National Quantum Mission

Why in News?

India's National Quantum Mission launched last year seeks to advance research in Quantum Technologies and promote indigenous research.

What is Quantum Computing?

- **Quantum computing** – It is the computing technology that utilizes quantum mechanics to solve complex problems faster than on classical computers.
- It harnesses the unique behavior of quantum physics such as superposition, entanglement, and quantum interference and apply it to computing.

> *Quantum mechanics - It is the science dealing with the behaviour of matter and light on the atomic and subatomic scale.*

- **Superposition -** is the ability of a quantum system to be in multiple states at the same time until it is measured.
- **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.
- **Interference -** It is a wavelike superposition of states of subatomic particles 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.
- **Qubit** – It is the basic unit of information in quantum computing that plays a similar role in quantum computing as bits play in classical computing, but they behave very differently.
- Classical bits are binary and can hold only a position of 0 or 1, but qubits can hold a superposition of all possible states.
- Signals can be sent to the qubits using a variety of methods, including microwaves, laser, and voltage.
- **Quantum Computer Components** – A quantum computer has three primary parts
  - An area that houses the qubits
  - A method for transferring signals to the qubits
  - A classical computer to run a program and send instructions

To Know more about Quantum technologies , Click Here.

What is National Quantum Mission (NQM)?

- **Objectives**
  - To seed, nurture and scale up scientific and industrial R&D.
  - To Create a vibrant & innovative ecosystem in Quantum Technology (QT).
  - To developing intermediate-scale quantum computers with 50-1000 physical qubits in 8 years.
  - To create Satellite-based secure quantum communications between ground stations over a range of 2000 km within India.
  - To develop long-distance secure quantum communications with other countries.
  - To create inter-city quantum key distribution over 2000 km.
  - To develop multi-node Quantum networks with quantum memories.
- **Launched in** - 2023
- **Mission Period** - 2023-24 to 2030-31
- **Nodal Ministry** - Ministry of Science and Technology
- **Four thematic hubs (T-hub)** – They will be established in top academic and National R&D institutes in the domains of
  - Quantum Computing
  - Quantum Communication
  - Quantum Sensing & Metrology
  - Quantum Materials & Devices

Quantum Computer Projects in India
• The Tata Institute of Fundamental Research (TIFR), Mumbai, has developed a 3-qubit quantum computer based on superconducting qubits, and is preparing to develop a computer with 7 qubits in collaboration with DRDO and TCS. • IISER Pune's I-HUB Quantum Technology Foundation is working on a 20+ qubit quantum computer based on ion traps and another computer based on neutral atoms along with IIT Roorkee and IIT Guwahati. • IIT Bombay and IISER Thiruvananthapuram are working on spin qubits based on semiconductors, while IISc Bangalore is also working on superconducting qubits. • The Chatterjee Group Centres for Research and Education in Science and Technology (TCG CREST), is building India's first quantum computer in association with TIFR and IISc Bangalore.

How the Mission is aligned with other initiatives?

- The Mission will also provide a huge boost to National priorities like Digital India, Make in India, Skill India and Stand-up India, Start-up India, Self-reliant India and Sustainable Development Goals (SDG).
- **Digital India –** NQM supports the aims and ambitions of Digital India scheme by making effective computing and secure communication through advancements in the field of quantum technology.
- **Make in India** - The National Quantum Mission creates a niche for indigenous research and development (R&D), manufacturing, and investments for building quantum devices and related products.
- **Skill India** - The National Quantum Mission encourages skill development in the field of quantum technologies through training and education.

- **Stand-up India, Start-up India-** The National Quantum Mission stimulates innovation and entrepreneurship under its various verticals.
- **Self-reliant India -** The National Quantum Mission aims at advancing quantum technologies within the country, promoting indigenous research to minimise reliance on foreign resources.
- **Sustainable Development Goals (SDGs) -** Through NQM, global challenges related to climate (SDG 13), energy (SDG 7), and healthcare (SDG 3) can be addressed.

What are the benefits of NQM in other sectors?

- The progress made in the field of the NQM can benefit various sectors such as communication, health, energy and finance in different ways.
- **Communication -** Quantum technologies enable secured encryption along with high speeds of data transfer in satellite communication.
- **Health** - Quantum computing would accelerate drug discovery, genomic research and precision in medical diagnostics.
- **Financial -** Quantum computing facilitates complex financial modelling and risk analysis through various optimization algorithms.
- Quantum cryptography enhances the security of financial transactions.
- **Energy - Improve** the optimization of energy grid and resource management through quantum computing.
- **Advanced materials -** Quantum simulations can lead to the discovery of new materials with unique properties such as superconductors, and advanced batteries.

Quantum simulations simulate the behaviour of materials at the atomic level.

What are the challenges in achieving NQM Objectives?

- India is lagging behind countries like the US and China in terms of investment, publishing papers on quantum-related science, and registering patents.
- **Insufficient Investment** - India has allocated 6,000 crores ($0.75 billion) for the National Quantum Mission whereas China and US allocate $15.3 billion and $3.75 billion respectively.
- **Inadequate Research -** India is 10th in terms of papers published related to Quantum Technologies.
- **Low Patent Creation** - Indian researchers had acquired only 339 such patents between 2015 and 2020 and ranks 9th by the number of patents obtained in Quantum Technologies.
- **Lack of Industry-academia linkage -** Collaborations between academic institutions, research organisations and industries are not enough to get the required momentum in research.
- **Fewer Quantum manufacturing -** In India, only about 3 per cent of deep tech start-ups are involved in the manufacturing or development of materials related to Quantum Technologies.
- **Deficient Skilled workforce -** Sufficient pool of scientists, engineers, and professionals who have specialised in quantum technology is not available.

What lies ahead?

- Research in this area would require building state-of-the-art laboratories, the purchase of advanced equipment, and long-term support.
- Public and private sectors can come forward to fund research infrastructure and facilities through comprehensive investment models
- A collaborative research and development ecosystem would help integrate efforts across academia, industry, and government.
- Educational outreach initiatives to increase public awareness and industry-specific conferences to engage business leaders and investors would aid such efforts.

References

[The Indian Express | National Quantum Mission]

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