User passwords, private keys, etc. should be protected.

3) **RESOURCE MANAGEMENT:** Allocation of resources to co-users, prioritizing local jobs over system jobs, and managing these resources without ownership is a big issue.

4) **DATA MANAGEMENT:** Providing secure, efficient, and transparent access to distributed, heterogeneous pool of data is a big issue in grid computing.

5) **INTEROPERABILITY WITH LOCAL SECURITY SOLUTIONS:** Access to local resources should have local security policy at a local level. Despite of modifying every local resource there is an <u>inter-domain security server</u> for providing security to local resource.

6) **STANDARDIZATION:** Standardizing multi-purpose protocols and interfaces is a big issue in grid computing.

7) *EXPORTABILITY:* *The code should be exportable i.e. they <u>cannot use a large amount of encryption at a time</u>. There should be a minimum communication at a time.*

8) *SUPPORT FOR SECURE GROUP COMMUNICATION:* *In a communication there are number of processes which coordinate their activities. This coordination must be secure and for this there is no such security policy.*

9) *SUPPORT FOR MULTIPLE IMPLEMENTATIONS:* *There should be a security policy which should provide security to multiple sources based on public and private key cryptography.*

SIMILAR QUESTIONS:

1. Grid computing is concerned with the sharing and use of resources in dynamic distributed virtual organizations. The dynamic nature of Grid environments introduces challenging security concerns that demand new technical approaches. In this context how can we address the key Grid security issues?

A. Refer above answer.

PART 3: CLOUD COMPUTING

Q.No.7. What is cloud computing? What are the Characteristics of Cloud Computing? (A) (MTP M18-6M)

1) A cloud is a <u>collection of servers, applications, databases, documents, agreements, spread sheets, storage capacity</u> etc. which allows organizations to share these resources from anywhere.

2) Cloud Computing is the use of various services such as software development platforms, servers, storage, and software, over the Internet, often referred to as the "cloud."

3) Cloud computing means the use of <u>computing resources as a service</u> through networks typically the internet.

4) The best example of cloud computing is Google Apps where any application can be accessed using a browser and it can be deployed on thousands of computers through the Internet.

5) For example, if you access your e-mail via your web browser, you are using a form of cloud computing. If you use Google Drive's applications, you are using cloud computing.

6) **CHARACTERISTICS:**

   a) **Elasticity and Scalability:** Cloud computing gives us the <u>ability to expand and reduce resources according to the specific service requirement</u>.

   b) **Pay-per-Use:** We pay for cloud services only when we use them, either for the short term or for a longer duration.

   c) **On-demand:** unlike our internal IT services, we use cloud services only when we need them, <u>they are not permanent parts of the IT infrastructure.</u>

   d) **Resiliency:** The resiliency of a cloud service offering can completely separate <u>the failure of server and storage resources from cloud users.</u>

   e) **Multi Tenancy:** Public cloud service providers often can host the cloud services for multiple users within the same infrastructure.

f) <u>Workload Movement:</u> This is related to <u>resiliency and cost considerations</u>. Here, cloud-computing providers can shift their workloads across servers both inside the data center and across data centers.

g) <u>Wide Range of Network Access Capacities:</u> Resources are available to customers through a network and can be accessed from different devices such as desktop computers, mobile phones, smartphones and tablet devices.

SIMILAR QUESTION:

1. Anywhere, Anytime, Anything availability of computational resources is the emerging trend in IT. How is it possible?

A. Refer the above answer.

B. Cloud computing is a big shift from the traditional way businesses think about IT resources. Cloud computing is the delivery of on-demand computing services from applications to storage and processing power typically over the internet and on a pay-as-you-go basis. In this context write about cloud computing and its characteristics.

A. Refer above answer.

Q.No.8. What are the Advantages and disadvantages of Cloud Computing?   (A)

ADVANTAGES OF CLOUD COMPUTING:

1) <u>Achieve economies of scale:</u> Productivity can be increased even with fewer systems and thereby reduce the cost per unit of a project or product.

2) <u>Reduce spending on technology infrastructure:</u> Data and information can be accessed with minimal direct spending in a on-demand pay per use basis.

3) <u>Globalize the workforce:</u> People worldwide can access the cloud with Internet connection.

4) <u>Streamline business processes:</u> Getting more work done in less time with less resources are possible.

5) <u>Reduce capital costs:</u> Not required to spend huge money on hardware, software, or licensing fees.

6) <u>Pervasive accessibility:</u> Data and applications can be accessed anytime, anywhere, using any smart computing device, making our life so much easier.

7) <u>Backup and Recovery:</u> It is relatively much easier to backup and restore data stored in cloud.

8) <u>Monitor projects more effectively:</u> It is feasible to confine within budgetary allocations and can be ahead of completion cycle times.

9) <u>Less personnel training is needed:</u> It takes fewer people to do more work on a cloud, with a minimal learning curve on hardware and software issues.

10) <u>Minimize maintenance and licensing software:</u> As on-premise computing resources are low, maintenance becomes simple and updates and renewals of software systems rely on the cloud vendor or provider.

11) <u>Improved flexibility:</u> It is possible to make fast changes in our work environment without serious issues at risk.

DRAWBACKS OF CLOUD COMPUTING:

1) If <u>Internet connection is lost</u>, the link to the cloud and thereby to the data and applications is lost.

2) <u>Security is a major concern</u> as entire working depends on other cloud vendors or providers.

3) Although Cloud computing supports scalability, <u>control on these resources</u> is not possible as these are not owned by the user or customer.

