

Faculty Development Programme (FDP) Report on “Emerging Frontiers in AI-Driven Edge & Quantum Computing: Bridging Future Technologies”

Date: 9th – 14th June 2025

Hub Institute: Noida Institute of Engineering & Technology (NIET), Greater Noida

Spoke Institute: Gujarat Technological University (GTU)

In Collaboration with: Electronics & ICT Academy, IIT Roorkee

Venue: Noida Institute of Engineering and Technology

Principal Investigator: Prof. Sanjeev Manhas, IIT Roorkee

Program Manager: Mr. Saurabh Pratap Yadav

Hub Institute Coordinator: Garima Jain, NIET Greater Noida

Spoke Institute Coordinator: Dr. Dipak Dabhi, Gujarat Technological University (GTU)

Day 1: 9th June 2025

Inaugural Function Highlights

The FDP commenced with a grand inauguration, setting the tone for an intellectually stimulating week. Esteemed dignitaries graced the occasion, delivering inspiring addresses:

- **Dr. Vinod Kapse, Director, NIET:** Emphasized NIET’s commitment to fostering innovation and quality education.
- **Prof. G. Raghavan, Chief Guest, Director, School of Quantum Technology, DIAT (D.U.), Pune:** Shared insights from his work with the Department of Atomic Energy, motivating attendees to embrace quantum advancements.
- **Prof. Sanjeev Manhas, Principal Investigator, EICT Academy IIT Roorkee:** Highlighted India’s semiconductor and quantum technology roadmap.
- **Prof. Anil Ahlawat, Director Academics, NIET:** Provided strategic direction for academic excellence.
- **Prof. Rajesh Thakker, Director R&D, GTU:** Addressed India’s potential in global R&D and quantum research.
- **Prof. (Dr.) Arun Kumar Tripathi, Dean, School of Computer Science in Emerging Technologies, NIET:** Outlined NIET’s mission to integrate cutting-edge technologies into education.

Sessions

1. **Session 1 (10:30 AM – 11:30 AM): Fundamentals of Quantum Computing and Nature-Inspired Technologies**
 - **Speaker:** Dr. Vishvendra Singh Poonia, IIT Roorkee

- **Highlights:** Dr. Poonia simplified quantum computing foundations, linking them to nature-inspired technologies and their relevance to next-generation applications.
2. **Session 2 (12:00 PM – 02:00 PM): Challenges and Opportunities in AI: How to Navigate**
- **Speaker:** Prof. Deepak Garg, Vice Chancellor, SR University, Warangal
 - **Highlights:** Prof. Garg discussed AI ethics, real-world applications, and strategies to navigate the evolving AI landscape.
3. **Session 3 (02:00 PM – 05:00 PM): Hands-on with IBM Qiskit Framework**
- **Speaker:** Dr. Jayakumar Vaithiyashankar, Founder and CEO, Anuthantra Pvt. Ltd., Bengaluru
 - **Highlights:** Participants engaged in live demonstrations of the IBM Quantum platform and Qiskit programming interface, gaining practical insights into quantum computing.

9 June 2025

Fundamentals of Quantum Computing and Nature-Inspired Quantum Technologies

Vishvendra S. Poonia
Indian Institute of Technology Roorkee, India

Diagrams illustrating chemical reactions and quantum circuit components:

- Reaction 1: $D + A \xrightarrow{k_1} D^+ + A^-$ (Ground State)
- Reaction 2: $D^+ + A^- \xrightarrow{k_2} D + A$ (Separated State)
- Reaction 3: $D^+ + A^- \xrightarrow{k_3} D^+ + A^-$ (Separated State)

Quantum circuit diagrams showing various gates and components.

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23:16

Participants:

- HS (Hiten Singh)
- GJ (Garima Jain)
- DT (Dr. Puneet Thapar (Guest))
- R (raghavan (Guest))
- DK (Dr. Vinod M Kapre)
- AS (AMRITPAL SINGH (Guest))
- DT (Dr. Anur Tripathi (Guest))
- DA (Director Academics)

Day 2: 10th June 2025

Sessions

1. Session 1 (09:30 AM – 11:30 AM): The Quantum Decade

- **Speaker:** Dr. L Venkata Subramaniam, IBM Quantum India Leader
- **Highlights:** Dr. Subramaniam provided a visionary overview of the “Quantum Decade,” discussing IBM’s quantum roadmap, societal impacts, and India’s leadership potential.

