

# 1

UNIT

## Internet of Things

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1-2 L (Sem-1 & 2)

Internet of Things

#### PART - 1

What is Internet of Things.

#### Questions-Answers

#### Long Answer Type and Medium Answer Type Questions

**Que 1.1.** Write short note on Internet of Things (IoTs).

#### Answer

1. The Internet of Things (IoT) describes the network of physical objects that are able to collect and transfer data over a wireless network without human intervention.
2. A 'physical object' can refer to any object, outfitted with sensors, that has the ability to gather and transfer data over a network. For example a connected medical device, a biochip transponder, a solar panel, etc.
3. Connecting up all these different objects and adding sensors to them adds a level of digital intelligence to devices thus enabling them to communicate real-time data.
4. The Internet of Things is making the fabric of the world around us more smarter and more responsive, merging the digital and physical universes.
5. IoT provides businesses and people better insight into and control over objects and environments that are currently beyond the reach of the internet.
6. By doing so, IoT helps businesses and people to be more connected to the world around them and to do more meaningful, higher-level work.

**Que 1.2.** Give the importance of Internet of Things (IoT).

#### Answer

1. Over the past few years, IoT has become one of the most important technologies of the 21<sup>st</sup> century.
2. Since we can connect everyday objects to the internet via embedded devices, seamless communication is possible between people, processes, and things.
3. By means of low-cost computing, the cloud, big data, analytics, and mobile technologies, physical things can share and collect data with minimal human intervention.

4. In this hyperconnected world, digital systems can record, monitor, and adjust each interaction between connected things.
5. The physical world meets the digital world—and they cooperate.

**Que 1.3.** Explain the vision of Internet of Things.

**Answer**

1. The vision of the Internet of Things (IoT) can be seen from two perspectives "internet centric" and "thing centric".
2. The internet centric architecture involves internet services as the main focus, as data is being generated by the "things".
3. In the thing centric architecture, smart devices take the center stage.
4. There are a number of factors powering the progression of the IoT within the digital economy, including:
  - a. Powerful new mobile, wearable or connected devices.
  - b. Application (apps) that fuel demand for mobile data and test the limits of the network within most industry sector.
  - c. Cloud-based apps and those that rely on content stored in the cloud, which will increase as development accelerates on new platform as a service, mobile point of sale and independent software vendor platforms.
  - d. New use cases, such as mobile video, which will be significant factors in driving expensive capacity upgrades in networks.
5. Device evolution, cloud-based application innovation and the proliferation of communication technologies within all industries will ensure the exponential growth in the demand for mobile-connected devices.
6. As a result, the expected throughput and performance of each device will continue to increase in the next decade.

**Que 1.4.** What technologies have made IoT possible?

**Answer**

Following are different technologies that have made IoT possible :

1. **Access to low-cost, low-power sensor technology** : Affordable and reliable sensors are making IoT technology possible for more manufacturers.
2. **Connectivity** : A host of network protocols for the internet has made it easy to connect sensors to the cloud and to other "things" for efficient data transfer.
3. **Cloud computing platforms** : The increase in the availability of cloud platforms enables both businesses and consumers to access the

infrastructure they need to scale up without actually having to manage it all.

4. **Machine learning and analytics** : With advances in machine learning and analytics, along with access to varied and vast amounts of data stored in the cloud, businesses can gather insights faster and more easily.
5. **Conversational artificial intelligence (AI)** : Advances in neural networks have brought natural-language processing to IoT devices and made them appealing, affordable, and viable for home use.

**Que 1.5.** What are the advantages and disadvantages of IoT ?

**Answer**

**Advantages :**

1. **Efficient resource utilization** : If we know the functionality and the way that how each device work we definitely increase the efficient resource utilization as well as monitor natural resources.
2. **Minimize human effort** : As the devices of IoT interact and communicate with each other and do lot of task for us, they minimize the human effort.
3. **Save time** : As it reduces the human effort it definitely saves out time. Time is the primary factor which can be saved through IoT platform.

**Disadvantages :**

1. **Security** : As the IoT systems are interconnected and communicate over networks. The system offers little control despite any security measures, and it can be lead the various kinds of network attacks.
2. **Privacy** : Even without the active participation on the user, the IoT system provides substantial personal data in maximum detail.
3. **Complexity** : Designing, developing, maintaining and enabling the large technology to IoT system is quite complicated.

**PART-2**

Sensors, their Types and Features.

Questions-Answers

Long Answer Type and Medium Answer Type Questions

**Que 1.6.** What is a sensor ?

**Answer**

1. Sensors are devices that detect external information, replacing it with a signal that humans and machines can distinguish.
2. Sensors made it possible to collect data in most situations and are used in various fields - medical care, nursing care, industrial, logistics, transportation, agriculture, disaster prevention, tourism, regional businesses and many more.
3. With the expansion of the fields in which sensors play an important role, the market is still growing with a variety of sensors.
4. A good sensor has following three features :
  - i. It should be sensitive to the phenomenon that it measures.
  - ii. It should not be sensitive to other physical phenomena.
  - iii. It should not modify the measured phenomenon during the measurement process.

**Que 1.7.** What is the purpose of a sensor ?**Answer**

1. A sensor converts the physical action to be measured into an electrical equivalent and processes it so that the electrical signals can be easily sent and further processed.
2. The sensor can output whether an object is present or not present (binary) or what measurement value has been reached (analog or digital).
3. Sensors interpret information from the real world and convert it to a signal that can be processed (by the main processing unit).
4. Sensors can have various Voltage outputs 5 volts, 10 volts, -5 to +5 volts and more. Sensors having a Voltage output are calibrated over this range against various engineering units such as so that the output value corresponds to a specific value of pressure, temperature, load, tilt etc.
5. Sensor data is the output of a device that detects and responds to some type of input from the physical environment. The output may be used to provide information or input to another system or to guide a process.

**Que 1.8.** What are the different types of sensors used in IoT ? Give the features of sensor.**Answer**

Different types of sensor are :

1. **Temperature sensors** : Temperature sensors detect the temperature of the air or a physical object and convert that temperature level into

an electrical signal that can be calibrated accurately to reflect the measured temperature.

2. **Pressure sensors** : Pressure sensors measure the pressure or force per unit area applied to the sensor and can detect things such as atmospheric pressure, the pressure of a stored gas or liquid in a sealed system such as tank or pressure vessel, or the weight of an object.
3. **Motion sensors** : Motion sensors or detectors can sense the movement of a physical object by using any one of several technologies, including passive infrared (PIR), microwave detection, or ultrasonic, which uses sound to detect objects.
4. **Level sensors** : Level sensors translate the level of a liquid relative to a benchmark normal value into a signal. Fuel gauges display the level of fuel in a vehicle's tank, as an example, which provides a continuous level reading.
5. **Image sensors** : Image sensors function to capture images to be digitally stored for processing. License plate readers are an example, as well as facial recognition systems. Automated production lines can use image sensors to detect issues with quality such as how well a surface is painted after leaving the spray booth.
6. **Proximity sensors** : Proximity sensors can detect the presence or absence of objects that approach the sensor through a variety of different technology designs.

**Features of sensor** : A sensor has following important features :

1. **Range** : The maximum and minimum values of the phenomenon that the sensor can measure.
2. **Sensitivity** : The minimum change of the measured parameter that causes a detectable change in output signal.
3. **Resolution** : The minimum change in the phenomenon that the sensor can detect.

**PART-3***IoT Components, Layers.***Questions-Answers****Long Answer Type and Medium Answer Type Questions****Que 1.9.** What are the components of IoT ?

**Answer**

Different components of IoT are :

1. Sensors/Devices :
  - a. First, sensors or devices help in collecting very minute data from the surrounding environment.
  - b. All of this collected data can have various degrees of complexities ranging from a simple temperature monitoring sensor or a complex full video feed.
  - c. A device can have multiple sensors that can bundle together to do more than just sense things.
  - d. For example, our phone is a device that has multiple sensors such as GPS, accelerometer, camera but our phone does not simply sense things.

2. Connectivity :

- a. Next, that collected data is sent to a cloud infrastructure but it needs a medium for transport.
- b. The sensors can be connected to the cloud through various mediums of communication and transports such as cellular networks, satellite networks, Wi-Fi, Bluetooth, wide-area networks (WAN), low power wide area network and many more.
- c. Every option we choose has some specifications and trade-offs between power consumption, range, and bandwidth.

3. Data Processing :

- a. Once the data is collected and it gets to the cloud, the software performs processing on the acquired data.
- b. This can range from something very simple, such as checking that the temperature reading on devices such as AC or heaters is within an acceptable range.
- c. It can sometimes also be very complex, such as identifying objects using computer vision on video.

4. User Interface :

- a. Next, the information made available to the end-user in some way.
- b. This can be achieved by triggering alarms on their phones or notifying through texts or emails.
- c. Also, a user sometimes might also have an interface through which they can actively check in on their IoT system.
- d. For example, a user has a camera installed in his house; he might want to check the video recordings and all the feeds through a web server.

Que 1.10. Explain the architectural view of IoT.

**Answer**

Architectural view of IoT consists of three layers. The functionalities of the layers are specified as :

1. Perception layer :

  - a. Object identification and information collection is the main function of this layer.
  - b. It comprises of sensors, actuators, RFID tags, RFID readers/writers and information display units (like PDA, Tablet PC, cell phone etc.)

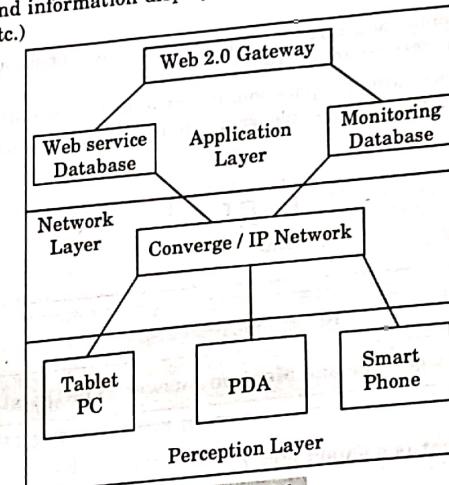


Fig. 1.10.1.

2. Network layer :

- a. Information transfer that is collected via perception layer is the main objective of this layer.
- b. Wireless networks, wired networks, internet, network management systems are the major components of the network layer.

3. Application layer : Event detection, intelligent solutions and to perform user required functions is the responsibility of this layer.

Que 1.11. Describe different layers of IOT.

**Answer**

Different layers of IOT are :

**1. Perception layer :**

- i. The perception layer is the physical layer, which has sensors for sensing and gathering information about the environment.
- ii. It senses some physical parameters or identifies other smart objects in the environment.

**2. Network layer :**

- i. The network layer is responsible for connecting to other smart things, network devices, and servers.
- ii. Its features are also used for transmitting and processing sensor data.

**3. Application layer :**

- i. The application layer is responsible for delivering application specific services to the user.
- ii. It defines various applications in which the Internet of Things can be deployed, for example, smart homes, smart cities, and smart health.

**PART-4**

*Smart Cities.*

**Questions-Answers**

**Long Answer Type and Medium Answer Type Questions**

**Que 1.12. What is a smart city ?**

**Answer**

1. A smart city is a framework, predominantly composed of Information and Communication Technologies (ICT), to develop, deploy, and promote sustainable development practices to address growing urbanization challenges.
2. Main part of this ICT framework is an intelligent network of connected objects and machines that transmit data using wireless technology and the cloud.
3. Cloud-based IoT applications receive, analyze, and manage data in real-time to help municipalities, enterprises, and citizens make better decisions that improve quality of life.
4. Citizens can engage with smart city ecosystems in various ways using smartphones and mobile devices and connected cars and homes.

- 5. Pairing devices and data with a city's physical infrastructure and services can cut costs and improve sustainability.
- 6. Communities can improve energy distribution, decrease traffic congestion, and even improve air quality with help from the IoT.

**Que 1.13. What makes smart cities successful ?**

**Answer**

Following four essential elements are necessary for thriving smart cities :

**1. Pervasive wireless connectivity :**

- i. The first building block of any smart city application is reliable, pervasive wireless connectivity.
- ii. Low Power Wide Area Network (LPWAN) technologies are well suited to most smart city applications because of their cost efficiency.
- iii. These technologies include LTE Cat M, NB-IoT, Bluetooth, and a few others.

**2. Open data :**

- i. Privacy concerns and fear of security breaches have far outweighed the perceived value of sharing information.
- ii. However, a key enabler of sustainable smart cities is that all participants in the complex ecosystem share information and combine it with contextual data that is analyzed in real-time.
- iii. Multiple sectors must cooperate to achieve better, sustainable outcomes by analyzing real-time contextual information.

**3. Security you can trust in :**

- i. Connected cameras, intelligent road systems, and public safety monitoring systems can provide an added layer of protection and emergency support to aid citizens when needed.
- ii. Physical data vaults and strong authentication and ID management solutions can defend against hacking, cyber-attacks, and data theft.
- iii. Smart cities can only work if we can trust them.

**4. Flexible monetization schemes :**

- i. For smart cities to thrive, we need to establish sustainable commerce models that facilitate all ecosystem players' success.
- ii. The software must be woven into the fabric of IoT solutions to benefit all ecosystem contributors.
- iii. Each member's intellectual property needs to be valued and rewarded.

**PART-5***Industrial IoT.***Questions-Answers****Long Answer Type and Medium Answer Type Questions**

**Que 1.14.** What is the industrial internet of things (IIoT)?

**Answer**

1. The industrial internet of things (IIoT) refers to the extension and use of the internet of things (IoT) in industrial sectors and applications.
2. With a strong focus on machine-to-machine (M2M) communication, big data, and machine learning, the IIoT enables industries and enterprises to have better efficiency and reliability in their operations.
3. The IIoT encompasses industrial applications, including robotics, medical devices, and software-defined production processes.
4. What makes IIoT distinct is the intersection of information technology (IT) and operational technology (OT).
5. The convergence of IT and OT provides industries with greater system integration in terms of automation and optimization, as well as better visibility of the supply chain and logistics.

**Que 1.15.** What are the risks to IIoT systems?

**Answer**

Following are the risks to IIoT systems :

1. Software vulnerabilities that can be exploited to attack systems.
2. Publicly searchable internet-connected devices and systems.
3. Malicious activities like hacking, targeted attacks, and data breaches.
4. System manipulation that can cause operational disruption (e.g., product recalls) or sabotage processes (e.g., production line stoppage).
5. System malfunction that can result in damage of devices and physical facilities or injury to operators or people nearby.
6. OT systems held for extortion, as compromised through the IT environment.

**Que 1.16.** What are the challenges that are linked with IoT?

**Answer**

Challenges that are linked with the IoT are :

1. **Standards :** There is no standard available for the deployment of IoT globally that may make it conventional for the people.
2. **Network foundation :** Limitations imposed due to the current internet architecture for mobility, scalability, manageability and availability, IoT network establishment is facing difficulties.
3. **Security, privacy and trust :** The crucial areas in IoT are security, privacy and trust.
  - a. In security area, IoT domain is facing the following challenges :
    - i. Security to be ensured at design time and execution time for the architecture of IoT.
    - ii. Proactive identification and protection of IoT from arbitrary attacks (For example, DoS and DDoS attacks) and malicious software.
  - b. Privacy is the second major concern. The term of privacy in IoT means user/object privacy that is facing the following challenges :
    - i. There is no privacy control over personal information and location privacy of individual's physical location and movement.
    - ii. Unavailability of Standard Operation Procedures (SOP)/ methodologies and tools, privacy enhancement technologies and relevant protection laws.
  - c. Trust is having the specific following challenges :
    - i. The system must provide the environment for easy and natural exchange of critical protected and sensitive data. For example, smart objects may communicate with the available trusted services on behalf of users / organizations.
    - ii. The IoT system design must provide built-in trust facility for each available service.
4. **Identification and authentication :**
  - a. In IoT, purpose of identification and tracking entities is to protect identification from tracking by unauthorized attacks in the network.
  - b. It must be provided to users with right control over the privacy of their personal information.
5. **Integration and coordination :**
  - a. The challenge in IoT is how to collaborate with two different type of network, one of them is internet and other is the physical world and they work as a joint venture for meaningful results.