4) Depending on the cloud vendor or provider, customers may have to <u>face restrictions</u> on the availability of applications, operating systems and infrastructure options.

5) <u>Interoperability</u> is an issue wherein all the applications may not reside with a single cloud vendor and two vendors may have applications that do not cooperate with each other.

SIMILAR QUESTION:

1. Cloud Computing is shaping how we live and work today. Whether we like it or not, it has become an integral part of our lives. Companies and businesses of all shapes and sizes are now turning to Cloud Computing. But nothing is perfect and

Cloud Computing is no exception. While it is vastly beneficial, it also has some risks and concerns that should not be overlooked. Then what are the pros and cons of Cloud computing?

A.   Refer above answer.

PART 4: TYPES OF CLOUDS

> **Q.No.9. What is private cloud? Explain different Characteristics of Private Cloud? Discuss several advantages and disadvantages?** (B)

1) **PRIVATE CLOUD:** This cloud computing environment exists within the boundaries of an organization and is used exclusively for the organization's benefits.

   These are also called **Internal Clouds** or **Corporate Clouds.**

   Private Clouds can either be managed by the single organization **(On- Premise Private Cloud)** or can be managed by third party **(Outsourced Private Cloud)**.

2) **CHARACTERISTICS OF PRIVATE CLOUD:**

   a) **Secure:** The private cloud is secure and the chances of data leaks are less as it is deployed and managed by the organization itself.

   b) **Central Control:** There is no need for the organization to rely on anybody and it is controlled by the organization itself.

   c) **Weak Service Level Agreements (SLAs):** SLAs are very important as they are defined as agreements between the user and the service provider in private cloud. In private cloud, either Formal SLAs do not exist or are weak as it is between the organization and user of the same organization.

3) **ADVANTAGES OF PRIVATE CLOUD:**

   a) It improves average server utilization; allow usage of low-cost servers and hardware while providing higher efficiencies.

   b) It provides a high level of security and privacy to the user.

   c) It is small and controlled and maintained by the organization.

4) **Limitation of Private Cloud** is that IT teams in the organization may have to invest in buying, building and managing the clouds independently. Budget is a constraint in private clouds and they also have loose SLAs.

SIMILAR QUESTIONS:

1.   A private cloud offers an enterprise more control and better security than a public cloud, but managing it requires a higher level of IT expertise. Because the owner of a private cloud maintains complete control, not only can organizations ensure tighter security, they also benefit from better availability and more uptime than a public cloud can offer. In this context write about the characteristics Private cloud along with its advantages and limitations.

A.   Refer above answer.

> **Q.No.10. What is public cloud? Explain Characteristics of Public Cloud? Discuss several advantages and disadvantages of public cloud?** (B)

1) **PUBLIC CLOUD:** The public cloud is established for open use by the general public. It may be owned, managed, and operated by a business, academic, or government organizations, or some combination of them. Typically, public clouds are administrated by third parties or vendors over the Internet, and the services are offered on pay-per-use basis.

2) **CHARACTERISTICS OF PUBLIC CLOUD:**

   a) **Highly Scalable:** The resources in the public cloud are large in number and the service providers make sure that all requests are granted. Hence public clouds are scalable.

   b) **Affordable:** The user has to pay only for what he or she is using as the cloud is offered to the public on a pay-as-you-go basis.

   c) **Less Secure:** Since it is offered by a third party having full control, the public cloud is less secure out of all the other deployment models.

d) **Highly Available:** It is highly available because anybody from any part of the world can access the public cloud with proper permission.

e) **Stringent SLAs:** They follow the strict SLAs as the service provider's business reputation and customer strength are totally dependent on the cloud services.

3) ADVANTAGES OF PUBLIC CLOUD:

a) It is widely used in the development, deployment and management of enterprise applications, at affordable costs.

b) It allows the organizations to deliver highly scalable and reliable applications rapidly and at more affordable costs.

c) There is no need for establishing infrastructure for setting up and maintaining the cloud.

d) Public clouds can easily be integrated with private clouds.

e) Strict SLAs are followed.

f) There is no limit for the number of users.

4) LIMITATION OF PUBLIC CLOUD: Is security assurance and thereby building trust among the clients is far from desired but slowly liable to happen. Further, privacy and organizational autonomy are not possible.

SIMILAR QUESTIONS:

1. Unlike private clouds, public clouds can save companies from the expensive costs of having to purchase, manage and maintain on-premises hardware and application infrastructure - the cloud service provider is held responsible for all management and maintenance of the system. In this context write about the characteristics of public cloud along with its advantages and limitations.

A. Refer above answer.

B. Public cloud is the cloud infrastructure that is provisioned for open use by the general public .Explain any four characteristics of public cloud.(N20-4M)

A.Refer characteristics of public cloud in the above answer..