2. Session 2 (12:00 PM – 02:00 PM): Quantum Technology for the Transportation Industry

- **Speaker:** Dr. Kumar Gautam, Founder, QRACE & EGREEN QUANTA
- **Highlights:** Dr. Gautam introduced quantum-inspired algorithms for optimizing transportation networks, focusing on vehicle routing problems and logistics efficiency.

3. Session 3 (02:00 PM – 03:30 PM): Quantum Approximate Optimization Algorithm (QAOA) using Qiskit

- **Speaker:** Dr. Ritajit Majumdar, Research Scientist, IBM Quantum
- **Highlights:** A hands-on session where participants implemented QAOA using Qiskit, exploring cost and mixer Hamiltonians for quantum optimization.

4. Session 4 (03:30 PM – 05:00 PM): Integrating Quantum and HPC for Sustainable Quantum AI

- **Speaker:** Garima Jain, Deputy Head, CSBS Dept., NIET
- **Highlights:** Ms. Jain discussed the synergy between quantum computing and high-performance computing (HPC) for scalable, sustainable Quantum AI frameworks.

Quantum Decade: India's Leap Forward

L Venkata Subramaniam
Head, IBM Quantum India

Quantum Circuit Diagram:

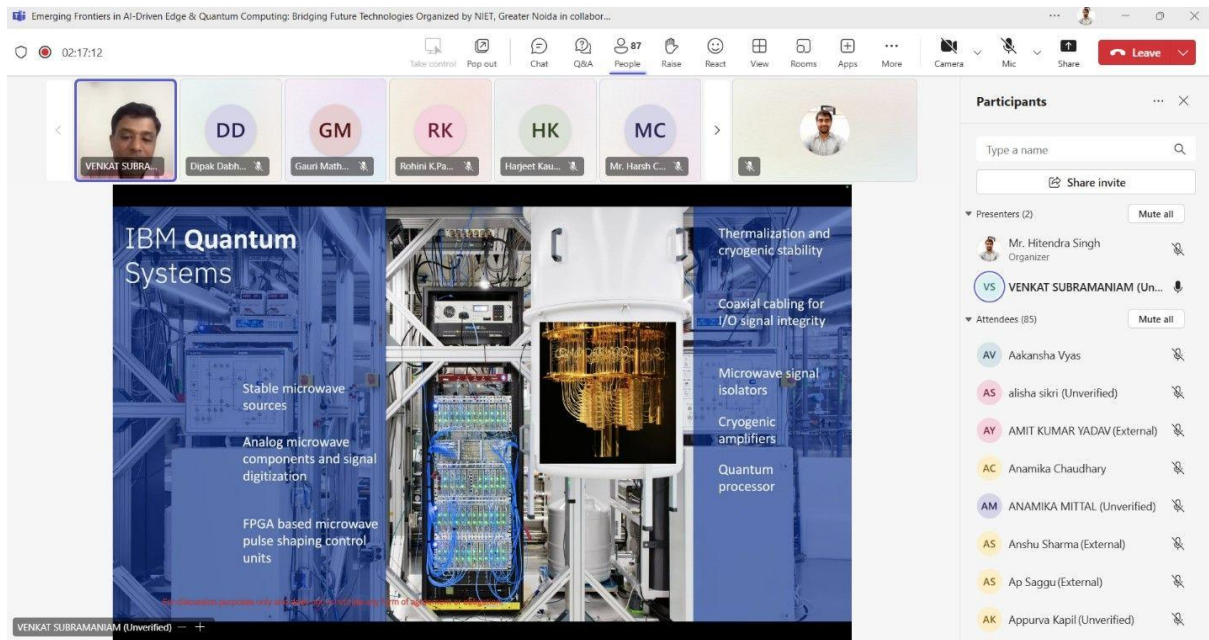
- QPU
- Controller
- QPU

Steps:

1. Prepare initial state
2. Apply classical inputs to quantum circuits and operators
3. Transform and optimize quantum objects
4. Execute via quantum primitives
5. Post-process results

Participants:

- Garima Jain
- Mr. Hitendra Singh
- L Venkata Subramaniam



Day 3: 11th June 2025

Sessions

1. **Session 1 (09:30 AM – 11:30 AM): Quantum Computing – A Revolution in Problem Solving**
 - **Speaker:** Prof. Amlan Chakrabarti, Director, A.K. Choudhury School of Information Technology, University of Calcutta
 - **Highlights:** Prof. Chakrabarti highlighted quantum algorithms' strategic applications, India's quantum ecosystem, and real-world quantum advantage.
2. **Session 2 (12:00 PM – 02:00 PM): Explainable AI – Enhancing Transparency and Trust in AI Systems**
 - **Speaker:** Dr. Rakesh Kumar, Lead Data Scientist, YUM! Brands
 - **Highlights:** Dr. Kumar conducted a hands-on session on explainable AI models (SHAP, LIME), emphasizing transparency in healthcare, retail, and compliance sectors.
3. **Session 3 (02:00 PM – 05:00 PM): Quantum Error Reduction via Circuit Cutting & Knitting**
 - **Speaker:** Saikat Basu, Quantum Computing Research Lead, LTIMindtree
 - **Highlights:** Mr. Basu demonstrated advanced quantum error mitigation techniques, focusing on circuit cutting and knitting for reliable NISQ computations.

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01:15:54

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Presenters (3)

Mute all

Mr. Hitendra Singh Organizer

AC Amlan Chakrabarti (Unverified)

Garima Jain Organizer

Attendees (67)

AV Aakansha Vyas

AS Aarti Sharma (Unverified)

AS Ajay Suri (Unverified)

AS alisha sikri (Unverified)

AJ Ankush Jain (External)

AS Anshu Sharma (External)

AS Ap Saggi (External)

Quantum Computing Group

Quantum Computing: A Revolution in Problem Solving

Prof. (Dr.) Amlan Chakrabarti
Director, A.K. Choudhury School of Information Technology, University of Calcutta
Adjunct Professor IIIT Delhi

Emerging Frontiers in AI-Driven Edge & Quantum Computing: Bridging Future Technologies
Organized by: Noida Institute of Engineering and Technology, Greater Noida
In Association With: Electronics and ICT Academy, IIT Roorkee
11th June 2025

Amlan Chakrabarti (Unverified)

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06:18:04

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Presenters (2)

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Mr. Hitendra Singh Organizer

SB Saikat Basu (Unverified)

Attendees (93)

AV Aakansha Vyas

AS Ajay Suri (Unverified)

AS Anshu Sharma (External)

AS Ap Saggi (External)

AK Appurva Kapil (Unverified)

AR Avani Raval (External)

BP Bhavesh Patel (External)

BN BRAHMANIYA CH... (Unverified)

Quantum Error Reduction Through Circuit
Cutting-knitting
(Part II)

Saikat Basu

Quantum Computing Research Group, University of Calcutta
Quantum CoE, LTIMindtree Research
saikat.basu@timindtree.com

June 11, 2025

Saikat Basu (Unverified)

Day 4: 12th June 2025

Sessions

- Session 1 (09:30 AM – 11:30 AM): Quantum AI – Enhancing Machine Learning with Quantum Algorithms**
 - Speaker:** Dr. Manish K. Gupta, Director Academics, Kaushalya The Skill University
 - Highlights:** Dr. Gupta explored quantum neural networks and variational quantum circuits, discussing their role in accelerating machine learning.

2. Session 2 (12:00 PM – 02:00 PM): Bio-Inspired AI – Evolutionary Algorithms for Smart Environments

- **Speaker:** Dr. Ankush Jain, Assistant Professor, NSUT, New Delhi
- **Highlights:** Dr. Jain showcased genetic algorithms and swarm intelligence, demonstrating their applications in smart cities and resource optimization.

3. Session 3 (02:00 PM – 05:00 PM): Implementation of Quantum Circuits for Cryptanalysis of AES using Grover's Algorithm

- **Speaker:** Mr. Sukhsagar Dubey, Quantum Research Engineer, LTIMindtree
- **Highlights:** Participants designed quantum circuits using Qiskit for AES cryptanalysis, exploring Grover's Algorithm's computational edge in symmetric encryption.