- b. In the integration, the major issues are cost, stability, communication speed, bandwidth, trust and security of the physical world and the internet.
- c. IoT requires collaboration and teamwork among people, programs, process and services to globally share the data.

**Que 1.17.** What are the five entities considered behind an IoT system?

**Answer**

Five entities that can be considered behind an IoT system are:

1. Device platform consisting of device hardware and software using a microcontroller and software for the device APIs and web application.
2. Connecting and networking (connectivity protocols, and circuits) enabling internetworking of devices and physical object called things, and enabling the internet connectivity to remote servers.
3. Server and web programming enables web applications and web services.
4. Cloud platform enables storage, computing prototype and product development platforms.
5. Online transactions processing, online analytics processing, data analytics, predictive analytics, and knowledge discovery enables wider applications of an IoT system.

**Que 1.18.** Give example of hardware sources for IoT prototype development.

**Answer**

Examples of hardware sources for IoT prototype development are:

1. **Arduino Yún :**
  - i. Arduino Yún board uses microcontroller ATmega32u4 that supports Arduino and includes Wi-Fi, Ethernet, USB port, micro-SD card slot and three reset buttons.
  - ii. The board also combines with Atheros AR9331 that runs Linux.
2. **Microduino :**
  - i. Microduino is a small board compatible with Arduino that can be stacked with the other boards.
  - ii. All the hardware designs are open source.
3. **Intel Galileo :**
  - i. Intel Galileo is a line of Arduino-certified development boards.
  - ii. Galileo is based on Intel x86 architecture.

- iii. It is open-source hardware that features the Intel SoC X1000 Quark based Soc.
- iv. Galileo is pin-compatible with Arduino. It has 20 digital I/O (12 GPIOs fully native), 12-bit PWM for more precise control, six analog inputs and supports power over Ethernet (PoE).

**4. Intel Edison :**

- i. Intel Edison is a compute module.
- ii. It enables creation of prototypes and fast development of prototyping projects and rapidly produces IoT and wearable computing devices.
- iii. It enables seamless device internetworking and device-to-cloud communication.
- iv. It includes foundational tools which collect, store and process data in the cloud, and process rules on the data stream.
- v. It generates triggers and alerts based on advanced analytics.

**5. BeagleBone Board :**

- i. BeagleBone based board has very low power requirement.
- ii. It is a card-like computer which can run Android and Linux.
- iii. Both the hardware designs and the software for the IoT devices are open source.

**6. Raspberry Pi Wireless Inventors Kit (RasWIK) :**

- i. RasWIK enables Raspberry Pi Wi-Fi connected devices.
- ii. It includes documentation for 29 different projects.
- iii. This devices are not open source but all of the included code is open source, and we can use it to build commercial products as well.

**Que 1.19.** Describe communication technology in IoT.

**Answer**

1. Communication technologies play an important role in any wireless network.
2. The networks comprise on energy constraint devices require low power communication technologies.
3. Internet of Things (IoT) is a new and progressing concept that provides connectivity to the internet via smart sensing devices to attain identification and management in a heterogeneous connectivity environment.
4. Various communication technologies for Wireless Personal Area Networks (WPAN) like IoT are available presenting several properties.
5. IoT concept involves all heterogeneous objects around us communication with each other locally and via internet globally.

6. Such kind of network poses several challenges and requirements for choosing the best amongst the available communication technologies.

**Que 1.20.** Explain communication technologies that are utilized by IoT devices.

**Answer**

The major communication technologies that can be utilized by IoT devices are:

**1. ZigBee :**

- a. ZigBee is IEEE 802.15.4 standard.
- b. It is reliable wireless networking technology.
- c. It is designed for limited range network monitoring and controlling due to its low data rate and short range.
- d. The main area of utilization of this technology is in home automation, smart energy devices, lighting, HVAC and security etc.
- e. Due to its low-power, high level communication protocol using small digital radios, it comes under Wireless Personal Area Network (WPAN).

**2. RFID :**

- a. RFID has been categorized as the enabling communication for the Internet of Things, due to its low cost, high mobility and efficiency in identifying devices and objects.
- b. The Radio Frequency Identification (RFID) technology has been initially introduced for identifying and tracking objects with the help of small electronic chips, called tags.
- c. It can provide communication range between 100m and 1km (depending on the transmission power and the antenna used).
- d. Data rates are quite low (up to 1 Mbps) and also need an Internet-enabled gateway that will provide access to the devices for making a complete IoT network.

**3. Bluetooth :**

- a. Bluetooth is an IEEE 802.15.1 standard for low cost, short range and cheap devices of wireless radio technology.
- b. Bluetooth has been one of the first wireless communication protocols designed with low power consumption for replacing short-range wired communications, short distance data sharing and devices mobility support.
- c. It has a property of creating personal area network during communication and discovers and communicates to its neighbour without need to be in visual line of sight.

**4. 6LoWPAN :**

- a. The 6LoWPAN is Wireless PAN with low power and supports IPv6 network.
- b. It is a connection oriented technology in which router forward the data to its next hop to 6LoWPAN gateway which is connected to 6LoWPAN with the IPv6 domain and then forward the data to its respected device correctly.
- c. In IP based network standard protocols (HTTP, TCP/IP) are directly applied on sensor nodes just as they do with traditional web servers out there in the Internet.

**5. 6Z-Wave :**

- a. It is low power consuming which mostly used in automation and light commercial environment.
- b. It has an open communication protocol.
- c. The main purpose of 6Z-wave is for a reliable message passing from a control unit to one or more nodes in the network.

**6. Wi-Fi :**

- a. Wireless fidelity is known as Wi-Fi, the IEEE 802.11x standards, is the most common way to connect devices wirelessly to the internet.
- b. Laptop, Smartphone and tablet PC are equipped with Wi-Fi interfaces and talk to wireless router and provide two way accesses to the internet.
- c. The Wi-Fi standard family allows establishing wireless network on short distances.
- d. The Wi-Fi group is working on unlicensed spectrum of 2.4 GHz (ISM) band.





## Cloud Computing

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#### PART- 1

*Cloud Computing : its Nature and Benefits.*

#### Questions-Answers

#### Long Answer Type and Medium Answer Type Questions

**Que 2.1.** What do you mean by cloud computing ? Also, give its properties.

#### Answer

1. Cloud computing is the means of delivering all IT from computer applications, software, business processes, messaging, and collaboration to end users as a service wherever and whenever they need it.
2. Cloud computing is a paradigm for delivering IT where rapid provisioning is an important characteristic for computing resources, data applications and IT.
3. Cloud computing helps us to face the challenges such as :
  - i. Decreasing the capex and opex cost.
  - ii. Enhancing the service quality.
  - iii. Maintaining the desired and right level of security, compliances, regulations, and policies across the different functions of enterprise.
  - iv. Rapid provisioning, agility, and business transparency for consistent self-service delivery.
4. Thus, cloud computing is the service and deployment model using large resource pool based provisioning of virtual or physical resources in a service model using the internet (public cloud) or intranet (private cloud).

Properties of cloud computing are :

1. **User centric** : This means once a user is connected to cloud any data, such as images, videos, applications, becomes his property. Not only the data but the devices connected to it and the user can share it with other users.
2. **Task centric** : Cloud computing focus on what one need and how application can do it. Here documents are given more priority than the applications which create them.
3. **Self healing** : In self healing, backups are available for every document in the cloud. Hence, if one document crashes there will be its duplicate ready to run.

4. **Multi-tenancy and intelligence :** Multi-tenancy refers to sharing of data and costs across a large pool of users. As various data are stored in cloud, data mining and analysis are necessary for accessing information in an intelligent manner.
5. **Programmable :** Many processes in cloud computing shall be automated such as backing up crashed data with its duplicate. Hence, programming is associated with cloud computing.
6. **Flexible :** Flexible as the users may be of different varieties and hence it has to match with their needs.

**Que 2.2.** Explain the evolution of cloud computing.

**Answer**

**Evolution of cloud computing :**

**1. Grid computing :**

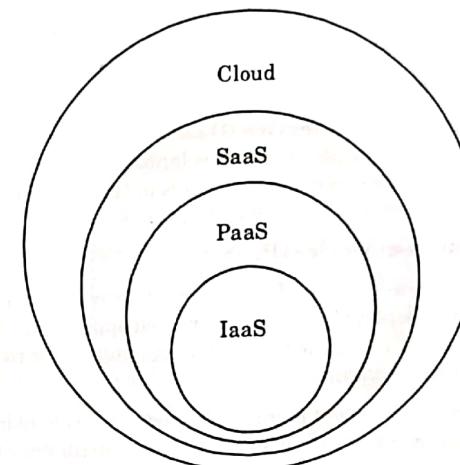
- i. Grid computing appeared in the early 1990s as an evolution of cluster computing.
- ii. Grid computing proposed a new approach to access large computational power, huge storage facilities, and a variety of services. Users can consume resources in the same way as they use other utilities such as power, gas, and water.
- iii. Grids initially developed as aggregation of geographically dispersed cluster by means of internet connection.
- iv. These clusters belonged to different organizations and arrangements were made among them to share the computational power.
- v. Different from a large cluster, a computing grid was a dynamic aggregation of heterogeneous computing nodes, and its scale was nationwide or even worldwide.

**2. Utility computing :**

- i. Utility computing is a vision of computing, defining a service provisioning model for computing services in which resources such as storage, compute power, applications, and infrastructure are packaged and offered on a pay-use basis.
- ii. The business model introduced with utility computing brought new requirements and led to an improvement of mainframe technology, additional features such as operating systems, process control and user metering facilities.
- iii. The idea of computing as utility remained and extended from the business domain to the academia with the advent of cluster computing.

**3. Software-as-a-Service :**

- i. Software-as-a-Service (SaaS) model enables the customer to use the provided application hosted on the cloud infrastructure.
- ii. In this model, the customer does not have any control over the cloud infrastructure but has a little control over the application configuration settings.
- iii. The applications are accessible from the client devices such as thin client or web browser interface.



**Fig. 2.2.1. Cloud services.**

**4. Cloud computing :** Refer Q. 2.1, Page 2-2L, Unit-2.

**Que 2.3.** Discuss the architecture of cloud computing.

**Answer**

Cloud computing architecture refers to the components and subcomponents required for cloud computing. These components consist of :

**1. Front end platform :**

- i. Cloud computing architecture consists of front end platforms called clients or cloud clients.
- ii. These clients comprise servers, fat (or thick) clients, thin clients, zero clients, tablets and mobile devices.
- iii. These client platforms interact with the cloud data storage through an application (middleware), through a web browser, or through a virtual session.

iv. The front end refers to the client part of cloud computing system, it consists of interfaces and applications that are required to access the cloud computing platforms like web browser.

## 2. Back end platform :

- The back end refers to the cloud itself. It consists of all the resources required to provide cloud computing services.
- It comprises of huge data storage, virtual machines, security mechanism, services, deployment models, servers, etc.
- It is online network storage where data is stored and accessible to multiple clients.

## 3. Cloud based delivery : These include the following :

- Software-as-a-Service (SaaS) :** Refer Q. 2.2, Page 2-3L, Unit-2.
- Development-as-a-Service (DaaS) :** Development as a service is web-based, community shared development tools. This is equivalent to locally installed development tools in the traditional (non-cloud computing) delivery of development tools.
- Platform-as-a-Service (PaaS) :**

- Platform-as-a-Service (PaaS) model provides capacity to the customer to deploy the customer-created applications into the cloud infrastructure using the programming language or tools supported by the cloud provider.
- The consumer does not manage the underlying cloud infrastructure such as network, storage, etc., but has control over the deployed applications.
- It also provides solutions for integrating cloud computing into existing application, services, and infrastructure with a market-oriented approach.

## iv. Infrastructure-as-a-Service (IaaS) :

- Infrastructure-as-a-Service (IaaS) model allows the customer to provision processing, storage, network and other important software such as operating system and applications.
- The consumer does not have control over the underlying infrastructure but has control over the operating systems, storage and deployed applications.

## 4. Network : The cloud network layer offers :

- High bandwidth (low latency) :** Allowing users to have uninterrupted access to their data and applications.
- Agile network :** On-demand access to resources requires the ability to move quickly and efficiently between servers and possibly even clouds.

iii. **Network security :** Security is always important, but when dealing with multi-tenancy, it becomes much more important because we are dealing with segregating multiple customers.

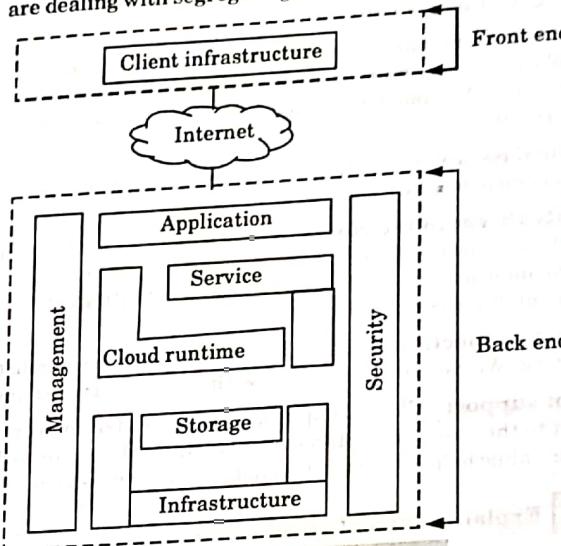


Fig. 2.3.1. Cloud computing architecture.

**Que 2.4.** What are the advantages and disadvantages of cloud computing ?

### Answer

#### Advantages of cloud computing :

- Cost saving :** It helps us to save substantial capital cost as it does not need any physical hardware investments.
- Strategic edge :** Cloud computing helps us to access the latest applications any time without spending our time and money on installations.
- High speed :** Cloud computing allows us to deploy our service quickly in fewer clicks. This faster deployment allows us to get the resources required for our system within fewer minutes.
- Reliability :** Through cloud computing we can always get instantly updated about the changes.
- Mobility :** Employees who are working on the premises or at the remote locations can easily access all the cloud services. All they need is internet connectivity.

- 6. Unlimited storage capacity :** Cloud computing offers limitless storage capacity.

#### Disadvantages of cloud computing :

1. **Performance can vary :** When we are working in a cloud environment, our application is running on the server which simultaneously provides resources to other businesses that can affect the performance of our shared resource.
2. **Technical issues :** Cloud technology is always prone to an outage and other technical issues.
3. **Security threat in the cloud :** Before adopting cloud technology, we should be well aware of the fact that we will be sharing all our company's sensitive information to a third-party cloud computing service provider. Hackers might access this information.
4. **Internet connectivity :** Good internet connectivity is must in cloud computing. We cannot access cloud without an internet connection.
5. **Lack of support :** Cloud computing companies fail to provide proper support to the customers. Moreover, they want their user to depend on FAQs or online help, which can be a tedious job for non-technical persons.

#### Que 2.5. Explain vision of cloud computing.

##### Answer

1. Cloud computing provides the facility to provision virtual hardware, runtime environment and services to a person having money.
2. These all things can be used as long as they are needed by the user.
3. The whole collection of computing system is transformed into collection of utilities, which can be provisioned and composed together to deploy systems in hours rather than days, with no maintenance costs.
4. The long term vision of a cloud computing is that IT services are traded as utilities in an open market without technological and legal barriers.
5. In the future, we can imagine that it will be possible to find the solution that matches with our requirements by simply entering out request in a global digital market that trades with cloud computing services.
6. The existence of such market will enable the automation of discovery process and its integration into its existing software systems.
7. Due to the existence of a global platform for trading cloud services will also help service providers to potentially increase their revenue.
8. A cloud provider can also become a consumer of a competition service in order to fulfill its promises to customers.

