QUANTUM TECHNOLOGY

Posted at: 24/09/2024

Context:

The Department of Science and Technology has invited proposals from start-ups engaged in quantum technologies under the National Quantum Mission, which aims to support, nurture and scale up scientific and industrial R&D in quantum technology.

Background:

Apart from being a new field, quantum technology is one of the most important interdisciplinary areas, with wide applications in science, research, healthcare, communication, security, and many other sectors.

What is Quantum Technology:

1. Quantum Technology is used as an umbrella term for the technological advancements that are specifically governed by the principles of quantum mechanics at its core – a fundamental aspect of quantum physics that deals with the behaviour of atomic and subatomic particles.
2. It was observed that the principles of classical physics (which includes Newtonian mechanics, electromagnetism, and classical thermodynamics) were not able to explain many important phenomena of atomic and subatomic particles, which were wave-particle duality, quantum superposition, quantum entanglement, and Heisenberg's Uncertainty Principle.
3. This inadequacy of classical physics led to the development of quantum mechanics, a new field in physics that revolutionised our understanding of the quantum world. Further developments in quantum mechanics were translated into real devices for applications.
4. Together (theories and devices), they made up what we call quantum technology. To be precise, quantum technology exploits the principles of quantum mechanics, which include superposition, quantum entanglement, and interference to achieve greater efficiency in large-scale computations.

Principles of Quantum Mechanics:

(a) Superposition:
In classical computing, the fundamental unit for computation is a 'bit', represented by either '0' or '1'. A bit can only take either of these two values because these are the only possibilities. In contrast, quantum computing uses 'qubit' (or quantum bit) as its fundamental unit. Unlike classical bits, qubits can exist in a superposition of both '0' and '1' (described by a linear combination of '0' and '1' and represented through the probabilities of the qubit being in the '0' or '1' state when measured).
This unique feature helps in finding multiple solutions to complex algorithms by scanning through a vast number of possibilities simultaneously and coming to the solution with the least error.
(b) Entanglement:
It is a phenomenon that explains how two subatomic particles get linked to each other irrespective

of distance such that a level of change in one particle gets reflected on the other. This intriguing property can help in preventing security breaches in quantum communication by entangling qubits of sender and receiver.

(c) Interference:

It is a wavelike superposition of subatomic particles' states that affect the probabilities of states of these particles when measured. While entanglement is a phenomenon between two particles, interference is an effect of many particles surrounding each other. Interference can be constructive as well as destructive which makes it suitable for use in quantum algorithms for improving accuracies by suppressing less probabilistic outcomes and amplifying high probabilistic outcomes.