Q.No.11. What is hybrid cloud? Explain characteristics of Cloud? Discuss several advantages and disadvantages of Hybrid cloud? **(B)**

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1) **HYBRID CLOUD:** This is a combination of both at least one private (internal) and at least one public (external) cloud computing environments.
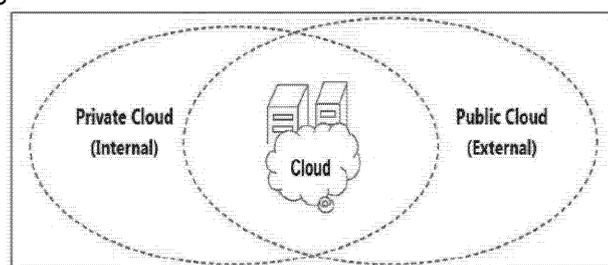
Hybrid cloud

2) CHARACTERISTICS OF HYBRID CLOUD (MTP M19-4M)

a) **Scalable:** The hybrid cloud has the property of both public cloud and private cloud environment. As public cloud is scalable so is the hybrid cloud.

b) **Partially Secure:** The private cloud is considered as secured and public cloud has high risk of security breach. The hybrid cloud thus cannot be fully termed as secure but as partially secure.

c) **Stringent SLAs:** Overall the SLAs are more stringent than the private cloud and might be as per the public cloud service providers.

d) **Complex Cloud Management:** Cloud management is complex as it involves more than one type of deployment models and also the number of users is high.

3) ADVANTAGES OF HYBRID CLOUD

a) It is highly scalable and gives the power of both private and public clouds.

**b)** It provides better security than the public cloud.

4) Limitation of Hybrid Cloud is that the security features are not as good as the private cloud and complex to manage.

SIMILAR QUESTIONS:

1. A hybrid cloud strategy provides businesses with greater flexibility by moving workloads between cloud solutions as needs and costs fluctuate. Hybrid cloud services are powerful because they give businesses greater control over their private data. In this context write about the characteristics of Hybrid cloud along with its advantages and limitations.
A. Refer above answer.

Q.No.12. What is community cloud? What are the Characteristics of Community Cloud? Discuss several advantages and disadvantages of community cloud?   **(B)**

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1) COMMUNITY CLOUD: The community cloud is the cloud infrastructure that is provided for exclusive use by a specific community of consumers from similar organizations. It may be owned, managed, and operated by one or more of the organizations in the community, a third party or some combination of them.
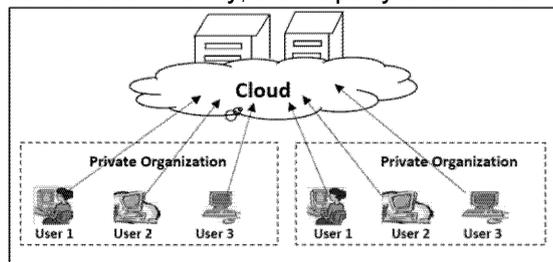
Community cloud

2) CHARACTERISTICS OF COMMUNITY CLOUD:

a) Collaborative and Distributive Maintenance: In this, no single company has full control over the whole cloud. This is usually distributive and hence better cooperation provides better results.

b) Partially Secure: There is a possibility that the data can be leaked from one organization to another, though it is safe from the external world.

c) Cost Effective: As the complete cloud if being shared by several organizations or community, not only the responsibility gets shared; the community cloud become cost effective too.

3) ADVANTAGES OF COMMUNITY CLOUD:

a) It allows establishing a low-cost private cloud.

b) It allows collaborative work on the cloud.

c) It allows sharing of responsibilities among the organizations.

d) It has better security than the public cloud.

4) Limitation of Community Cloud is that the autonomy of the organization is lost and some of the security features are not as good as the private cloud. It is not suitable in the cases where there is no collaboration.

SIMILAR QUESTIONS:

1. Community clouds are distributed systems created by integrating the services of different clouds to address the specific needs of an industry, a community, or a business sector. In this context write about the characteristics of Community cloud along with its advantages and limitations.

    A. Refer above answer

2. The Prime Minister Office of a country X plans to establish specific infrastructure setup with its access shared amongst members of the group constituting of some selected high-profiled dignitaries and officers from different ministries. The objective of the group is to carry out certain assignments related to nation's security and integrity. Which is the most suitable choice of the cloud under Cloud Computing? Discuss its advantages and limitations as well.   (RTP N19)

    A. The most suitable choice is Community Cloud +Refer above answer.

PART 5: CLOUD COMPUTING SERVICE MODELS

Software as a Service

Platform as a Service

Infrastructure as a Service
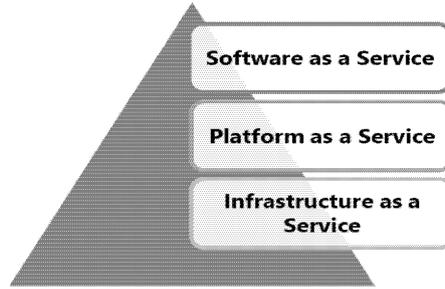
Cloud Computing Basic Service Models as per National Institute of Standards and Technology (NIST)

Q.No.13. What is Infrastructure as a Service (IaaS) model? Explain Characteristics of IaaS?   (B)

INFRASTRUCTURE AS A SERVICE, a hardware-level service, provides computing resources such as processing power, memory, storage, and networks for cloud users to run their application on-demand. This allows users to maximize the utilization of computing capacities without having to own and manage their own resources.

Examples of IaaS providers include Amazon Web Services (AWS), Google Compute Engine, OpenStack and Eucalyptus.

CHARACTERISTICS OF IaaS:

1) **Web access to the resources:** The IaaS model enables the IT users to access infrastructure resources over the Internet.

2) **Centralized Management:** The resources distributed across different parts are controlled from any management monitoring location that ensures effective resource management utilization.

3) **Elasticity and Dynamic Scaling:** Depending on the load, IaaS services can provide the resources and elastic services where the usage of resources can be increased or decreased according to the requirements.

4) **Shared infrastructure:** IaaS follows a one-to-many delivery model which ensures high resource utilization.