**Que 2.6. Discuss the issues related to cloud computing.**

##### Answer

Several issues related to cloud computing are :

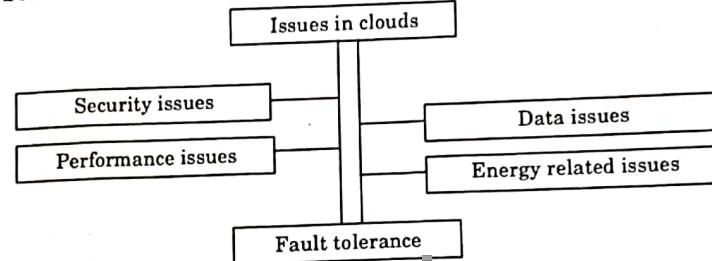


Fig. 2.6.1.

**Security issues :** Some of the security problems which are faced by the cloud computing are as follows :

1. **Data integrity :** When a data is on a cloud, anyone from any location can access those data from the cloud. Cloud does not differentiate between a sensitive data from a common data thus enabling anyone to access those sensitive data. Thus there is a lack of data integrity in cloud computing.
2. **Data theft :** Most of the cloud vendors instead of acquiring a server try to lease a server from other service providers because they are cost effective and flexible for operation.
3. **Security on vendor level :** Vendor should make sure that the server is well secured from all the external threats it may come across. A cloud is good only when there is good security provided by the vendor to the customers.
4. **Security on user level :** Even though the vendor has provided good security layer for the customer, the customer should make sure that because of its own action, there should not be any loss of data or tampering of data for other users who are using the same cloud.
5. **Information security :** Security related to the information exchanged between different hosts or between hosts and user. This issues pertaining to secure communication, authentication, issues concerning single sign on and delegation.

**Data issues :** Various data issues in cloud computing are as follows :

1. **Data loss :** If the vendor closes due to financial or legal problems there will be a loss of data for the customers. The customers will not be able to access those data because data is no more available for the customer as the vendor shut down.

2. **Data location :** When it comes to location of the data nothing is transparent even the customers do not know where his own data are located. The vendor does not reveal where all the data are stored. The data will not even be in the same country of the customer, it might be located anywhere in the world.
3. **Data lock-in :** Software stacks have improved interoperability among platforms, but the APIs for cloud computing itself are still essentially proprietary, or at least have not been the subject of active standardisation. Thus, customers cannot easily extract their data and programs from one site to run on another.
4. **Data segregation :** Data in the cloud is typically stored in a shared environment whereby one customer's data is stored alongside another customer's data, hence it is difficult to assure data segregation.
5. **Data confidentiality and auditability :** Current cloud offerings are essentially public (rather than private) networks, exposing the system to more attacks. Auditability could be added as an additional saver beyond the reach of the virtualized guest OS providing facilities arguably more secure than those built into the applications themselves and centralizing the software responsibilities related to confidentiality and auditability to a single logical layer.
6. **Data integrity :** One of the biggest concerns with cloud data storage is the verification of data integrity at untrusted servers, and how to deal with sensitive data. It is not an easy task to maintain customer's most sensitive cloud data securely, which is needed in many applications for clients.
7. **Deletion of data :** Data that has to be deleted by the user because he or she no longer needs it or many no longer process it for another reason is also deleted by the provider and no more copies of data are available. This can lead to problems, particular in connection with backups.
8. **Service level agreements :** According to the purpose for which the data is processed, it is important to agree on binding service levels for availability and data recovery and if necessary, safe guarded by supporting fixed penalties in the event of non-compliance with the agreed service levels.

Various performance issues in cloud computing are :

1. **Poor application performance or application hang-ups :** Usually the application is starved for RAM or CPU cycles, and faster processors or more RAM is added.
2. **Slow access to applications and data :** Bandwidth is usually the cause, and the most common solution is to add faster network connections.
3. **Horizontal and vertical scalability :**

- i. **Vertical scaling :** Vertical scaling (up) entails adding more resources to the same computing pool.
- ii. **Horizontal scaling :** Horizontal scaling (out) requires the addition of more machines/devices to the computing platform to handle the increased demand. Sustained increases in demand, however, require horizontal scaling and load balancing to restore and maintain peak performance.

**Energy related issues :** Various energy related issues are as follows :

1. Cloud computing is rapidly growing in importance as increasing numbers of enterprises and individuals are shifting their workload to cloud service providers.
2. The electricity costs involved in operating a large cloud infrastructure of multiple data centres can be enormous. In fact, cloud service providers often must pay for the peak power they draw, as well as the energy they consume.
3. Lowering these high operating costs is one of the challenges facing cloud service providers.
4. Insufficient or malfunctioning cooling system can lead to overheating of the resources reducing system reliability and devices lifetime.
5. High power consumption by the infrastructure leads to substantial carbon dioxide ( $\text{CO}_2$ ) emission contributing to the greenhouse effect.

**Fault tolerance :**

1. Fault tolerance is one of the key issues of cloud computing. Fault tolerance is concerned with all the techniques necessary to enable a system to tolerate software faults.
2. These software faults may or may not manifest themselves during systems operations, but when they do, software fault tolerant techniques should provide the necessary mechanisms of the software system to prevent system failure occurrences.
3. Fault tolerance techniques are employed during the procurement, or development, of the software. When a fault occurs, these techniques provide mechanisms to the software system to prevent system failure from occurring.

**Que 2.7. What are the hurdles in cloud computing ?**

**Answer**

**Hurdles in cloud computing :**

1. **Security :**
  - i. As the services are opened and delivered over the network between the cloud service provider and the consumer, the security in this model is perceived at higher levels.

- ii. Other inhibitors can be location-independent resource pooling or where consumer does not know where his services are running or where his data is stored.
- iii. Limited service management and monitoring capabilities in the public cloud model also add to the complexities.

**2. Regulation and compliances :**

- i. There is a need of data governance models to be established in the enterprises and federating data privacy.
- ii. In large organizations, IT delivery is taken with the concerns of reliability, performance, and availability.
- iii. There are different levels of maturities for organizations seeking different levels of Service Level Agreements (SLA) but cloud service providers are not equipped to deliver the services.
- iv. There is a need of stringent Recovery Point Objective (RPO) and the Recovery Time Objective (RTO) with the agreed number of mins/hours down-time.

**3. Cloud migration :**

- i. This requires the property of powerful interoperability of platforms that should identify the appropriate application that can be migrated to the cloud.
- ii. It is important to identify the interdependencies and integration points with standards and interfaces that are lacking among service providers.
- iii. Cloud migration becomes more complex if the service bundles are integrated from multiple cloud service providers. This can also become the deal breaker or the reason for downgraded performance.

**4. Workload suitability for cloud :**

- i. Not all the applications are suitable candidates for the cloud.
- ii. It depends on the function of the business, enterprise policies, application architecture, scalability, suitability, usage patterns according to pay-per-use-model, or infrastructure requirements in the service model.

**Que 2.8. Write some applications of cloud computing.**

**Answer**

**Applications of cloud computing :**

1. **Big data analytics :** From fraud recognition to statistical investigation, big data exist universally. Analyse how Hadoop and great presentation computing clusters can be set-up in both public and private clouds.

2. **Develop and test :** Build and test applications in on-requirement platforms using constantly configured resources, lower expenditure, and decreased release cycles.
3. **Disaster recovery :** Public and private clouds facilitate commercial solutions to maintain highly accessible applications with flexible multiple datacentres and provider architectures, and reduce down-time and data loss.
4. **Gaming applications :** Distribute flexible capacity to assemble random traffic actions and to lower expenditure for the ongoing life cycle management by public and private clouds.
5. **Web and mobile applications :** Deploy mobile applications and web applications that are extremely scalable and accessible across a range of verified architectures, technologies and clouds.

**Que 2.9. Give limitations of cloud computing.**

**Answer**

**Limitations of cloud computing :**

**1. Data protection :**

- i. Data security is a crucial element that warrants scrutiny.
- ii. Enterprises are reluctant to buy an assurance of business data security from vendors.
- iii. They fear losing data to competition and the data confidentiality of consumers.
- iv. In many instances, the actual storage location is not disclosed, adding onto the security concerns of enterprises.
- v. In the existing models, firewalls across datacentres (owned by enterprises) protect this sensitive information.
- vi. In the cloud model, service providers are responsible for maintaining data security and enterprises would have to rely on them.

**2. Data recovery and availability :**

- i. All business applications have service level agreements that are stringently followed.
- ii. Operational teams play a key role in management of service level agreements and runtime governance of applications.
- iii. In production environments, operational teams support :
  - a. Appropriate clustering and fail over
  - b. Data replication
  - c. System monitoring (transactions monitoring, logs monitoring and others)
  - d. Maintenance (runtime governance)

- e. Disaster recovery
- f. Capacity and performance management.

**3. Management capabilities :**

- i. Despite there being multiple cloud providers, the management of platform and infrastructure is still in its infancy.
- ii. For example, features like Auto-scaling are a crucial requirement for many enterprises.
- iii. There is huge potential to improve on the scalability and load balancing features provided today.

**4. Regulatory and compliance restrictions :**

- i. In some of the European countries, government regulations do not allow customer's personal information and other sensitive information to be physically located outside the state or country.
- ii. In order to meet such requirements, cloud providers need to set-up a datacentre or a storage site exclusively within the country to comply with regulations.
- iii. Having such an infrastructure may not always be feasible and is a big challenge for cloud providers.

**Que 2.10. What are the characteristics of cloud computing ?**

**Answer**

**Characteristics of cloud computing are :**

1. **On demand self-service :** Resources can automatically be provisioned without the need of human interaction as and when needed.
2. **Compatibility :** Cloud services allow access to the data from any location and on any device. Employees can work from anywhere.
3. **Elasticity :** Cloud services are scalable. Consumers can add resources they need and discard resources they do not want.
4. **Reliability :** Cloud runs on multiple servers and is automated to run even if one server fails. Resources are drawn from the other servers to ensure continuity without any interruption.
5. **Disaster recovery :** With replication and storing across multiple servers, cloud allows easy cost-effective solutions at times of data loss due to some theft or calamity.
6. **Updates :** Consumers need not worry about software updates and technical issues. The cloud servers are located in different places away from our business premises. The providers do all the updates and patches.
7. **Security :** Cloud services offers enhanced security. We can access our data from any system even if we lose our personal device.

**PART-2**

AWS.

**Questions-Answers**

**Long Answer Type and Medium Answer Type Questions**

**Que 2.11. Write short note on AWS.**

**Answer**

1. AWS (Amazon Web Services) is a comprehensive, evolving cloud computing platform provided by Amazon that includes a mixture of infrastructure as a service (IaaS), platform as a service (PaaS) and packaged software as a service (SaaS) offerings.
2. AWS services can offer an organization tools such as compute power, database storage and content delivery services.
3. AWS launched in 2006 from the internal infrastructure that Amazon.com built to handle its online retail operations.
4. AWS was one of the first companies to introduce a pay-as-you-go cloud computing model that scales to provide users with compute, storage or throughput as needed.
5. AWS is separated into different services; each can be configured in different ways based on the user's needs.
6. Users should be able to see configuration options and individual server maps for an AWS service.

**Que 2.12. Describe storage service and database used in AWS.**

**Answer**

Following are the storage service used in AWS :

1. **S3 (Simple Storage Service) :**
  - a. Storage service of AWS in which we can store objects like files, folders, images, documents, songs, etc.
  - b. It cannot be used to install software, games or Operating System.
2. **EFS (Elastic File System) :**
  - a. Provides file storage for use with your EC2 instances.
  - b. It uses NFSv4 protocol and can be used concurrently by thousands of instances.

3. **Glacier :** It is an extremely low-cost archival service to store files for a long time like a few years or even decades.
4. **Storage Gateway :**
  - a. It is a virtual machine that you install on your on-premise servers.
  - b. Your on-premise data can be backed up to AWS providing more durability.
- Following are the databases used by AWS :
  1. **RDS (Relational Database Service) :**
    - a. It allows you to run relational databases like MySQL, MariaDB, PostgreSQL, Oracle or SQL Server.
    - b. These databases are fully managed by AWS like installing antivirus and patches.
  2. **DynamoDB :**
    - a. It is a highly scalable, high-performance NoSQL database.
    - b. It provides single-digit millisecond latency at any scale.
  3. **ElastiCache :**
    - a. It is a way of caching data inside the cloud.
    - b. It can be used to take load off of your database by caching most frequent queries.
  4. **Neptune :**
    - a. It has been launched recently.
    - b. It is a fast, reliable and scalable graph database service.
  5. **RedShift :** It is AWS's data warehousing solution that can be used to run complex OLAP queries.

**Que 2.13. Explain developer tools used in AWS.**

**Answer**

Following are the developer tools used in AWS :

1. **CodeStar :**
  - a. It is a cloud-based service for creating, managing, and working with software development projects on AWS.
  - b. You can quickly develop, build, and deploy applications on AWS with an AWS CodeStar project.
2. **CodeCommit :** It is AWS's version control service that allows you to store your code and other assets privately in the cloud.
3. **CodeBuild :** It automates the process of building (compiling) your code.
4. **CodeDeploy :** It is a way of deploying your code in EC2 instances automatically.

5. **CodePipeline :** Allows you to keep track of different steps in your deployment like building, testing, authentication, and deployment on development and production environments.
6. **Cloud9 :** It is an IDE (Integrated Development Environment) for writing, running, and debugging code in the cloud.
7. **X-Ray :** It makes it easy for developers to analyze the behavior of their distributed applications by providing request tracing, exception collection, and profiling capabilities.

**Que 2.14. Describe Management Tools used in AWS.**

**Answer**

Following are the management tools used in AWS :

1. **CloudWatch :**
  - a. It can be used to monitor AWS environments like CPU utilization of EC2 and RDS instances and trigger alarms based on different metrics.
2. **CloudFormation :**
  - a. It is a way of turning infrastructure into the cloud.
  - b. You can use templates to provision a whole production environment in minutes.
3. **CloudTrail :**
  - a. A way of auditing AWS resources.
  - b. It logs all changes and API calls made to AWS.
4. **OpsWorks :** It helps in automating Chef deployments on AWS.
5. **Config :** It monitors your environment and notifies you when you break certain configurations.
6. **Service Catalog :** For larger enterprises, helps to authorize which services will be used and which won't be.
7. **Trusted Advisor :** Gives you recommendations on how to do cost optimizations, and secure your environment.
8. **AWS Auto Scaling :** Allows you to automatically scale your resources up and down based on CloudWatch metrics.
9. **Systems Manager :** Allows you to group your resources, so you can quickly gain insights, identify issues and act on them.
10. **Managed Services :** It provides ongoing management of your AWS infrastructure so you can focus on your applications.

**Questions-Answers****Long Answer Type and Medium Answer Type Questions**

**Que 2.15.** Write a short note on Google Cloud Platform (GCP).

**Answer**

1. Google Cloud Platform (GCP) is a suite of cloud computing services that runs on the same infrastructure that Google uses internally for its end-user products, such as Google Search, Gmail, file storage, and YouTube.
2. Alongside a set of management tools, it provides a series of modular cloud services including computing, data storage, data analytics and machine learning.
3. Google Cloud Platform provides infrastructure as a service, platform as a service, and serverless computing environments.
4. In April 2008, Google announced App Engine, a platform for developing and hosting web applications in Google-managed data centers, which was the first cloud computing service from the company.
5. Google Cloud Platform is a part of Google Cloud, which includes the Google Cloud Platform public cloud infrastructure, as well as Google Workspace, enterprise versions of Android and Chrome OS, and application programming interfaces (APIs) for machine learning and enterprise mapping services.

