

Quantum Computing

Quantum computing is a form of computing which employs technology based on quantum theory.

Quantum theory explains the behaviour of energy and material on the atomic and subatomic levels.

Employment of quantum theory will make sure computers work far beyond their binary code, as in they can only process information in bits that take the value of 1 or 0, restricting their ability in the process.

This article will give details about quantum computing within the context of the IAS Exam. It is part of the Science and Technology segment.

To know more about this segment in detail, visit the UPSC Syllabus page.

Overview of Quantum Computing

Quantum computing is based on two features of quantum physics: Superposition and entanglement.

Superposition means the ability of a quantum system to exist in multiple states at the same time. Entanglement, on the other hand, is the ability of two members of a pair (Qubits) to exist in a single quantum state.

Both these features allow quantum computers to handle operations beyond the limits of conventional computers while consuming lesser amounts of energy.

Research in quantum computing began in the 1980s when it was discovered that some computational problems could be solved efficiently with the help of quantum algorithms as opposed to their classical counterparts.

Quantum computing would help immensely in fields of finance, military, intelligence, drug design, discovery, artificial intelligence and digital manufacturing.

Difference between Quantum Computing and Classical Computing

Quantum computers are able to process information differently. While classical computers can only process data as either 1 or 0 at different times, quantum computers can process 1 or 0 at the same time. This is known as qubits. When qubits are linked together, this increases the processing power of quantum computers greatly

Classic computers are good at completing everyday tasks that do not involve complex amounts of data to be processed. Quantum computers are better for running complex simulations, chemical or drug

trials or any form of tasks which involve processing complex levels of data. However, quantum computers are expensive to build and maintain.

Quantum computing can help in developing new drugs to fight diseases like cancer or run simulations that can test the effectiveness of such drugs. They also help in improving radars and in keeping an eye on the environment using chemical sensors.

While some companies have built personal (although expensive) quantum computers, there is still nothing available on the commercial side. And there is interest in quantum computing and its technology, with JPMorgan Chase and Visa looking into the technology. Once developed, Google could launch a quantum computing service via the cloud.²

India and Quantum Computing

In the Union Budget of 2020-2021, the Central Government has allocated Rs. 8000 crore for the National Mission on Quantum Technology and Applications (NMQTA).

The mission seeks to develop quantum computing linked technologies amidst the second quantum revolution and make India the world's third-biggest nation in the sector after the US and China.

- The areas of focus of the NM-QTA Mission will be fundamental science, translation, technology developed and towards fulfilling natural properties.
- The mission can help prepare next generation skilled manpower, boost translational research and also encourage entrepreneurship and start-up ecosystem development.
- Quantum principles will be used for engineering solutions to extreme complex problems in computing, communications, sensing, chemistry, cryptography, imaging and mechanics
- Their applications will be boosted include those in aerospace engineering, numerical weather predictions, simulations, securing the communications & financial transactions, cybersecurity, advanced manufacturing, health, agricultural, education
- It can bring Indian in the list of a few countries with an edge in this emerging field and will have a greater advantage in garnering multifold economic growth and a dominant leadership role.