5) **Metered Services:** IaaS allows the IT users to rent the computing resources instead of buying it. The services consumed by the IT user will be as per on-demand pay per use basis.

SIMILAR QUESTION:

1. Infrastructure-as-a-service (IaaS), also known as cloud infrastructure services, is a form of cloud computing in which IT infrastructure is provided to end users through the internet. IaaS is commonly associated with computing. In this context write about the characteristics of IaaS.

   A.   Refer above answer.

2. ABC university wants to conduct online exams for its different courses for which a contract is given to vendor XYZ. The vendor provides computing resources such as processing power, memory, storage, and networks to ABC university users to run their online exam application on-demand. Identify the Service Model of Cloud Computing that vendor XYZ is providing to ABC university and also describe its characteristics.   (RTP M20)

   A. The Service Model provided by vendor XYZ to ABC university is Infrastructure as a Service (IaaS).+Refer above answer.

Q.No.14. Write different instances of IaaS   (B)

Instance	Description
Network as a Service (NaaS)	• Provides users with needed data communication capacity to accommodate bursts in data traffic during data-intensive activities such as video conferencing or large file downloads. • It is an ability given to the end-users to access virtual network services that are provided by the service provider over the Internet on a pay-per-use basis.

	• Allows network architects to create virtual networks; virtual network interface cards (NICs), virtual routers, virtual switches, and other networking components.
Storage as a Service (STaaS)	• Provides storage infrastructure on a subscription basis • It is an ability given to the end users to store the data on the storage services provided by the service provider. • STaaS allows the end users to access the files at any time from any place. STaaS provider provides the virtual storage that is abstracted from the physical storage of any cloud data center.
Database as a Service (DBaaS)	• Provides users with seamless mechanisms to create, store, and access databases at a host site on demand. • It is an ability given to the end users to access the database service without the need to install and maintain it on the pay-per-use basis. • The end users can access the database services through any Application Programming Interfaces (APIs) or Web User Interfaces provided by the service provider.
Backend as a Service (BaaS)	• Provides web and mobile app developers a way to connect their applications to backend cloud storage with added services such as user management, push notifications, social network services integration using custom software development kits and application programming interfaces.
Desktop as a Service (DTaaS)	• Provides ability to the end users to use desktop virtualization without buying and managing their own infrastructure. • It is a pay-per-use cloud service delivery model in which the service provider manages the back-end responsibilities of data storage, backup, security and upgrades. • The end-users are responsible for securing for managing their own desktop images, applications, and security. These services are simple to deploy, are highly secure and produce better experience on almost all devices.

Q.No.15. Explain about Platform as a Service (PaaS) model?   (B)

1) **Platform as a Service** model provides the users the ability to <u>develop and deploy an application</u> on the development platform provided by the service provider.

2) In traditional application development, the application will be <u>developed locally</u> and will be hosted in the <u>central location</u>.

3) In stand-alone application development, the application will be developed by traditional development platforms result in licensing - based software, whereas PaaS changes the application development from <u>local machine to online</u>.

4) For example- Google AppEngine, Windows Azure, Compute etc.

<u>SIMILAR QUESTIONS:</u>

1. Cloud platform services, also known as Platform as a Service (PaaS), provide cloud components to certain software while being used mainly for applications. PaaS delivers a framework for developers that they can build upon and use to create customized applications. Comment.

A. Refer above answer.

Q.No.16. Explain about Software as a Service (SaaS) model?   (B)

1) **Software as a Service (SaaS)** provides ability to the end users to <u>access an application</u> over the Internet that is hosted and managed by the service provider.

2) Thus, the end users are exempted from <u>managing or controlling an application</u> the development platform, and the underlying infrastructure.

3) SaaS changes the way the software is delivered to the customers.

4) SaaS provides users to <u>access large variety of applications</u> over internets that are hosted on service provider's infrastructure.

5) For example, one can make his/her own word document in Google docs online.

<u>SIMILAR QUESTIONS:</u>

1. **Software as a service (SaaS) is a software distribution model in which a third-party provider hosts applications and makes them available to customers over the Internet. Comment**

A. **Refer above answer.**

Q.No.17. Write different instances of SaaS.   **(C)**

Instance	Description
Testing as a Service (TaaS)	Provides users with software testing capabilities such as generation of test data, generation of test cases, execution of test cases and test result evaluation on a pay-per-use basis.
API as a Service (APIaaS)	Allows users to explore functionality of Web services such as Google Maps, Payroll processing, and credit card processing services etc.
Email as a Service (EaaS)	Provides users with an integrated system of emailing, office automation, records management, migration, and integration services with archiving, spam blocking, malware protection, and compliance features.

Q.No.18. Explain different Cloud Service Models?   **(C)**

Instance	Description
Communication as a Service (CaaS)	• It is an outsourced enterprise communication solution that can be leased from a single vender. The CaaS vendor is responsible for all hardware and software management and offers guaranteed Quality of Service (QoS). It allows business to selectively deploy communication devices and modes on a pay-as-you-go, as-needed basis. • This approach eliminates the large capital investments. **Examples:** Voice over IRP (VoIP), Instant Messaging (IN), Collaboration and Videoconferencing application using fixed and mobile devices.
Data as a Service (DaaS)	• Provides data on demand to a diverse set of users, systems or application. The data may include text, images, sounds, and videos. • Data encryption and operating system authentication are commonly provided for security. DaaS users have access to high-quality data in a centralized place and pay by volume or data type, as needed.
Security as a Service (SECaaS)	• It is an ability given to the end user to access the security service provided by the service provider on a pay-per-use basis. • It is a new approach to security in which cloud security is moved into the cloud itself whereby cloud service users will be protected from within the cloud using a unified approach to threats.
Identity as a Service (IDaaS)	• It is an ability given to the end users; typically an organization or enterprise; to access the authentication infrastructure that is built, hosted, managed and provided by the third party service provider. • Generally, IDaaS includes directory services, authentication services, risk and event monitoring, single sign-on services, and identity and profile management.