**Que 2.16.** Write a short note on Google App Engine (GAE).

**Answer**

1. Google App Engine (GAE) is a Platform-as-a-Service (PaaS) product that provides web app developers and enterprises with access to Google's scalable hosting and tier-1 Internet service.
2. The App Engine requires that apps written in Java or Python, store data in Google BigTable and use the Google query language. Non-compliant applications require modification to use App Engine.
3. Google App Engine provides more infrastructure than other scalable hosting services such as Amazon Elastic Compute Cloud (EC2).
4. The App Engine also eliminates some system administration and developmental tasks to make it easier to write scalable applications.
5. Google App Engine is free up to a certain amount of resource usage.
6. Users exceeding the per-day or per-minute usage rates for CPU resources, storage, number of API calls or requests and concurrent requests can pay for more of these resources.

**Que 2.17.** What are the advantage and disadvantages of GAE ?

**Answer****Advantages of Google App Engine (GAE) :**

1. GAE do not scale however, even after we empower billing, the whole system is augmented to support only 500 requests per second. If we want more, we can reach Google's disposal to increase our thresholds, so we can have millions of users, but more than 500 requests per second.
2. GAE feature set is good enough to build a decent website and we do not need to do the maintenance work.
3. It does not require any server administration. It has free usage allocation and provides scalability. GAE has better access to Google user accounts and deployment process is very easy.
4. GAE has the highest admin load, but once it is set up, deploying and re-deploying is quick.
5. We can get any feature from the store with GAE.

**Disadvantages of GAE :**

1. GAE is not stable enough and the budget would increase much when the website becomes bulky.
2. Without native file system read/write access, it is hard to process some data transform with existing library, and it do not support some native file system base library as well.
3. It does not provide full text search API.
4. SDK (Software Development Kit) Java is unfavorable with GAE as it is unsatisfactory to accomplish lots of external libraries.
5. The SDK/Java depth rest on IDE and the default project directory structure is different from normal web app.
6. It is not easy to process unit test. It cannot fix the root cause and does not support add SSL to website.
7. The GAE may be the development for future web application, but it is not equipped for building a modern web site.
8. It suffers from the inability to weak server software. The file system and many standard library modules are inaccessible. Only Python and a few runs of Java Virtual Machine are accessible.

**Que 2.18.** What are the features of Google App Engine ?

**Answer****Features of Google App Engine :**

- i. Persistent storage with queries, sorting and transactions.

- ii. Automatic scaling and load balancing.
- iii. APIs for authenticating users and sending email using Google accounts.
- iv. Task queues for performing work outside of the scope of a web request.
- v. Scheduled tasks for triggering events at specified times and regular intervals.
- vi. Dynamic web serving, with full support for common web technologies.

**Que 2.19.** Explain the services provided by Google App Engine.

**Answer**

**Services provided by Google App Engine :**

**1. Data store :**

- i. App engine provides a powerful distributed data storage service that features query engine and transactions. Data store entities are schemaless.
- ii. The structure of data entities is provided and enforced by application code. The Java interfaces and the Python data store interface include features for applying and enforcing structure within app.
- iii. The data store is strongly consistent and uses optimistic concurrency control. An update of an entity occurs in a transaction that retried a fixed number of times if other processes are trying to update the same entity simultaneously.
- iv. The application can execute multiple data store operations in a single transaction which either all succeed or all fail ensuring the integrity of our data.

**2. Google accounts :**

- i. App Engine supports integrating an app with Google accounts for user authentication. The application can allow a user to sign in with a Google account, and access the email address and displayable name associated with the account.
- ii. It also saves the effort of implementing a user account system just for the application.
- iii. If the application is running under Google apps, it can use the same features with members of the organization and Google apps accounts.
- iv. The users API can also tell the application whether the current user is a registered administrator for the application. This makes it easy to implement admin-only areas of the site.

**3. URL fetch :** Applications can access resources on the Internet, such as web services or other data using App Engine. URL fetch service retrieves web resources using the same high-speed Google infrastructure that

- 4. **Mail :** Applications can send email messages using App Engine's mail service. The mail service uses Google infrastructure to send email messages.
- 5. **Image manipulation :** The image service lets the application manipulate images. With this API, we can resize, crop, rotate and flip images in JPEG and PNG formats.
- 6. **Memcache :**
  - i. The memcache service provides application with a high performance in memory key value cache that is accessible by multiple instances of the application.
  - ii. Memcache is useful for data that do not need the persistence and transactional features of the data store, such as temporary data or data copied from the data store to the cache for high speed access.
- 7. **Scheduled tasks and task queues :**
  - i. An application can perform tasks outside of responding to web requests.
  - ii. The application can perform these tasks on a schedule, such as on a daily or hourly basis.
  - iii. The application can perform tasks added to a queue by the application itself, such as a background task created while handling a request.

**Que 2.20.** Describe briefly the supported environments for Google App Engine.

**Answer**

**Supported environments for Google App Engine :**

**1. Java Runtime Environment :**

- i. Develop application using common java web development tools and API standards.
- ii. It includes java Runtime Environment 6, platform and libraries.
- iii. App interacts with the environment using Java Servlet standard and can use common web application techniques such as Java Server Pages.

**2. Python Runtime Environment :**

- i. Implement app using the Python runtime environment, and run it on an optimized Python interpreter.
- ii. App engine includes rich data modelling APIs and tools for managing and accessing app's data.
- iii. Uses Python version 2.5.2, in future being considered Python 3.
- iv. Provides rich APIs for the data store, Google accounts, URL fetch,

- v. It provides simple Python web application framework called web app to make it easy to start building applications.

**PART-4**

Microsoft.

**Questions-Answers****Long Answer Type and Medium Answer Type Questions**

**Que 2.21.** Write a short note on : Microsoft Azure.

**Answer**

1. Microsoft Azure is a cloud computing service created by Microsoft for building, testing, deploying, and managing applications and services through Microsoft-managed data centers.
2. It provides software as a service (SaaS), platform as a service (PaaS) and infrastructure as a service (IaaS).
3. It supports many different programming languages, tools, and frameworks, including both Microsoft-specific and third-party software and systems.
4. Azure is the largest commercial cloud vendor by revenue.

**Services offered by Microsoft Azure :****A. Computer services :**

1. Virtual machines, infrastructure as a service (IaaS) allowing users to launch general-purpose Microsoft Windows.
2. App services, platform as a service (PaaS) environment letting developers easily publish and manage websites.
3. Azure Web Sites allows developers to build sites using ASP.NET, PHP, Node.js, or Python.

**B. Mobile services :**

1. Mobile Engagement collects real-time analytics that highlight users' behavior.
2. It also provides push notifications to mobile devices.

**C. Storage services :**

1. Storage Services provides REST and SDK APIs for storing and accessing data on the cloud.
2. Table Service lets programs store structured text in partitioned collections of entities that are accessed by partition key and primary key.

**D. Data management :**

1. Azure Data Explorer provides big data analytics and data-exploration capabilities.
2. Azure Search provides text search and a subset of OData's structured filters using REST or SDK APIs.
3. Azure Synapse Analytics is a fully managed cloud data warehouse.

**E. Messaging :**

1. The Microsoft Azure Service Bus allows applications running on Azure premises or off-premises devices to communicate with Azure.
2. This helps to build scalable and reliable applications in a service-oriented architecture (SOA).
3. The Azure service bus supports four different types of communication mechanisms :

- i. Event Hubs
- ii. Queues
- iii. Topics
- iv. Relays

**F. Azure AI :**

1. Microsoft Azure Machine Learning (Azure ML) provides a set of modern tools and ML frameworks for developers to create their own machine learning and AI services.

**G. Internet of Things (IoT) :**

1. Azure IoT Hub lets you connect, monitor, and manage billions of IoT assets.
2. Azure IoT Edge is a fully managed service built on IoT Hub that allows for cloud intelligence deployed locally on IoT edge devices.
3. Azure IoT Central is a fully managed SaaS app that makes it easy to connect, monitor, and manage IoT assets at scale.

**PART-5****Vendor Offering -IBM.****Questions-Answers****Long Answer Type and Medium Answer Type Questions**

**Que 2.22.** Write a short note on : IBM Cloud.

**Answer**

1. IBM cloud computing is a set of cloud computing services offered by the information technology company IBM.
2. The IBM cloud platform combines infrastructure as a service (IaaS) with platform as a service (PaaS).
3. IBM Cloud includes infrastructure as a service (IaaS), software as a service (SaaS) and platform as a service (PaaS) offered through public, private and hybrid cloud delivery models, in addition to the components that make up those clouds.
4. IBM offers three hardware platforms for cloud computing.
5. These platforms offer built-in support for virtualization, cloud management, and cloud services and workloads.

**Virtualization :**

1. For virtualization IBM offers IBM Websphere application infrastructure that supports programming models and open standards for virtualization.

**Cloud management :**

1. The management layer of the IBM cloud framework includes IBM Tivoli middleware.
2. Management tools provide capabilities to regulate images with automated provisioning and de-provisioning, monitor operations and meter usage while tracking costs and allocating billing.

**Cloud services and workloads :**

1. The last layer of the framework provides integrated workload tools.
2. Workloads for cloud computing are services or instances of code that can be executed to meet specific business needs.
3. IBM offers tools for cloud based collaboration, development and test, application development, analytics, business-to-business integration, and security.

**IBM Cloud :**

1. The IBM Cloud is offered under three umbrellas : SmartCloud Foundation, SmartCloud Services and SmartCloud Solutions. SmartCloud Foundation consists of the infrastructure, hardware, provisioning, management, integration and security that serve as the underpinnings of a private or hybrid cloud.
2. Built using those foundational components, PaaS, IaaS and backup services make up SmartCloud Services.
3. Running on this cloud platform and infrastructure, SmartCloud Solutions consist of a number of collaboration, analytics and marketing SaaS applications.



## Blockchain

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| <b>Part-5</b> : Blockchain Application ..... 3-11L to 3-13L    | and use cases |

**PART- 1***What is Blockchain, Fundamentals.***Questions-Answers****Long Answer Type and Medium Answer Type Questions****Que 3.1.** Write short note on Blockchain.**Answer**

1. A blockchain is a decentralized ledger of all transactions across a peer-to-peer network.
2. Using this technology, participants can confirm transactions without a need for a central clearing authority.
3. Potential applications can include fund transfers, settling trades, voting, and many other issues.
4. Blockchain can also be described as a data structure that holds transactional records while ensuring security, transparency, and decentralization.
5. A Blockchain is a type of diary or spreadsheet containing information about transactions.
6. Each transaction generates a hash.
7. Each block refers to the previous block and together make the Blockchain.
8. A Blockchain is effective as it is spread over many computers, each of which has a copy of the Blockchain.

**Que 3.2.** What are the strengths of a Blockchain system ?**Answer**

Following are the strengths of Blockchain system :

1. **Process Integrity :** Due to the security reasons, this program was made in such a way that any block or even a transaction that adds to the chain cannot be edited which ultimately provides a very high range of security.
2. **Traceability :** The format of Blockchain design is in such a way that it can easily locate any problem and correct if there is any. It also creates an irreversible audit trail.

3. **Security :** Blockchain technology is highly secure because of the reason that each and every individual who enters into the Blockchain network is provided with a unique identity which is linked to his account. This ensures that the owner of the account himself is operating the transactions.
4. **Faster processing :** Before the invention of the Blockchain, the traditional banking organization take a lot of time in processing and initiating the transaction but after the blockchain technology speed of the transaction increased to a very high extent.

**Que 3.3.** Explain the disadvantages of Blockchain system.**Answer**

Following are the disadvantages of Blockchain system:

1. **Power Use :**
  - a. The consumption of power in the Blockchain is comparatively high; as in a particular year the power consumption of Bitcoin miners was alone more than the per capita power consumption of 159 individual countries.
  - b. Keeping a real-time ledger is one of the reasons for this consumption because every time it creates a new node, it communicates with each and every other node at the same time.
2. **Cost :**
  - a. As per the studies an average cost of the Bitcoin transaction is \$75-\$160 and most of this cost cover by the energy consumption.
  - b. There are very fewer chances that this issue we can resolve by the advancement in the technology.
3. **Uncertain regulatory status :**
  - a. In each and every part of world modern money has been created and controlled by the central government.
  - b. It becomes a hurdle for Bitcoin to get accepted by the preexisting financial institutions.

**PART- 2***Principles and Technologies.***Questions-Answers****Long Answer Type and Medium Answer Type Questions**

**Que 3.4.** Explain the core principles of Blockchain.**Answer**

Following are the principles of Blockchain :

- 1. Distributed database :**
  - a. Each party on a Blockchain has access to the whole database and its complete history. No single party regulates the data or the information.
  - b. Every party can validate the records of its transaction partners directly, without an intermediary.
- 2. Peer-to-peer transmission :**
  - a. Communication occurs straightforwardly between peers instead of through a central node.
  - b. Each node stores and forwards information to all other nodes.
- 3. Transparency with pseudonymity :**
  - a. Every transaction and its respective value are visible to anyone with an access to the system.
  - b. Each node, or user, on a Blockchain has a unique 30-plus-character alphanumeric address that identifies it.
  - c. Users can choose to remain anonymous or provide proof of their identity to others. Transactions occur between Blockchain addresses.
- 4. Irreversibility of records :**
  - a. Once a transaction is inputted in the database and the accounts are updated, the records cannot be changed, because they are linked to every transaction record that came before them (this is basically where the term "chain" comes from).
  - b. Various computational algorithms and approaches are deployed to ensure that the recording on the database is permanent, chronologically ordered, and available to all others on the network.
- 5. Computational logic :**
  - a. The digital nature of the ledger means that Blockchain transactions can be tied to computational logic and in essence programmed.
  - b. So users can set up algorithms and rules that automatically trigger transactions between the nodes.

**Que 3.5.** What is Blockchain technology ?**Answer**

1. Blockchain, sometimes referred to as Distributed Ledger Technology (DLT), makes the history of any digital asset unalterable and transparent through the use of decentralization and cryptographic hashing.

2. A simple analogy for understanding blockchain technology is a Google Doc.
3. When we create a document and share it with a group of people, the document is distributed instead of copied or transferred.
4. This creates a decentralized distribution chain that gives everyone access to the document at the same time.
5. No one is locked out awaiting changes from another party, while all modifications to the doc are being recorded in real-time, making changes completely transparent.
6. Blockchain is more complicated than a Google Doc, but the analogy is apt because it illustrates three critical ideas of the technology :
  - a. Digital assets are distributed instead of copied or transferred.
  - b. The asset is decentralized, allowing full real-time access.
  - c. A transparent ledger of changes preserves integrity of the document, which creates trust in the asset.

**Que 3.6.** How does Blockchain works ?**Answer**

Blockchain consists of three important concepts :

- 1. Blocks :**
  - a. Every chain consists of multiple blocks and each block has three basic elements :
    - i. The data in the block.
    - ii. A 32-bit whole number called a nonce. The nonce is randomly generated when a block is created, which then generates a block header hash.
    - iii. The hash is a 256-bit number wedged to the nonce. It must start with a huge number of zeroes (i.e., be extremely small).
  - b. When the first block of a chain is created, a nonce generates the cryptographic hash. The data in the block is considered signed and forever tied to the nonce and hash unless it is mined.
- 2. Miners :**
  - a. Miners create new blocks on the chain through a process called mining.
  - b. In a Blockchain every block has its own unique nonce and hash, but also references the hash of the previous block in the chain, so mining a block isn't easy, especially on large chains.
  - c. Miners use special software to solve the incredibly complex math problem of finding a nonce that generates an accepted hash.

- Blockchain
- d. Because the nonce is only 32 bits and the hash is 256, there are roughly four billion possible nonce-hash combinations that must be mined before the right one is found.
  - e. When that happens miners are said to have found the "golden nonce" and their block is added to the chain.

**3. Nodes:**

- a. One of the most important concepts in Blockchain technology is decentralization.
- b. No one computer or organization can own the chain. Instead, it is a distributed ledger via the nodes connected to the chain.
- c. Nodes can be any kind of electronic device that maintains copies of the Blockchain and keeps the network functioning.

