
Prelims and Mains focus: about the move and its significance; about quantum computing and its applications

News: The Union Budget 2020-21 proposal to earmark Rs.8,000 crore for quantum computing over the next five years can boost critical areas of the Indian economy, including space research and defence capabilities.

About the move

- The quantum of money proposed for the sector is almost on a par with the amount invested by the US to develop the technology.

- However, the success of the initiative will depend on careful planning and implementation. Moreover, considering that there are no private companies in India working on quantum computing, the initiative, by and large, will have to be led by state-run institutions.

Need

The announcement is significant as the scale of investments necessary to make headway in quantum computing is not possible without the support of the government or large corporations. It should boost attempts of domestic technology providers, who have been keen to enter this field, but did not have the necessary scale or resources.

Significance of Quantum computing for India

- Quantum computers will open up enormous opportunities for India, particularly in the field of defence, space research, weather forecasting, and healthcare by crunching large amounts of data and solving problems infinitely faster than existing supercomputers.
The quantum science and technology initiative in India has been broadly defined around computing, communications, and measurements. Of these, quantum computing is expected to provide the ability to solve hitherto intractable problems in resource optimisation, machine learning, and data security, and also help to design new materials with futuristic applications.

**Quantum Computing: Global scenario**

- The recent advancements in the field of quantum computing, including IBM’s unveiling of the world’s first quantum computing system for scientific and commercial use, Google’s quantum supremacy, and Microsoft taking quantum computing to the cloud, have made the world realise the possibilities it can offer. Google’s 54-bit quantum computer took merely 200 seconds for an experimental computation that a supercomputer would have taken 10,000 years to solve.

- Governments the world over are starting to grasp the potential of the technology. China already has a national strategy on quantum computing, having spent $400 million on a national quantum lab and filing twice as many patents as the US on quantum technology.

- The US government had also announced a National Quantum Initiative in 2019 with an outlay of $1.2 billion (Rs.8,500 crore).

**What is quantum computing?**

- Quantum computing is essentially harnessing and exploiting the amazing laws of quantum mechanics to process information.

- A traditional computer uses long strings of “bits,” which encode either a zero or a one. A quantum computer, on the other hand, uses quantum bits, or qubits.

**What’s the difference?**

- Well a qubit is a quantum system that encodes the zero and the one into two
distinguishable quantum states. But, because qubits behave quantumly, we can capitalize on the phenomena of "superposition" and "entanglement."

- **Superposition** is essentially the ability of a quantum system to be in multiple states at the same time — that is, something can be “here” and “there,” or “up” and “down” at the same time.

- **Entanglement** is an extremely strong correlation that exists between quantum particles — so strong, in fact, that two or more quantum particles can be inextricably linked in perfect unison, even if separated by great distances. The particles are so intrinsically connected, they can be said to “dance” in instantaneous, perfect unison, even when placed at opposite ends of the universe. This seemingly impossible connection inspired Einstein to describe entanglement as “spooky action at a distance.”

**Why do these quantum effects matter?**

- First of all, they’re fascinating. Even better, they’ll be extremely useful to the future of computing and communications technology.

- Thanks to superposition and entanglement, a quantum computer can process a vast number of calculations simultaneously. Think of it this way: whereas a classical computer works with ones and zeros, a quantum computer will have the advantage of using ones, zeros and “superpositions” of ones and zeros. Certain difficult tasks that have long been thought impossible (or “intractable”) for classical computers will be achieved quickly and efficiently by a quantum computer.

**Applications**

1. Cybersecurity
2. Drug Development
3. Financial Modeling
4. Better Batteries
5. Cleaner Fertilization
6. Traffic Optimization
7. Weather Forecasting and Climate Change
8. Artificial Intelligence
9. Solar Capture
10. Electronic Materials Discovery