Q.No.19.What are the Pertinent Issues Related to Cloud Computing ?   **(C)**

As an emerging technology, cloud computing involves several issues. Some of the pertinent issues related to cloud computing are:

1) **THRESHOLD POLICY:** A carefully drafted threshold policy outlines what cloud computing service consumers and providers should do.

2) **INTEROPERABILITY:** Once a company is locked in with one cloud provider, it is not easy to move an entire infrastructure to other clouds. Moreover, each cloud provider offers a unique set of services and tools for operating and controlling its cloud.

3) **HIDDEN COSTS:** Such costs may include higher network charges for storage and database applications, or latency issues for users who may be located far from cloud service providers.

4) **UNEXPECTED BEHAVIOUR:** An application may perform well at the company's internal data Centre, but not in cloud. Therefore, it is essential   to test its performance in the cloud for unexpected behavior.

5) **SECURITY ISSUES:** The important security issues with cloud computing are: the management of the data might not be fully trustworthy; the risk of malicious insider attacks in the cloud; and the failing of cloud services. Maintaining confidentiality is one the major issue.

6) **LEGAL ISSUES:** Cloud systems need to adhere to several regulatory requirements, privacy laws and data security laws.

7) **SOFTWARE DEVELOPMENT IN CLOUD:** From the perspective of the application development, developers face the complexity of building secure applications that may be hosted in the cloud.

8) **BUGS IN LARGE-SCALE DISTRIBUTED SYSTEMS:** One of the difficult challenges in Cloud Computing is removing errors in these very large scale distributed systems.

PART 6: MOBILE COMPUTING

Q.No.20. What is Mobile Computing? Explain different components of Mobile Computing?   (A)
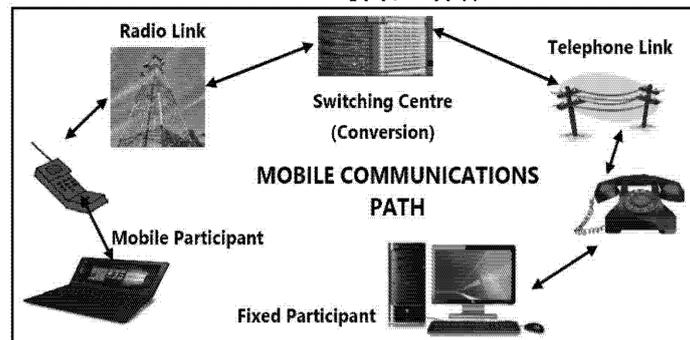
Mobile Computing

Mobile Computing refers to the technology that allows transmission of data via a computer <u>without having</u> to be connected to a <u>fixed physical link</u>. Mobile voice communication is widely established throughout the world.

<u>THE KEY COMPONENTS OF MOBILE COMPUTING ARE:</u>

1) **Mobile Communication:** This would include communication properties, protocols, data formats and concrete technologies for smooth and reliable communication.

2) **Mobile Hardware:** Mobile Hardware includes <u>mobile devices or device components</u> that receive or access the service of mobility. Ex. Portable laptops, Smart Phones, Tablet PCs, and Personal Digital Assistants (PDA).

3) **Mobile Software:** Mobile Software is the actual program which is the operating system of that appliance and is the <u>essential component</u> that makes the mobile device operates. Mobile applications are popularly called as Apps

<u>SIMILAR QUESTIONS:</u>

1. Mobile Computing refers a technology that allows transmission of data, voice and video via a computer or any other wireless enabled device. Comment

A. Refer above answer.

Q.No.21. Write about the Benefits of Mobile Computing? (B)

1) It provides mobile <u>workforce with remote access</u> to work order details, such as work order location, contact information, required completion date etc.,

2) It enables mobile sales personnel to <u>update work order status in real-time</u>, facilitating excellent communication.

3) It facilitates access to corporate services and information <u>at any time, from anywhere</u>.

4) It provides remote <u>access to the corporate Knowledge base</u> at the job location.

5) It enables to <u>improve management effectiveness</u> by enhancing information quality, information flow, and ability to control a mobile workforce.

6) Mobile computing enables the organization to <u>improve the services</u> offered to its customers.

<u>SIMILAR QUESTIONS:</u>

1. Mobile computing has changed the complete landscape of our day-to-day life. In this context what are the advantages of mobile computing?

A. Refer above answer

Q.No.22. Write about the Limitations of Mobile Computing? (B) (M19-8M) (RTP M19)

1) **INSUFFICIENT BANDWIDTH:** Mobile Internet access using GPRS,3G,4G is generally slower than direct cable connections

2) **SECURITY STANDARDS:** Security is a <u>major concern</u> while concerning the mobile computing standards. One can easily attack the VPN through a huge number of networks interconnected through the communication line.

3) **POWER CONSUMPTION:** When a power outlet or portable generator is not available, mobile computers must rely entirely on battery power.