**PART-3**

**Cryptocurrencies.**

**Questions-Answers**

**Long Answer Type and Medium Answer Type Questions**

**Que 3.7.** Write short note on cryptocurrency.

**Answer**

1. Cryptocurrency is a kind of digital money that is designed to be secure and, in many cases, anonymous.
2. It is a currency associated with the internet that uses cryptography, the process of converting legible information into an almost uncrackable code, to track purchases and transfers.
3. The first cryptocurrency was Bitcoin, which was created in 2009 and is still the best known.
4. There has been a proliferation of cryptocurrencies in the past decade and there are now thousands available on the internet, but Bitcoin remains the most well known.
5. It has soared this year to more than \$40,000 per digital coin, although remains highly volatile.

**Que 3.8.** How does cryptocurrency work ?

**Answer**

1. Cryptocurrencies use decentralised technology to let users make secure payments and store money without the need to use their name or go through a bank.
2. They run on a distributed public ledger called Blockchain, which is a record of all transactions updated and held by currency holders.
3. Units of cryptocurrency are created through a process called mining, which involves using computer power to solve complicated math's problems that generate coins.
4. Users can also buy the currencies from brokers, then store and spend them using cryptographic wallets.
5. Cryptocurrencies and applications of Blockchain technology are still nascent in financial terms and more uses should be expected.
6. Transactions including bonds, stocks and other financial assets could eventually be traded using the technology.

**Que 3.9.** What are the advantages and disadvantages of cryptocurrency ?

**Answer**

**Advantages of cryptocurrency :**

1. **Protection from inflation :**
  - a. Inflation has caused many currencies to get their value declined with time. Almost every cryptocurrency, at the time of its launch, is released with a fixed amount.
2. **Self-governed and managed :**
  - a. Governance and maintenance of any currency is a major factor for its development.
  - b. The cryptocurrency transactions are stored by developers/miners on their hardware, and they get the transaction fee as a reward for doing so.
  - c. Since the miners are getting paid for it, they keep transaction records accurate and up-to-date, keeping the integrity of the cryptocurrency and the records decentralized.
3. **Secure and private :**
  - a. Privacy and security have always been a major concern for cryptocurrencies.
  - b. The Blockchain ledger is based on different mathematical puzzles, which are hard to decode.
  - c. This makes a cryptocurrency more secure than ordinary electronic transactions.

- ii. Issues in product authenticity as consumers can sometimes receive counterfeit goods.
- 2. Supply chain is a network which is established between a business and its suppliers.
- 3. Using Blockchain we can find remedy to supply chain problems through the digitization of assets.
- 4. Products are assigned unique identities which are then transplanted onto an immutable, transparent, and secure blockchain.
- 5. Blockchain helps in tracking information such as the state of the product, shelf life, time, and location.
- 6. With blockchain-enabled asset digitization in place, a product's supply chain can be effectively transplanted onto a supply chain.

#### B. Digital Identity :

- 1. Digital identity can be described as an online record of information pertaining to individuals and organizations.
- 2. In a blockchain, users can have control over their information.
- 3. Instead of providing consent to many service providers, users can store their digital identity data in an encrypted digital hub.
- 4. Individuals can control access to the hub and can also revoke access, if necessary.
- 5. Using blockchain technology, the user can be in control of their digital data and the way in which it is utilized.

#### C. Healthcare :

- 1. The main issues faced here are :
  - i. Medical practitioners lack a clear and complete understanding of a patient's medical history. This hinders in providing effective healthcare solutions.
  - ii. Counterfeit medicines are also a major issue within the medical supply chain.
- 2. Blockchain will serve as a tamper-proof and secure database to reduce the problems faced in the healthcare industry.
- 3. Patient medical records can be stored on a blockchain.
- 4. This will make it easier for medical practitioners to get a better idea of a patient's medical history.
- 5. Blockchain would also help tag and track drugs at every stage of the supply chain.
- 6. It will act as a medium to assure the authenticity of the drugs.

#### D. Food Safety :

- 1. The supply chain for foods has become longer and complex.
- 2. There is no transparency regarding the journey of our foods.

- 3. This results in the increase of contaminated food.
- 4. Blockchain technology allows quick and easy verification of history, location, and status of a particular food product.
- 5. Farm origination details such as batch numbers, storage temperatures, shipping details, expiry dates can be digitally recorded on the blockchain.
- 6. Hence everyone with access to the blockchain can access the data.
- 7. End-to-end traceability would improve the efficiency of the food supply chain.

#### E. Energy Market :

- 1. Blockchain helps decentralize the energy market, which is controlled by large corporations.
- 2. Blockchain allows smart metering of electricity which is generated through the solar panel of individuals to record, trade, and settle on a ledger.
- 3. If it is possible to trade electricity, energy prices will respond to forces of demand and supply instead of operating on a fixed regulated price.
- 4. This way, individuals can be both consumers and producers of energy.
- 5. This helps improve efficiency and reduce costs.



### 3-10 L (Sem-1 & 2)

- Blockchain
- 2. They're self-enforcing when the rules are met at all stages;
  - 3. They're tamper-proof, as no one can change what's been programmed.
- Capabilities of smart contracts are :**
- 1. Automate processes done manually;
  - 2. Ensure security;
  - 3. Reduce relation to trusted intermediaries;
  - 4. Support multi-signature accounts to distribute funds as soon as all parties involved confirm the agreement;
  - 5. Manage users' agreements;
  - 6. Provide utility to other contracts (similar to how a software library works);
  - 7. Store information about an app (domain registration information, membership records, etc.).

#### Que 3.12. What are the advantages of smart contracts ?

##### Answer

Following are the advantages of smart contracts :

1. **Direct business relationships :**
  - a. Digital contracts remove the necessity of a third party to perform any dealings between two entities who want to exchange money, property, shares, or anything else of value.
  - b. Parties commit themselves to the rules of the digital contract that are placed within lines of code.
2. **Integrity :** The network will still work as predetermined even if someone leaves it.
3. **Trustworthiness :**
  - a. The terms and conditions of smart contracts are visible and accessible to trusted parties.
  - b. There's no way to dispute the conditions of a contract once it's been established.
  - c. The parties can fully rely on the smart contract.
4. **Speed :**
  - a. Smart contracts use code and live on the internet.
  - b. They execute transactions quickly.
  - c. This saves time for many business processes and eliminates the need to process documents manually.
5. **Security :**
  - a. Smart contracts use the same level of security as a cryptocurrency.

### Emerging Technology for Engineering

### 3-11 L (Sem-1 & 2)

- b. As of today, they're the safest way to store data on the web.
- 6. **Keeping records :** All contracts are stored in chronological order and can be easily accessed when necessary.
- 7. **Paper-free :** Contracts that are signed on paper can be lost, stolen, or destroyed, whereas smart contracts exist in lines of code in digital space.

## PART-5

Block Chain Application and use cases.

### Questions-Answers

#### Long Answer Type and Medium Answer Type Questions

#### Que 3.13. Describe the application of Blockchain system.

##### Answer

Following are the application of Blockchain system :

- 1. Secure sharing of medical data
- 2. Music royalties tracking
- 3. Cross-border payments
- 4. Real-time IoT operating systems
- 5. Personal identity security
- 6. Anti-money laundering tracking system
- 7. Supply chain and logistics monitoring
- 8. Voting mechanism
- 9. Advertising insights
- 10. Original content creation
- 11. Cryptocurrency exchange
- 12. Real estate processing platform

#### Que 3.14. Describe use cases of blockchain across various industry verticals.

##### Answer

#### A. Supply Chain Management :

1. The main issues faced here are :
  - i. Lack of transparency as the product moves along its supply chain.

- d. Cryptocurrencies, for better security and privacy, use pseudonyms that are unconnected to any user, account or stored data that could be linked to a profile.
- 4. **Currency exchanges can be done easily :**
  - a. Cryptocurrency can be bought using many currencies like the US dollar, European euro, British pound, Indian rupee or Japanese yen.
  - b. With the help of different cryptocurrency wallets and exchanges, one currency can be converted into the other by trading in cryptocurrency, across different wallets, and with minimal transaction fees.
- 5. **Decentralized :**
  - a. A major pro of cryptocurrency is that they are mainly decentralized.
  - b. A lot of cryptocurrencies are controlled by the developers using it and the people who have a significant amount of the coin, or by an organization to develop it before it is released into the market.

#### **Disadvantages of cryptocurrency :**

1. **Can be used for illegal transactions :**
  - a. Since the privacy and security of cryptocurrency transactions are high, it's hard for the government to track down any user by their wallet address or keep tabs on their data.
  - b. Bitcoin has been used as a mode of exchanging money in a lot of illegal deals in the past, such as buying drugs on the dark web.
2. **Data losses can cause financial losses :**
  - a. The developers wanted to create virtually untraceable source code, strong hacking defenses, and impenetrable authentication protocols.
  - b. If any user loses the private key to their wallet, there's no getting it back.
  - c. The wallet will remain locked away along with the number of coins inside it. This will result in the financial loss of the user.
3. **Decentralized but still operated by some organization :**
  - a. The cryptocurrencies are known for its feature of being decentralized.
  - b. But, the flow and amount of some currencies in the market are still controlled by their creators and some organizations.
4. **Some coins not available in other fiat currencies :**
  - a. Some cryptocurrencies can only be traded in one or a few fiat currencies.
  - b. This forces the user to convert these currencies into one of the major currencies like Bitcoin or Ethereum first and then through

#### **5. No refund or cancellation policy :**

- a. If there is a dispute between concerning parties, or if someone mistakenly sends funds to a wrong wallet address, the coin cannot be retrieved by the sender.

### **PART-4**

#### *Smart Contracts.*

#### **Questions-Answers**

#### **Long Answer Type and Medium Answer Type Questions**

#### **Que 3.10. Explain smart contracts.**

#### **Answer**

1. Smart contracts are like regular contracts except the rules of the contract are enforced in real-time on a Blockchain, which eliminates the middleman and adds levels of accountability for all parties involved in a way not possible with traditional agreements.
2. This saves businesses time and money, while also ensuring compliance from everyone involved.
3. Blockchain-based contracts are becoming more and more popular as sectors like government, healthcare and the real estate industry discover the benefits.
4. Examples how companies are using Blockchain to make contracts smarter :
  - a. Mediachain uses smart contracts to get musicians the money they deserve. By entering into a decentralized, transparent contract, artists can agree to higher royalties and actually get paid in full and on time.
  - b. Propy is a global real estate marketplace with a decentralized title registry system. The online marketplace uses Blockchain to make title issuance instantaneous and even offers properties that can be purchased using cryptocurrency.

#### **Que 3.11. What are the characteristics and capabilities of smart contracts ?**

#### **Answer**



# Digital Manufacturing 3D Printing and Drones

## CONTENTS

- Part-1 :** The History and Survey ..... 4-2L to 4-4L
- Part-2 :** Design Principles and Tools ..... 4-4L to 4-6L
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Course / Regulation and  
Becoming a Drone Pilot

### PART - 1

The History and Survey of 3D Printing.

#### Questions-Answers

#### Long Answer Type and Medium Answer Type Questions

**Que 4.1.** Write short note on 3D printing.

**Answer**

1. 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file.
2. The creation of a 3D printed object is achieved using additive processes.
3. In an additive process an object is created by laying down successive layers of material until the object is created.
4. Each of these layers can be seen as a thinly sliced cross-section of the object.
5. 3D printing is the opposite of subtractive manufacturing which is cutting out / hollowing out a piece of metal or plastic with a milling machine.
6. 3D printing enables us to produce complex shapes using less material than traditional manufacturing methods.

**Que 4.2.** What are the advantages and disadvantages of 3D printing ?

**Answer**

**Advantages :**

1. **Customization :** With just a raw material, a blueprint and a 3d printer, one can print any design no matter how complex it might be.
2. **Constant Prototyping and Increased Productivity :**
  - a. It enables quick production with a high number of prototypes or a small-scale version of the real object in less time than using conventional methods.
  - b. This helps designers to improve their prototypes, for any design flaws that may affect the quality of the product.
3. **Affordability :**
  - a. The initial cost for setting up a 3d printing facility is definitely high; however, it is much cheaper compared to labor costs and manufacturing costs while using the conventional way.

- b. Adding to it, is the fact that the cost of producing or manufacturing products using 3d printing technology is equal for small-scale and mass manufacturing.
- 4. **Storage :** 3d printing technology, products can be "printed" when needed thus excess products are eliminated and no storage cost is required.
- 5. **Employment Opportunities :**
  - a. The widespread use of 3d printing technology will definitely increase the demand for engineers who are needed to design and build these printers.
  - b. Technicians who are skilled at troubleshooting and maintenance and designers to design blueprints for products and more jobs will be created.

#### **Disadvantages :**

1. **Decrease in Manufacturing Jobs :** The decrease in manufacturing jobs will greatly affect the economy of countries that rely on a large number of low skill jobs.
2. **Limited Size :** The size of objects created with 3d printers is currently limited however, in the near future; large items such as architectural structures can be created using 3d printing.
3. **Limited Raw Materials :** 3d printers can work up to approximately 100 different raw materials and creating products that uses more raw materials are still under development.
4. **Violation of Copyrights :**
  - a. The biggest disadvantage of 3d printing is Counterfeiting.
  - b. Anyone who gets a hold of a blueprint will be able to counterfeit products easily.
  - c. It will become more common and tracing the source of the counterfeited items will be nearly impossible.
  - d. Many copyright holders will have a hard time protecting their rights and businesses producing unique products will suffer.
5. **Production of Dangerous Items :**
  - a. With 3d printers, plastic knives, guns and any other hazardous objects can be created.
  - b. It makes easier for terrorists and criminals bring a weapon without being detected.

**Que 4.3.** Give the history of 3D printing.

#### **Answer**

##### **1981-1999:**

1. In 1981, Hideo Kodama of Nagoya Municipal Industrial Research Institute published his account of a functional rapid-prototyping system using photopolymers.
2. A solid, printed model was built up in layers, each of which corresponded to a cross-sectional slice in the model.
3. In 1984, Charles Hull invented stereolithography for 3D-printing.
4. Stereolithography lets designers create 3D models using digital data, which can then be used to create a tangible object.

##### **1999-2010:**

5. In 1999 the first 3D-printed organ was implanted in humans.
6. Scientists at Wake Forest Institute for Regenerative Medicine printed synthetic scaffolds of a human bladder and then coated them with the cells of human patients.
7. The newly generated tissue was then implanted into the patients.
8. In 2005, Dr. Adrian Bowyer launched an open-source initiative to create a 3D printer that could basically build itself—or at least print most of its own parts.
9. The first SLS machine became commercially viable in 2006, which opened the door to on-demand manufacturing of industrial parts.

##### **2011-Present Day:**

10. Designers are no longer limited to printing with plastic.
11. Engineers at the University of Southampton have flown the world's first 3D-printed unmanned aircraft.
12. KOR Ecologic prototyped Urbee, a car with a 3D-printed body that's built to get 200 mpg on the freeway.
13. 3D printing is now being used to manufacture affordable housing for the developing world

#### **PART-2**

*Design Principles and Tools.*

#### **Questions-Answers**

**Long Answer Type and Medium Answer Type Questions**

**Que 4.4.** What are the design principles of 3D printing?**Answer**

Following are the principles of 3D printings :

1. **Manufacturing complexity is free :** Printing a complex design is no more expensive than printing a simple design.
2. **Variety is free :** A 3D printer only requires a new digital blueprint and raw materials to create an infinite variety of forms.
3. **No assembly required :** Traditional manufacturing requires assembling many parts, however, 3D printing can print fully assembled final products, reducing labor, global supply chains, and freight costs.
4. **Zero lead time :** Products can be printed on demand, eliminating inventory.
5. **Unlimited design space :** 3D printers can print shapes never before possible with traditional manufacturing methods.
6. **Zero skill manufacturing :** A 3D printer requires less operator skill than traditional manufacturing methods.
7. **Compact, portable manufacturing :** 3D printers have recently become small enough for home or office use, even as small as microwave ovens.
8. **Less waste by-product :** Depending on the materials involved, 3D printing can significantly reduce waste from traditional machining methods.
9. **Infinite shades of materials :** Blending and mixing different kinds of raw materials into a product will become possible in new ways with 3D printing.
10. **Precise physical replication :** Digital 3D modeling allows unlimited copying of designs without loss of fidelity. Similarly, the 3D model/file is not degraded, regardless of how many times the object is printed.

