

Science and Technology 11

13th August, 2023 at 1:00 PM

QUANTUM TECHNOLOGY (01:20 PM)

- **Wave-Particle duality of light**- light has a dual nature. it behaves like both a wave and a particle.
- The **Heisenberg uncertainty principle** says that both the position and velocity of a particle can not be determined with exact accuracy.
- Quantum technologies are based on ideas of quantum mechanics which were developed in the early 20th century to explain nature at a very small scale such as atomic, molecular, nuclear, and elementary particles level, the laws of Physics change for e.g. we can only determine probabilities and not certainties.
- Despite this, the understanding of quantum mechanics has facilitated many branches of technologies such as Quantum Computing, Quantum communication, Quantum sensing and metrology, Quantum systems and materials.

QUANTUM COMPUTING (02:01 PM)

- Quantum computers rely on postulates of quantum mechanics to process data.
- They use Quantum bits or qubits which can be both 0 and 1 or any combination simultaneously with different probabilities.
- This is called **Quantum Superposition**.
- qubits can also be entangled with each other so that Quantum computers can perform operations on many qubits at once which can speed up calculations.
- This is called **Quantum entanglement**.
- The computing power of a quantum computer increases exponentially with an increase in the number of qubits.
- With the number of qubits, the computational capacity of a computer increases many times.

APPLICATIONS OF QUANTUM COMPUTING (02:28 PM)

- **Cryptography**
- Modern cyber security techniques rely upon mathematical problems which are very difficult to solve.
- For ex- To decrypt data, finding the prime factors of a very large number.
- The most popular technique is called **public key distribution**.
- A sufficiently strong quantum computer can solve such problems in seconds and minutes.
- Quantum computers can be used for **Quantum simulations** i.e. to simulate properties of new materials leading to unique properties.
- This can lead to the discovery of new drugs, high-temperature superconductors, better solar panels etc.
- **Superconductors**
- Superconductivity is the property- very low (nearly zero) resistance.
- It occurs at very low temperatures.
- Quantum technology could have possible applications in developing superconductors at room temperature.
- **Metrology**- In the science of measurement, with the help of quantum sensors, accurate measurements can be done.

CHALLENGES (03:16 PM)

- **1) Quantum decoherence**
- It refers to the tendency of qubits to lose their quantum properties and become classical.
- This can lead to errors in computation.
- **2) Scalability**
- To be useful for practical applications, quantum computers need to have thousands or lakhs of qubits.
- As the number of qubits increases their manipulations become more difficult.
- 3) Quantum computers **need to be kept in isolated conditions** at very low temperatures. Even a small disturbance can lead to errors in computations.
- 4) The hardware and software of quantum computers is still in its early stages.
- For e.g. how to design logical qubits, new programming languages, software and algorithms are in a nascent stage.
- 5) It is very **expensive** to build and operate a quantum computer.

QUANTUM COMMUNICATION (03:34 PM)

- It is a type of communication that used postulates of quantum mechanics to ensure the security and privacy of data transmitted over a network.
- Information is encoded into qubits which are sent over a network.
- If an eavesdropper attempts to intercept qubits will be disturbed making it immediately apparent that information has been compromised.
- To ensure the security of the communication, the sender and receiver can establish a shared secret key using quantum postulates e.g. in Quantum key distribution (QKD), a pair of entangled photons can be used to determine the shared key for encryption and decryption.
- Any eavesdropper will change the quantum state and immediately both sender and receiver will be alerted.
- Recently, Govt of India announced a **National Quantum Mission**, to be implemented by the Department of Science and Technology in 4 major domains of Quantum systems.

THE TOPIC OF THE NEXT CLASS- BLOCKCHAIN TECHNOLOGY, ARTIFICIAL INTELLIGENCE.