Finalising Implementation Strategy of NQM

For Prelims: National Quantum Mission**,** Quantum Technology, Department of Science & Technology (DST), Mission Coordination Cell (MCC).

For Mains: National Quantum Mission and its role in developing Quantum Technology, Quantum Technology: Application, Challenges and Way Forward.

Source: PIB

Why in News?

Recently, the first meeting of the **Mission Governing Board (MGB)** of the **National Quantum Mission (NQM)** discussed implementation strategy and timelines of NQM as well as the formation of **the Mission Coordination Cell (MCC).**

- The MCC will be set up in an institution identified by the Department of Science and Technology (DST), based on merit and existing infrastructure and will function under the overall supervision and guidance of the **Mission Technology Research Council (MTRC).**

What is the National Quantum Mission (NQM)?

- **About:**
  - The mission planned for **2023-2031, aims to seed, nurture, and scale up scientific and industrial R&D and create a vibrant & innovative ecosystem in** Quantum Technology (QT).
  - It'll be implemented by the DST under the Ministry of Science & Technology.
  - With the launch of this mission, **India will be the seventh country to have a dedicated quantum mission** after the US, Austria, Finland, France, Canada and China.
- **Salient features of NQM:**
  - It will target **developing intermediate-scale quantum computers with 50-100 physical qubits in 5 years** and **50-1000 physical qubits in 8 years.**
  - Just like bits (1 and 0) are the basic units by which traditional computers process information, **'qubits' or 'quantum bits' are the units of process by quantum computers.**
  - The mission will **help develop magnetometers with high sensitivity for precision timing (atomic clocks), communications, and navigation.**
  - It will also support the design and synthesis of quantum materials such as superconductors, novel semiconductor structures and topological materials for fabrication of quantum devices.
- **Development of Quantum Communications:**
  - Satellite based secure quantum communications between ground stations over a range of 2000 km within India.
  - Long distance secure quantum communications with other countries.
  - **Inter-city** quantum key distribution **over 2000 km.**

    - Multi-node Quantum network with quantum memories.
- **Four Thematic Hubs (T-Hubs) would be set up in top academic and National R&D institutes on the domains of Quantum Technology:**
    - **Quantum computation**
    - **Quantum communication**
    - Quantum Sensing & Metrology
    - Quantum Materials & Devices

Quantum Technology

- **About:**
    - Quantum technology is a **field of science and engineering that deals with the principles of quantum mechanics**, which is the study of the behaviour of matter and energy at the smallest scale.
    - Quantum mechanics is the branch of physics that describes the behaviour of matter and energy at the atomic and subatomic level.
- **A Comparison between India and China:**
    - **R&D in China:** China started its research and development (R&D) in the field of quantum technology in 2008.
        - **In 2022, China boasts of developing the world's first quantum satellite**, creating a quantum communication line between Beijing and Shanghai, and **owning two of the world's fastest quantum computers.**
        - This was a **result of decade-long research** carried out in the hope of achieving critical breakthroughs.
    - **India:** Quantum Technology remains a **field highly concentrated in long-term R&D in India.**
        - **Just a few hundred researchers, industry professionals,** academicians, and entrepreneurs are in the field right now without a constant focus on R&D.

What are the Advantages of Quantum Technology?

- **Increased Computing Power:** Quantum computers are much faster than the computers we today have. They also have the capability to solve complex problems that are currently beyond our reach.
- **Improved Security:** Because they rely on principles of quantum mechanics, quantum encryption techniques are much more secure than traditional encryption methods.
- **Faster Communication:** Quantum communication networks can transmit information faster and more securely than traditional networks, with the potential for completely unhackable communication.
- **Enhanced AI:** Quantum machine learning algorithms can potentially enable more efficient and accurate training of **Artificial Intelligence** models.
- **Better Sensing and Measurement:** Quantum sensors can detect extremely small changes in the environment, making them useful in areas such as medical diagnostics, environmental monitoring, and geological exploration.

What are the Disadvantages of Quantum Technology?

- **Expensive:** The technology requires specialized equipment and materials which make it more expensive than the traditional technologies.
- **Limited Applications:** Currently, quantum technology is only useful for specific applications such as cryptography, quantum computing, and quantum communication.
- **Sensitivity to Environment:** Quantum technology is highly sensitive to environmental interference, such as temperature changes, magnetic fields, and vibrations.
    - **Qubits are easily disrupted by their surroundings which can cause them to lose their quantum properties and make mistakes in calculations.**
- **Limited Control:** It is difficult to control and manipulate quantum systems. Quantum-powered AI

could create unintended consequences.
    - **Quantum-powered AI systems could potentially arrive at conclusions that are unexpected or difficult to explain** as they operate on principles that are fundamentally different from classical computing.

What Should be the Way Forward?

- **Enhance the Investment:** Quantum technology requires substantial investment in research and development, infrastructure, and human resources to achieve its full potential.
    - India has taken a step in this direction by launching the National Quantum Mission with a budget of Rs. 6000 crores.
    - However, more public and private funding is needed to support the growth of quantum start-ups, service providers, and academic institutions.
        - **Private Sector R&D funding can be enhanced in this segment** which is already very low in India compared to developed countries.
- **A Regulatory Framework is a must:** Quantum technology also poses ethical, legal, and social challenges that need to be addressed before it becomes widely available. **For example, quantum sensing may infringe on privacy rights, and quantum weapons may cause mass destruction.**
    - Therefore, it would be **prudent to develop a regulatory framework for quantum technology that balances innovation and security.**
- **Promote Quantum Education**: Quantum technology also **requires skilled and trained professionals who can understand and apply its principles and methods.** Therefore, it is essential to promote quantum education and awareness among students and researchers across various disciplines.
    - This can be done by introducing quantum courses in schools and colleges, organising workshops and seminars, and creating online platforms and resources.
- **Collaboration among Various Stakeholders:** For better understanding of Quantum technology, it is required to have proper collaboration and cooperation among various stakeholders, such as government agencies, industry players and institutions.
    - This can foster knowledge sharing, innovation, and standardization across different domains and applications of quantum technology.
    - It can also **enable India to participate in global initiatives and networks on quantum technology.**

What are the Related Government Initiatives?

- **Quantum-Enabled Science & Technology (QuEST)**
- **National Mission for Quantum Technologies and Applications (NM-QTA)**
- **Quantum Key Distribution (QKD) solution.**

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