**Que 4.5.** Describe different types of tools used for 3D printing.**Answer**

Following are the different tools used for 3D printing :

**1. Masking Tape :**

- a. Masking tape is the most basic and most widely used surface covering for print beds.
- b. Adding masking tape to the print bed is a simple way to help the 3D printed objects to adhere better.

**2. Kapton Tape :**

- a. Kapton tape is a polyimide adhesive tape that is used as an alternative material to cover print beds.
- b. Contrary to masking tape however, Kapton tape has been specifically designed to withstand high temperatures (up to 400°C).
- c. Kapton tape is used to improve 3D print adhesion and to prevent warping but mostly in combination with ABS filament.

**3. Glue Stick :**

- a. Glue sticks come in handy when you are trying to improve 3D print adhesion: just cover your print bed in water soluble glue stick and the adhesion of the 3D prints will improve instantly.
- b. The glue stick can be applied on top of blue/Kapton tape or even directly to glass in case your 3D printer uses a glass print bed.

**4. Digital Caliper :**

- a. In the context of 3D printing, a caliper will have many applications: you can use it to check the precision of your prints as well as you can use it to dimension parts that you want to replicate in CAD software.
- b. 3D printer filament, though advertised as being 3mm or 1.75 mm, rarely turns out to be manufactured to these exact measurements.

**5. Pliers :**

- a. A set of pliers will have various uses, be it to remove hard sticking prints or to fix something on your 3D printer.
- b. Quality pliers with rubberized slip-resistant grips are recommended.

**6. Screw Drivers & Hex Key Screw Drivers :** Hex nuts and bolts are widely used in the assembly of 3D printers so it pays to have a good set of hex key screwdrivers and hex key wrenches.**PART-3****Emerging Trends and use Case in 3D Printing.****Questions-Answers****Long Answer Type and Medium Answer Type Questions****Que 4.6.** Describe the emerging trends of 3D printing.

## 4-7 L (Sem-1 & 2)

### Emerging Technologies for Engineering

Following are emerging trends in 3D printing :

**Answer** Following are emerging trends in 3D printing :

**Following are emerging trends in 3D printing is encouraging, as it means that**

**The 3D printing number of exhibitors is encouraging, as it means that**

1. The growing number of exhibitors is encouraging, as it means that
  - a. the industry is on a steady growth path.
  - b. But at the same time, this growth is signalling the increasing number of companies entering the market as start-ups and spinoffs, with new technologies or their own take on existing ones.
2. **A wider range of application-specific materials are on the horizon :**  
Material cost and availability are two of the key challenges when it comes to adopting 3D printing for production.
  - a. While material costs are unlikely to decrease substantially in 2020, we'll see more materials developed with industrial applications in mind.
  - b. We'll see more materials developed with industrial applications in mind.

**2. Expect more options for high-temperature polymer 3D printing:**

**3. and materials :**

- In 2019, we saw a surge in high-temperature polymer 3D printers. In 2019, we saw a surge in high-temperature polymer 3D printers and materials like Roboze, Zortrax and Essentium.
- a. Entering the market from companies like Roboze, Zortrax and Essentium.
  - b. This surge has been largely driven by the growing demand for high-performance thermoplastics like PEEK.

**4. Composite 3D printing will enter a growth stage :**

- a. Composites are lightweight, strong materials, highly sought-after in industries like aerospace, automotive, oil and gas and industrial goods.
- b. When combined with 3D printing, the technology can streamline and cut the cost of composite manufacturing, when compared to typically manual traditional composite manufacturing methods.

**5. The evolution of 3D printing software will accelerate significantly :**

- a. Focus on 3D printing software has been lacking, when compared with the hardware and materials segments.
- b. With 3D printing, designers have had to deal with a cumbersome design preparation process, where a lot of disparate design tools create an inefficient and complex workflow.

**6. MES software will become essential for scalability :**

- a. Many companies are now looking to establish an AM serial production line. However, in doing so, they're faced with many workflow challenges.
- b. Minimizing weight is a primary way in which 3D printing has enabled the aerospace industry to make a considerable saving.

## 4-8 L (Sem-1 & 2)

### Digital Manufacturing : 3D Printing and Drones

#### Ques 4.7. Explain use case of 3D printing.

##### Answer

Following are the use case of 3D printing :

##### 1. Automobiles :

- a. The automotive industry has been tapping the potential of 3D printing for decades already.
- b. 3D printing is extremely useful in rapid prototyping and has proved capable of significantly reducing design times and lead times on new car models.

##### 2. Jewelry :

- a. 3D printing is instigating a design revolution in jewelry.
- b. Creating 3D printed pieces that had a comparable look and feel to traditionally handcrafted and cast jewelry used to be a challenge.

##### 3. Spare & Replacements Parts :

- a. The effects of losing or breaking parts of products or devices can range from the inconvenient to the disastrous.
- b. 3D printing will enable consumers to produce replacement and spare parts.

##### 4. Aerospace :

- a. Minimizing weight is a primary way in which 3D printing has enabled the aerospace industry to make a considerable saving.
- b. The lower volume of components required in a 3D printed construction of a part leads to parts that are lighter overall; this seemingly small change to production positively affects an aircraft's workflow challenges.

payload, emissions, and fuel consumption and speed and safety, all while markedly reducing production waste.

5. **Glasses and Eyewear :**

- Having to cater to all manner of face shapes, eyewear is also an industry that stands to benefit distinctly from 3D printing's limitless capacity for customization.
- New designs intended to optimize both comfort and quality of design can be, as elsewhere, rapidly prototyped using 3D and produced at a lower cost and at greater convenience to the customer.

**PART-4**  
*Introduction of Drones, Emerging Disciplines.*

**Questions-Answers**

**Long Answer Type and Medium Answer Type Questions**

**Que 4.8.** Write short note on drone.

**Answer**

- The term "drone" usually refers to any unpiloted aircraft.
- It is also referred to as "Unmanned Aerial Vehicles" (UAVs), these crafts can carry out an impressive range of tasks, ranging from military operations to package delivery.
- On Earth, drones are often used for military purposes because they don't put a pilot's life at risk in combat zones.
- In addition, drones don't require rest, enabling them to fly as long as there is fuel in the craft and there are no mechanical difficulties.
- Spaceborne drones could include cargo spacecraft, satellites and machines that leave Earth.
- While drones serve a variety of purposes, such as recreational, photography, commercial and military, their two basic functions are flight and navigation.
- Drones require a controller, which is used remotely by an operator to launch, navigate and land it. Controllers communicate with the drone using radio waves, including Wi-Fi.

**Que 4.9.** What are the components and features of drones ?

**Answer**

Following are the components of drone :

- Electronic Speed Controllers (ESC), an electronic circuit that controls a motor's speed and direction.
- Flight controller
- GPS module
- Battery
- Antenna
- Receiver
- Cameras
- Sensors, including ultrasonic sensors and collision avoidance sensors.
- Accelerometer, which measures speed.
- Altimeter, which measures altitude.

Following are the features of a drone :

- Camera type, video resolution, megapixels and media storage format.
- Maximum flight time, such as how long the drone can remain in the air.
- Maximum speeds, including ascent and descent.
- Hover accuracy.
- Obstacle sensory range.
- Altitude hold, which keeps the drone at a fixed altitude.
- Live video feed.
- Flight logs.

**Que 4.10.** What are the applications of drones ? Explain

**Answer**

Following are the application of a drone :

- Drones can assist farmers by measuring and recording the height of crops. They use a remote sensing technology called Lidar that illuminates the crop with a laser and calculates distance by measuring what is reflected back.
- Drones with biological sensors can fly to unsafe areas to take air quality readings and check for the presence of specific micro-organisms or atmospheric elements.
- During wildfires, drones can survey the extent of the affected areas and determine how quickly the fires are spreading. Images taken can provide details of the damage in specific areas.

4. Drones are used by television sport networks to capture sporting event footage, such as taped and live flyover footage, that would otherwise be difficult to acquire.

**Que 4.11.** Describe the types of drone with advantages and disadvantages.

**Answer**

Following are the types of drones :

**1. Fixed Wing :**

- A fixed wing drone consists of one rigid wing and is designed to look and works like an airplane.
- Fixed wing UAVs are well known in the military, as they are often used when manned flight is considered too risky or difficult.
- They are also used in the commercial industry.

**Advantages :**

- The average flight time is a couple hours and can go up to 16 hours or more if the drone is gas engine powered.
- Fixed wings can fly at a high altitude.
- They are more forgiving in the air than other models.
- They have the ability to carry more weight.

**Disadvantages :**

- Fixed wing drones can be expensive.
- Training is usually required to fly them.
- In most cases, a launcher is needed to get a fixed wing drone into the air.
- They are more difficult to land.
- They can only move forward and can't hover in the air.

**2. Single Rotor :**

- Single rotor drones are strong and look similar in structure and design to actual helicopters.
- They have one big rotor plus a small sized rotor on the tail for direction and stability.

**Advantages :**

- Single rotor drones are able to hover vertically in the air.
- They are built to be strong and durable.
- They have a long-lasting flight time, which increases if the drone is gas powered.
- They have a heavy payload capability.

**Disadvantages :**

- Single rotors are harder to fly than multi-rotor drone types.
- They can be expensive.
- These drones have a higher complexity.
- They can be dangerous because of the heavy spinning blade.

**3. Multirotor :**

- The most popular type of drone for getting an "eye in the sky" is the multi-rotor drone. This is the popular choice for aerial photography, filmmaking and surveillance.
- It is used by professionals and hobbyists alike because of its small size and ready to fly out of the box capabilities.

**Advantages :**

- Multi-rotor drones are easy control and maneuver.
- They have the ability to hover.
- They can take off and land vertically.
- They are very stable.

**Disadvantages :**

- Multi-rotors have a limited flying time (usually 15-30 minutes).
- They only have small payload capabilities.
- Most of the drone's energy is spent on fighting gravity and stabilizing in the air.

**PART-5**

**Multi-rotor Drone Assembly Course / Regulation and Becoming a Drone Pilot.**

**Questions-Answers**

**Long Answer Type and Medium Answer Type Questions**

**Que 4.12.** Why should we do multi-drone assembly course ?

**Answer**

We should do multi-drone assembly course to :

- Learn to assemble Multirotor Drones.
- Get trained from expert instructors.

3. To gain in-depth knowledge about working of a Multirotor drone.
4. Get hands-on experience of assembly and troubleshooting.
5. Learn Emergency Procedures.
6. Explore the opportunities in Drone market.

**Que 4.13. | Describe drone regulatory policy.**

**Answer**

1. In order to successfully (and might we add, legally) pursue a career as a drone pilot, you must be well-versed with the regulatory policy surrounding piloting commercial drones in India.
2. The policy came to effect in 2018 when the DGCA (Directorate General of Civil Aviation) announced the release of its Civil Aviation Regulations (CAR) to ensure safe usage and flight of UAVs in India.
3. Firstly, the policy classified drones in different categories based on their weight.
4. The categories include - Nano drones (up to 250 gms), Micro drones (250 gms - 2 kg), Small drones (2 kg - 25 kg), Medium drones (25 kg - 150 kg) and lastly, Large drones (anything higher than 150 kg).
5. Under this policy, all drone sizes apart from Nano drones, are required to be registered by the pilot/operator on the Digital Sky Platform.
6. Therefore, civilians can no longer simply buy any drone and fly it. They are required to follow a lengthy list of compliances.
7. The Digital Sky Platform is a platform which allows the Indian government to control commercial usage of drones with national Unmanned Traffic Management (UTM).
8. India also has an NPNT (No Permission - No Takeoff) clause which prohibits drones (micro and above) from flying unless they have been given regulatory permission.

**Que 4.14. | What are the eligibility criteria for becoming a drone pilot?**

**Answer**

**Eligibility :** To become a pilot you must :

1. Be at least 16 years old
2. Be able to read, speak, write, and understand English
3. Be in a physical and mental condition to safely fly a drone
4. Pass the initial aeronautical knowledge exam

**Requirements for Remote Pilot Certificate :**

1. Must be easily accessible by the remote pilot during all UAS operations.

2. Valid for 2 years. Certificate holders must pass a recurrent knowledge test every two years.

**Que 4.15. | Explain the navigating process to become a drone pilot.**

**Answer**

**Navigating process to become a drone pilot :**

**Step 1 :** Obtain an FAA Tracking Number (FTN) by creating an Integrated Airman Certification and Rating Application (IACRA) profile prior to registering for a knowledge test.

**Step 2 :** Schedule an appointment with a Knowledge Testing Center which administer initial and recurrent FAA knowledge exams. Be sure to bring a government-issued photo ID to your test.

**Step 3 :** Pass the initial aeronautical knowledge test. Knowledge test topic areas include :

- i. Applicable regulations relating to small unmanned aircraft system rating privileges, limitations, and flight operation.
- ii. Airspace classification and operating requirements, and flight restrictions affecting small unmanned aircraft operation.
- iii. Aviation weather sources and effects of weather on small unmanned aircraft performance.
- iv. Small unmanned aircraft loading and performance.
- v. Emergency procedures.
- vi. Crew resource management.
- vii. Radio communication procedures.
- viii. Determining the performance of small unmanned aircraft.
- ix. Physiological effects of drugs and alcohol.
- x. Aeronautical decision-making and judgment.
- xi. Airport operations.
- xii. Maintenance and preflight inspection procedures.

**Step 4 :** Complete FAA Form 8710-13 for a remote pilot certificate (FAA Airman Certificate and/or Rating Application) using the electronic FAA Integrated Airman Certificate and/or Rating Application system (IACRA).

- a. Register using the FAA IACRA system.
- b. Login with username and password.
- c. Click on "Start New Application" and 1) Application Type "Pilot", 2) Certifications "Remote Pilot", 3) Other Path Information, 4) Start Application.
- d. Follow application prompts. When prompted, enter the 17-digit Knowledge Test Exam ID.

e. Sign the application electronically and submit for processing.

**Step 5 :** A confirmation email will be sent when an applicant has completed the TSA security background check. This email will provide instructions for printing a copy of the temporary remote pilot certificate from IACRA.

**Step 6 :** A permanent remote pilot certificate will be sent via mail once all other FAA-internal processing is complete.

**Step 7 :** Have your Remote Pilot Certificate available whenever you fly your UAV.



## Future Trends

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**PART-1***Augmented Reality (AR) and Virtual Reality.***Questions-Answers****Long Answer Type and Medium Answer Type Questions****Que 5.1.** Write short note on augmented reality.**Answer**

1. Augmented reality refers to any technology that 'augments' the user's visual (and in some case auditory) perception of their environment.
2. Digital information is superimposed over a natural existing environment.
3. Information is tailored to the user's physical position as well as the context of the task, thereby helping the user to solve the problem and complete the task.
4. AR is not a simulation of reality - rather, it integrates and adds value to the user's interaction with the real world.
5. AR remote assistance can improve training in situations where new hires need help, and enable real-time collaboration between field personnel and remote experts - with the ultimate goal of increased customer satisfaction.

**Que 5.2.** Describe the benefits of augmented reality.**Answer****Benefits of AR :**

1. The primary benefit of Augmented Reality is that it can be used by anyone including mentally and physically disabled individuals.
2. It blurs the line of difference between the virtual and real world, thus increasing its usability and effectiveness in the area of application.
3. It possesses a highly interactive nature which enables to assess several instances in advance.
4. Success or failure of an instance can be determined by using the computing power of AR, thus saving lot of money.
5. It finds heavy usage in the field of health, thus increasing the accuracy of diagnosis for diseases.

