India & Quantum Computing

For Prelims: Quantum Computing, Qiskit Challenge, quantum computing laboratory, National Mission on quantum technologies and applications, Centre for Development of Telematics (C-DOT), I-HUB Quantum Technology Foundation, Centre for Development of Advanced Computing (C-DAC), National Mission on quantum technologies and applications.

For Mains: Significance of Quantum Computing.

Why in News?

According to a study by IBM, **India is witnessing a growing interest in** quantum computing, with students, developers, and academia actively participating. Consequently, the country is **emerging as a talent hub for quantum computing.**

What is Quantum Computing?

- **About:**
  - Quantum computing is a **rapidly-emerging technology that harnesses the laws of quantum mechanics** to solve problems too complex for classical computers.
    - Quantum mechanics is a subfield of physics that describes the behavior of particles — atoms, electrons, photons, and almost everything in the molecular and submolecular realm.
  - It is an exciting **new technology that will shape our world tomorrow** by providing us with an edge and a myriad of possibilities.
  - It is a fundamentally **different way of processing information** compared to today's classical computing systems.
- **Features:**
  - **Different from Traditional Computers:**
    - While today's **classical computers store information as binary 0 and 1 states, quantum computers** draw on the fundamental laws of nature to **carry out calculations using quantum bits.**
    - Unlike a bit that has to be a 0 or a 1, a **qubit can be in a combination of states,** which allows for exponentially larger calculations and **gives them the potential to solve complex problems** which even the most powerful classical supercomputers are not capable of.

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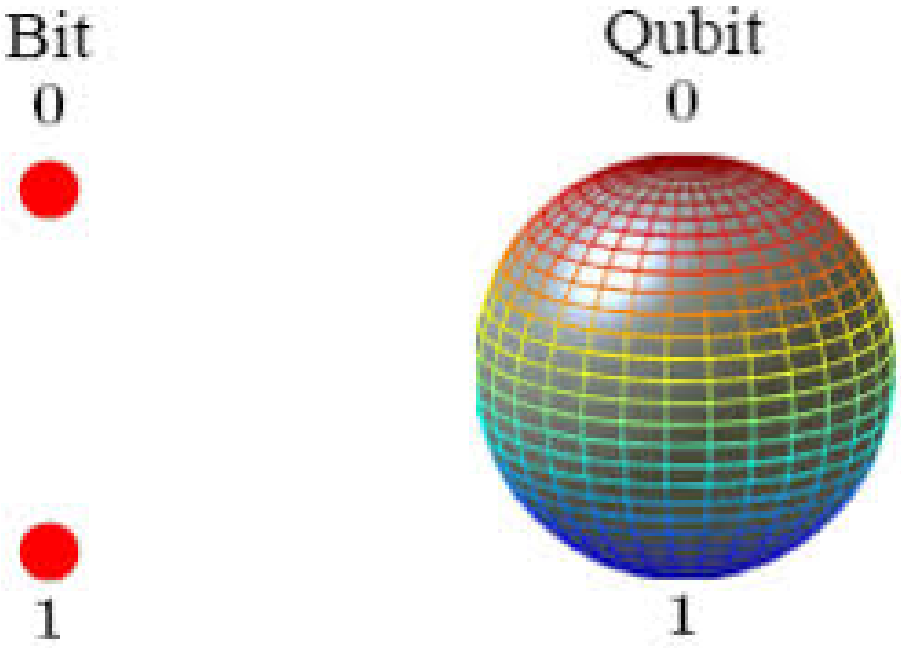

- **Significance:**
  - Quantum computers can tap into the quantum mechanical phenomenon to **manipulate information and are expected to shed light on processes of molecular and chemical interactions**, address difficult optimization problems, and boost the power of artificial intelligence.
  - These could **open the door to new scientific discoveries,** life-saving drugs, and improvements in supply chains, logistics and the modelling of financial data.

What are IBM India's Initiatives around Quantum Computing?

- **Qiskit Challenge:** Qiskit is an **open-source software development kit** built by IBM for the quantum developer community.
- **Qiskit India Week of Quantum:** IBM regularly organizes India-focused programmes such as Qiskit India Week of Quantum, which **celebrated women in quantum to kickstart their journeys in quantum**, and was attended by almost 300 students.
- **The Qiskit Textbook:** Qiskit textbook is available in Tamil, Bengali and Hindi and was accessed more than 30,000 times by students in India in 2021 alone.
- **IBM Quantum Educators Programme:** IBM is **collaborating with leading educational institutions in India** through the IBM Quantum Educators Programme.
  - The faculty and students of these institutions will be able to **access IBM Quantum systems, quantum learning resources and quantum tools** over IBM Cloud for educational purposes.

What are the Key Initiatives taken by the Indian Government?

- **National Mission on quantum technologies and applications:** The Government in its 2021 budget allocated INR 8000 Crore towards the **National Mission on quantum technologies and applications** to spur developments in quantum computing, cryptography, communications, and material science.
- **Quantum Computing Laboratory**: In December 2021, the Indian Army set up a **quantum computing laboratory** and an AI centre at a military engineering institute at Mhow, Madhya Pradesh. It is also backed by the **National Security Council Secretariat (NSCS).**
- **Quantum Communication Lab:** The **Centre for Development of Telematics (C-DOT)** launched a **quantum communication lab** in October 2021. It can support more than 100 km of standard optical fibre.

- **Collaborations**: The **Defence Institute of Advanced Technology (DIAT)** and the **Centre for Development of Advanced Computing (C-DAC)** agreed to collaborate and develop quantum computers.
- **I-HUB Quantum Technology Foundation:** The Department of Science and Technology and about 13 research groups from IISER Pune launched **I-HUB Quantum Technology Foundation** (I-HUB QTF) to further enhance the development of quantum tech.
- **Startups:** A number of Start-Ups such as **Qunu Labs, Bangalore; BosonQ, Bhilai** have also emerged and as a result, they are making inroads in this area.

Way Forward

- Similar to the **fast-growing Artificial Intelligence market, quantum computing, as another technology, has created a wave among the countries and companies globally** to get into a race and acquire a leadership position.
- The need of the hour, therefore, is simultaneously to **build sufficient quantum computational capacity, develop skills** in building and operationalizing a **practical size and affordable cost quantum computer,** continue research into realizing the various practical applications, and **introduce contents into the educational courses at undergrad and post-grad levels** to develop quantum science and engineering as a discipline at the university level that will produce a large number of science and technology heads.

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims

Q. Which one of the following is the context in which the term "qubit" is mentioned?

(a) Cloud Services
(b) Quantum Computing
(c) Visible Light Communication Technologies
(d) Wireless Communication Technologies

Ans: (b)

Exp:

- **Quantum Supremacy**
  - Quantum computers compute in ‘qubits’ (or quantum bits). They exploit the properties of quantum mechanics, the science that governs how matter behaves on the atomic scale.
- **Hence, option (b) is correct.**

Mains

Q. “The emergence of the Fourth Industrial Revolution (Digital Revolution) has initiated e-Governance as an integral part of government”. Discuss. **(2020)**

Source: TH