Conference on Emerging Frontiers in AI-Driven Edge and Quantum Computing: Bridging Future Technologies, Noida Institute of Eng. and Technology, New Delhi

Error Correction and AI in Quantum Realms: From Inception to Innovation

June 12th 2025

Manish K. Gupta, PhD (IIT Kanpur)

Image Credit: <http://noida.institute-of-engineering-and-technology.com/quantum-computing-is-with-the-future-practical>

IEEE computer society

mankg@guptalab.org

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<https://www.guptalab.org>

IEEE

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07:19:17

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Mr. Hitendra Singh Organizer

Garima Jain Organizer

SD Sukhsagar Dubey (Unverified)

Attendees (65)

Mute all

AS Ajay Suri (Unverified)

AS alisha sikri (Unverified)

AY AMIT KUMAR YADAV (External)

AM ANAMIKA MITTAL (Unverified) On hold

AS Anshu Sharma (Unverified)

AK Anuj Kumar (External)

AS Ap Saggu (External)

Overview of quantum resources for the design of S-Box

- The detailed analysis of quantum resource requirements for all 624 S-Boxes can be accessed in Appendix B of the report. This extensive assessment is conducted based on the Verilog code that defines the structure of each of the 624 S-Boxes [2].
- A comparison of our results with other research findings is depicted in the following table:

Schemes	# Qubits	#Toffoli	#CNOT	#NOT	Toffoli Depth	Ancilla cleaning
[Langenberg 2018]	40	512	369	4	-	No
[Langenberg 2020]	32	55	314	4	40	No
[Luo et al. 2022]	21	55	131	4	43	No
[Li et al. 2023]	20	44	197	4	32	Yes
My work	20	43	169	4	23	Yes

- We have achieved an efficient quantum circuit for S-Box ($C2$): $|\alpha\rangle|\gamma\rangle \rightarrow |\alpha\rangle|\gamma + s(\alpha)\rangle$ by modifying the S-Box ($C1$), resulting in 188 CNOT gates and 50 Toffoli gates, with a depth of 30.
- Similarly, for the implementation of S-Box ($C3$): $|\alpha\rangle \rightarrow |s(\alpha)\rangle$, using the most efficient structures, we require 231 CNOT gates and 89 Toffoli gates, with a depth of 63.

² Github-banerjeeutsav/aes-sbox-exploration

Sukhsagar Dubey (Unverified) Sukhsagar Dubey Implementation of Quantum Circuits for Cryptanalysis of AES using Grover's Algorithm 26 / 36

Day 5: 13th June 2025

Sessions

- Session 1 (09:30 AM – 11:30 AM): Quantum Algorithms for Utility Applications in Near Term**
 - Speaker:** Dr. Mostafizur Rahaman, Research Scientist, IBM Quantum
 - Highlights:** Dr. Rahaman discussed quantum linear algebraic subroutines for signal processing, focusing on NISQ-era applications and IBM Quantum's ecosystem.
- Session 2 (12:00 PM – 02:00 PM): AI-Augmented Edge Intelligence & Quantum Systems for Future Computing**
 - Speaker:** Ms. Priyambada Jain, Vice President & Senior Data Scientist, BlackRock AI Labs, USA
 - Highlights:** Ms. Jain shared insights on scalable AI systems, retrieval-augmented generation (RAG), and LLM fine-tuning for enterprise applications.
- Session 3 (02:00 PM – 05:00 PM): Quantum Communication, Cryptography, and Business Impact**
 - Speaker:** Ms. Nivedita Dey, Emerging Technology Researcher, PwC US R&D
 - Highlights:** Ms. Dey connected quantum cryptography with business implications, discussing secure communication and post-quantum readiness.

The screenshot shows a Zoom meeting window. The title bar reads "Emerging Frontiers in AI-Driven Edge & Quantum Computing: Bridging Future Technologies Organized by NIET, Greater Noida in collabor...". The meeting ID is 01:08:13. The top toolbar includes icons for Take control, Pop out, Chat, Q&A, People (62), Raise, React, View, Rooms, Apps, More, Camera, Mic, Share, and a red Leave button. Below the toolbar is a gallery of participant avatars with initials: DG (deepak gar...), Mostafizur Rah..., DB (Dr. Archita ...), DS (Dr. Dalwind...), DR (Dr. krishan ...), and DR (Dr. Indr Jee...). The main presentation slide is titled "QISKIT Patterns" and features a diagram of the transpilation process: Map (qubit graph) → Optimize (circuit diagram) → Execute (gears) → Post-processing (gears). A metric box lists: Qubit Count, EPLG (Error per layered gate), and CLOPS (Circuit Layer operations per second). Below this, a graph shows "Circuit Depth \propto Time of execution" with qubits q0-q11 on the y-axis and time on the x-axis. A section on "Error suppression" lists: Dynamic Decoupling (cancels out noise by inserting gates whose net effect is to perform the identity operations) and Pauli Twirling (inserting random gates to simplify the average noise). The bottom of the screen shows the name "Mostafizur Rahaman Laskar (Unverified)". On the right, the "Participants" panel lists 3 presenters (Mr. Hitendra Singh, Garima Jain, Mostafizur Rahaman Laskar) and 59 attendees, including Ajay Suri, Anshu Sharma, Ap Saggi, Avani Raval, Bhavesh Patel, Christopher Josep..., and deepak garg.