**Que 5.3.****What are the drawbacks of AR ?****Answer****Drawbacks of AR :**

1. One major drawback of AR based application is the lack of privacy
2. AR based applications or devices cannot be leveraged without appropriate training thus increase costs and time involved
3. There can be certain instances where AR applications have recorded low performance, thus reducing the overall appeal of the package.
4. It can get extremely costly to develop and maintain an AR based device or an application.

**Que 5.4.****What are the applications of augmented reality ?****Answer****Following are the application of AR :**

- 1. Medical Training :**
  - a. From operating MRI equipment to performing complex surgeries, AR tech holds the potential to boost the depth and effectiveness of medical training in many areas.
  - b. Human anatomy can be learned utilizing an AR headset allowing user's to delve into the human body in an interactive 3D format.
- 2. Education :**
  - a. Technology like tablets have become widespread in many schools. Using AR teachers and educators are now ramping up student's learning experience.
  - b. Many AR apps are being used in schools so that students can view their classes via a smartphone or tablet for a rich learning environment.
- 3. Repair & Maintenance :**
  - a. One of the biggest industrial use cases of AR is for repair and maintenance of complex equipment.
  - b. Whether it's a car motor or an MRI machine, repair and maintenance staff are beginning to use AR headsets and glasses while they perform their jobs to provide them with useful information on the spot, suggest potential fixes, and point out potential trouble areas.
- 4. Design & Modeling :**
  - a. From interior design to architecture and construction, AR is helping professionals visualize their final products during the creative process.

- b. Use of headsets enables architects, engineers, and design professionals step directly into their buildings and spaces to see how their designs might look, and even make virtual on the spot changes.
5. **Business Logistics :**
- AR presents a variety of opportunities to increase efficiency and cost savings across many areas of business logistics.
  - This includes transportation, warehousing, and route-optimization.
  - Shipping company DHL has already implemented smart AR glasses in some of its warehouses, where lenses display to workers the shortest route within a warehouse to locate and pick a certain item that needs to be shipping.

**Que 5.5.** Write short note on virtual reality.

**Answer**

- Virtual reality (VR) refers to a computer-generated simulation in which a person can interact within an artificial three-dimensional environment using electronic devices, such as special goggles with a screen or gloves fitted with sensors.
- In this simulated artificial environment, the user is able to have a realistic feeling experience.
- Virtual reality (VR) creates an immersive artificial world that can seem quite real, via the use of technology.
- Through a virtual reality viewer, users can look up, down, or any which way, as if they were actually there.
- Virtual reality has many use-cases, including entertainment and gaming, or acting as a sales, educational, or training tool.
- The concept of virtual reality is built on the natural combination of two words the virtual and the real.
- The former means "nearly" or "conceptually", which leads to an experience that is near-reality through the use of technology.
- Software creates and serves up virtual worlds that are experienced by users who wear hardware devices such as goggles, headphones, and special gloves.
- Together, the user can view and interact with the virtual world as if from within.

**Que 5.6.** What are the advantages and disadvantages of virtual reality?

**Answer**

**Advantages of Virtual Reality :**

- Quality visualizations :** There is no doubt about what VR can achieve when it comes to providing an impressive visualization. A VR headset is what you need for improved levels of experiences.
- A solution to language barrier :** With the use of a suitable software, you can comfortably blend in a foreign language domineered place or country and do just fine using a VR headset.
- Increases levels of interest :** Watching as well as reading are some of the things that use of VR has created much interest in than before. It is engaging and this has increased the level of interest in education for many students.
- Facilitates retention of information :** It is easy to recall content that you have so vividly seen and that is one reason you should use a VR headset. Its ability to produce vivid scenarios makes it easy to recall what has been covered using it.

**Disadvantages of Virtual Reality :**

- It can be addictive :** Being used in both learning and playing games, VR has become addictive to some students and gamers who cannot just let go and that makes them salves to the technology.
- Provides no room for interaction :** When used for learning in the classroom, VR does not provide any room for interaction since you are not open to asking questions or even giving suggestions. It is always a one man show when it comes to learning with using a VR headset.
- It is expensive :** Using VR is expensive due to the advanced features it uses to perform. It can therefore be used by those who can afford it, and they are the minority compared to those who cannot afford them. This makes it unfair especially in learning since not all students can afford it.

**Que 5.7.** Differentiate between augmented and virtual reality.

**Answer**

S.No.	AR	VR
1.	The system augments the real-world scene.	Completely immersive virtual environment.
2.	In AR, user always has a sense of presence in the real world.	In VR, visual senses are under control of the system.
3.	AR is 25% virtual and 75% real.	VR is 75% virtual and 25% real.
4.	This technology partially immerses the user into the action.	This technology fully immerses the user into the action.

5.	AR requires upwards of 100 Mbps bandwidth.	VR requires at least a 50 Mbps connection.
6.	No AR headset is needed.	Some VR headset device is needed.
7.	With AR, end-users are still in touch with the real world while interacting with virtual objects nearer to them.	By using VR technology, VR user is isolated from the real world and immerses himself in a completely fictional world.
8.	It is used to enhance both real and virtual worlds.	It is used to enhance fictional reality for the gaming world.

**PART-2**  
*History, Objective and Global Scenario of 5G Telecom,  
 5G in India, Application and Use Case.*

**Questions-Answers****Long Answer Type and Medium Answer Type Questions**

**Que 5.8.** Write short note on 5G technology.

**Answer**

1. 5G is the 5th generation mobile network.
2. It is a new global wireless standard after 1G, 2G, 3G, and 4G networks.
3. 5G enables a new kind of network that is designed to connect virtually everyone and everything together including machines, objects, and devices.
4. 5G wireless technology is meant to deliver higher multi-Gbps peak data speeds, ultra low latency, more reliability, massive network capacity, increased availability, and a more uniform user experience to most users.
5. Higher performance and improved efficiency empower new user experiences and connects new industries.

**Que 5.9.** Describe the history of 5G technology.

**Answer****History of 5G technology :****First generation :**

- a. The first generation of mobile networks, or 1G, as they were retroactively dubbed when the next generation was introduced, was launched by Nippon Telegraph and Telephone (NTT) in Tokyo in 1979. By 1984, NTT had rolled out 1G to cover the whole of Japan.

**Second generation :**

- a. The second generation of mobile networks, or 2G, was launched under the GSM standard in Finland in 1991.
- b. For the first time, calls could be encrypted and digital voice calls were significantly clearer with less static and background crackling.

**Third generation :**

- a. 3G was launched by NTT DoCoMo in 2001 and aimed to standardize the network protocol used by vendors.
- b. This meant that users could access data from any location in the world as the 'data packets' that drive web connectivity were standardized.
- c. This made international roaming services a real possibility for the first time.

**Fourth generation :**

- a. 4G was first deployed in Stockholm, Sweden and Oslo, Norway in 2009 as the Long Term Evolution (LTE) 4G standard.
- b. It was subsequently introduced throughout the world and made high-quality video streaming a reality for millions of consumers.
- c. 4G offers fast mobile web access (up to 1 gigabit per second for stationary users) which facilitates gaming services, HD videos and HQ video conferencing.

**Fifth generation :**

- a. In 2008, NASA helped launch the Machine-to-Machine Intelligence (M2Mi) Corp to develop IoT and M2M technology, as well as the 5G technology needed to support it.
- b. In the same year, South Korea developed a 5G R&D program, while New York University founded the 5G-focused NYU WIRELESS in 2012.

**Que 5.10.** Write the application of 5G technology.

**Answer****Applications of 5G :**

1. It will make unified global standard for all.
2. Network availability will be everywhere and will facilitate people to use their computer and mobile devices anywhere anytime.
3. Because of the IPv6 technology, visiting care of mobile IP address will be assigned as per the connected network and geographical position.
4. Its application will make world real Wi-Fi zone.
5. Its cognitive radio technology will facilitate different version of radio technologies to share the same spectrum efficiently.
6. Its application will facilitate people to avail radio signal at higher altitude as well.

**Que 5.11. What are the features of 5G technology?****Answer****Following are the features of 5G technology :**

1. Practically possible to avail the super speed i.e., 1 to 10 Gbps.
2. Latency will be 1 millisecond (end-to-end round trip).
3. 1,000x bandwidth per unit area.
4. Feasibility to connect 10 to 100 number of devices.
5. Worldwide coverage.
6. About 90% reduction in network energy usage.
7. Battery life will be much longer.
8. Whole world will be in Wi-Fi zone.

**Que 5.12. What are the advantages and disadvantages of 5G technology ?****Answer****Advantages of 5G technology :**

1. High resolution and bi-directional large bandwidth shaping.
2. Technology to gather all networks on one platform.
3. More effective and efficient.
4. Technology to facilitate subscriber supervision tools for quick action.
5. Will provide a huge broadcasting data (in Gigabit), which will support more than 60,000 connections.
6. Easily manageable with the previous generations.

7. Technological sound to support heterogeneous services (including private network).
8. Possible to provide uniform, uninterrupted, and consistent connectivity across the world.

**Disadvantages of 5G technology :**

1. Technology is still under process and research on its viability is going on.
2. Due to the incompetent technological support in most parts of the world.
3. Many of the old devices would not be competent to 5G, hence, all of them need to be replaced with new ones.
4. Developing infrastructure needs high cost.
5. Security and privacy issue yet to be solved.

**Que 5.13. Describe 5G use case.****Answer****Following are the 5G use cases :**

- 1. Expanded Industrial IoT :**
  - a. Manufacturers are already making extensive use of IoT sensors to monitor performance and optimize both production and logistics.
  - b. Lower latency and increased wireless flexibility will allow them to further streamline their infrastructure, build interconnected and semi-automated smart factories, and increase visibility throughout their supply chains.
- 2. More Real-Time Data for Better Decisions :**
  - a. Whether it's a retail environment, a power utility grid, or a healthcare facility, 5G can provide reliable data in real-time that can help an organization make better decisions.
  - b. Because it can transmit so much information so quickly, a 5G network can gather and process data from multiple sources so people can actually see and address potential issues as they're happening rather than trying to determine what went wrong after the fact.
  - c. This allows for rapid optimization and dynamic decision-making that reflects the reality on the ground.
- 3. Autonomous Vehicles :**
  - a. Self-driving cars may not quite be here in large numbers just yet, but the lack of a powerful 5G network is one of the reasons why they're not a more common sight on the road.
  - b. Since 5G is especially effective at transmitting data between moving objects, it will be absolutely essential to the success of autonomous

### 5-10 L (Sem-1 & 2)

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- c. vehicle networks, which will need to deliver huge amounts of information between vehicles.
- c. Other connectivity needs like remote diagnostics, operating system updates, predictive maintenance, in-car payments, and fleet management will be difficult to scale without the power of 5G networks.
4. **Smart City Applications :**
  - a. Another application for 5G is smart city technology.
  - b. Cities around the world are experimenting with digital solutions that could minimize traffic congestion, improve safety, and make public services more efficient.
  - c. Smart IoT sensors could potentially transmit data quickly over 5G networks to alert city officials of problems, notify commuters of traffic conditions, or even notify people of open parking spaces.
5. **Improved Healthcare Networks :**
  - a. Few industries are more poised for a technology-induced disruption than the healthcare sector.
  - b. Data limitations have long presented an obstacle to healthcare interoperability, but 5G networks could make it possible for high-resolution images to be transmitted quickly and easily between providers.
  - c. The increased capacity of 5G networks would be especially beneficial to hospitals, allowing them to expand the use and flexibility of connected IoT devices without compromising performance.

### PART-3

#### Brain Computer Interface, Application, Model and Global Market.

##### Questions-Answers

##### Long Answer Type and Medium Answer Type Questions

#### Que 5.14. Describe brain computer interface.

##### Answer

1. A brain-computer interface (BCI) is a system that measures activity of the central nervous system (CNS) and converts it into artificial output that replaces, restores, enhances, supplements, or improves natural CNS output, and thereby changes the ongoing interactions between the CNS and its external or internal environment.

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2. Brain-computer interfaces (BCIs) measure brain activity, extract features from that activity, and convert those features into outputs that replace, restore, enhance, supplement, or improve human functions.
3. BCIs may replace lost functions, such as speaking or moving.
4. They may restore the ability to control the body, such as by stimulating nerves or muscles that move the hand.
5. BCIs have also been used to improve functions, such as training users to improve the remaining function of damaged pathways required to grasp.
6. BCIs can also enhance function, like warning a sleepy driver to wake up.

#### Que 5.15. How does brain interface machine work.

##### Answer

Brain machine interface records brain waves and sends them to the computer system to perform the intended task. These transmitted waves are used for controlling an object or expressing an idea. The following functions make this possible :

1. **Communication and control :**
  - a. The Brain Machine Interface eliminates the need for typical information delivery methods by building a communication bridge between human brain and external world.
  - b. By means of this communication protocol, the Brain Machine Interface manages the sending of messages from human brains and decoding their silent thoughts.
  - c. This is how the Brain Machine Interface can help handicapped people in telling or writing their opinions via a variety of methods such as in spelling applications, silent speech communication, or semantic categorization.
2. **User state monitoring :**
  - a. Early Brain Machine Interface applications aimed at providing an alternative communication channel for disabled users who had mobility or speaking issues.
  - b. But today, Brain Machine Interface has entered the world of healthy people as well.
  - c. It now works as a physiological measuring tool that retrieves and uses information about an individual's cognitive, emotional, or effectiveness state.

#### Que 5.16. What are the applications of brain computer interface?

**Answer**

- Following are the application of brain computer interface :
1. The applications of Brain Machine Interface include, but are not limited to, neuroergonomics, medical, smart environment, education and self-regulation, games and entertainment, neuromarketing and advertisement.
  2. In the field of healthcare, Brain Machine Interface can be employed to prevent, detect and diagnose, and rehabilitate and restore from a sickness.
  3. Brain Machine Interface also extends excellent cooperation between the Internet of Things and the BMI technologies, creating smart environments such as smart houses, transportsations, or workplaces.
  4. Marketing field has also shown great interest in the BMI technologies.
  5. Brain Machine Interface helps measures the attention generated post watching of a commercial on TV or any other marketing channel.
  6. On the other hand, researchers are also interested in estimating the memorization of advertisements using Brain Machine Interface.
  7. Brain Machine Interface utilizes brain electrical signals to determine the degree of clarity in the information studied, in the field of education.

**Que 5.17.** Describe the evolution of brain computer interface.**Answer**

1. In the 1920's, German scientist Hans Berger was the first to show that the human brain was producing electrical currents.
2. Berger was the first to record human brain activity by means of EEG.
3. In 1968 Kamiya has notably showed that features of EEG activity could purposely be controlled by a human subject after some training. This was the beginning of neurofeedback.
4. In 1973 Jacques J. Vidal coined the term "Brain-Computer Interface" (BCI).
5. Vidal describe BCIs as "utilizing the brain signals in a man-computer dialogue" and "as a mean of control over external processes such as computers or prosthetic devices".
6. In 1988, Farwell and Donchin proposed the famous and widely used BCI paradigm known as the "P300-speller".
7. They proposed a BCI for spelling letters based on Event-Related Potentials (ERP), which are EEG deflections in response to a specific event or stimulus.
8. In 1993 both in the USA and in Europe, researchers developed BCIs based on Sensori Motor Rhythms (SMR), i.e., based on the oscillatory EEG activity.

9. In 1999 Birbaumer was working on BCIs based on Slow Cortical Potential (SCP).
10. SCP are low frequency variations of EEG signals amplitude, whose amplitude can be voluntarily increased or decreased using training and neurofeedback.
11. This principle was used to design the "Thought Translation Device" (TTD), which enables a user to select one group of commands or another by respectively increasing or decreasing the SCP amplitude.
12. These pioneering groups essentially defined the BCI field and are all prominent figures in BCI research nowadays.
13. Their work sparked the rapid increase in BCI research that follows the years after.