4) **TRANSMISSION INTERFERENCES:** Weather, terrain, and the range from the nearest signal point can all interfere with <u>signal reception</u>. Reception in tunnels, some buildings, and rural areas is often poor.

5) **POTENTIAL HEALTH HAZARDS:** People who use mobile devices while driving are often assumed to be involved in traffic accidents. Cell phones may interfere with sensitive medical devices like pacemakers in heart. There are allegations that <u>cell phone signals may cause health problems.</u>

6) **HUMAN INTERFACE WITH DEVICE:** Screens and keyboards tend to be small, which may make them hard to use.

<u>SIMILAR QUESTIONS:</u>

1. Mobile computing is the discipline for creating an information management platform, which is free from spatial and temporal constraints, but mobile computing has its fair share of concerns and constraints. In this context write about the limitations of mobile computing.

A. Refer above answer.

PART 7: GREEN IT

Q.No.23. What is Green Computing or Green IT? What are the Best Practices of Green Computing? (A)

Green Computing or **Green IT** refers to the study and practice of environmentally sustainable computing or IT. In other words, it is the study and practice of establishing/ using computers and IT resources in a more efficient and <u>environmentally friendly</u> and responsible way.

<u>GREEN COMPUTING BEST PRACTICES:</u>

1) <u>Develop a sustainable Green Computing plan:</u>

   a) Involve stakeholders to include recycling policies, recommendations for <u>disposal of used equipment.</u>

b) Follow government guidelines and recommendations for purchasing green computer equipment.

c) Use cloud computing so that multiple organizations share the same computing resources by making more efficient use of hardware resources.

2) Recycle:

a) Dispose e-waste according to central, state and local regulations.

b) Discard used or unwanted electronic equipment which emit harmful emissions in a environmentally responsible manner.

c) Manufacturers must offer safe end-of-life management and recycling options when products become unusable.

3) Make environmentally sound purchase decisions:

a) Purchase of desktop computers, notebooks and monitors based on environmental attributes.

b) Use Server and storage virtualization that can help to improve resource utilization, reduce energy costs and simplify maintenance.

4) Reduce Paper Consumption:

a) Reduce paper consumption by use of e-mail and electronic archiving.

b) Use of "track changes" feature in electronic documents, rather than red line corrections on paper.

c) Use online marketing rather than paper based marketing.

d) While printing documents, make sure to use both sides of the paper, recycle regularly, use smaller fonts and margins, and selectively print required pages.

5) Conserve Energy:

a) Use Liquid Crystal Display (LCD) monitors rather than Cathode Ray Tube (CRT) monitors;

b) Use notebook computers rather than desktop computers whenever possible;

c) Use the power-management features to turn off hard drives and displays after several minutes of inactivity;

d) Power-down the CPU and all peripherals during extended periods of inactivity.

e) Adapt more of Web conferencing offers instead of travelling to meetings in order to go green and save energy.

SIMILAR QUESTION:

1. Environmental sustainability should be given much importance in IT areas also. comment

A. Refer the above answer.

2. Many IT manufacturers and vendors are continuously investing in designing energy-efficient computing devices, reducing the use of dangerous materials and encouraging the recyclability of digital devices. In this context write about Green computing and its best practices.

A. Refer above answer.

PART 8: BYOD

> **Q.No.24. What is BYOD (Bring Your Own Device)? Write down the advantages associated with BYOD?** (C)

1) **BYOD (Bring Your Own Device)** refers to business policy that allows employees to use their preferred computing devices, like smart phones and laptops for business purposes.

2) It means employees can use personal devices (laptops, smart phones, tablets etc.) to connect to the corporate network to access information and application.

3) **ADVANTAGES OF BYOD:**

a) **Happy Employees:** Employees love to use their own devices when at work. This also reduces the number of devices an employee has to carry.

b) **Lower IT budgets:** There could be financial savings to the organization since employees would be using the devices they already possess without organizations providing devices to employees.

c) **IT reduces support requirement:** IT department does not have to provide end user support and maintenance for all these devices resulting in cost savings.

d) **Early adoption of new Technologies:** Employees are generally proactive in adoption of new technologies that result in productivity and overall growth of business.

e) **Increased employee efficiency:** The efficiency is more when the employee works on his/her own device thus eliminating learning difficulties.

SIMILAR QUESTION:

1. Happy employees add productivity to the organization. How can you make your employees happy?

A. Refer the above answer.

2. BYOD empowers employees to work and collaborate the way they prefer, with the freedom to use a device with which they are familiar. Companies that leverage application virtualization benefit from increased security and management options. In this context write about BYOD and its advantages.

A. Refer above answer.

Q.No.25. Write down the Threats (or) risks associated with BYOD?   B) (N19-4M) (MTP N18-4M)

EMERGING BYOD THREATS:

1) **Network Risks:** As BYOD permits employees to carry their own devices the IT practice team is unaware about the number of devices being connected to the network. This lack of visibility can be hazardous.

2) **Device Risks:** A lost or stolen device can result in a large financial and reputational embarrassment to an organization as the device may hold sensitive corporate information.

3) **Application Risks:** A report revealed that a majority of employees' phones and smart devices that were connected to the corporate network were protected by security software. Organizations are not clear in deciding that 'who is responsible for device security - the organization or the user'.

4) **Implementation Risks:** The absence of a strong BYOD policy would fail to communicate employee expectations, thereby increasing the chances of device misuse.

SIMILAR QUESTIONS:

1. While there are many benefits of BYOD policies, there are some notable drawbacks. BYOD risks become more apparent after considering the impact of having so many different entry points into company systems. In this context list out the risks of BYOD.