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Noida Institute of Engineering and Technology

03:45:37

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Participants

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Presenters (3)

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Mr. Hitendra Singh Organizer

Garima Jain Organizer

PJ Priyambada Jain (Unverified)

Attendees (72)

AS Ajay Suri (Unverified)

AS alisha sikri (Unverified)

AY AMIT KUMAR YADAV (External)

AM ANAMIKA MITTAL (Unverifi... On hold)

AS Anshu Sharma (Unverified)

AK Anuj Kumar (External)

AS Ap Saggi (External)

AI-Augmented Edge Intelligence

Users IoT Devices Gateway AI for Fog Broker Layer Serverless Cloud Datacenters Fog Nodes Edge Nodes AI on Fog Worker Layer Fog Continuum


Day 6: 14th June 2025

Sessions


- Session 1 (09:30 AM – 11:30 AM): Quantum Technology for 6G Wireless Communications**
 - Speaker:** Dr. Neel Kanth Kundu, Assistant Professor, IIT Delhi
 - Highlights:** Dr. Kundu discussed quantum-enhanced signal processing and entanglement-based communication for 6G wireless networks.
- Session 2 (12:00 PM – 02:00 PM): Quantum Safe Cryptography: Securing the Future of Data Privacy**
 - Speaker:** Dr. Harish Sahu, Scientist, DRDO
 - Highlights:** Dr. Sahu outlined post-quantum cryptographic techniques, emphasizing quantum-resilient security for national cybersecurity.
- Session 3 (02:00 PM – 03:30 PM): Hands-On: Simulating the Hydrogen Molecule on IBM Quantum Systems using VQEs**
 - Speaker:** Mr. Siddharth Golecha, Quantum Support Engineer, IBM Quantum
 - Highlights:** A repeat hands-on session reinforcing quantum chemistry simulations using VQE algorithms.




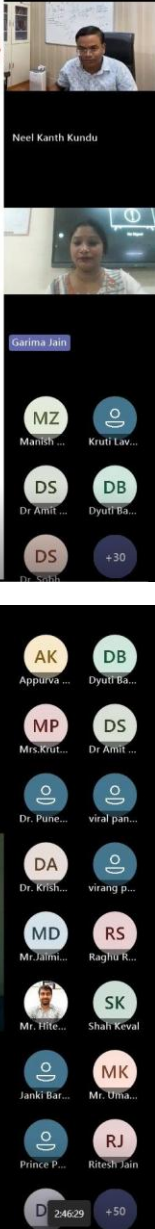
Quantum Technology for 6G Wireless Communications



Dr. Neel Kanth Kundu
Assistant Professor
Centre for Applied Research in Electronics (CARE)
Indian Institute of Technology Delhi
Online FDP at NIET, Greater Noida
14-Jun'25







Valedictory Ceremony Highlights

The FDP concluded with a valedictory ceremony, reflecting on the transformative journey:

- **Chief Address: Prof. Kumud Saxena, Dean, SCSIT, NIET**
 - Highlighted educators' role in preparing quantum-ready talent and the urgency of advancing AI and frontier technologies.
- **Vote of Thanks: Dr. Deepti Gupta, Head, Department of CSBS, NIET**
 - Commended participants' dedication and emphasized interdisciplinary convergence in addressing real-world challenges.

Participants' Overview:

The Faculty Development Program (FDP) witnessed enthusiastic participation from a total of **63 individuals**. The participants comprised **48 faculty members**, **1 industry professional**, **3 research scholars**, and **11 undergraduate students**, contributing to a diverse and engaging learning environment. This diverse group contributed to a rich exchange of knowledge and perspectives, enhancing the collaborative learning experience throughout the FDP.