**PART-4***Brain Computer interface and Human Brain.***Questions-Answers****Long Answer Type and Medium Answer Type Questions****Que 5.18.** Explain about brain computer interface.**Answer**

Refer Q. 5.14, Page 5-10L, Unit-5.

**Que 5.19.** Describe human brain.**Answer**

1. The human brain is the command center for the human nervous system. It receives signals from the body's sensory organs and outputs information to the muscles.
2. The human brain is the largest brain of all vertebrates relative to body size.
3. It weighs about 3.3 lbs. (1.5 kilograms).
4. The average male has a brain volume of 1,274 cubic centimeters.
5. The average female brain has a volume of 1,131 cm<sup>3</sup>.
6. The brain makes up about 2 percent of a human's body weight.
7. The cerebrum makes up 85 percent of the brain's weight.
8. It contains about 86 billion nerve cells (neurons) - the "gray matter."

9. It contains billions of nerve fibers (axons and dendrites) - the "white matter."
10. These neurons are connected by trillions of connections, or synapses.

**Que 5.20.** Explain the structure of human brain.

**Answer**

Structure of human brain consists of :

1. **Cerebrum :**
  - a. It is the largest part of the brain and is composed of right and left hemispheres.
  - b. It performs higher functions like interpreting touch, vision and hearing, as well as speech, reasoning, emotions, learning, and fine control of movement.
2. **Cerebellum :**
  - a. It is located under the cerebrum.
  - b. Its function is to coordinate muscle movements, maintain posture, and balance.
3. **Brainstem :**
  - a. It acts as a relay center connecting the cerebrum and cerebellum to the spinal cord.
  - b. It performs many automatic functions such as breathing, heart rate, body temperature, wake and sleep cycles, digestion, sneezing, coughing, vomiting, and swallowing.



## Internet of Things (2 Marks Questions)

**1.1. Define IoT.**

**Ans:** Internet of Things (IoT) is a concept which enables communication between internetworking devices and application.

**1.2. Write the components of IoT conceptual framework.**

**Ans:** Components of IoT conceptual framework are :

1. Gather
2. Consolidate
3. Connect
4. Collect
5. Assemble
6. Manage and analyse

**1.3. What is IoT vision ?**

**Ans:** Internet of Things is a vision where things (wearable watches, alarm clocks, home devices) become 'smart' and function like living entities by sensing, computing and communicating through embedded devices which interact with remote objects (servers, clouds, applications services) or persons through the Internet.

**1.4. What are the major components of IoT system ?**

**Ans:** Major components of IoT system are :

1. Physical object
2. Hardware
3. Communication module
4. Software

**1.5. Mention some communication technologies used in IoT.**

**Ans:** Communication technologies that are used in IoT are :

1. RFID
2. Bluetooth
3. Wi-Fi

**1.6. What are the requirements of IoT ?**

## SQ-2 L (Sem-1 & 2)

## 2 Marks Questions

**Ans.** Requirements of IoT are :

1. Energy
2. Intelligence
3. Communication
4. Integration
5. Dependability
6. Modeling and design

**1.7.** What are the requirements of communication technologies in IoT ?

**Ans.** Requirements of communication technologies in IoT are :

1. Range and dissemination
2. Power consumption
3. Throughput
4. Number of devices
5. Multi-protocol support
6. Security and privacy

**1.8.** List some examples of IoT.

**Ans.** Examples of IoT are :

1. Wearable devices
2. Smart cities
3. Smart home

**1.9.** Define digital sensors.

**Ans.** Digital sensors produce discrete digital output signals or voltages that are a digital representation of quantity being measured. Digital sensors produce a binary output signal in the form of a logic 1 or logic 0 (ON and OFF).

**1.10.** What are the security challenges in IoT ?

**Ans.** Security challenges in IoT are :

1. Data confidentiality
2. Privacy
3. Trust

**1.11.** What are the challenges in IoT ?

**Ans.** Challenges in IoT are :

1. Security
2. Privacy
3. Standards
4. Regulation

**1.12.** What are the components of smart street lighting in smart city ?

## Emerging Technology for Engineering

## SQ-3 L (Sem-1 & 2)

**Ans.** Components of smart street lighting in smart city are :

1. Sensor circuit
2. 8-bit microcontroller
3. Relay driver
4. LED panel mode
5. ESP8266 (Wi-Fi modem)
6. Web server

**1.13.** Define smart city.

**Ans.** A smart city is a designation given to a city that incorporates Information and Communication Technologies (ICT) to enhance the quality and performance of urban services.

**1.14.** What is the aim of smart cities ?

**Ans.** Aim of smart cities is to promote cities that provide core infrastructure and give a decent quality of life to its citizens.





## Cloud Computing (2 Marks Questions)

**2.1. What do you mean by cloud computing ?**

**Ans.** Cloud computing is the means of delivering all IT from computer applications, software, business processes, messaging, and collaboration to end users as a service wherever and whenever they need it.

**2.2. What are the properties of cloud computing ?**

**Ans.** Following are the Properties of cloud computing are :

1. User centric
2. Task centric
3. Self healing
4. Multi-tenancy and intelligence
5. Programmable
6. Flexible

**2.3. Define the evolution of cloud computing.**

**Ans.** Evolution of cloud computing :

1. Grid computing
2. Utility computing
3. Software-as-a-service
4. Cloud computing

**2.4. What are the advantages of cloud computing ?**

**Ans.** Advantages of cloud computing :

1. Cost saving
2. Strategic edge
3. High speed
4. Reliability
5. Mobility

**2.5. What are the disadvantages of cloud computing ?**

**Ans.** Disadvantages of cloud computing :

1. Performance can vary

2. Technical issues
3. Security threat in the cloud
4. Internet connectivity
5. Lack of support

**2.6. What are the security issues related with cloud computing ?**

**Ans.** Following are the Security issues related with cloud computing :

1. Data integrity
2. Data theft
3. Security on vendor level
4. Security on user level
5. Information security

**2.7. What are the data issues related with cloud computing ?**

**Ans.** Following are the data issues related with cloud computing :

1. Data loss
2. Data segregation
3. Data integrity
4. Data confidentiality
5. Data audibility

**2.8. What are the applications of cloud computing ?**

**Ans.** Following are the applications of cloud computing :

1. Big data analytics
2. Develop and test
3. Disaster recovery
4. Gaming applications
5. Web and mobile applications

**2.9. What are the limitations of cloud computing ?**

**Ans.** Following are the limitations of cloud computing :

1. Data protection
2. Data recovery and availability
3. Management capabilities
4. Regulatory and compliance restrictions

**2.10. What are the storage services used by AWS ?**

**Ans.** Following are the storage services used by AWS :

1. Simple storage service
2. Elastic file system
3. Glacier
4. Storage Gateway

**2.11. What are the database used by AWS ?**

**Ques.** Following are the databases used by AWS :

1. RDS (Relational Database Service)
2. DynamoDB
3. ElastiCache
4. Neptune
5. RedShift

**Ques.** Define IBM cloud computing.

**Ans.** IBM cloud computing is a set of cloud computing services for business offered by the information technology company IBM.



## Blockchain (2 Marks Questions)

**3.1. Define Blockchain.**

**Ans.** Blockchain is a decentralized ledger of all transactions across a peer-to-peer network. Using this technology, participants can confirm transactions without a need for a central clearing authority.

**3.2. What are the strengths of a Blockchain system ?**

**Ans.** Following are the strengths of Blockchain system :

1. Process Integrity
2. Traceability
3. Security
4. Faster processing

**3.3. What are the disadvantages of Blockchain system ?**

**Ans.** Following are the disadvantages of Blockchain system :

1. Power Use
2. Cost
3. Uncertain regulatory status

**3.4. What are the core principles of Blockchain ?**

**Ans.** Following are the principles of Blockchain :

1. Distributed database
2. Peer-to-peer transmission
3. Transparency with pseudonymity
4. Irreversibility of records
5. Computational logic

**3.5. What are the components of Blockchain ?**

**Ans.** Blockchain consists of three components :

1. Blocks
2. Miners
3. Nodes

**3.6. Define cryptocurrency.**

**Ans.** Cryptocurrency is a kind of digital money that is designed to be secure and, in many cases, anonymous. It is a currency associated with the internet that uses cryptography, the process of converting legible information into an almost uncrackable code, to track purchases and transfers.

**3.7. What are the advantages of cryptocurrency ?**

**Ans.** Advantages of cryptocurrency :

1. Protection from inflation
2. Self-governed and managed
3. Secure and private
4. Currency exchanges can be done easily
5. Decentralized

- 3.8. What are the disadvantages of cryptocurrency ?**
- Ans.** Disadvantages of cryptocurrency :
1. It can be used for illegal transactions.
  2. Data losses can cause financial losses.
  3. Decentralized but still operated by some organization.
  4. There is no refund or cancellation policy.

**3.9. Define smart contracts.**

**Ans.** Smart contracts are like regular contracts except the rules of the contract are enforced in real-time on a Blockchain, which eliminates the middleman and adds levels of accountability for all parties involved in a way not possible with traditional agreements.

**3.10. What are the characteristics of smart contracts ?**

- Ans.** Smart contracts have the following characteristics :
1. Self-verifying
  2. Self-enforcing
  3. Tamper-proof

**3.11. What are the capabilities of smart contracts ?**

- Ans.** Following are the Capabilities of smart contracts :
1. Automate processes done manually
  2. Ensure security
  3. Reduce relation to trusted intermediaries
  4. Manage users' agreements
  5. Provide utility to other contracts

**3.12. What are the advantages of smart contracts ?**

- Ans.** Following are the advantages of smart contracts :
1. Direct business relationships
  2. Integrity
  3. Trustworthiness
  4. Speed
  5. Security

**3.13. What are the applications of Blockchain system ?**

- Ans.** Following are the application of Blockchain system :
1. Secure sharing of medical data
  2. Music royalties tracking
  3. Cross-border payments
  4. Real-time IoT operating systems
  5. Personal identity security

**3.14. What are different use case in Blockchain ?**

- Ans.** Different use case in Blockchain are :
1. Peer to Peer Money Transfer System
  2. Digital Identity Check
  3. Blockchain-Enabled Trading Platforms
  4. Blockchain-Driven Fundraising
  5. Blockchain In Hedge Funds



## Digital Manufacturing : 3D Printing and Drones (2 Marks Questions)

**4.1. What do you mean by 3D printing ?**

**Ans.** 3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. The creation of a 3D printed object is achieved using additive processes.

**4.2. What are the advantages of 3D printing ?**

- Ans.** Following are the Advantages of 3D printing :
1. Customization
  2. Constant Prototyping and Increased Productivity
  3. Affordability
  4. Storage
  5. Employment Opportunities

**4.3. What are the disadvantages of 3D printing ?**

- Ans.** Following are the Disadvantages of 3D printing :
1. Decrease in Manufacturing Jobs
  2. Limited Size
  3. Limited Raw Materials
  4. Violation of Copyrights
  5. Production of Dangerous Items

**4.4. What are the design principles of 3D printing ?**

- Ans.** Following are the design principles of 3D printings :
1. Manufacturing complexity is free
  2. Variety is free
  3. No assembly required
  4. Zero lead time
  5. Unlimited design space

**4.5. What are the different types of tools used for 3D printing ?**

- Ans.** Following are the different tools used for 3D printing :
1. Masking Tape
  2. Kapton Tape
  3. Glue Stick
  4. Digital Caliper
  5. Pliers
  6. Screw Drivers and Hex Key Screw Drivers

**4.6. What are the use case of 3D printing ?**

- Ans.** Following are the use case of 3D printing :
1. Automobiles
  2. Jewelry
  3. Onshoring
  4. Spare and Replacements Parts
  5. Aerospace

**4.7. What is a drone ?**

**ANS:** The term "drone" usually refers to any unpiloted aircraft. It is also referred to as "Unmanned Aerial Vehicles" (UAVs), these crafts can carry out an impressive range of tasks, ranging from military operations to package delivery.

**4.8. What are the components and features of drones ?**

**ANS:** Following are the components of drone :

1. Electronic Speed Controllers (ESC), an electronic circuit that controls a motor's speed and direction.
2. Flight controller
3. GPS module
4. Battery
5. Antenna

**4.9. What are the features of drones ?**

**ANS:** Following are the features of a drone :

1. Camera type, video resolution, megapixels and media storage format
2. Maximum flight time
3. Maximum speeds
4. Hover accuracy
5. Obstacle sensory range

**4.10. What are the types of drones ?**

**ANS:** Following are the types of drones :

1. Fixed Wing
2. Single rotor
3. Multirotor

**4.11. Define fixed wing drone.**

**ANS:** A fixed wing drone consists of one rigid wing and is designed to look and works like an airplane. Fixed wing UAVs are well known in the military, as they are often used when manned flight is considered too risky or difficult.

**4.12. Define single rotor.**

**ANS:** Single rotor drones are strong and look similar in structure and design to actual helicopters. They have one big rotor, which is like one big spinning wing, plus a small sized rotor on the tail for direction and stability.

**4.13. Define Multirotor drone.**

**ANS:** Multi-rotor drone is the popular choice for aerial photography, filmmaking and surveillance. It is used by professionals and hobbyists alike because of its small size and ready to fly out of the box capabilities.

**Future Trends  
(2 Marks Questions)****5.1. Define augmented reality.**

**ANS:** Augmented reality refers to any technology that 'augments' the user's visual (and in some case auditory) perception of their environment.

**5.2. What are the benefits of augmented reality ?**

**ANS:** Following are the Benefits of AR :

1. It can be used by anyone including mentally and physically disabled individuals.
2. It blurs the line of difference between the virtual and real world, thus increasing its usability and effectiveness in the area of application.
3. It possesses a highly interactive nature.

**5.3. What are the drawbacks of AR ?**

**ANS:** Drawbacks of AR :

1. Lack of privacy
2. AR cannot be leveraged without appropriate training.
3. It can get extremely costly to develop and maintain an AR based device or an application.

**5.4. What are the applications of augmented reality ?**

**ANS:** Following are the applications of AR :

1. Medical Training
2. Retail
3. Repair & Maintenance
4. Design & Modeling
5. Business Logistics

**5.5. What do you mean by virtual reality ?**

**ANS:** Virtual reality (VR) refers to a computer-generated simulation in which a person can interact within an artificial three-dimensional environment using electronic devices, such as special goggles with a screen or gloves fitted with sensors.

**5.6. What are the advantages of virtual reality ?**

**ANS:** Following are advantages of virtual reality :

1. Quality visualizations

2. A solution to language barrier
3. Increases levels of interest
4. Facilitates retention of information

**5.7. What are the disadvantages of virtual reality ?**

**Ans.** Following are the disadvantages of virtual reality :

1. It can be addictive
2. Provides no room for interaction
3. It is expensive

**5.8. What are the advantages of 5G technology ?**

**Ans.** Advantages of 5G technology :

1. High resolution and bi-directional large bandwidth shaping.
2. Technology to gather all networks on one platform.
3. More effective and efficient.
4. Technology to facilitate subscriber supervision tools for the quick action.
5. Possible to provide uniform, uninterrupted, and consistent connectivity across the world.

**5.9. What are the disadvantages of 5G technology ?**

**Ans.** Disadvantages of 5G technology :

1. Developing infrastructure needs high cost.
2. Security and privacy issue yet to be solved.

**5.10. Define brain computer interface.**

**Ans.** A brain-computer interface (BCI) is a system that measures activity of the central nervous system (CNS) and converts it into artificial output that replaces, restores, enhances, supplements, or improves natural CNS output, and thereby changes the ongoing interactions between the CNS and its external or internal environment.

**5.11. What are the functions of brain interface machine ?**

**Ans.** Following are the functions of BCI :

1. Communication and control
2. User state monitoring

**5.12. Define human brain.**

**Ans.** The human brain is the command center for the human nervous system. It receives signals from the body's sensory organs and outputs information to the muscles.

**5.13. What are the parts of human brain ?**

**Ans.** Following are the parts of human brain :

1. Cerebrum
2. Cerebellum
3. Brainstem