A. Refer above answer.

2. Mr. R as an IT manager of a financial company, advised his management to allow their senior employees to use their own computing devices for official work under Bring Your Own Device(BYOD) policy. The management wishes to know about the risk associated with BYOD. Briefly explain the classification of BYOD risks.   (RTP-N20)

A. Refer above answer.

PART 9: IOT

Q.No.26. What is Internet of Things (IoT) ?   (B)(M18-2M)

1) **INTERNET OF THINGS (IOT):** is a system of interrelated computing devices, mechanical and digital machines, objects, that are provided with unique identifiers and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction.

2) *For example: Washing machines with Wi-Fi networking capabilities can connect themselves to home Wi-Fi. Once these machines are so connected they can be controlled through machine manufacturer mobile APP from anywhere in the world.*

3) We have Wi-Fi enabled water purifiers. When the purifying agents deplete in the machine, it connects to home Wi-Fi and informs the service agents of the company.

4) Gartner, the technology researcher has projected that by 2020 the IOT business across the world would increase to USD 1.9 Trillion.

SIMILAR QUESTIONS:

1. The Internet of Things *(IoT)* is changing how we live, work, travel, and do business. It is even the basis of a new industrial transformation, known as Industry 4.0, and key in the digital transformation of organizations, cities, and society overall. In this context write about IoT

A. Refer above answer.

Q.No.27. What are the various Applications of IoT?   (C) (M19-2M) (MTPM18-4M)

APPLICATIONS of IoT:

1) **All home appliances to be connected and that shall create a virtual home.**

    a) Home owners can keep <u>track of all activities</u> in house through their hand held devices.

2) **Office machines shall be connected through net.**

    a) Human resource managers shall be <u>able to see how many people have had a cup of acoffee</u> from vending machine and how many are present.

    b) <u>How many printouts</u> are being generated through office printer?

3) **Governments can keep track of resource utilizations.**

    a) Under SWACHH mission government <u>can tag all dustbins</u> with IOT sensors.

    b) As a research study, individuals have got themselves <u>implanted with electronic chips</u> in their bodies. This chip allows him / her to connect to home / office Wi-Fi. This chip becomes individual's authentication token

4) **Wearables:** Just like smart homes, wearables remain another important potential IoT application like Apple smart watch.

5) **Smart City:** Smart cities, like its name suggests, is a big innovation and spans a wide variety of use cases, from water distribution and traffic management to waste management and environmental monitoring.

6) **Smart Grids:** A smart grid basically promises to extract information on the behaviors of consumers and electricity suppliers in an automated fashion to improve the efficiency, economics, and reliability of electricity distribution.

7) **Industrial Internet of things** With an IoT enabled system, factory equipment that contains embedded sensors communicate data about different parameters, such as pressure, temperature, and utilization of the machine. The IoT system can also process workflow and change equipment settings to optimize performance.

8) **Connected Car:** Connected car technology is a vast and an extensive network of multiple sensors, antennas, embedded software, and technologies that assist in communication to navigate in our complex world.

9) **Connected Health (Digital Health/Telehealth/Telemedicine):** IoT has various applications in healthcare, which are from remote monitoring equipment to advance and smart sensors to equipment integration. It has the potential to improve how physicians deliver care and keep patients safe and healthy.

10) **Smart Retail:** Retailers have started adopting IoT solutions and using IoT embedded systems across several applications that improve store operations, increasing purchases, reducing theft, enabling inventory management, and enhancing the consumer's shopping experience.

11) **Smart Supply Chain:** Supply chains have already been getting smarter for a couple of years. Offering solutions to problems like tracking of goods while they are on the road or in transit or helping suppliers exchange inventory information are some of the popular offerings.

SIMILAR QUESTIONS:

1. IoT applications promise to bring immense value into our lives. With newer wireless networks, superior sensors and revolutionary computing capabilities, the Internet of Things could be the next frontier in the race for its share of the wallet. IoT applications are expected to equip billions of everyday objects with connectivity and intelligence. In this context, write about the various emerging applications of IoT.

A. Refer above answer.

Q.No.28. What are the risks associated with Internet of Things (IoT)? (A)

RISKS: Internet of things is an evolving phenomenon. The nature of risk it carries is based on <u>academic logics and available practical experiences</u>. The risk listed are those which are most discussed for IoT today.

1) **Risk to Product manufacturer**

   a) Manufacturers may be out of business in few years if IoT becomes a necessary product feature.

   b) The manufacturers will to ensure the huge data generated from IoT devices is kept secured.

2) **Risk to user of these products**

   a) **Security:** As home devices / office equipment's are connected to network they are affected by network related risks, including <u>hacking, virus attacks, stealing confidential data etc.</u>

   b) **Privacy, autonomy and control:** <u>The personal life can be hacked and made public.</u> The other major concern is who has the ownership of the personal data.

   c) **Intentional obsolescence of devices:** This may happen due to -

      i) Companies which want to bring a new product may force users to <u>dump the old products</u>. This they can do by disabling the operating software of old product.

      ii) A manufacturer is acquired by another manufacturer. The buyer does not support old products sold.

3) **Technology Risk:** Platform fragmentation and lack of technical standards in terms of hardware and software makes the task of developing applications tough.

4) **Environmental Risk due to Technology:** These studies are being done to see the impact on house air quality, due to use of heavy earth metals in devices.

<u>SIMILAR QUESTIONS:</u>

1. **IoT is wonderful in many ways. But unfortunately,** technology has not matured yet, and it is not entirely safe. **The entire IoT environment, from manufacturers to users, still have many security challenges of IoT to overcome hence list out and briefly explain the risks of IoT.**

A. Refer above answer.

PART 10: ARTIFICIAL INTELLIGENCE

Q.No.29. What is Artificial Intelligence? What are the applications of Artificial Intelligence? (A)

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1) Intelligence, as defined in Chambers dictionary is "The ability to use memory, knowledge, experience, understanding, reasoning, imagination and judgment to <u>solve problems and adapt to new situations</u>". The above ability when exhibited by machines is called as Artificial intelligence (AI). It is intelligence exhibited by machines.

2) Artificial Intelligence (AI) is the distinct area of computer science focusing on creating machines that <u>tries to imitate aspects of human behavior</u>, such as to reason, communicate, see, and hear.

3) *Expert systems, Pattern recognition, Natural language processing, and many others are some of the various purposes on which AI may be applied.*

SOME COMMERCIAL APPLICATIONS:

1) <u>Autonomous vehicles</u> (such as drones and self-driving cars).

2) <u>Medical diagnosis, in cancer research</u>. Predicting the chances of an individual getting ill by a disease.

3) <u>Creating art</u> (such as poetry).

4) <u>Proving mathematical theorems.</u>

5) <u>Playing games</u> (such as Chess).

6) <u>Search engines</u> (such as Google search).

7) <u>Online assistants</u> (Apple online assistant such as SIRI).

SIMILAR QUESTIONS:

1. Artificial intelligence (AI) is wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence. Comment

A. Refer above answer.

Q.No.30. what are the risks and controls of Artificial Intelligence?   (B)

RISKS OF ARTIFICIAL INTELLIGENCE:

1) AI relies heavily of data it gets. Incorrect data can lead to incorrect conclusions.

2) AI (robots) carries a security threats. Countries are discussing to have a KILL button in all AI capable machines. This is important otherwise someday machine may start controlling humans.

3) AI in long term may kill human skills of thinking the unthinkable.

4) **Controls of Artificial Intelligence:** The set of controls in AI will be extremely complex because of the nature of processing of information depends on the nature of the AI tool and the purpose, etc.

SIMILAR QUESTIONS:

1. Besides many advantages AI has considerable concerns.Comment

A. Refer above answer.

Q.No.31. What is Machine Learning? What are the applications and risks associated with Machine Learning?   (B)

Machine Learning is a type of Artificial Intelligence (AI) that provides computers with the ability to learn without being explicitly programmed. Machine learning focuses on the development of computer programs that can change when exposed to new data. The process of machine learning is similar to that of data mining.

For example:

1) Machine learning has been used for image, video, and text recognition, as well as serving as the power behind recommendation engines. Apple SIRI is a good example.

2) This technology is being is being used in autonomous vehicles, the google car.

APPLICATIONS: Virtually all applications were in AI using Machine learning so that some value is added.It includes specifically following application:

1) Autonomous vehicles 2) Medical diagnosis 3) Playing games 4) Search engines 5) Online assistants (such as Siri),

Risk: Machine learning being an application of AI, the nature of risks to it remain similar to those posed by AI systems.

SIMILAR QUESTIONS:

1. Machine learning is the science of getting computers to act without being explicitly programmed. Many researchers also think it is the best way to make progress towards human-level AI. Then write about Machine learning and its applications.

A. Refer above answer.

Q.No.32. What is Web 3.0? Write about Components of Web 3.0?   (B)

1) The term **Web 3.0,** also known as the Semantic Web, describes sites wherein the computers will be generated raw data on their own without direct user interaction.

2) **Web 3.0** standard uses semantic web technology, drag and drop mash-ups, widgets, user behavior, user engagement, and consolidation of dynamic web contents depending on the interest of the individual users.

3) Web 3.0 technology uses the "Data Web" Technology, which features the data records that are publishable and reusable on the web through query-able formats.

4) *An example of typical Web 3.0 application is the one that uses <u>content management systems along</u> <u>with artificial intelligence</u>. These systems can answer the questions posted by the users, because the application can think on its own and find the most probable answer, depending on the context, to the query submitted by the user.*

COMPONENTS OF WEB 3.0:

1) **Semantic Web:** This provides the web user a common framework that could be used to <u>share and</u> <u>reuse the data across various applications</u>, enterprises, and community boundaries. This allows the data and information to be readily intercepted by machines, so that the machines are able to take contextual decisions on their own.

2) **Web Services:** It is a software system that <u>supports computer-to-computer interaction</u> over the Internet.

SIMILAR QUESTIONS:

1. *Web 3.0* is slated to be the new paradigm in web interaction and will mark a fundamental change in how developers create websites. Comment

A. Refer above answer.

SECTION 2: QUESTIONS FOR ACADEMIC INTEREST FOR STUDENTS SELF STUDY

Q.No.1. Write about Web 4.0.   (C)

1) As technology evolves new application are coming into use. These applications are further changing the way individuals/businesses/ government interacts with each other and does business.

2) Moving ahead, a new concept Web 4.0 is set to evolve; proposed to be autonomous, proactive, content-exploring, self-learning, collaborative, and content-generating agents based on fully matured semantic and reasoning technologies as well as Artificial Intelligence.

3) These services will support adaptive content presentation that will use the Web database via an intelligent agent.

4) Examples might be services interacting with sensors and implants, natural-language services or virtual reality services.

THE END